

# **PROPOSED REVISION TO THE DESIRED FUTURE CONDITION OF THE EDWARDS- TRINITY (PLATEAU) AQUIFER, KINNEY COUNTY PORTION OF GROUNDWATER MANAGEMENT AREA 7**

Prepared for:

**Kinney County Groundwater Conservation District**

April 14, 2026

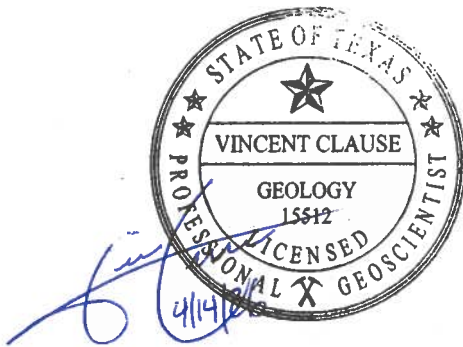
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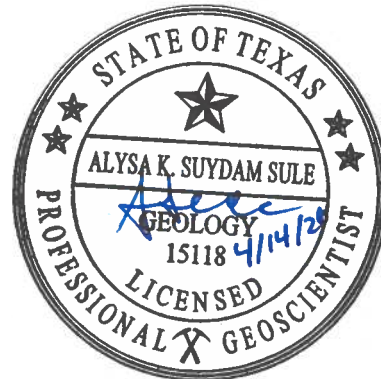
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## EXECUTIVE SUMMARY

Freese and Nichols, Inc. (FNI) prepared this report for the Kinney County Groundwater Conservation District (KCGCD or District) to support continued use of best available science in the Groundwater Management Area 7 (GMA 7) joint planning process. This report summarizes the work completed to date that supported the KCGCD Board's selection of a revised Desired Future Condition (DFC) for the Edwards-Trinity (Plateau) Aquifer on March 3, 2026.

The current DFC for the Edwards-Trinity (Plateau) Aquifer in the GMA 7 portion of Kinney County was originally adopted in 2010 and was based on results from the Texas Water Development Board's (TWDB) Kinney County groundwater model. The model assumed a constant annual withdrawal of 77,000 acre-feet per year and reported simulated end-of-year Las Moras Springs discharge statistics of 24.4 cubic feet per second (cfs) (median) and average of 23.9 cfs (mean).

Since adoption of the original DFC, management challenges have emerged due to the evolving interpretations of the DFC, the difficulty of evaluating a model-based year-end spring discharge target, and an apparent disconnect between modeled outcomes and observed conditions. During the ongoing drought, Las Moras Springs has repeatedly gone dry during spring and summer months even though reported groundwater pumping has remained well below the Modeled Available Groundwater (MAG) associated with the current DFC. These conditions contributed to community concern and highlighted the need for a clearer, more observable DFC framework. As a result, the KCGCD Board engaged FNI to assist with MAG considerations and, after multiple Board meetings and public discussions, ultimately worked towards development of a revised DFC for the Kinney County portion of GMA 7.

Through this process, the KCGCD Board evaluated multiple DFC frameworks while maintaining Las Moras Springs discharge as the primary planning objective. Using historical spring discharge, drought indicators, precipitation metrics, and pumping information, the Board considered multiple lines of evidence in the context of the nine statutory factors required under Texas Water Code §36.108(d). At the March 3, 2026 Special Board Meeting, the Board voted in favor of the following revised DFC for the Edwards-Trinity (Plateau) Aquifer in the GMA 7 portion of Kinney County:

**“Daily mean spring discharge measured as Las Moras Springs shall not be less than 15 cubic feet per second (cfs) when averaged over 5 years.”**

Historical evaluation indicates this one-tier DFC statement would have been met approximately 88% of the time over the historic period, reflecting balance between selecting a target that is protective of spring discharge while remaining feasible for planning and management purposes. By grounding the DFC in observed data and using a multi-year averaging window, the revised framework is expected to support development of a MAG that is more closely aligned with reported and estimated pumping conditions in Kinney County.

In advance of an updated groundwater flow model, FNI recommends that TWDB consider an interim, data-driven MAG estimate informed by pumping during years that would have met the revised DFC. Based on available data, the 75th percentile of pumping during DFC-attainment years is 9,610 acre-feet per year, which provides a reasonable planning-level value that balances water supply needs with spring discharge objectives.

## **1.0 HISTORY OF THE DESIRED FUTURE CONDITIONS STATEMENT FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GMA 7 IN KINNEY COUNTY**

The current and original Desired Future Condition (DFC) for the Edwards-Trinity (Plateau) Aquifer in the Kinney County portion of Groundwater Management Area 7 (GMA 7) was originally adopted in 2010 (GMA 7, 2010 and Shi, 2012). This section summarizes the original DFC basis and documents how the DFC language and its interpretation have evolved over subsequent planning cycles.

### **1.1 DFC FORMULATION FOR KINNEY COUNTY**

For the GMA 7 portion of Kinney County, the current DFC for the Edwards-Trinity (Plateau) Aquifer is expressed in terms of Las Moras Springs discharge (or spring flow) as simulated under Scenario 3 of the Texas Water Development Board's (TWDB) Draft Groundwater Availability Model (GAM) Task 10-027, (revised; Hutchison, 2011), which is based on the Groundwater Flow Model of the Kinney County Area (Hutchison and others, 2011). Under this framework, the aquifer system was simulated over 56 annual stress periods with a constant annual withdrawal of 77,000 acre-feet per year from the Edwards-Trinity (Plateau) Aquifer.

Based on the predictive simulation results, TWDB reported mean (average) and median end-of-year simulated discharge at Las Moras Springs. These statistics were subsequently adopted as the DFC targets for Kinney County:

- **Average simulated end-of-year-spring discharge: 23.9 cubic feet per second (cfs)**
- **Median simulated end-of-year-spring discharge: 24.4 cfs**

### **1.2 GMA 7 RESOLUTION LANGUAGE AND SUBSEQUENT INTERPRETATION**

The originating joint-planning action for Kinney County's GMA 7 DFC is documented in GMA 7 Resolution 07-29-10-9 (GMA 7, 2010), which explicitly links the DFC to Scenario 3 of Draft GAM Task 10-027 (revised). For Kinney County, the resolution states:

*"In Kinney County, that drawdown which is consistent with maintaining, at Los Moras Springs [sic], an annual average flow of 23.9 cfs and a median flow of 24.4 cfs based on Scenario 3 of the Texas Water Development Board's flow model presented on July 27, 2010..."*

During the 2016 planning cycle, GMA 7 reaffirmed the same spring discharge-based DFC for Kinney County, while extending the planning horizon to 2070. The April 21, 2016 Proposed DFCs document (Groundwater Management Area 7, 2016; reproduced in Hutchison, 2018) includes the following Kinney County DFC declaration:

*“Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of annual average flow of 23.9 cfs and an annual median flow of 24.4 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph.D. and Marious Jigmond, TWDB, dated August 26, 2011).”*

When the DFCs were formally adopted and later documented in the GMA 7 Explanatory Report (Hutchison, 2018; restated in Hutchison, 2021), the Kinney County DFC appears as:

*“Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph. D and Marious Jigmond, TWDB, dated August 26, 2011).”*

Between the 2010 resolution and subsequent GMA 7 actions, the average spring discharge target remained at 23.9 cfs. However, the median value changed from 24.4 cfs in the original 2010 resolution and 2016 proposed DFC document to 23.9 in the final DFC language adopted in 2018 and remained at 23.9 in the 2021 Explanatory Report (Hutchison, 2021).

The wording of the DFC also evolved in a meaningful way that affects interpretation. The 2010 resolution explicitly references Scenario 3 of GAM Task 10-027. In contrast, the 2016 and 2021 DFC language references the TWDB GAM for Kinney County but does not name Scenario 3 in the DFC statement itself (even though the Explanatory Report explicitly notes that the DFC is based on Scenario 3). The Explanatory Report further notes that GMA 7 and KCGCD “voted to keep the same DFC based on the 2010 analysis despite issues that have been identified with the model,” acknowledging both the model’s limitations and reliance on the original Scenario 3 analysis.

### 1.3 ISSUES WITH THE CURRENT DFC STATEMENT

The following issues have been identified in the current DFC statement and its implementation:

1. **Reduced clarity in the linkage between the DFC and the underlying modeling scenario.**

Although streamlined DFC wording in summary tables and subsequent planning documents improved readability, it also appears to have obscured the direct linkage between (1) the specific predictive scenario and its associated assumptions and limitations within the TWDB model framework and (2) the end-of-year spring discharge statistics used to define the Kinney County DFC. This loss of explicit linkage has likely contributed to confusion regarding the DFC's intended management objective and the appropriate methods for monitoring and evaluating compliance.

2. **The DFC is tied explicitly to annual end-of-year model conditions.**

The Kinney County model uses annual stress periods and reports spring discharge as end-of-year values; therefore, the DFC is best evaluated against end-of-year spring discharge conditions. Direct comparison of daily, seasonal, or other non-end-of-year measurements to the modeled end-of-year DFC statistics is not consistent with the original formulation of the DFC. Evaluation is further complicated by reliance on externally maintained datasets for spring discharge and precipitation metrics, which may remain provisional for extended periods of time. This can introduce uncertainty and administrative challenges by establishing a DFC compliance period that may lag behind current conditions.

3. **Disconnect between Modeled Available Groundwater and pumping in Kinney County.**

Within GMA 7, the current Modeled Available Groundwater (MAG) for the Edwards-Trinity (Plateau) Aquifer is 70,341 acre-feet per year, which is substantially misaligned with observed year-to-year groundwater use in Kinney County. This disconnect complicates practical use of the DFC and makes it more difficult to relate joint-planning outputs to local management of groundwater resources.

## 2.0 SUMMARY OF ACTIONS FROM AUGUST 2025 TO PRESENT

The current GMA 7 DFC for the Edwards-Trinity (Plateau) Aquifer in Kinney County reads *“Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras*

*Springs*” (TWDB, 2021a). The MAG associated with this DFC, as calculated using the Kinney County GAM is 70,341 acre-feet per year (TWDB, 2021b).

During the ongoing drought, Las Moras Springs has repeatedly gone dry during the spring and summer months, despite groundwater pumping remaining well below the MAG. In response to this disconnect between modeled pumping and observed conditions, the KCGCD Board directed FNI to evaluate alternative approaches for estimating pumping under the existing DFC for the 2026 joint planning cycle in advance of completing a new county-scale groundwater availability model.

During the December 16, 2025 Board Meeting, FNI presented two practical approaches grounded in best available data, science, and policy. The first approach proposed whether the Edwards-Trinity (Plateau) Aquifer in the GMA 7 portion of Kinney County could be considered non-relevant for joint planning purposes. The second approach proposed a statistics-driven method to revise MAG in alignment with the existing DFC to approximately 6,200 acre-feet per year (Clause, 2025; Appendix A). This statistics-driven approach considered observed relationships among measured groundwater pumping from 2003 to 2024 (period of measured record), precipitation reported for Quad 807 (TWDB, 2025), and historical attainment of the existing spring discharge-based DFC. As part of this evaluation, other climate indicators (including Oceanic Niño Index) were reviewed for potential correlation with Las Moras Springs discharge. Following this discussion, the Board elected to pursue neither approach and instead requested that FNI return to a Special Board Meeting with additional options and further guidance.

At the January 5, 2026 Special Board Meeting, the KCGCD Board directed FNI to shift focus from revising MAG under the current DFC and instead explore alternative DFC frameworks for the Edwards-Trinity (Plateau) Aquifer in the GMA 7 portion of Kinney County.

FNI returned to the regular January 27, 2026 Board Meeting with additional data analysis and four candidate DFC statement frameworks (Clause, 2026; Appendix B). These frameworks were intentionally drafted with placeholder metrics and phrasing to allow the Board to first consider the overall structure of the potential DFC statements before selecting a specific threshold or time period. To support evaluation of the DFC frameworks, FNI provided summary tables and figures describing historical discharge patterns at Las Moras Springs across multiple time periods and under varying drought conditions. Following discussion, the Board directed FNI to develop additional information to support evaluation of two preferred frameworks:

1. a one-tier DFC framework based on daily mean discharge at Las Moras Springs averaged over a specified time period, and
2. a two-tier DFC framework based on daily mean discharge at Las Moras Springs averaged over a specified time period, with an alternative metric and timeframe applied during drought conditions.

A primary objective of revising the DFC was to improve interpretability and to better align DFC evaluation, and the eventual calculation of MAG, with observed data. To support that objective, and in advance of the regular February 24, 2026 Board meeting, FNI developed an Excel-based calculator to demonstrate how hypothetical DFC statements would have performed using historical data (Clause and Sule, 2026; Appendix C). The tool was presented and discussed at the February 24 meeting, but ultimately the Board decided to call a Special Board Meeting on March 3, 2026 to ensure more Board Directors could be present before taking action. Additionally, FNI was informally directed to evaluate groundwater pumping that could correspond to a potentially revised DFC, in order to inform future MAG considerations.

At the March 3, 2026 Special Board Meeting, FNI again demonstrated how alternative DFC statements would have performed using historical data. At the conclusion of this discussion, the KCGCD Board voted in favor of a new DFC for the Edwards-Trinity (Plateau) Aquifer in GMA 7 that reads:

***“Daily mean spring discharge measured at Las Moras Springs shall not be less than 15 cubic feet per second (cfs) when averaged over 5-years.”***

### **3.0 DESIRED FUTURE CONDITIONS – NINE FACTORS**

Per Texas Water Code Sec. 36.108(d), “before voting on the desired future conditions of the aquifers under Subsection (d-2), the districts shall consider” nine factors:

1. “aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another”
2. “the water supply needs and water management strategies included in the state water plan”
3. “hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge”
4. “other environmental impacts, including impacts on springflow and other interactions between groundwater and surface water”
5. “the impact on subsidence”

6. “socioeconomic impacts reasonably expected to occur”
7. “the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002”
8. “feasibility of achieving the desired future condition”
9. “any other information relevant to the specific desired future conditions”

At the March 3, 2026 Special Board Meeting, the KCGCD Board considered multiple alternative DFC statements in the general context of these nine factors, prior to voting on a revised DFC for the Edwards-Trinity (Plateau) Aquifer in the GMA 7 portion of Kinney County. Listed below is a factor-by-factor discussion of how the new DFC relates to the nine statutory considerations.

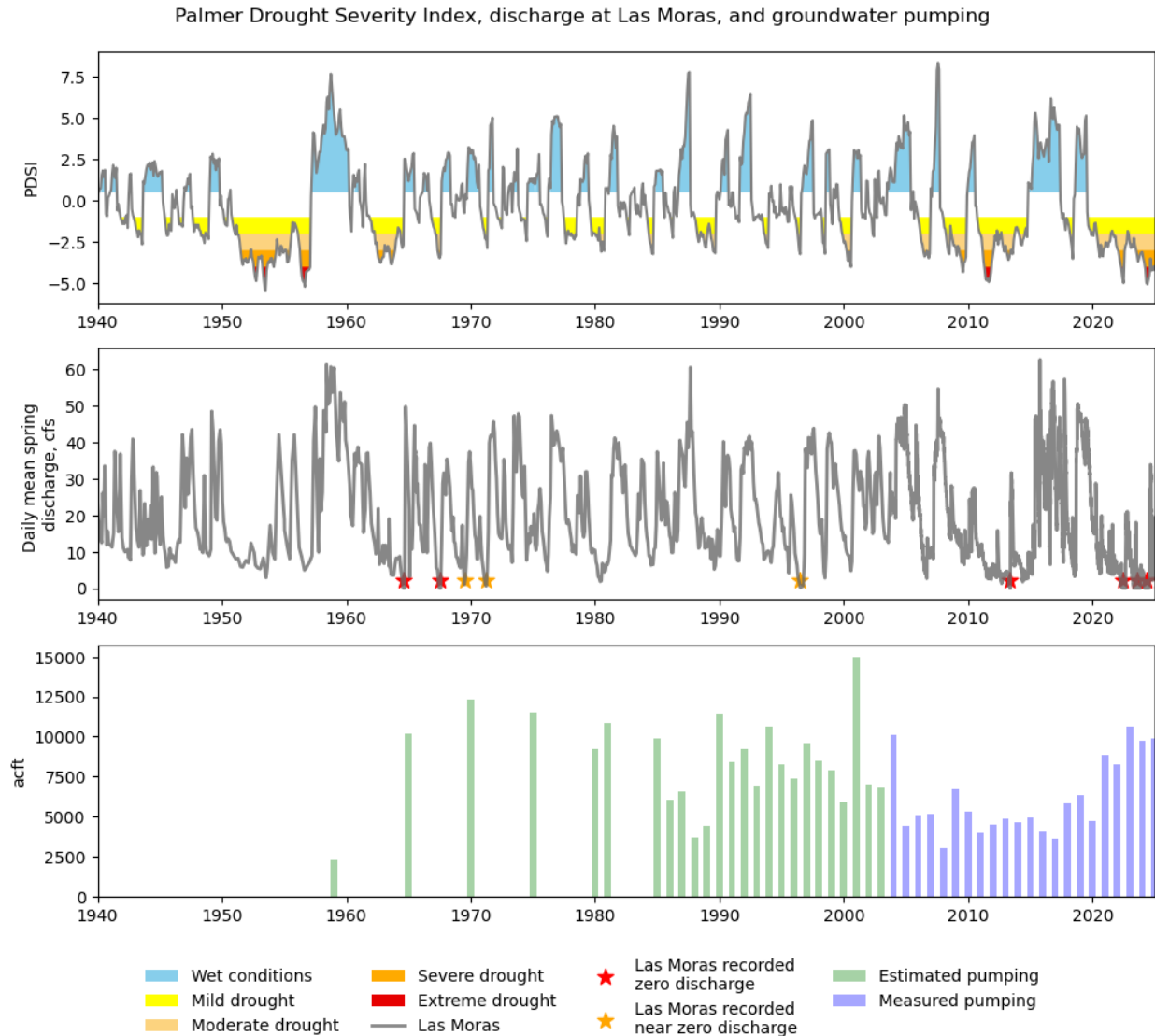
### **3.1 FACTOR 1: AQUIFER USES OR CONDITIONS WITHIN THE MANAGEMENT AREA**

A discharge-based DFC tied to Las Moras Springs uses a single, well-known hydrologic expression of aquifer conditions in the Las Moras Springs area. Although spring discharge does not represent conditions everywhere in Kinney County, the Board discussed DFC structures that would be understandable, observable, align with community values, and be trackable for the portions of the aquifer system most closely connected to the spring system. This framework also closely aligns with the “best available science” objective by grounding the DFC in historic data that directly reflects aquifer response to historic pumping and recharge conditions within the management area.

Factor 1 requires consideration of how aquifer uses and conditions vary across the management area. In Kinney County, aquifer conditions and groundwater uses are not spatially uniform due to hydrogeologic characteristics (e.g., permeability, structural controls) and discrete groundwater development areas and users. General community consensus is that a flowing Las Moras Springs is a useful indicator of aquifer health. The KCGCD is working towards an updated conceptual model of the District’s aquifers that would allow the District to use indicator wells in various parts of the District to inform spring discharge-based management, but this work will be completed after the 2026 joint planning cycle concludes.

As part of the discussion, Figure 1 was used to communicate historical groundwater pumping practices in Kinney County with climatic variability and Las Moras Springs discharge through time. This direct side-by-side comparison frames the relationship between annual groundwater pumping volumes, drought conditions, and spring discharge in Kinney County. In Kinney County, discharge at Las Moras Springs appears to be most strongly correlated with drought indicators (Clause, 2026; Appendix B).

In summary, the DFC framework supports Factor 1 by relying on a meaningful local indicator of aquifer health in Kinney County, leveraging historical data that reflects the combined effects of aquifer use, annual pumping, and climatic variability within the management area that provides a transparent basis for communicating variable hydraulic conditions. Furthermore, because Kinney County is located at the southern extent of the Edwards-Trinity (Plateau) Aquifer, local groundwater usage and aquifer conditions are expected to have limited influence on aquifer conditions elsewhere within the management area.



**Figure 1.** Palmer Drought Severity Index for Kinney County, daily mean spring discharge at Las Moras Springs, and groundwater pumping volumes from 1940 to 2025. cfs = cubic feet per second. acft = acre-feet

### **3.2 FACTOR 2: WATER SUPPLY NEEDS AND WATER MANAGEMENT STRATEGIES IN THE STATE WATER PLAN**

In Kinney County, the Board’s discussions were informed by the mismatch between the current DFC and MAG framework with observed conditions, including periods where Las Moras Springs experienced very low flow or went dry while reported pumping remained well below the MAG. This disconnect indicates that the current DFC and MAG relationship does not provide a reliable basis for local or regional planning discussions.

By grounding the revised DFC in observed spring discharge behavior and using a multi-year averaging approach, the District establishes a clearer, more defensible linkage between management goals and the groundwater quantities that may later be considered for planning purposes.

### **3.3 FACTOR 3: HYDROLOGICAL CONDITIONS**

The Board evaluated historical discharge data from the Las Moras Springs in the context of precipitation metrics, pumping records, and drought indicators such as the Palmer Drought Severity Index to understand how spring discharge changes over time. Spring discharge was also correlated with static water level observations in monitoring wells. This analysis provided direct insight into the hydrogeological conditions under a wide range of wet and dry climatic conditions and roots the DFC threshold to the historic record. To minimize the influence of short-term climate variability, a five-year averaging window was used, which emphasizes average discharge trends more representative of multi-year climate conditions. Although TERS is a statutory consideration, the revised DFC is not expressed directly in terms of drawdown or total storage but instead uses spring discharge as an integrative indicator of aquifer health. For this reason, this conversation is best framed around discharge behaviors and by implication, the balance of recharge and pumping.

#### **3.3.1 Las Moras Springs Discharge**

Spring discharge data for Las Moras Springs were obtained from multiple sources and compiled into a single dataset (Bennett and Sayre, 1962; LBG-Guyton Associates, 2009; USGS, 2025a and 2025b). Bennett and Sayre (1962) report daily spring discharge sporadically at Las Moras from December 23, 1895, to September 25, 1956. For this analysis, those daily measurements are interpreted as mean daily discharge. LBG-Guyton Associates (2009) reported spring discharge as mean cfs-days per month for the period February 1965 through March 2004. FNI converted these monthly values to estimated daily discharge by

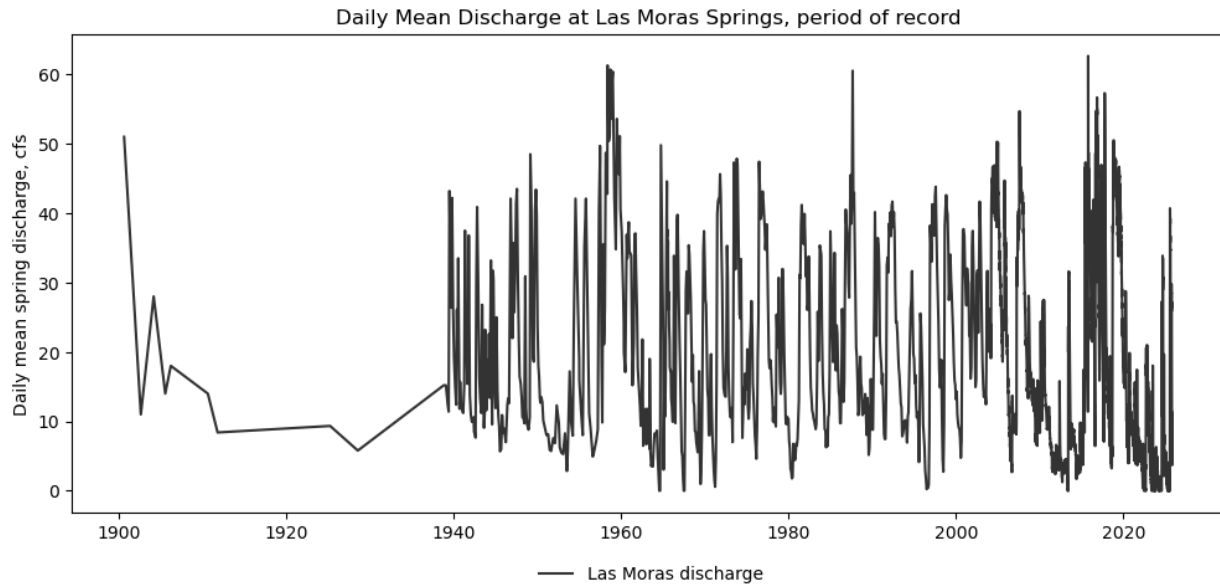
dividing the reported cfs days per month by the number of days in the month and reported the value only at the end of the month.

The USGS has operated two spring gages at Las Moras (2025a and 2025b). The “old” gage (active 2003 to 2014) reports mean daily discharge, and the “new” gage (2014 to present) reports 15-minute mean discharge. FNI resampled the “new” gage data to obtain a mean daily discharge value.

Prior to 2003, daily mean discharge values were reported with varying temporal resolution. From 1895 to 1965, the record was sporadic in time. From 1965 to 2003, mean discharge was reported at month end. From 2003 to present, a continuous daily record is available, except from August 27, 2014 to October 1, 2014 when the USGS gage was relocated. For purposes of this analysis and to maintain consistency across data processing environments, the period of record was evaluated as 1900 to present. This composite spring discharge record is presented in Figure 2.

Summary statistics for daily mean discharge at Las Moras Spring over the period of record, the 2009 to 2015 drought period (referred to as 2011 drought), and the recent drought (2020 to 2025) are presented in Table 1.

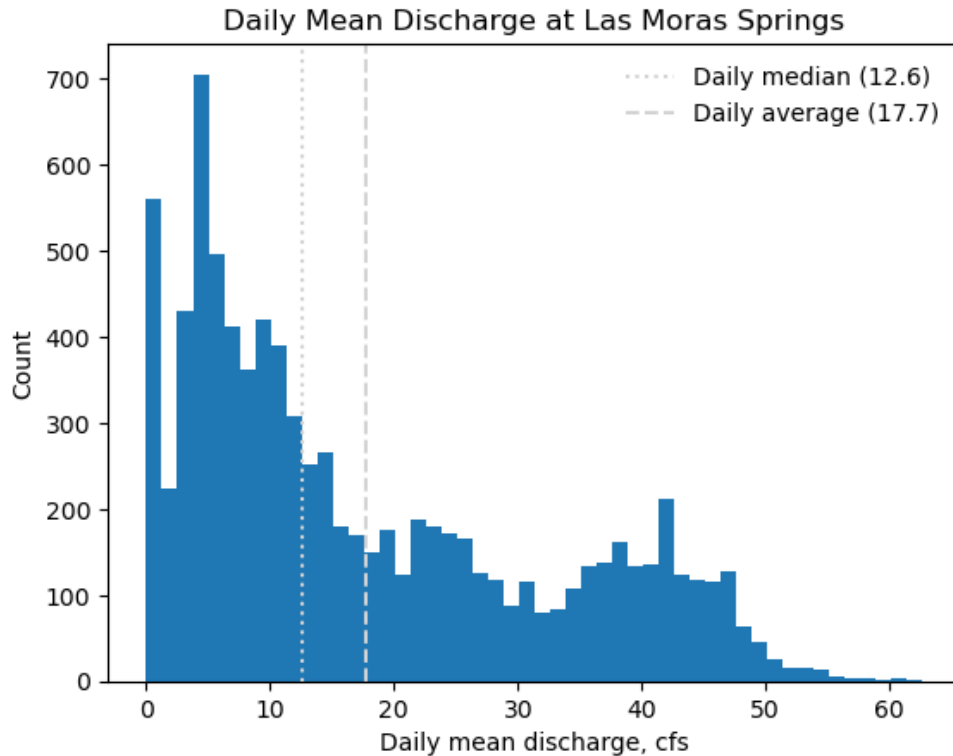
The distribution of daily mean discharge for the full period of record is bimodal (Figure 3). One peak occurs between approximately 0 and 10 cfs and a second with a shallower peak between 30 and 50 cfs. This right skew in the distribution suggests relatively frequent low to moderate flows and intermittent high flows. As a result of this right-skew in distribution, the mean spring discharge exceeds the median spring discharge, an observation that is not consistent with the Scenario 3 GAM results.



**Figure 2.** Daily mean discharge at Las Moras Springs, 1900 to 2025.

**Table 1.** Las Moras Springs daily mean discharge (cfs) during periods of interest. 25% = 25th percentile, 75% = 75th percentile

Statistic	Scenario 3 (1950 to 2005)	Drought of Record (1950 to 1957)	2011 Drought (2009 to 2015)	Recent Drought (2020 to 2025)
Count	1,418	49	2,433	2,127
Standard Deviation	12.6	12.3	10.1	7.3
Minimum	0.0	2.8	0.0	0.0
25%	20.0	7.6	4.5	1.4
Median	26.6	10.1	8.2	5.1
Mean	28.4	15.6	11.3	7.0
75%	40.0	18.4	13.3	9.9
Maximum	61.3	49.7	62.7	40.7



**Figure 3.** Distribution of daily mean discharge measurements at Las Moras Springs.

### 3.3.2 Precipitation

The primary precipitation dataset used in this analysis is the TWDB Quad 807 record, which reports monthly precipitation totals (in inches) for a 1-degree by 1-degree grid cell covering the period from 1940 to present (TWDB, 2025). Summary statistics for Quad 807 are presented in Table 2 for three intervals: the full period of record, the 2011 drought period (approximated as 2009-2015), and recent drought period (2020-2025).

Although mean monthly precipitation during the 2011 drought and the recent drought are similar (1.51 to 1.67 inches), the median precipitation during 2020-2025 (1.05 inches) is notably lower than both the long-term median (1.65 inches) and 2011 drought median (1.33 inches). In addition, the highest monthly total observed during 2020-2025 (7.58 inches) is substantially lower than the maximum monthly total observed over the full period of record.

**Table 2.** Summary statistics for monthly precipitation (Quad 807, inches)

Statistic	Period of Record (1940 to June 2025)	2011 Drought (2009 to 2015)	Recent Drought (2020 to 2025)
Count	858	84	66
Standard Deviation	1.8	1.63	1.45
Minimum	0.00	0.01	0.01
Median	1.65	1.33	1.05
Mean	2.07	1.67	1.51
Maximum	16.23	8.52	7.58

The distribution of monthly precipitation totals in Figure 4 is right-skewed, with a long tail toward higher rainfall events that highlights the influence of relatively less frequent but large storm events on the long-term average.

Figure 5 summarizes this data for both the 2011 and recent drought periods, showing the number of consecutive months with precipitation below the long-term median alongside quarterly precipitation totals. The 2011 drought is characterized by three extended periods of below-median precipitation, interrupted by periods of relatively higher rainfall. In contrast, the recent drought reflects lower overall cumulative precipitation and six shorter, more moderate runs of below-median precipitation.

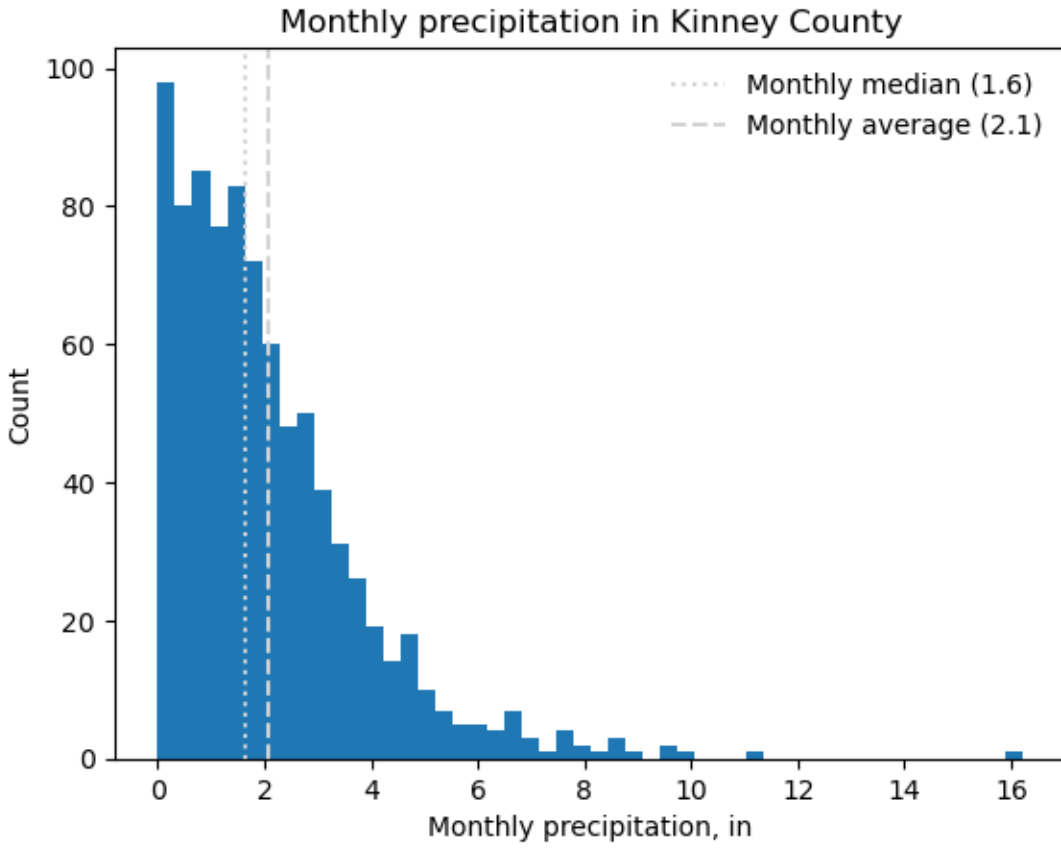
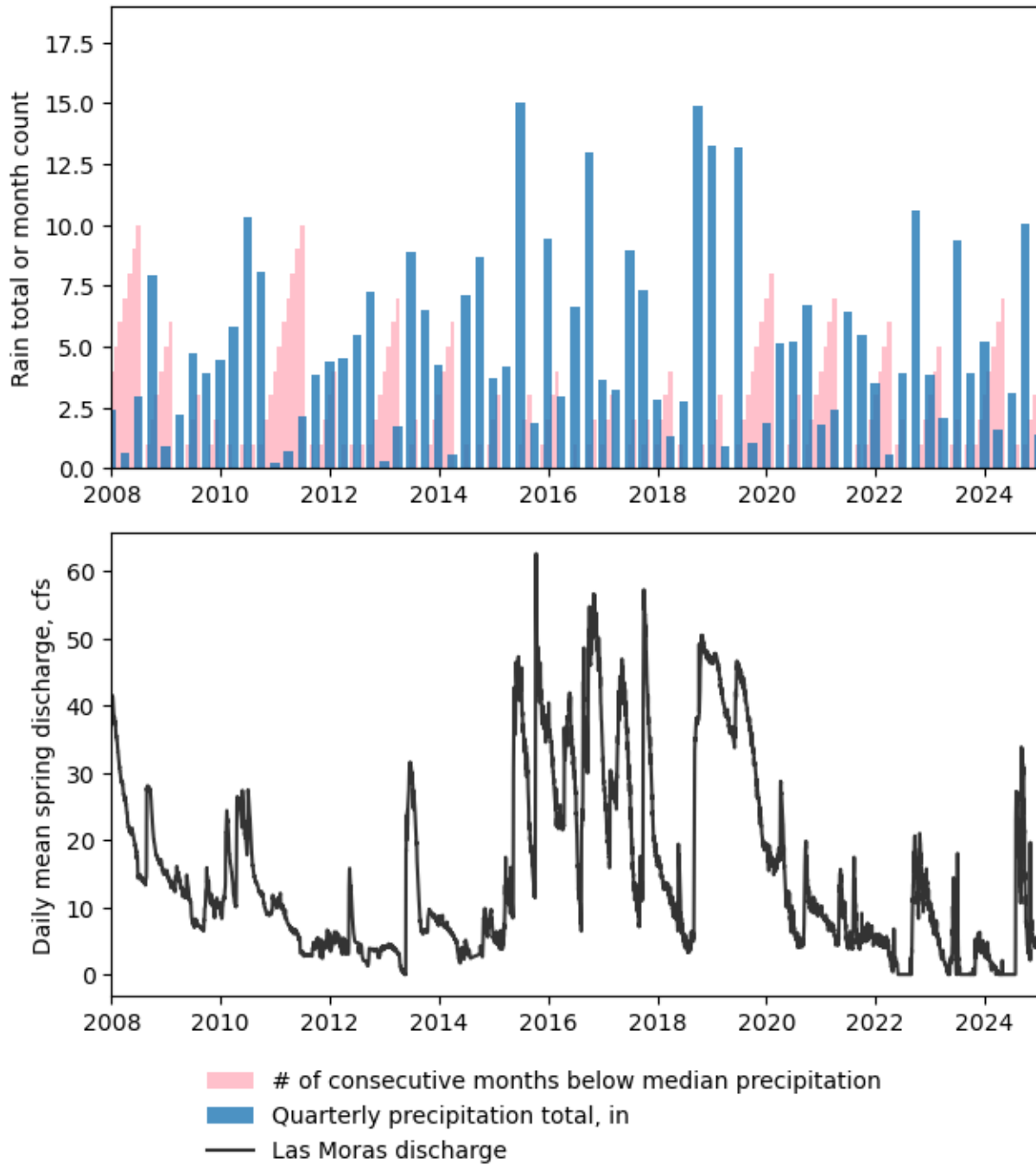


Figure 4. Distribution of monthly precipitation totals from Quad 807.



**Figure 5.** Las Moras Springs daily mean discharge, quarterly precipitation totals from Quad 807, and the number of consecutive months with below median precipitation.

### 3.3.3 Groundwater Pumping

Groundwater pumping volumes were provided to FNI by EcoKai as annual totals for non-exempt wells over the period from 2003 to 2024, along with a preliminary total for 2025. In addition to the measured groundwater pumping, Green (2012) compiled estimated groundwater pumping volumes from 1958 to 2002 (Figure 6). This combined measured and estimated dataset was used to develop summary statistics of annual groundwater pumping volumes (Table 3). The distribution of total annual pumping is bimodal, indicating low and high pumping periods over time (Figure 7).

The median total annual pumping for the full period of record is 6,945 acre-feet per year, which falls between the median observed during the 2011 drought period (4,639 acre-feet per year) and the recent drought period (9,788 acre-feet per year). The recent drought has been more severe than the 2011 drought, and groundwater pumping volumes have increased accordingly during the recent drought relative to the 2011 drought period.

To provide additional clarity, each well was assigned to a source aquifer. The resulting distribution of annual pumping by aquifer is presented in Figure 8, which illustrates how production has changed over time within GMA 7, including shifts among the Edwards-Trinity (Plateau), Austin Chalk and other aquifers.

**Table 3.** Summary statistics for measured and estimated annual groundwater pumping volumes (acre-feet).

Statistic	Estimated and Measured Annual Pumping	GMA 7 Pumping	GMA 10 Pumping	2011 Drought (County Total)	Recent Drought (County Total)
Count	48	22	22	7	6
Standard Deviation	2,882	2,262	393	498	1,263
Minimum	2,301	2,999	12	3,981	8,265
25%	4,951	4,185	71	4,252	9,082
Median	6,945	4,773	245	4,639	9,788
Mean	7,423	5,748	372	4,616	9,859
75%	9,750	7,585	513	4,928	10,422
Maximum	14,973	10,089	1,376	5,330	11,829

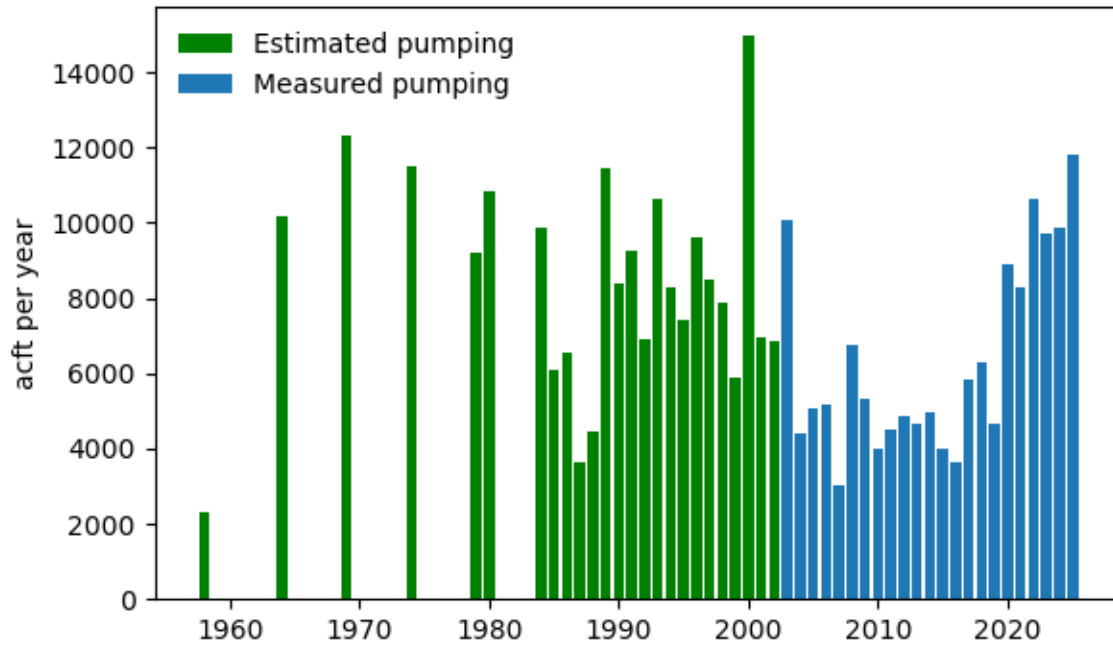


Figure 6. Measured and estimated annual groundwater pumping volumes in Kinney County.

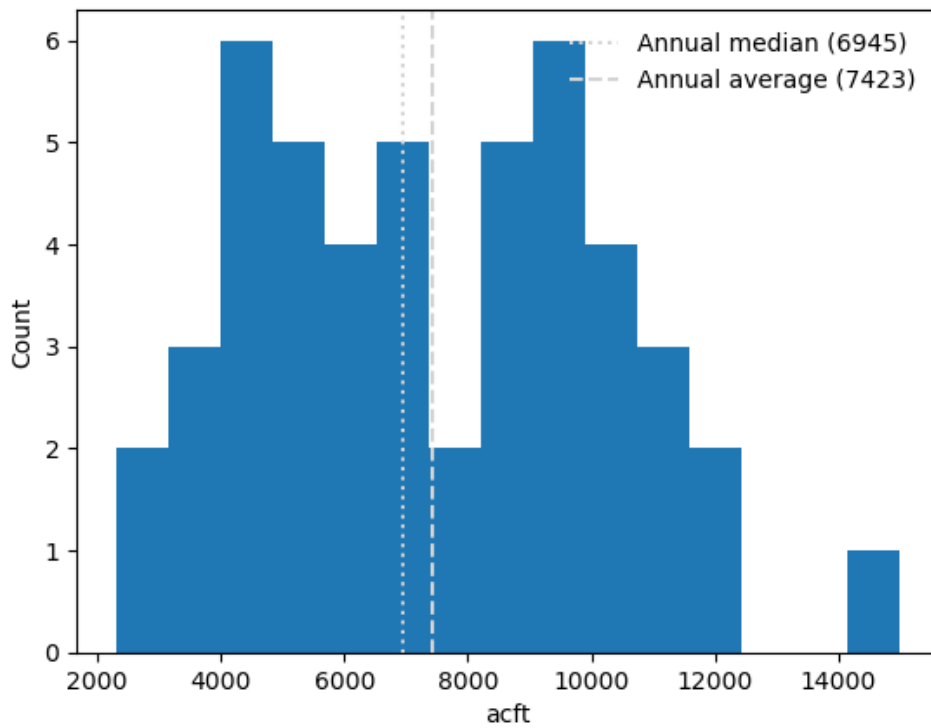
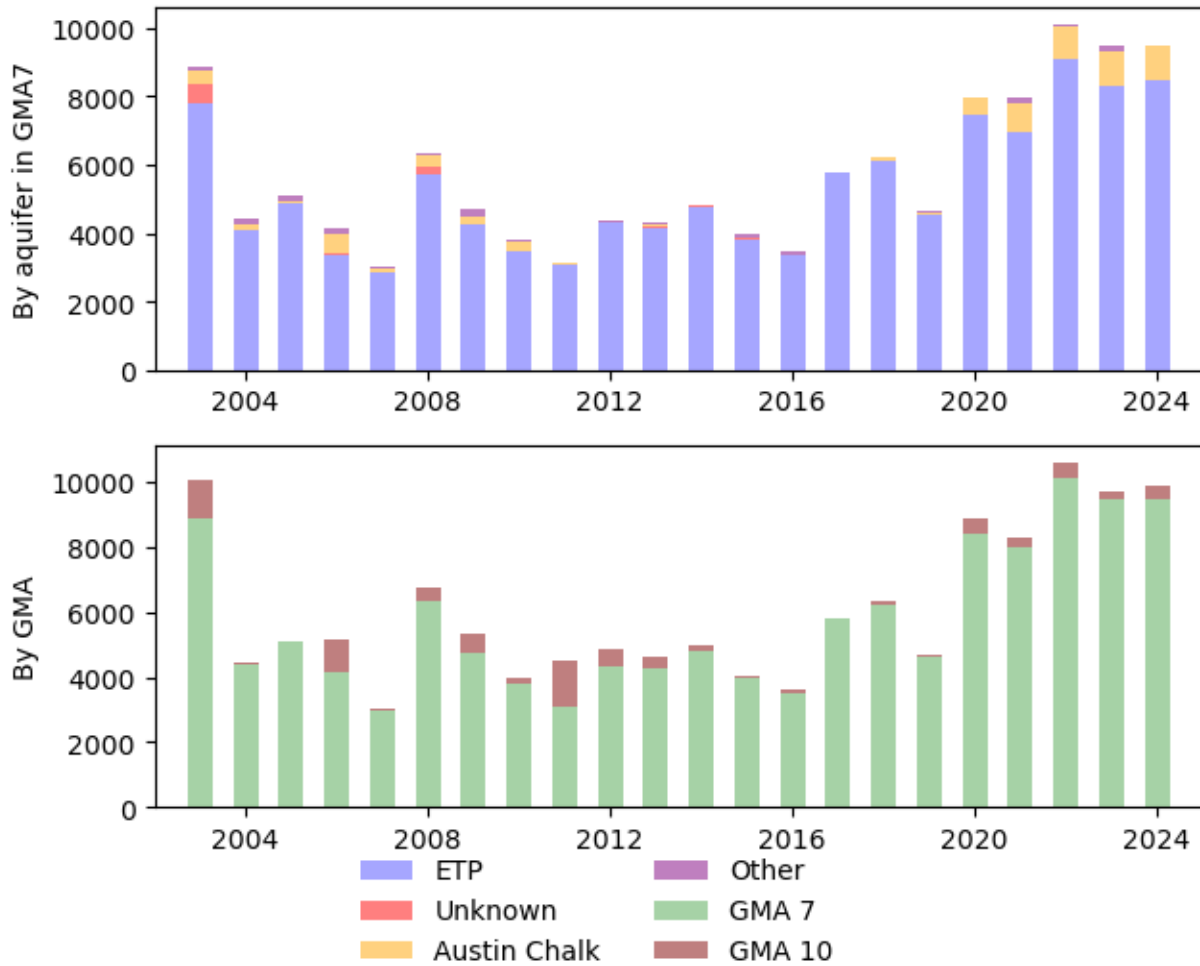


Figure 7. Distribution of measured and estimated annual groundwater pumping volumes (acre-feet).



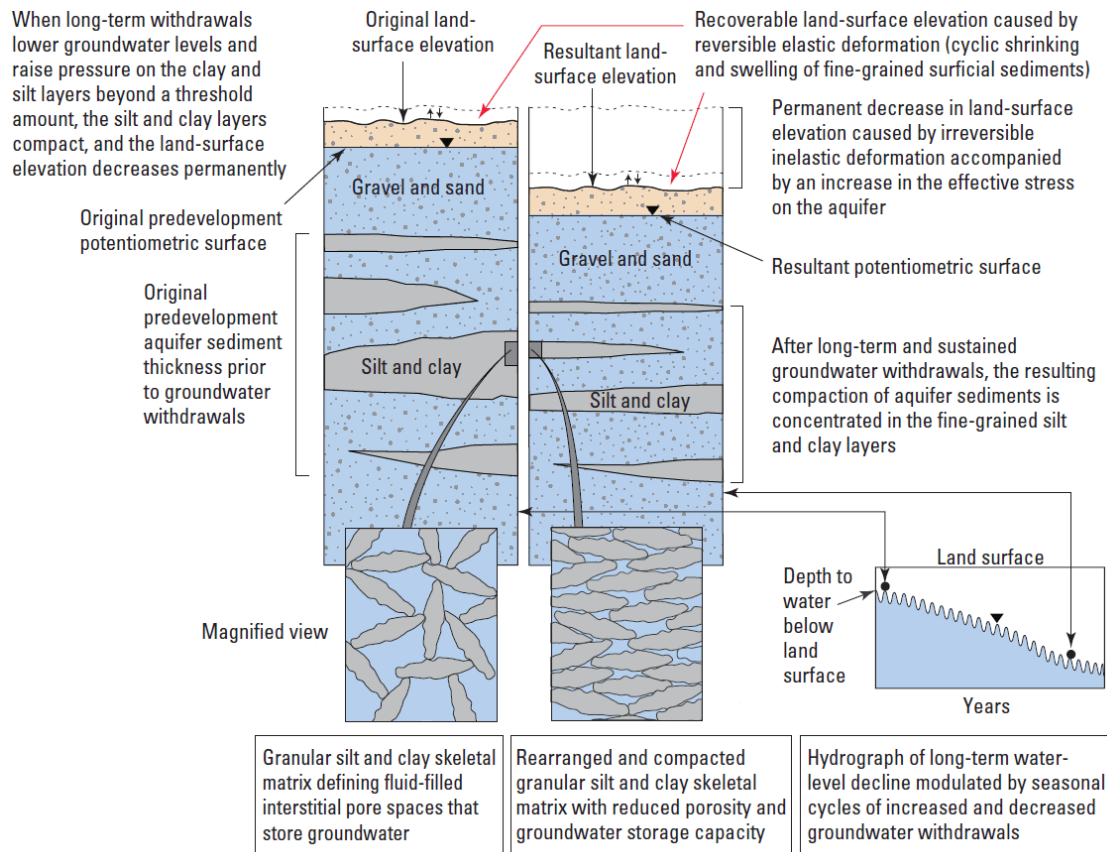
**Figure 8.** Groundwater pumping volumes in Kinney County by GMA and by aquifer in GMA7. ETP = Edwards-Trinity (Plateau)

### 3.4 FACTOR 4: OTHER ENVIRONMENTAL IMPACTS

Factor 4 is directly considered because the revised DFC is directly linked to groundwater-surface water interactions. The Board’s focus on spring discharge as the DFC metric reflects an intent to preserve a visible and meaningful environmental indicator of aquifer health. This DFC is designed to be more transparent for tracking spring conditions in a way that supports discussion of environmental impacts including those to the Las Moras creek watershed. The Board’s decision to adopt a multi-year averaging approach also recognizes that this spring system exhibits seasonable variability and aims to avoid overreacting to short term seasonal lows while still promoting sustained discharge through 2080.

### 3.5 FACTOR 5: IMPACT ON SUBSIDENCE

Subsidence is mainly a concern in thick sequences of sands and shales, as seen in the Gulf Coast Aquifer system. When sands are dewatered in a sand/shale aquifer, shales and clays depressurize and compact, which leads to subsidence (Figure 9). In Kinney County and across the Edwards-Trinity (Plateau) Aquifer, subsidence is not known to be an associated geohazard with groundwater withdrawal.



**Figure 9.** Schematic diagram of subsidence in the Gulf Coast Aquifer system from Kasmarek and others (2016).

### 3.6 FACTOR 6: SOCIOECONOMIC IMPACTS REASONABLY EXPECTED TO OCCUR

Kinney County is 100% reliant on groundwater, and adverse socioeconomic outcomes associated with failing a spring discharge based DFC could include: 1) declining static water levels that make it cost-prohibitive for domestic wells to access groundwater, 2) decreased property values associated with reduced water reliability and loss of spring flow in the community, and 3) reduced water availability for groundwater dependent industry, including agriculture.

The Board's deliberations reflected an extensive balancing process aimed at selecting a DFC that supports meaningful protection of Las Moras Springs without being overly restrictive or lenient. A target that is too stringent could adversely impact local industry, whereas a target that is too lenient could allow for prolonged periods of water level decline, potentially resulting in the springs going dry. The revised DFC threshold (15 cfs) and 5-year averaging window was evaluated against historical performance to help ensure the DFC is consistent with historical conditions, represents a realistic management goal, and provides the Board with a defensible basis for implementing management strategies intended to protect spring discharge over the planning period.

### **3.7 FACTOR 7: PRIVATE PROPERTY INTERESTS AND RIGHTS**

In a county that is 100% reliant on groundwater, considerations related to private property interests and rights are closely tied to water reliability and the socioeconomic outcomes discussed under Factor 6. Community engagement throughout this process supported the Board's decision to select a DFC that is reasonable, understandable, and directly tied to discharge at Las Moras Springs.

By relating the DFC to spring discharge, the Board selected a metric that directly reflects aquifer conditions in the springshed and provides a transparent management objective that is closely linked to availability. In addition, the revised threshold was selected with consideration of the historical record and the potential for future reductions in recharge due to changing climatic conditions. This approach supports a balanced outcome by establishing a defensible protection goal while avoiding a target that would be unnecessarily punitive to existing groundwater users and groundwater dependent economic activity within the county.

### **3.8 FACTOR 8: FEASIBILITY OF ACHIEVING THE DFC**

The Board gave special attention to feasibility at the March 3, 2026 Board Meeting by evaluating how candidate DFC statements would have performed when applied to historical spring discharge and drought data. This use of observed, real-world hydrologic behavior as a practical screening tool helped the Board identify a target performed reasonably under both average and drought conditions. As part of this discussion, the Board sought a threshold that balanced average and drought conditions in acknowledgement of the potential for decreased spring discharge and short-term non-attainment during drought, without making the minimum spring discharge so low that it would provide limited protection

or weaken the management objective. This balancing process informed the selection of the revised DFC, which has historically been attained 88% of the time (Table 4).

The Board also discussed that achieving the revised DFC will require implementation through the District's Management Plan, including the adoption of practices that respond to observed declining spring discharge or static water levels in monitoring wells. Importantly, the use of a single-tier metric allows the District to evaluate compliance in a transparent, straightforward, and repeatable manner. Finally, the five-year moving average provides an opportunity to enact meaningful groundwater management practices in sustained conditions rather than short-term fluctuations, allowing the District to implement groundwater management actions incrementally and to avoid abrupt shifts in management actions.

**Table 4.** Percent of years the one-tier DFC is met from 1940 to 2025.

		Number of years in averaging window									
		1	2	3	4	5	6	7	8	9	10
Minimum spring discharge (cfs)	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	4	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	5	97%	98%	99%	100%	100%	100%	100%	100%	100%	100%
	6	93%	96%	96%	98%	99%	100%	100%	100%	100%	100%
	7	92%	94%	94%	96%	98%	100%	100%	100%	100%	100%
	8	85%	89%	93%	95%	98%	99%	100%	100%	100%	100%
	9	84%	89%	90%	94%	96%	98%	100%	100%	100%	100%
	10	81%	87%	90%	93%	95%	98%	100%	100%	100%	100%
	11	80%	86%	88%	92%	94%	98%	99%	100%	100%	100%
	12	76%	82%	87%	89%	94%	94%	96%	100%	100%	100%
	13	73%	80%	85%	89%	91%	93%	96%	97%	100%	100%
	14	71%	79%	85%	87%	88%	93%	94%	96%	99%	100%
	15	66%	79%	82%	87%	88%	89%	90%	94%	97%	99%
	16	60%	73%	79%	81%	88%	86%	89%	91%	94%	97%
	17	58%	66%	75%	76%	82%	84%	85%	87%	88%	94%
	18	55%	60%	65%	75%	72%	78%	79%	82%	85%	84%
	19	51%	54%	58%	60%	61%	60%	68%	72%	73%	70%
	20	47%	51%	51%	51%	52%	53%	54%	57%	60%	60%
	21	43%	46%	44%	43%	46%	40%	41%	48%	47%	44%
	22	40%	44%	37%	39%	33%	33%	36%	33%	29%	27%
	23	34%	33%	31%	31%	23%	28%	28%	23%	21%	21%
	24	30%	27%	26%	22%	20%	20%	23%	16%	18%	19%
	25	28%	20%	17%	14%	16%	17%	14%	15%	17%	16%
	26	28%	19%	15%	13%	15%	17%	14%	14%	13%	12%
	27	26%	18%	14%	12%	12%	11%	13%	10%	9%	8%
	28	22%	15%	11%	11%	11%	10%	10%	9%	8%	4%
	29	19%	13%	8%	10%	9%	9%	8%	6%	4%	3%
	30	16%	9%	7%	6%	7%	7%	8%	5%	3%	3%
	31	12%	6%	7%	6%	7%	7%	5%	4%	3%	3%
	32	12%	6%	6%	6%	7%	7%	5%	3%	3%	3%
	33	10%	6%	6%	6%	7%	4%	1%	1%	1%	1%
	34	8%	6%	5%	5%	4%	1%	1%	1%	0%	0%
	35	6%	5%	5%	5%	1%	0%	0%	0%	0%	0%

### **3.9 FACTOR 9: ANY OTHER RELEVANT INFORMATION**

For Kinney County, “other relevant information” that informed the Board’s deliberations include:

1. The history of confusion created by evolving DFC wording and the desire to improve interpretability and transparency.
2. Ongoing and persistent drought.
3. Community engagement and stakeholder input emphasizing the importance of Las Moras Springs as a focal management objective.

Collectively, these nine factors supported the Board’s selection of a spring discharge-based DFC that is both technically grounded in real world data and easy to understand. By selecting a DFC expressed as a rolling five-year average of daily mean discharge at Las Moras Springs, the Board selected a metric that emphasizes sustained spring discharge conditions, strengthens transparency for landowners and groundwater users, and is supported by historical feasibility screening. The selected framework also supports joint planning by providing a clearer, more interpretable basis for future evaluations and for subsequent discussions regarding modeled available groundwater and management strategies.

### **4.0 DFC TRACKING AND MANAGEMENT STRATEGIES**

The District will initiate the steps necessary to work towards achieving the DFC through its management plan and as needed, the adoption of new rules. This will include the establishment of a clear and repeatable method for tracking progress toward DFC attainment, as well as identifying management responses that may be triggered by sustained declines in Las Moras Springs discharge and/or groundwater levels. These implementation details will be developed through future Board discussions and subsequent management plan updates and rulemaking.

### **5.0 MODELED AVAILABLE GROUNDWATER**

As part of this revised DFC that departs from the current Kinney County Groundwater Availability Model, the TWDB should consider a revised MAG for the Edwards-Trinity (Plateau) Aquifer in the GMA 7 portion of Kinney County. In advance of an updated groundwater flow model, FNI recommends that TWDB consider an interim, data-driven approach that uses the historical record to bracket pumping volumes that are broadly consistent with attainment of the revised DFC. Under this approach, annual groundwater pumping totals for years that would have met the new DFC are summarized in Table 5, and the processed annual DFC evaluation dataset is provided in Table 6.

Interpretation of the historical pumping record requires several important qualifications. First, measured annual pumping volumes do not include withdrawals from exempt domestic wells and do not fully capture public supply wells that are not reported to the District (e.g., City of Brackettville and Fort Clark Springs MUD). Second, the estimated pumping volumes compiled by Green (2012) are provided as countywide totals and do not distinguish pumping by aquifer or GMA. However, available information indicates that groundwater pumping in GMA 10 is relatively small compared to GMA 7 (Figure 8) and is expected to have a relatively small impact on a MAG estimate for the GMA 7 portion of the county.

For purposes of developing a MAG estimate from observed data, the 75th percentile of groundwater pumping during years that meet the DFC may provide for a more reasonable planning-level estimate for several reasons: (1) MAG represents the average annual pumping amount that would satisfy a DFC, (2) Kinney County is 100% reliant on groundwater, and groundwater use in recent years has exceeded the historic long-term average, and (3) inclusion of exempt and unreported pumping from public water supply wells would increase total pumping and likely shift the estimated average upward, closer to the 75th percentile value. Rather than selecting the maximum groundwater pumping value from years that met the DFC or a more conservative mean or median, the 75th percentile provides a balanced approach that considers both water supply needs and spring discharge objectives.

A total of 48 years of measured and estimated annual groundwater pumping data are available for Kinney County. The record is sporadic beginning in 1958 and becomes more regular in 1984. Spring discharge observations at Las Moras Springs extend back to the 1940s, with more continuous records beginning in 2003. Given the available datasets and revised DFC, the **75th percentile groundwater pumping volume is 9,610 acre-feet**, calculated using 41 years for which annual pumping totals were available and the DFC would have been met.

**Table 5.** Summary data of annual groundwater pumping volumes from years that 'met' the new DFC. 25% = 25th percentile, 75% = 75th percentile

Count	Minimum	25%	Median	Mean	75%	Maximum
41	2,301	5,182	6,975	7,473	9,610	14,973

**Table 6.** Summary of data used to evaluate DFC compliance and calculate the MAG. #N/A indicates there was insufficient data to look back at to calculate the 5-year average.

Year	Spring Discharge observation count (mean daily discharge)	Average discharge at Las Moras Springs for the previous 5-years (cfs)	Estimated or Measured groundwater pumping (acft)
1940	10	#N/A	
1941	10	#N/A	
1942	9	#N/A	
1943	9	#N/A	
1944	10	18.63	
1945	9	17.23	
1946	10	16.76	
1947	9	19.12	
1948	10	18.57	
1949	9	20.82	
1950	8	21.67	
1951	5	20.68	
1952	5	16.78	
1953	5	16.56	
1954	5	12.46	
1955	6	13.84	
1956	5	13.89	
1957	10	18.29	
1958	10	28.62	2,301
1959	10	33.66	
1960	9	34.58	
1961	9	36.25	
1962	10	33.57	
1963	10	24.64	
1964	10	18.31	10,147
1965	25	18.08	
1966	12	17.73	
1967	12	17.96	
1968	12	19.71	
1969	12	19.50	12,333
1970	12	17.51	
1971	12	17.98	
1972	12	19.08	
1973	12	21.02	
1974	12	21.79	11,484
1975	12	22.11	

Year	Spring Discharge observation count (mean daily discharge)	Average discharge at Las Moras Springs for the previous 5-years (cfs)	Estimated or Measured groundwater pumping (acft)
1976	12	22.91	
1977	12	24.53	
1978	12	22.03	
1979	12	21.65	9,203
1980	12	19.32	10,834
1981	12	19.30	
1982	12	18.07	
1983	12	18.90	
1984	12	18.11	9,853
1985	12	21.73	6,066
1986	12	20.27	6,536
1987	12	23.71	3,647
1988	12	22.51	4,447
1989	12	22.03	11,451
1990	12	22.87	8,394
1991	12	22.24	9,244
1992	12	21.36	6,915
1993	12	20.88	10,624
1994	12	22.46	8,261
1995	12	19.94	7,402
1996	12	17.92	9,610
1997	12	17.99	8,474
1998	12	20.14	7,900
1999	12	21.32	5,902
2000	12	21.93	14,973
2001	12	25.56	6,975
2002	12	24.27	6,863
2003	101	23.89	10,078
2004	366	34.83	4,422
2005	365	33.12	5,087
2006	365	26.57	5,182
2007	365	28.13	3,043
2008	366	27.31	6,744
2009	365	21.77	5,330
2010	365	18.87	3,981
2011	365	17.79	4,489
2012	366	12.05	4,883
2013	365	9.45	4,639



Year	Spring Discharge observation count (mean daily discharge)	Average discharge at Las Moras Springs for the previous 5-years (cfs)	Estimated or Measured groundwater pumping (acft)
2014	285	8.42	4,974
2015	322	10.34	4,015
2016	354	16.19	3,639
2017	364	21.27	5,821
2018	365	23.69	6,307
2019	365	29.41	4,683
2020	366	26.42	8,871
2021	365	21.14	8,265
2022	365	16.73	10,608
2023	365	13.15	9,715
2024	366	6.88	9,862
2025	365	6.00	11,829

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## **APPENDIX A**

“Draft Findings on Desired Future Conditions in GMA-7”

# DRAFT TECHNICAL MEMORANDUM



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<b>TO:</b>	Kinney County Groundwater Conservation District, Board of Directors
<b>FROM:</b>	Vince Clause, PG Freese and Nichols, Inc.
<b>SUBJECT:</b>	Draft Findings on Desired Future Conditions in GMA-7
<b>PROJECT:</b>	KGD25636 – FY26 Hydrogeological Consulting Services
<b>DATE:</b>	December 12, 2025

<b>DRAFT</b>
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF <u>VINCE CLAUSE, P.G., TEXAS NO. 15512</u> ON 12/12/2025. IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES. FREESE AND NICHOLS, INC. TEXAS REGISTERED GEOSCIENCE FIRM F-50655

## 1.00 INTRODUCTION

Freese and Nichols, Inc. (FNI) has prepared this draft technical memorandum on behalf of the Kinney County Groundwater Conservation District (KCGCD) to support continued use of the best available science in the joint planning process for Desired Future Conditions (DFCs). The purpose of this draft technical memorandum is to provide the Kinney County Groundwater Conservation District (KCGCD) Board of Directors with relevant data and analysis to help guide discussion as the Board determines its preferred approach for calculating Modeled Available Groundwater (MAG) in GMA 7. This document is intended as a preliminary summary of selected data and findings and is not a substitute for the comprehensive technical report that will be provided in January. All data and analyses presented herein should be regarded as draft and are subject to revision.

This work was completed under FY26 Hydrogeological Consulting Services, Task 2: Support Desired Future Conditions Joint Planning, authorized on August 23, 2025, under the Master Services Agreement between KCGCD and FNI.

## 2.00 BACKGROUND

### DFC FORMULATION FOR KINNEY COUNTY

For the GMA 7 portion of Kinney County, the DFC for the Edwards-Trinity (Plateau) Aquifer is expressed in terms of Las Moras Spring discharge as simulated in Scenario 3 of the Texas Water Development Board's (TWDB) Draft Groundwater Availability Model (GAM) Task 10-027, (revised; Hutchison, 2011), which is based on the Groundwater Flow Model of the Kinney County Area (Hutchison and others, 2011). Under this framework, the aquifer system is simulated over 56-annual stress periods with a constant annual withdrawal of 77,000 acre-feet per year from the Edwards Trinity (Plateau) Aquifer.

From this predictive simulation, TWDB reported average and median end-of-year simulated Las Moras Spring discharge which were subsequently adopted as the DFC for Kinney County, as follows:

- Average simulated end-of-year spring flow: 23.9 cubic feet per second (cfs)
- Median simulated end-of-year-spring flow: 24.4 cfs

Key takeaways from this DFC formulation are provided below.

1. **The stated DFC is a statistical indicator, not a hard cap on minimum spring flow.** Within the Scenario 3 results, end-of-year Las Moras Spring flow is between 5 and 20 cfs about 38 percent of the time and greater than 25 cfs about 49 percent of the time over the 56-year simulation. This frequency distribution indicates that Las Moras flows are expected to vary significantly from year to year. Therefore, the adopted DFC reflects a typical modeled spring discharge under the Scenario 3 assumptions and not a minimum instantaneous or annual flow requirement to be met every year.
2. **The DFC is tied explicitly to annual end-of-year conditions in the model.** Because the Kinney County model uses annual stress periods and reports spring discharge as end-of-year values, the DFC should be evaluated against end-of-year spring flow conditions. Comparing daily, seasonal, or other non-end-of-year measurements directly to the DFC statistics is not consistent with the model's temporal resolution and initial interpretation of the DFC. Both Draft GAM Task 10-027 and the KCGCD Management Plan (KCGCD, 2023, "Management Plan") emphasize that end-of-year flows are the appropriate basis for comparison and that direct use of daily, seasonal, or instantaneous measurements as if they were equivalent is not appropriate.

### **GMA 7 DFC RESOLUTION LANGUAGE AND SUBSEQUENT INTERPRETATIONS**

The founding joint-planning action for Kinney County's GMA 7 DFC is documented in GMA 7 Resolution 07-29-10-9 (GMA 7, 2010), which explicitly links the DFC to Scenario 3 of Draft GAM Task 10-027 (revised). For Kinney County, the resolution states:

"In Kinney County, that drawdown which is consistent with maintaining, at Los Moras Springs [sic], an annual average flow of 23.9 cfs and a median flow of 24.4 cfs based on Scenario 3 of the Texas Water Development Board's flow model presented on July 27, 2010..."

During the 2016 planning cycle, GMA 7 elected to reaffirm the same spring-flow based DFC for Kinney County, while extending the planning horizon to 2070. The April 21, 2016 proposed DFCs document (Groundwater Management Area 7, 2016; reproduced in Hutchison, 2018) includes the following Kinney County DFC declaration:

"Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of annual average flow of 23.9 cfs and an annual median flow of 24.4 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph.D. and Marious Jigmond, TWDB, dated August 26, 2011)."

When the DFCs were formally adopted and later documented in the GMA 7 Explanatory Report (Hutchison, 2018; restated in Hutchison, 2021), the Kinney County DFC appears as:

“Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph. D and Marious Jigmond, TWDB, dated August 26, 2011).”

Between the 2010 resolution and later GMA 7 actions, the average spring-flow target remained the same at 23.9 cfs, however the median value shifted from 24.4 cfs in the original 2010 resolution and 2016 proposed DFC document to 23.9 in the final DFC language adopted in 2018 and remained at 23.9 in the 2021 Explanatory Report (Hutchison, 2021).

The wording of the DFC also evolved in a meaningful way that affects how the DFC is interpreted. The 2010 resolution explicitly references Scenario 3 of GAM Task 10-027. In contrast, the 2016 and 2021 resolutions reference the TWDB GAM for Kinney County but do not name Scenario 3 in the DFC statement itself, even though the Explanatory Report explicitly notes that the DFC is based on Scenario 3. The Explanatory Report also notes that GMA 7 and KCGCD “voted to keep the same DFC based on the 2010 analysis despite issues that have been identified with the model,” acknowledging both model limitations and the original Scenario 3 analysis.

Although the streamlined DFC wording in summary tables and subsequent planning documents may improve readability, it may also obscure the direct linkage between (1) the predictive scenario and its limitations in the TWDB GAM and (2) the end-of-year spring-flow statistics used to define the Kinney County DFC. For the remainder of this memorandum, that explicit linkage is maintained to provide a clearer technical basis for revisiting the way the associated MAG is calculated and communicated.

### **KCGCD MANAGEMENT PLAN AND IMPLEMENTATION OF THE DFC**

The KCGCD Management Plan confirms that the GMA 7 DFC for Kinney County is expressed as an average and median Las Moras Spring flow based on Scenario 3 of TWDB Draft GAM Task 10-027. The Plan reiterates that the average flow of 23.9 cfs and median flow of 24.4 cfs were calculated from a 56-year simulation under a constant pumping assumption and emphasizes that the simulated spring flow values are end-of-year results. The Plan also states that comparing any single measured spring-flow value directly to the long-term average “for purposes of demonstrating consistency with the desired future condition would be inappropriate.”

Spring flow data from the United States Geological Survey (USGS) gauge at Las Moras Spring serves as the primary basis for evaluating DFC compliance on a year-to-year basis. To move from simulated results to an observable metric, the Plan establishes an empirical model that relates annual precipitation to end-of-year spring flow. Figures 5 through 8 in the Plan illustrate how this empirical relationship is used to evaluate recent end-of-year observations based on established relationships within a broader historical context.

Under this approach, the Management Plan does not define a single pass/fail threshold for DFC compliance. Instead, it establishes an envelope of expected end-of-year spring flows for a given annual precipitation and commits the District to annual documentation and interpretation of whether observed spring flow is broadly consistent with that envelope. This approach recognizes key limitations of the modeling on which the DFC is based (e.g. temporal resolution and statistical nature of the DFC) and formalizes a practical evaluation tool for tracking whether groundwater conditions in Kinney County remain consistent with the DFC adopted for the Edwards-Trinity (Plateau) Aquifer in GMA 7.

The stated objective for this approach is to “assess annually the end-of-year Las Moras Spring flow and annual precipitation to evaluate consistency with the desired future condition” (KCGCD, 2023, p. 20). This evaluation tool is formalized as a DFC Performance Standard that:

“each year, data on annual precipitation from Quad 807 and end-of-year Las Moras Spring flow will be collected. The results will be reported as an agenda item at the first Board meeting after the annual precipitation data are available from TWDB, and final (not provisional) Las Moras Springs flow data are available from the USGS.” (KCGCD, 2023, p. 20)

### **3.00 GROUNDWATER PUMPING**

Groundwater pumping volumes were provided to FNI by EcoKai as annual totals by permitted well for the period of 2003 to 2024. Using this record, we prepared summary statistics (Table 1 and Table 2) and a general trend analysis (Figure 1). The distribution of total annual pumping is bimodal, indicating distinct low and high pumping periods over time.

The median total annual pumping for the full period of record is 5,135 acre-feet per year, which is comparable to the median during the 2011 drought interval (2009 to 2015) of 4,761 acre-feet per year. In contrast, recent pumping volumes during 2020 to 2024 are substantially greater with a median of 9,715 acre-feet per year, indicating a marked increase in groundwater production relative to historical conditions.

To provide additional clarity, source aquifers have been assigned to each well. The resulting distribution of pumping by aquifer and year is illustrated in Figure 2, which highlights the temporal evolution of production among the Edwards-Trinity (Plateau), Austin Chalk and other aquifers. Figure 3 provides the same data but illustrates it as percent of total annual pumping by aquifer.

**Table 1 – Summary statistics for total annual permitted groundwater pumping volumes (acre-feet per year) across Kinney County.**

	<b>Period of record (2003 to 2024)</b>	<b>Drought with baseline pumping (2009 to 2015)</b>	<b>Drought with increased pumping (2020 to 2025)</b>
Count	22	6	5
Standard deviation	2,343	462	911
Minimum	3,043	3,981	8,265
Median	5,135	4,761	9,715
Mean	6,120	4,716	9,464
Maximum	10,608	5,330	10,608

**Table 2 – Summary statistics for total annual permitted groundwater pumping volumes (acre-feet per year) across Kinney County and by GMA.**

	<b>Total Pumping (2003 to 2024)</b>	<b>GMA 7 Pumping (2003 to 2024)</b>	<b>GMA 10 Pumping (2003 to 2024)</b>
Count	22	22	22
Standard deviation	2,343	2,262	393
Minimum	3,043	2,999	12
Median	5,135	4,773	245
Mean	6,120	5,748	372
Maximum	10,608	10,089	1,376

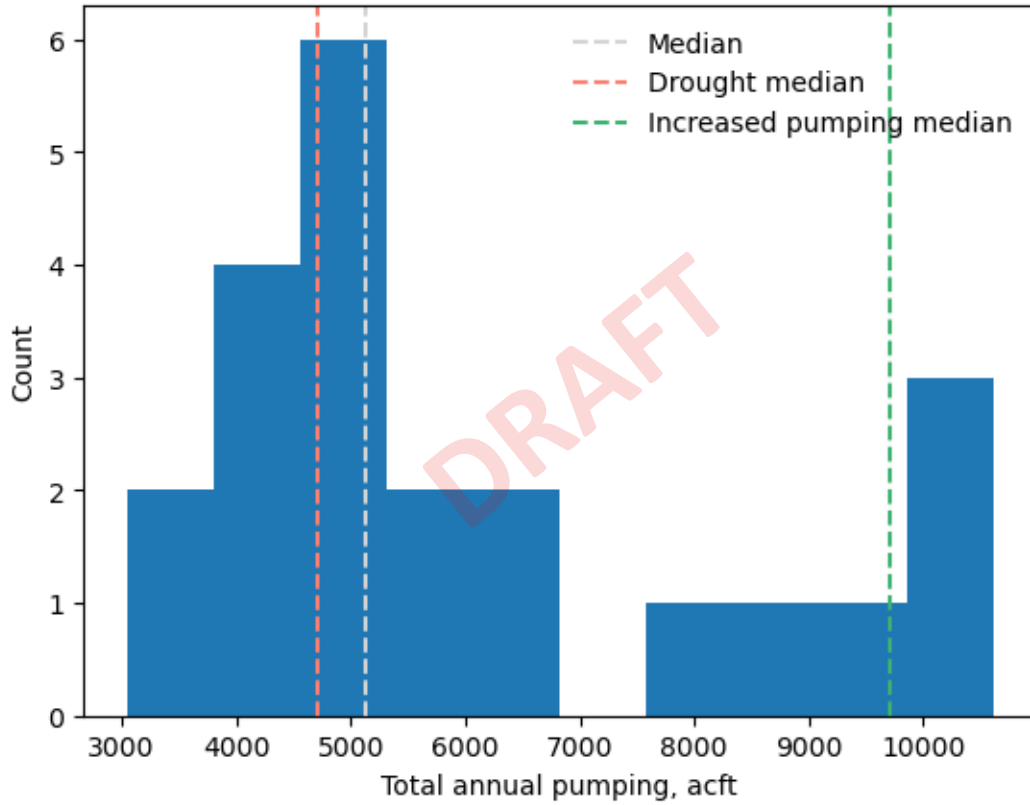


Figure 1 – Distribution of total annual groundwater pumping volumes (acre-feet per year) in Kinney County. Drought median is in reference to 2011 drought (2009 to 2015), while increased pumping median is in reference to 2020 to 2025 period.

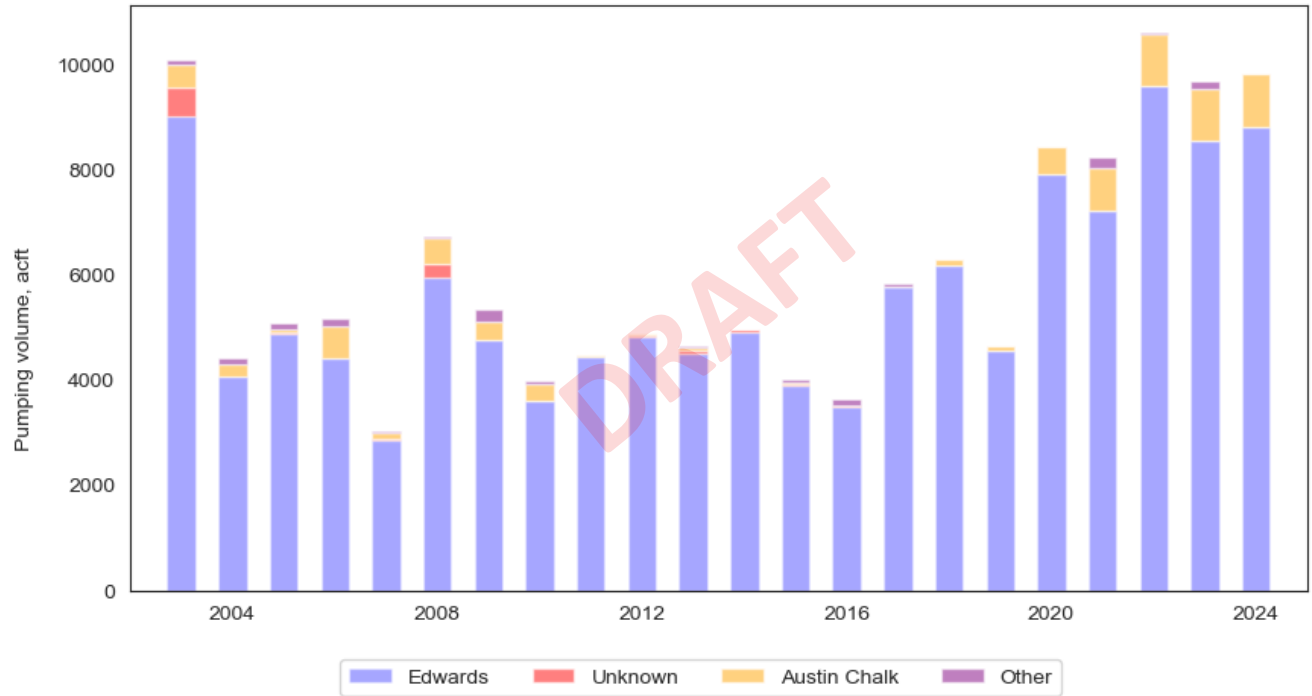


Figure 2 – Annual groundwater (acre-feet per year) pumping by aquifer.

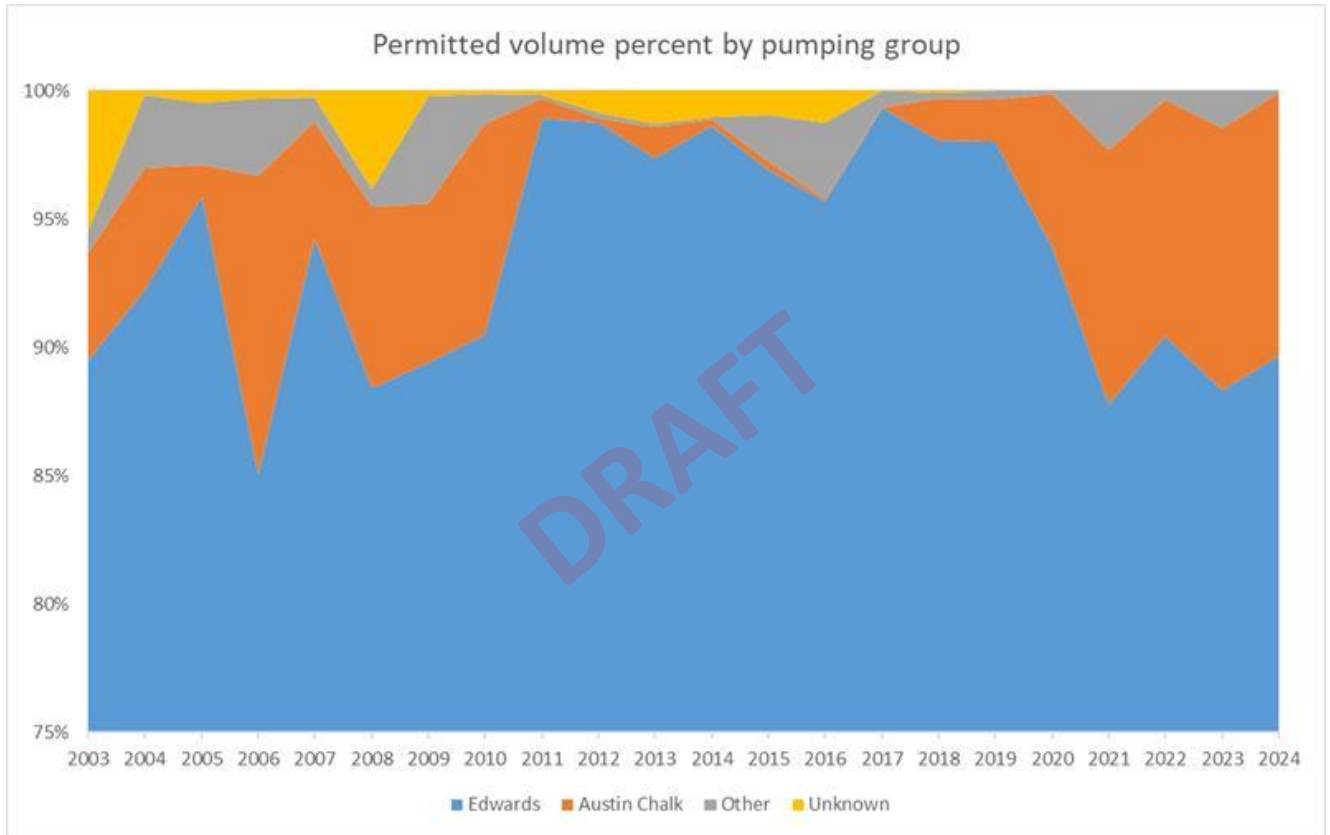


Figure 3 – Annual groundwater pumping volume percent by aquifer.

## 4.00 PRECIPITATION

The primary source of precipitation data used in this analysis is the TWDB Quad 807 dataset, which reports monthly precipitation (in inches) over a 1-degree by 1-degree grid cell for the period 1940 to present (TWDB, 2025). Summary statistics for the Quad-807 dataset are presented in Table 3 for three intervals: the full period of record, the 2011 drought period (approximated as 2009-2015), and recent drought period with increased pumping (2020-2025).

**Table 3. Summary Statistics for Monthly Precipitation (Quad 807, inches)**

	Period of record (1940 to Present)	Drought with baseline pumping (2009 to 2015)	Drought with increased pumping (2020 to 2025)
<b>Count</b>	1,026	73	66
<b>Standard deviation</b>	1.75	2.49	1.45
<b>Minimum</b>	-	-	0.01
<b>Median</b>	1.61	1.00	1.05
<b>Mean</b>	2.01	2.00	1.51
<b>Maximum</b>	16.23	10.00	7.58

The distribution of monthly precipitation totals in Figure 4 is right-skewed, with a long tail toward higher rainfall events. This skewness is reflected in the full period of record summary statistics, where the mean monthly precipitation (2.01 in.) exceeds the median (1.61 in.), highlighting the influence of relatively less frequent but large storm events on the long-term average. Figure 4 also marks the median monthly precipitation during the 2009-2015 drought interval and the 2020-2025 drought with increased pumping. Although the median precipitation in these two sub-periods is similar (1.0 to 1.05 inches), the mean precipitation from 2020-2025 (1.51 in.) is notably lower than both the long-term mean (2.01 in.) and mean during the 2009-2015 drought period (2.0 in.). The maximum monthly rainfall during 2020-2025 (7.58 in.) is also substantially lower than the maximum observed over the full record and during the 2009-2015 drought interval.

Figure 5 presents this same data in a different form, showing the number of consecutive months below the long-term median alongside quarterly precipitation totals. This chart allows a direct visual comparison between the 2009-2015 drought and the 2020-2025 drought periods. The 2009-2015 drought is characterized by longer runs of below median precipitation, but with overall higher rainfall totals than the 2020 to 2025 period, which is notably marked by overall lower cumulative rainfall and fewer large precipitation events.

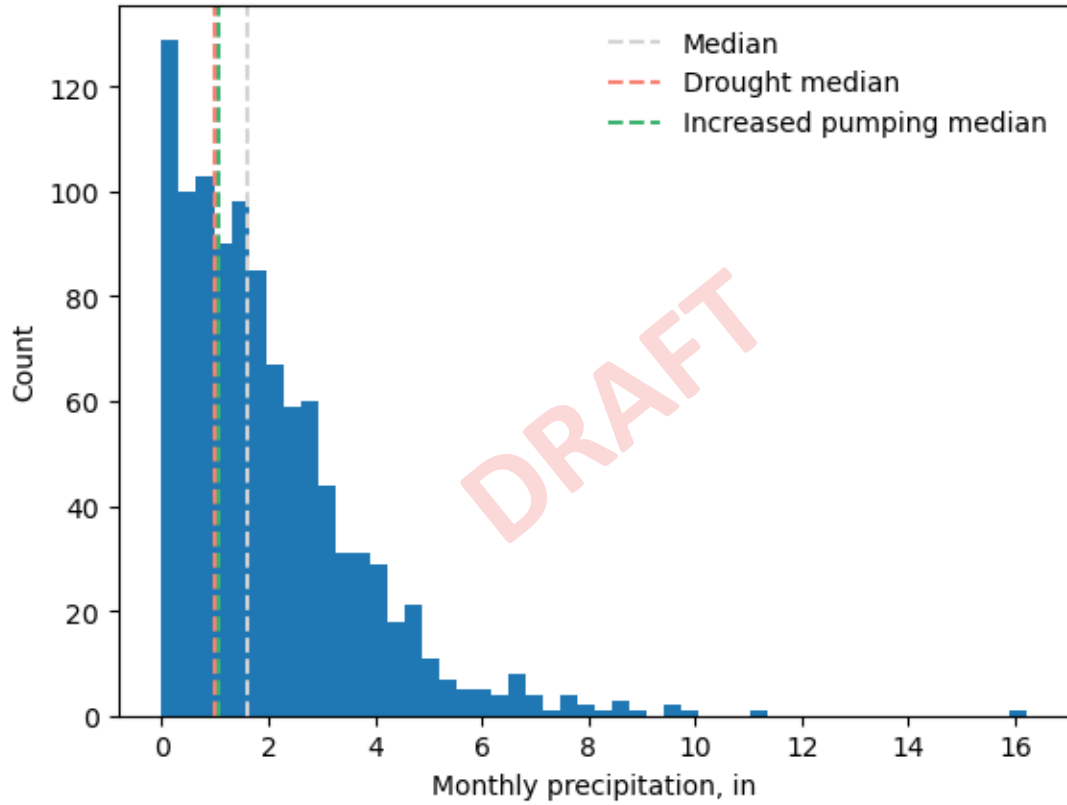
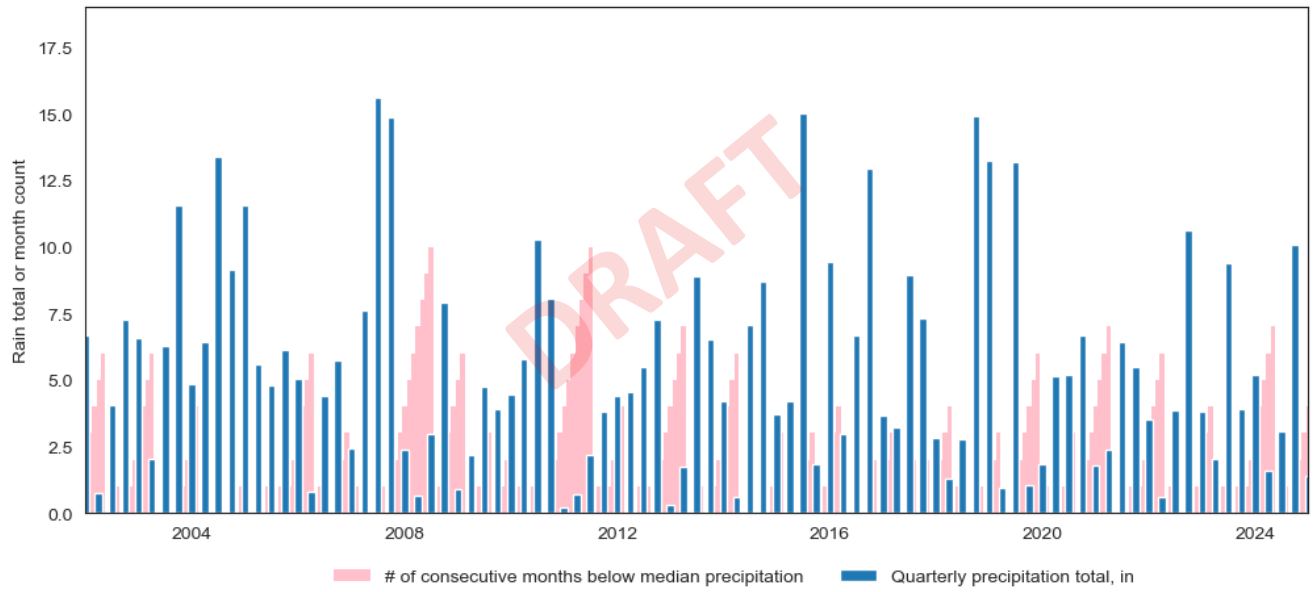


Figure 4 – Distribution of monthly rainfall totals from Quad-807. Drought median is in reference to 2011 drought (2009 to 2015), while increased pumping median is in reference to 2020 to 2025 period.



**Figure 5 – Quarterly precipitation totals and number of consecutive months below median precipitation.**

## 5.00 LAS MORAS SPRING DISCHARGE

Spring discharge data for Las Moras Spring were obtained from multiple sources and harmonized into a single dataset (2003 to 2025 presented in Figure 6; Bennett and Sayre, 1962; LBG-Guyton Associates, 2009; USGS, 2025a and 2025b). Bennett and Sayre (1962) report daily spring discharge sporadically at Las Moras from Dec. 23, 1895, to Sept. 25, 1956. For this analysis, those daily measurements are interpreted as mean daily discharge. LBG-Guyton Associates (2009) reported spring flow as mean cfs-days per month for the period February 1965 through March 2004. We converted these monthly values to estimated daily discharge by dividing the reported cfs days per month by the number of days in the month and reported the value only at the end of the month.

The USGS has operated two spring gauges at Las Moras (2025a and 2025b). The “old” gauge (active 2003 to 2014) reports mean daily discharge, and the “new” gauge (2014 to present) reports 15-minute mean discharge. We resampled the “new” gauge data to obtain a mean daily discharge value.

Prior to 2003, daily mean discharge values are reported with varying temporal resolution. From 1895 to 1965, the record is sporadic in time. From 1965 to 2003, mean discharge is reported at month end. From 2003 to present, a continuous daily record is available except from August 27, 2014 to October 1, 2014 when the USGS gauge was replaced and upgraded. For purposes of this analysis and to maintain consistency across data processing environments, we consider our period of record to be 1900 to present.

Summary statistics for daily mean discharge at Las Moras Spring over the period of record, the 2009 to 2015 drought period, and a recent period of increased groundwater pumping (2020 to 2025) are presented in Table 4. Based on available documentation, we assume the DFC for Kinney County GCD is currently assessed against the mean daily discharge on Dec. 31. To align with the DFC, we also prepared summary statistics for all the available reported values for Dec. 31 of a given year (Table 5).

The distribution of daily mean discharge for the full period of record is bimodal (Figure 7). One peak occurs between approximately 0 and 10 cfs and a second with a shallower peak between 30 and 50 cfs. This right skew in the distribution suggests that we have relatively frequent low to moderate flows and intermittent high-flows. As a result of this right-skew in distribution, the mean spring flow exceeds the median spring flow, an observation that is not consistent with the Scenario 3 GAM results.

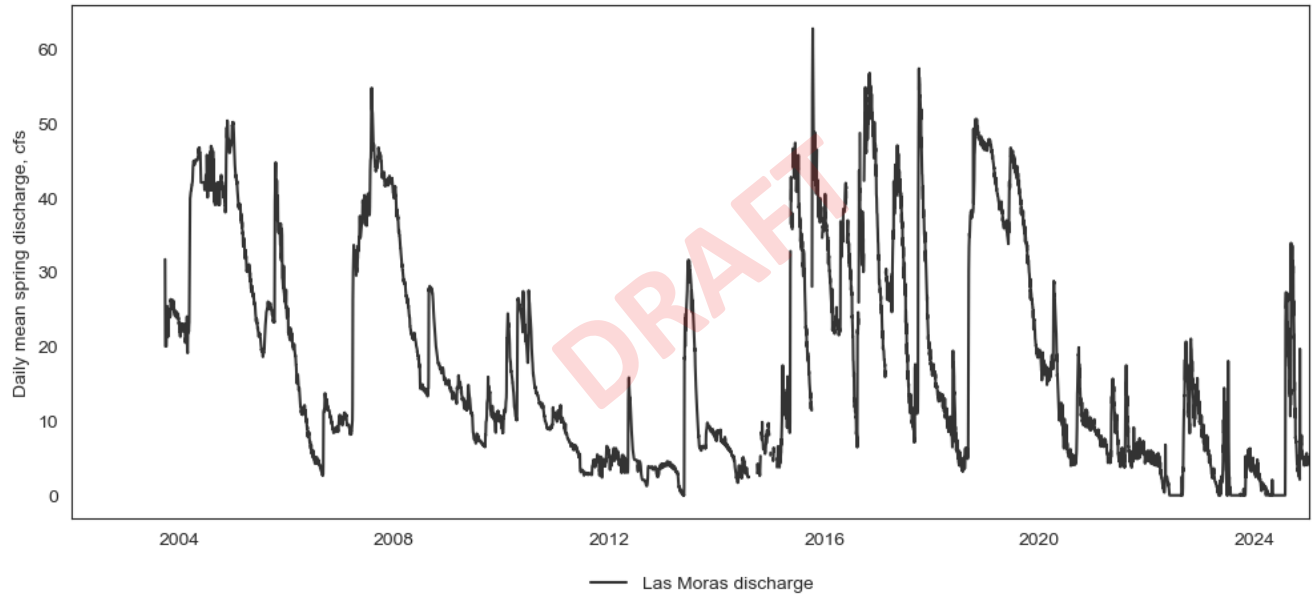


Figure 6 – Las Moras Spring discharge, 2003 to 2025.

**Table 4. Summary statistics of mean daily discharge at Las Moras Springs. Discharge reported in cubic feet per second.**

	Period of record (1900 to 2025)	Drought (2009 to 2015)	Increased pumping (2020 to 2025)
Count	8,544	2,127	2,112
Standard deviation	14.47	7.33	6.24
Minimum	-	-	-
Median	12.50	5.07	7.23
Mean	17.62	7.04	8.91
Maximum	62.66	40.70	31.60

**Table 5. Summary statistics of mean daily discharge on Dec. 31 for Las Moras Springs. Discharge values are reported in cubic feet per second.**

	Period of record (1900 to 2025)	Drought (2009 to 2015)	Increased pumping (2020 to 2025)
Count	60	6	5
Standard deviation	12.99	2.61	3.08
Minimum	2.91	4.12	2.91
Median	16.34	6.49	5.61
Mean	20.67	7.12	6.62
Maximum	49.80	11.00	9.92

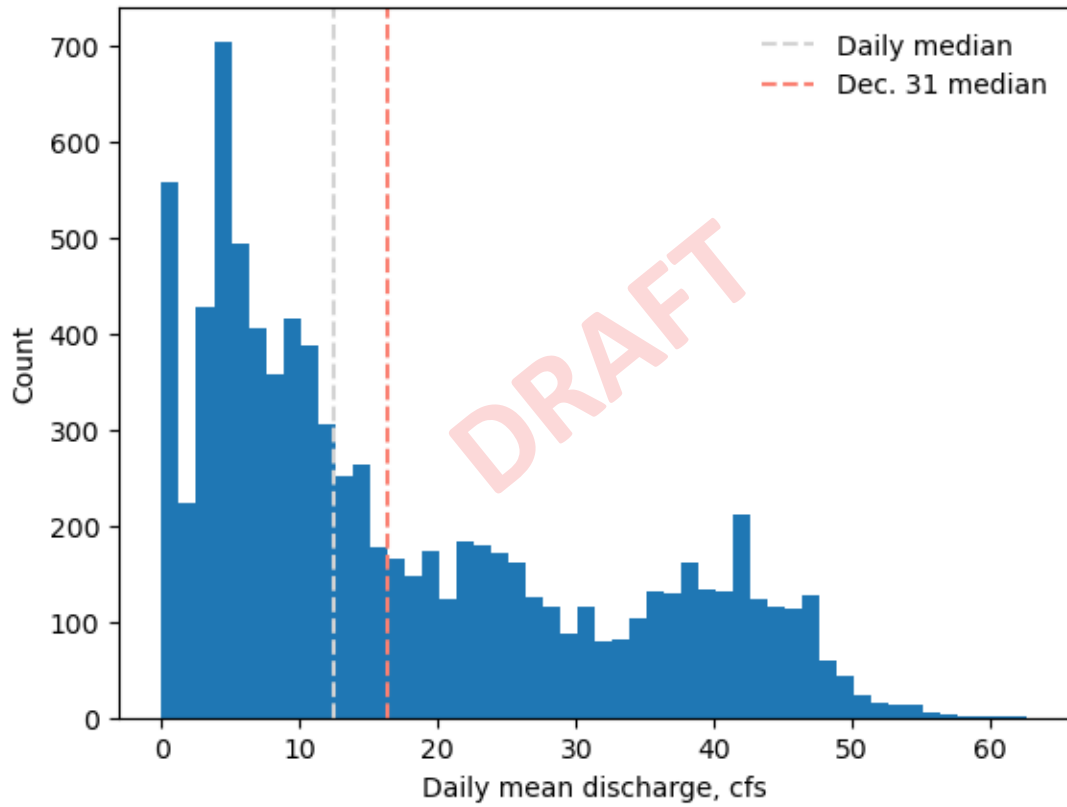


Figure 7 – Distribution of daily mean discharge at Las Moras Springs for the period of record.

## 6.00 PUMPING RECORD OVERLAY

A simple overlay of Las Moras Spring discharge, rainfall, and pumping by aquifer is provided in Figure 8 below. This information is provided as a visual summary for data presented with the previous sections.

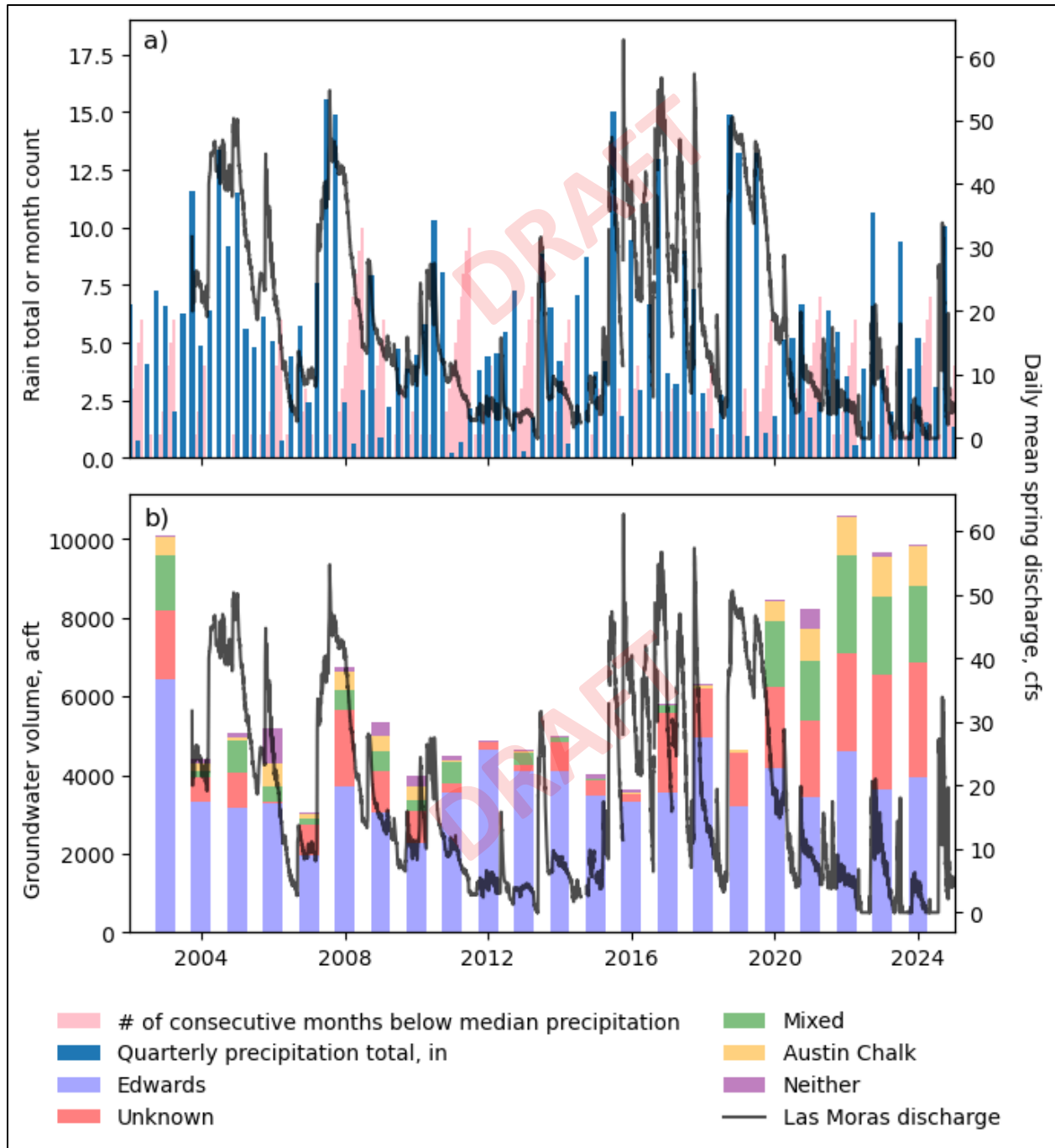


Figure 8 - Groundwater pumping volumes, precipitation, and discharge at Las Moras during the period of record for groundwater pumping volumes. A) Quarterly precipitation totals in inches, daily mean discharge at Las Moras measured in cubic feet per second, and the number of consecutive months below median precipitation (1.61 inches). B) Groundwater pumping volumes by aquifer and daily mean discharge at Las Moras.

## 7.00 REGRESSION AND CONDITIONAL PROBABILITY ANALYSIS

To estimate a groundwater pumping volume that on average, would be consistent with the GMA 7 DFC, we evaluated the relationships among groundwater pumping, precipitation, and Las Moras Spring flow. A primary challenge in this analysis is the limited length and completeness of the groundwater pumping record, which constrains the robustness of any predictive model.

### REGRESSION ANALYSIS

Our initial approach was to develop a relatively simple multivariate regression model. Three different input configurations were tested, each using variations of annual precipitation and annual pumping as predictors. The resulting models produced  $R^2$  values between approximately 0.3 and 0.5, which was only marginally satisfactory for this type of analysis. We then tested the model predictions to observed spring discharge (Figure 9). Although each model captured the general shape of spring discharge, all overestimated spring flow during the 2009-2015 drought. Because the DFC is tied directly to spring flow, this tendency to overpredict discharge under drought conditions is not viewed as acceptable for DFC-based pumping estimates.

### CONDITIONAL PROBABILITY ANALYSIS

Given the limitations of the multivariate regression and the available data, we adopted an alternative approach focused on pairwise relationships with stronger apparent correlations. Specifically, precipitation and Las Moras Spring discharge ( $R^2 = 0.7175$ ), as these variables exhibit a stronger relationship than pumping and discharge ( $R^2 = 0.10$ ). We then used this relationship to (1) quantify the precipitation and spring flow relationship, and then (2) used that relationship within a probabilistic framework to explore a range of groundwater pumping volumes that would be broadly consistent with the DFC.

Because the DFC is currently evaluated using mean daily spring flow at Las Moras on December 31, we plotted December 31 mean daily discharge against annual Quad 807 precipitation (Figure 10) for the overlapping period of record. We then performed a simple linear regression between these two variables, which yielded a satisfactory  $R^2$  value (Equation 1;  $R^2 = 0.7175$ ):

**Equation 1. Linear regression of annual Quad 807 precipitation and Las Moras mean daily discharge on Dec. 31 (from 2003 to 2024).**

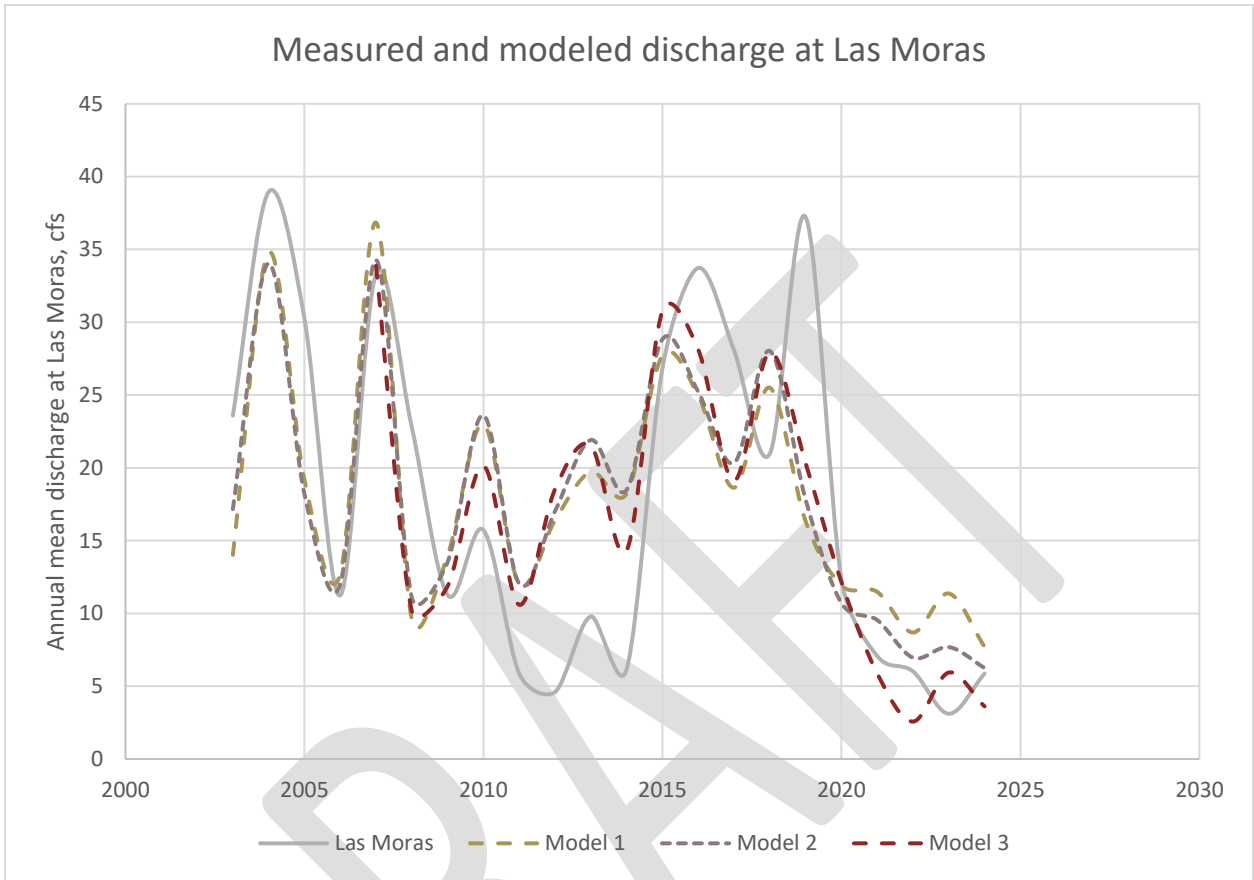
$$Q_{\text{Dec 31}} \text{ (cfs)} = -16.09167 + (1.5453 \times P_{\text{annual}}) \\ R^2 = 0.7175$$

$Q_{\text{Dec 31}}$  is the mean daily Las Moras Spring discharge on December 31 (cfs)

$P_{\text{annual}}$  is the annual precipitation from Quad 807 (inches).

This regression provides a better statistical fit than any of the multivariate regression models and forms the basis for the subsequent probabilistic analysis of pumping scenarios relative to the DFC.

From past data and observations, the most likely annual pumping volume that occurred given a specific annual precipitation value (the conditional probability) was assessed. The contemporaneous annual precipitation and annual pumping data from 2003 to 2024 was organized into five bins with a precipitation based width of 10-inches. In each of the precipitation bins, we calculated the average pumping volume, the 25th percentile, and the 75th percentile. From these three values the average annual pumping volume that occurred given a precipitation value and the band of most likely pumping values (25th to 75th percentiles) that occurred given a precipitation value were graphed as bands of conditional probabilities (Figure 11). This conditional probability approach is similar to the current approach used to assess the DFC (assess an envelope of values to account for actual variability), but the input data is based on real, although limited, observations.



**Figure 9 – Multivariate regression model predictions compared with actual Las Moras Spring flow. R2 for the models is between 0.3 and 0.5.**

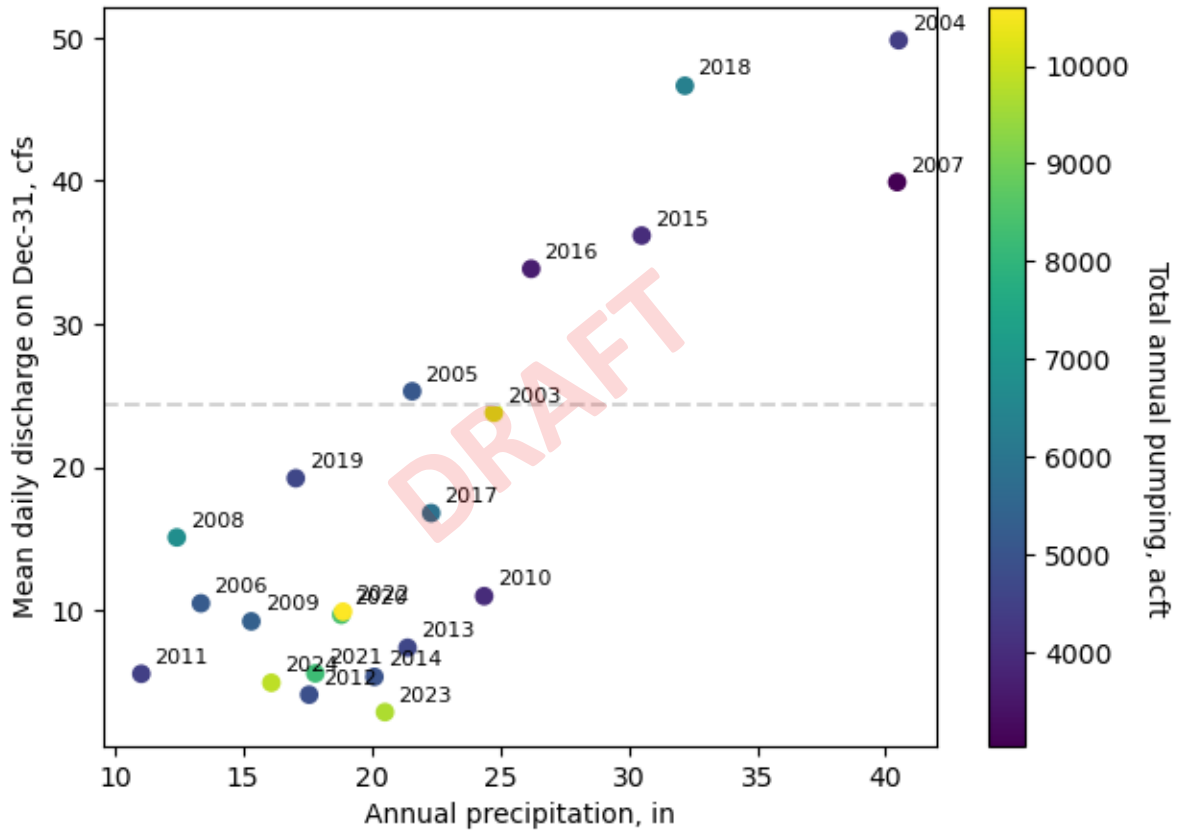


Figure 10 - Annual precipitation, mean daily discharge on December 31, and total annual pumping. The DFC discharge of 24.4 cfs is plotted as a dashed line on the graph.

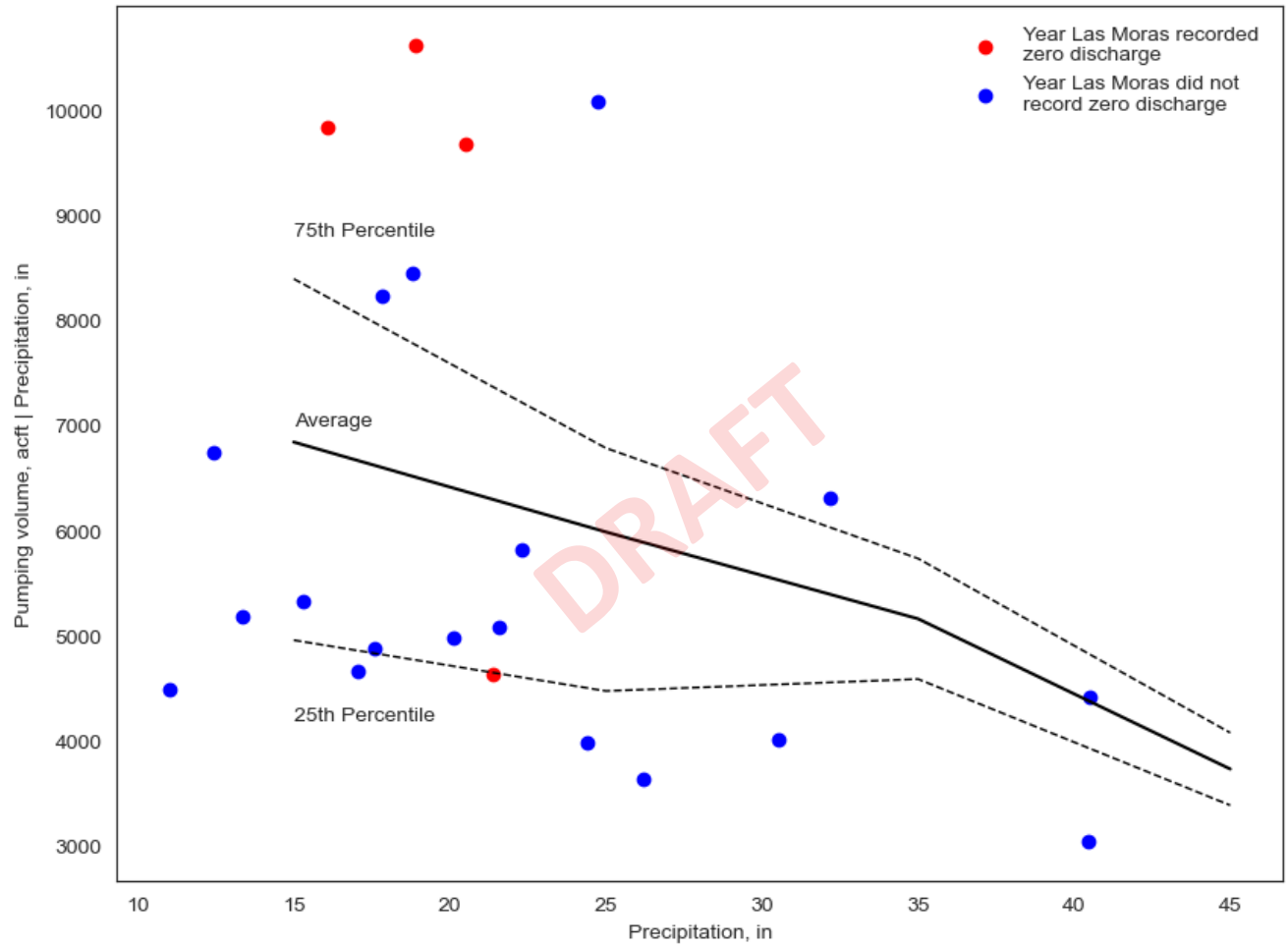


Figure 11. Conditional probability of annual pumping volume given a specific annual precipitation total.

## 8.00 RECOMMENDATIONS

To support a revised and more transparent approach to calculating the MAG for Kinney County within GMA 7, two technical recommendations are provided below. The first is to consider designating the Edwards-Trinity (Plateau) in Kinney County as non-relevant for joint planning purposes. This option ultimately removes the need to force a spring-flow based DFC into a MAG under a conceptual model that is not directly controlled by pumping. If the Board wishes to keep the aquifer as relevant, the second is to replace the existing GAM framework with a statistical analysis that links MAG to measurable variables (e.g. pumping and long-term spring flow statistics). Either path forward would improve overall technical defensibility, reduce ambiguity in how the DFC is interpreted and applied, and provide a clearer basis for communicating groundwater availability.

### **1. Consider the Edwards-Trinity (Plateau) Aquifer in Kinney County as Non-Relevant for Joint Planning in GMA 7**

The current GMA 7 DFC for Kinney County is expressed as average and median Las Moras Spring flows derived from Scenario 3 of TWDB Draft GAM Task 10-027. Both, the Scenario 3 analysis and the empirical framework in the KCGCD Management Plan indicate that Las Moras Spring flow correlates strongly to variations in recharge (i.e. rainfall), rather than with changes in pumping. The regression analysis presented in this technical memorandum further reinforces this point as spring flow exhibits a much stronger statistical relationship with precipitation ( $R^2 = 0.72$ ) rather than pumping and spring flow ( $R^2 = 0.10$ ). This contrast in  $R^2$  values demonstrates that Las Moras Spring flow is more sensitive to climate variability than to changes in groundwater pumping. There is insufficient evidence that policy-level changes in pumping are likely to generate a meaningful change in the DFC.

Based on review of available technical information, it is reasonable for KCGCD and GMA 7 to consider classifying the Edwards-Trinity (Plateau) as non-relevant for joint planning purposes under 31 TAC §356.31, which allows districts to classify a portion of a relevant aquifer as non-relevant “if the districts determine that aquifer characteristics, groundwater demands, and current groundwater uses do not warrant adoption of a desired future condition.” This recommendation is grounded in (1) a strong correlation climate-driven variability and Las Moras Spring flow, and (2) the relatively small and localized role that Edwards-Trinity (Plateau) groundwater in Kinney County plays in the broader regional water supply planning. This classification would apply only to joint planning under Chapter 36 and would not diminish KCGCD’s authority or intent to manage, monitor, and permit groundwater production locally.

From a joint planning perspective, the dominant driver of Las Moras Spring flow is rainfall, which is outside the control of the GCD or GMA and limits the usefulness of a DFC that is framed in terms of long-term statistical spring-flow metrics. Furthermore, while groundwater is important locally, pumping in Kinney County represents a relatively small volume at the regional scale and has a minimal impact on adjacent areas. Collectively, these factors support the conclusion that the Edwards-Trinity (Plateau) Aquifer in Kinney County does not warrant a GMA-level DFC and can be considered as non-relevant for joint planning purposes under 31 TAC §356.31.

## 2. Replace the Existing GAM Framework with a Statistical Analysis that Aligns with the Existing DFC

Using the conditional probability approach outlined in Section 7.00, Equation 1 can be solved for an annual precipitation total that meets the DFC, which is 26.2 inches. An analytical MAG suggestion is the average annual pumping volume given an annual precipitation total of 26.2 inches, which can be estimated from Figure 12 and is approximately 6,200 acre-feet per year.

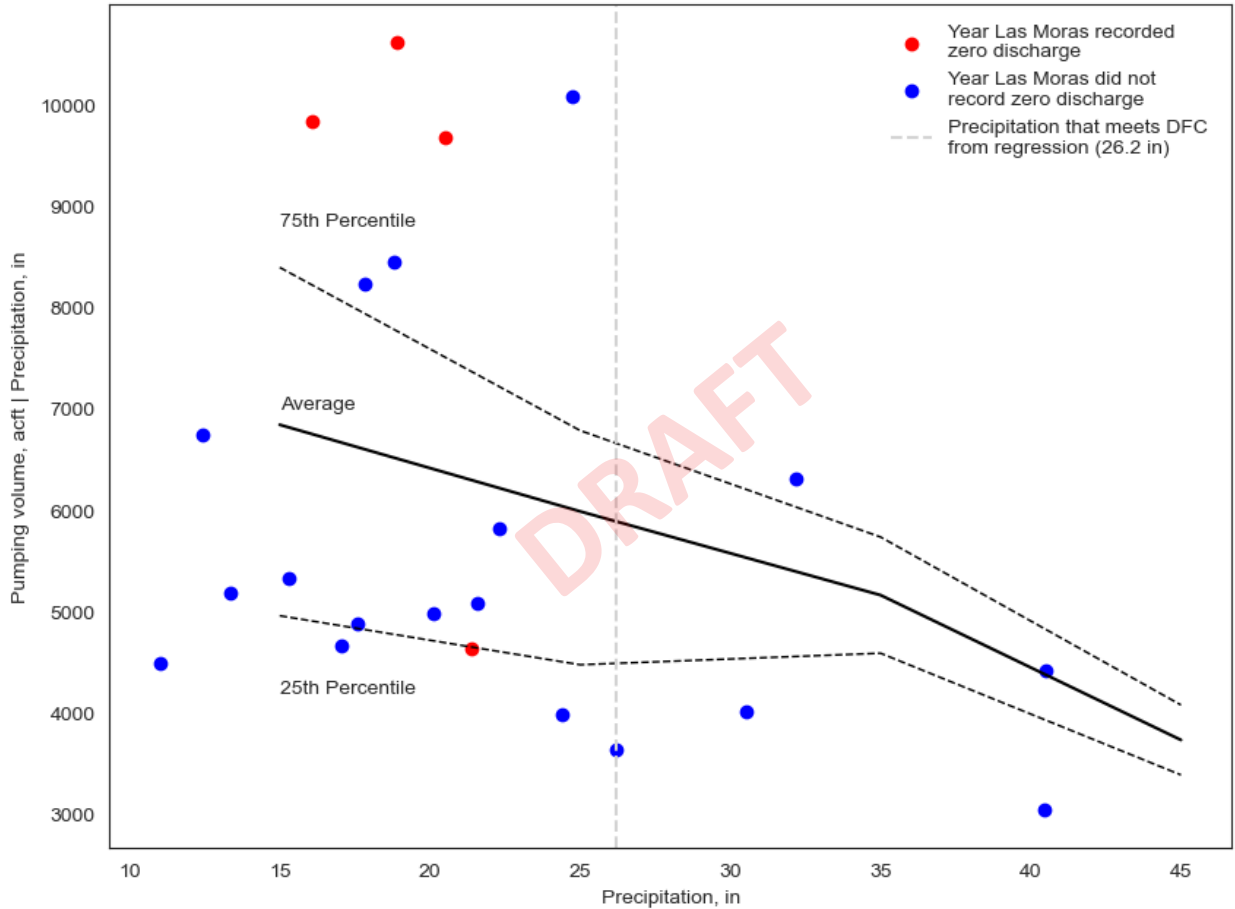


Figure 12. Annual pumping volume given an annual precipitation from 2003 to 2024.

## 9.00 REFERENCES

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## **APPENDIX B**

“Frameworks to revise the Desired Future Conditions in GMA7”

<b>TO:</b>	Kinney County Groundwater Conservation District, Board of Directors
<b>FROM:</b>	Vince Clause, PG Freese and Nichols, Inc.
<b>SUBJECT:</b>	Frameworks to Revise the Desired Future Conditions in GMA7
<b>PROJECT:</b>	KGD25636 – FY26 Hydrogeological Consulting Services
<b>DATE:</b>	January 21, 2026

<b>DRAFT</b>
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF <u>VINCE CLAUSE, P.G., TEXAS NO. 15512 ON 1/21/2025</u> . IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES. FREESE AND NICHOLS, INC. TEXAS REGISTERED GEOSCIENCE FIRM F- 50655

## 1.00 INTRODUCTION

Freese and Nichols, Inc. (FNI) has prepared this technical memorandum for the Kinney County Groundwater Conservation District (KCGCD) to support continued use of best available science in the joint planning process for Desired Future Conditions (DFCs). This memorandum summarizes high-level findings from relevant datasets and prior studies and presents a set of Desired Future Condition frameworks for the KCGCD Board to consider as it evaluates potential revisions to the existing Desired Future Condition. This work was completed under FY26 Hydrogeological Consulting Services, Task 2: Support Desired Future Conditions Joint Planning, authorized on August 23, 2025, under the Master Services Agreement between KCGCD and FNI.

**Note on scope relative to the December 12, 2025 draft memorandum.** The analysis presented in this memo differs from the draft memorandum dated December 12, 2025. The December 12 draft focused on developing an analytical approach to revise Modeled Available Groundwater (MAG) using the currently adopted Desired Future Condition for the Edwards-Trinity (Plateau) Aquifer in GMA 7 in Kinney County. Since that time, KCGCD has directed FNI to explore potential frameworks associated with a revised Desired Future Condition, and the evaluation framework has been expanded accordingly. Key differences include the following:

- **Broader use of available information.** The analysis is not limited to the period for which measured groundwater pumping records are available. Estimated pumping compiled by Green (2012) was incorporated into the analysis.
- **Updated reference conditions.** The analysis is not tied to end-of-year conditions at Las Moras Springs.
- **Newly incorporated spring discharge data.** Since December 12, 2025, additional spring discharge information was obtained from the International Boundary and Water Commission, as documented in LBG-Guyton Associates (2010) and tabulated by Hutchison (2023), covering 1957 through 1965. This eight-year interval coincides with a relatively wet period in Kinney County based on the Palmer Drought Severity Index.
- **Analytical limitations.** In the absence of a calibrated groundwater flow model, some more complex relationships (e.g., pumping volumes and spring discharge response) are evaluated using simplified statistical methods (e.g., correlation) rather than process-based simulations.

Together, these refinements are intended to better inform discussion of potential Desired Future Condition frameworks. For additional information on Joint Groundwater Planning, See Section 7.0.

## 2.00 DATA AND METHODS

### 2.01 DATA INVESTIGATED

The following datasets were reviewed for use in evaluating factors associated with discharge at Las Moras Springs:

#### Las Moras Springs Discharge

- Bennet and Sayre (1962)
- LBG-Guyton (2010) as tabulated by Hutchison (2023)
- USGS (2025a and 2025b)

#### Climate

- Precipitation, gross evaporation, and net evaporation (TWDB, 2025)
- Oceanic Nino Index anomaly (NOAA, 2025)
- Palmer Drought Severity Index (NOAA, 2026)

#### Groundwater Pumping Volumes

- EcoKai (2025a)
- Green (2012)

#### Static Water Levels

- EcoKai (2025b and 2025c)

### 2.02 CORRELATION APPROACH

To screen for statistical relationships between each dataset and Las Moras Springs discharge, we applied the following workflow:

1. **Time-step matching (“data resampling”):** Las Moras Springs discharge data were resampled to match the observation frequency of the dataset being evaluated.
  - a. *Example:* Precipitation data from Quad-807 are reported monthly, therefore, Las Moras Springs discharge data was resampled to a monthly frequency for comparison.
2. **Dataset pairing:** Each dataset of interest was paired with the resampled discharge time series over the period of overlapping record.
3. **Regression screening:** A simple linear regression was fit between the paired dataset values and spring discharge.
4. **Fit Statistic:** The coefficient of determination ( $R^2$ ) was calculated and recorded as a consistent screening statistic across datasets.

References to supporting sections are provided below.

- For summary information (tables and graphs) on each dataset, see Section 5.00.
- For correlation results with Las Moras Spring discharge, see Section 6.00.

### 2.03 LAS MORAS SPRINGS DISCHARGE SUMMARY DATA

Discharge measurements for Las Moras Springs span the period from 1900 through 2025. Over the full record, the average (“mean”) daily discharge is 17.7 cubic feet per second (cfs), and the median daily discharge is 12.6 cfs (Table 1). Data coverage is uneven through time. The most continuous and complete portion of the record begins in 2003 and continues through 2025, when monitoring is generally available on a consistent basis.

To support comparisons among periods of interest, summary statistics for daily mean discharge are presented for three drought periods and the Scenario 3 period in Table 2. To characterize longer-term conditions and reduce short-term variability (“noise”), annual mean discharge was also computed using 2-, 5-, and 7-year moving window averages. Summary statistics for these moving-window annual series are provided in Table 3.

**Data completeness note.** Monthly and annual mean values were calculated from the available daily mean values for each month or year. During the historical period, some months or years include only limited measurements. Consequently, monthly and annual statistics may be disproportionately influenced by the earlier, discontinuous portions of the record, whereas daily mean statistics are more strongly influenced by the recent period of continuous monitoring.

**Table 1.** Summary statistics from measured discharge at Las Moras Springs from the period of record (1900 to 2025). (Min. = minimum, Max. = maximum, and Std. Dev. = standard deviation)

	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
Daily mean <sup>1</sup> , cfs*	8,635	0.0	5.5	12.6	17.7	27.7	62.7	14.5
Monthly mean <sup>2</sup> , cfs*	951	0.0	9.4	16.1	20.0	30.8	60.7	13.4
Annual mean <sup>3</sup> , cfs*	97	3.1	11.8	18.7	19.7	26.8	51.0	10.3

<sup>1</sup>- Daily mean discharge represents the mean flow for a given day (cfs) based on measurements available for that date (or the reported daily mean discharge value, where applicable).

<sup>2</sup>- Monthly mean discharge is the arithmetic average of the daily mean values within a given month.

<sup>3</sup>- Annual mean discharge is the arithmetic average of the available daily mean values within each calendar year.

\* - Month or years with limited measurements may be represented by as few as one daily value; therefore, monthly and annual means are weighted toward earlier, discontinuous portions of the record, whereas daily means are weighted toward more recent observations where monitoring is more continuous.

**Table 2.** Las Moras Springs daily mean discharge (cfs) during periods of interest.\*

Period	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
Scenario 3 (1950 to 2005)	1,418	0.0	20.0	26.6	28.4	40.0	61.3	12.6
Drought of Record (1950 to 1957)	49	2.8	7.6	10.1	15.6	18.4	49.7	12.3
2011 Drought (2009 to 2015)	2,433	0.0	4.5	8.2	11.3	13.3	62.7	10.1
Recent Drought (2020 to 2025)	2,127	0.0	1.4	5.1	7.0	9.9	40.7	7.3

\* - Reported values differ from those in the December 12, 2025 draft memo due to the revised scope described in Section 1.0.

**Table 3.** Las Moras Springs annual mean discharge (cfs) from moving-window averages (1900 to 2025).

Moving-Window Annual Average	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
2-year moving average	90	4.5	15.3	19.9	19.8	24.0	48.3	8.0
5-year moving average	84	6.0	17.7	20.0	20.2	22.6	36.0	5.5
7-year moving average	82	10.9	17.8	20.1	20.4	23.2	29.9	4.2
10-year moving average	79	14.8	18.6	20.5	20.5	22.0	26.0	2.8

## 2.04 CLIMATE DATA

**Palmer Drought Severity Index (PDSI) plain-language note.** The Palmer Drought Severity Index (PDSI) describes how unusually wet or dry an area is based on recent weather conditions. It uses precipitation and temperature to estimate moisture conditions, where positive values indicate wetter than normal conditions and negative values indicate drier than normal conditions. Larger values represent more extreme conditions. Because PDSI reflects accumulated conditions over the course of weeks to months, it responds more slowly than precipitation alone.

Among the climate data evaluated, Las Moras Springs discharge exhibited the strongest correlation with the PDSI (Table 4). Average daily discharge during wet conditions (PDSI > 1) was 31.7 cfs, while average daily discharge during dry conditions (PDSI < -1) was 11.3 cfs (Table 5). Over the PDSI period of record, conditions in Kinney County are most often (“median”) characterized as an ‘incipient dry spell’ (Table 6).

**Table 4.** Summary statistics for monthly precipitation, gross and net evaporation, the Palmer Drought Severity Index, and the Oceanic Nino Index (ONI) Anomaly.

Climatic Data Type	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.	Correlation with Las Moras Springs mean monthly discharge (cfs)
Precipitation, in <sup>1</sup>	858	0.0	0.8	1.7	2.1	2.9	16.2	1.8	0.08
Gross Evaporation, in <sup>1</sup>	858	1.2	3.5	5.5	5.7	7.5	14.4	2.6	0.06
Net Evaporation, in <sup>1</sup>	858	-8.3	1.5	3.3	3.6	5.6	13.7	3.1	0.13
PDSI <sup>2</sup>	1,511	-5.5	-2.2	-0.7	-0.3	1.6	8.3	2.6	0.52
ONI Anomaly <sup>3</sup>	909	-2.03	-0.56	-0.06	0.01	0.53	2.64	0.83	0.01

<sup>1</sup> – TWDB (2025)

<sup>2</sup> – NOAA (2026)

<sup>3</sup> – NOAA (2025)

**Table 5.** Las Moras Springs monthly mean discharge (cfs) during different climatic conditions based on the Palmer Drought Severity Index (PDSI).

PDSI Condition	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
Wet conditions (PDSI >= 1)	290	0.0	22.5	33.9	31.7	40.5	60.7	12.0
Dry Conditions (PDSI <= -1)	410	0.0	5.6	9.7	11.3	14.8	49.1	8.3
Extremely Wet (PDSI >= 4)	72	22.2	38.2	41.9	42.2	47.1	60.7	8.1
Very Wet (3 <= PDSI < 4)	48	19.9	30.2	37.6	36.3	41.5	51.1	7.7
Moderate Wet (2 <= PDSI < 3)	71	0.0	19.2	30.8	28.2	35.7	49.8	10.9
Slightly Wet (1 <= PDSI < 2)	99	5.2	14.8	24.2	24.2	33.3	41.7	10.4
Incipient Wet Spell (0.5 <= PDSI < 1)	49	0.9	10.1	15.5	18.2	25.4	47.4	10.6
Near Normal (-0.5 < PDSI < 0.5)	110	0.4	11.6	18.5	21.0	30.6	47.1	11.5
Incipient Dry Spell (-0.5 >= PDSI > -1)	86	2.8	13.6	19.7	21.4	28.3	42.9	9.9
Mild Drought (-1 >= PDSI > -2)	138	1.5	9.3	13.7	15.6	19.4	49.1	8.9
Moderate Drought (-2 >= PDSI > -3)	144	0.0	5.9	9.8	11.0	13.4	43.2	7.6
Severe Drought (-3 >= PDSI > -4)	88	0.0	4.3	6.8	7.8	9.9	27.9	5.6
Extreme Drought (-4 >= PDSI)	40	0.0	2.3	4.8	5.8	7.1	23.1	5.6

**Table 6.** Summary statistics for the Palmer Drought Severity Index in Kinney County.

Measured Timeframe	Count	Min	25%	Median	Mean	75%	Max	Std Dev
Mean Monthly PDSI	1,511	-5.5	-2.2	-0.7	-0.3	1.6	8.3	2.6
2-Year Window Moving Average	1,488	-4.4	-1.1	-0.2	-0.3	0.6	4.9	1.6
5-Year Window Moving Average	1,452	-3.5	-0.7	-0.1	-0.2	0.4	2.6	1.0
7-Year Window Moving Average	1,428	-3.1	-0.5	0.0	-0.2	0.3	1.0	0.8
10-Year Window Moving Average	1,392	-2.2	-0.4	-0.1	-0.2	0.2	0.8	0.5

## 2.05 GROUNDWATER PUMPING VOLUMES

From the data evaluated, average groundwater pumping in Kinney County is 7,329 acre-feet per year (ac-ft/yr), with annual estimates ranging from 2,301 to 14,973 ac-ft/yr (Table 7). Maximum reported annual groundwater pumping volumes occurred prior to metered reporting. Groundwater pumping estimates reported from Green (2012) are compiled from two datasets. For years with values reported in both datasets, the two estimates were averaged to produce a single annual pumping value.

**Table 7.** Summary statistics for annual groundwater pumping in Kinney County.

	Count	Min	25%	Median	Mean	75%	Max	Std Dev	Correlation with Las Moras Springs mean annual discharge (cfs)
Estimated and Measured <sup>1</sup>	47	2,301	4,928	6,915	7,329	9,663	14,973	2,838	0.20
GMA 7 <sup>2</sup>	22	2,999	4,185	4,773	5,748	7,585	10,089	2,262	0.16
GMA 10 <sup>2</sup>	22	12	71	245	372	513	1,376	393	0.21

<sup>1</sup> – Estimated and measured values include available annual measurements for Kinney County and are non-differentiated by location or aquifer.

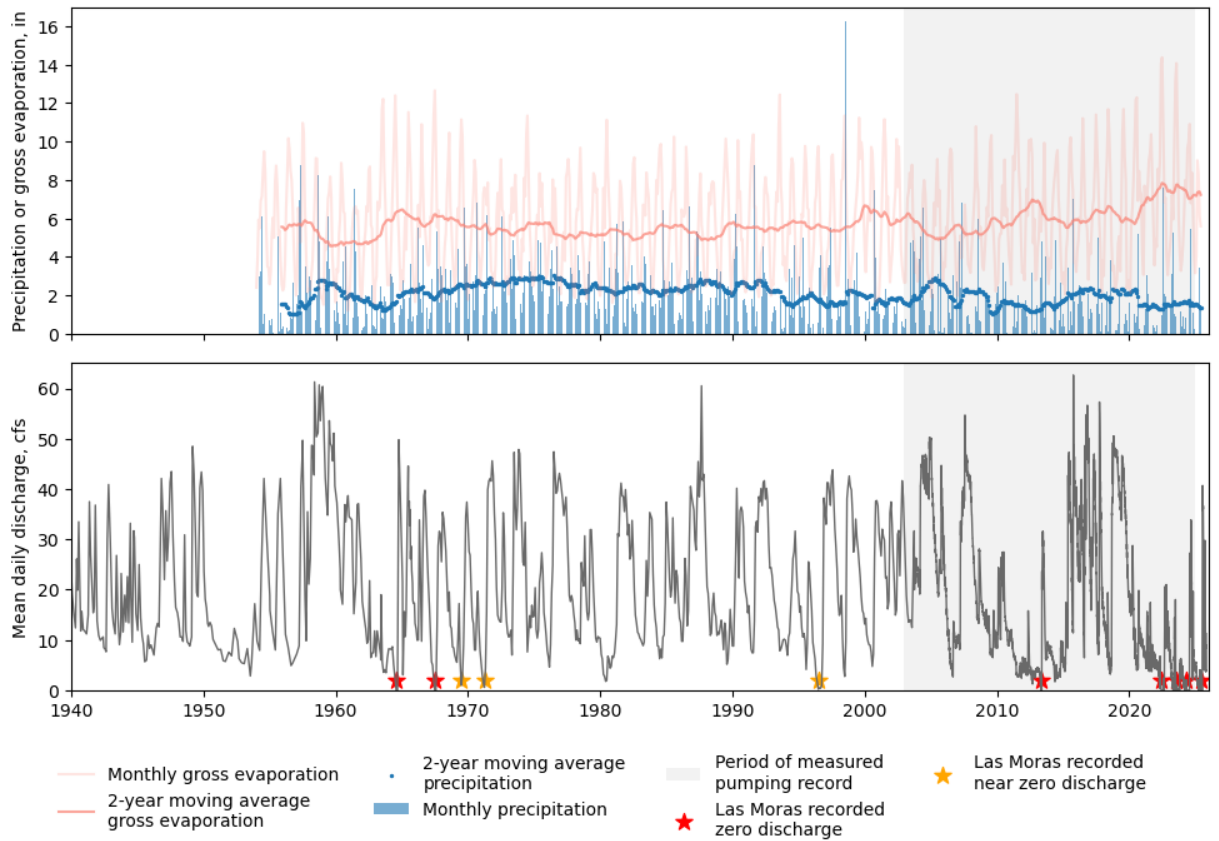
<sup>2</sup> – GMA 7 and 10 records are based on data provided by Kinney County and were assigned to GMA 7 or 10 by FNI based on spatial designation. These results are not differentiated by aquifer.

## 2.06 INITIAL STATIC WATER LEVEL OBSERATIONS

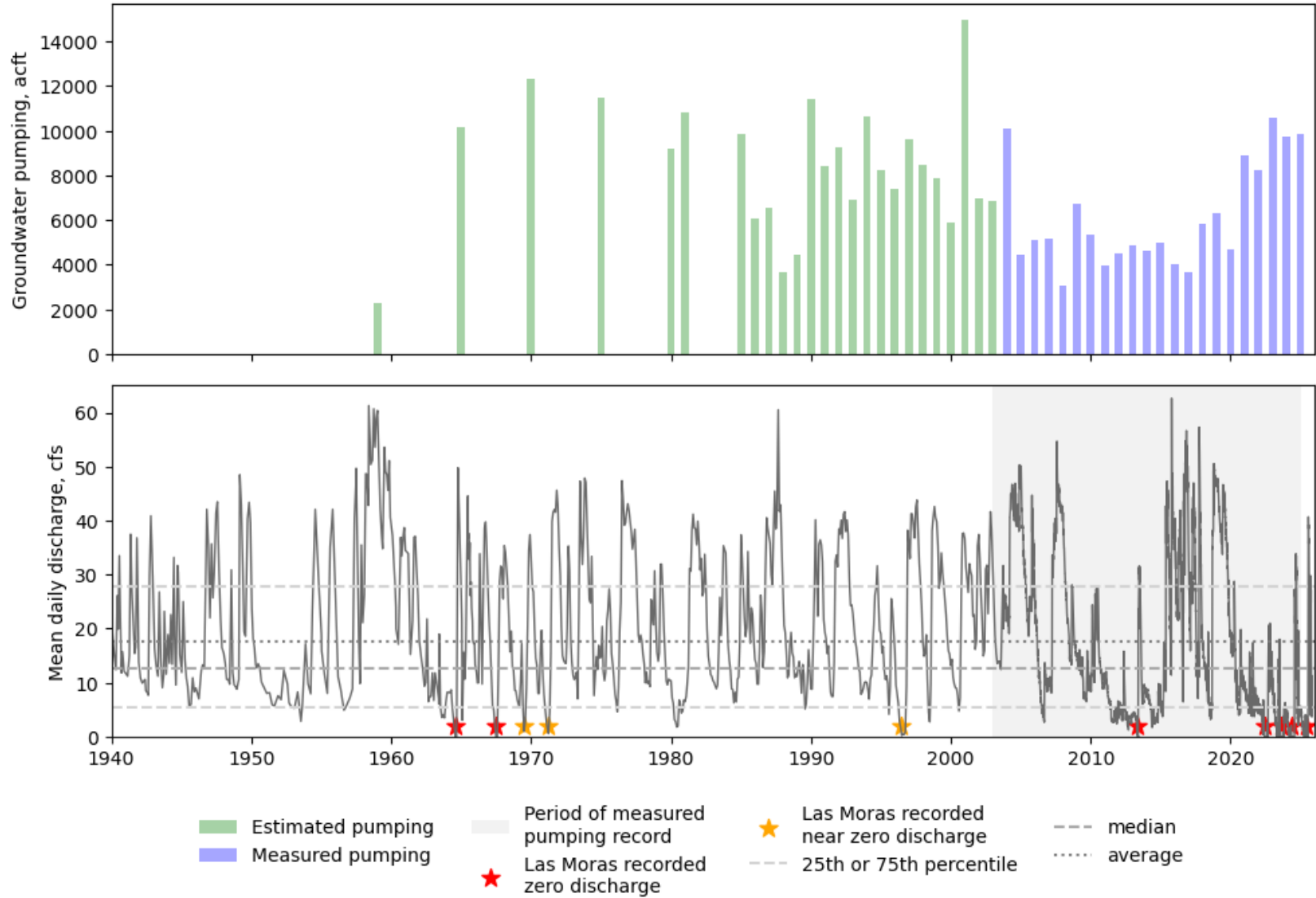
**Initial Static Water Level note.** The information presented in this section is preliminary. Additional data screening, cleansing and QA/QC are needed to increase confidence in any interpretation and conclusions. Correlations presented here should not be interpreted as causation, and a lack of correlation should not be interpreted as evidence that no relationship exists. This section is included to demonstrate that static water levels in some Kinney County wells correlate strongly with Las Moras discharge along the “bowling alley,” as described by Mr. Jim Burton.

Daily mean static water level data from each available dataset were paired with Las Moras Springs daily mean discharge records over periods of overlapping record. The paired data were evaluated by cross-plotting mean daily static water level versus mean daily discharge, and an R<sup>2</sup> value was calculated to quantify the strength of a linear relationship. Because R<sup>2</sup> reflects a linear correlation, some well plots that show a non-linear correlation were also evaluated for a potential ‘critical threshold’. This ‘critical threshold’ resembles an “elbow” or “cliff” in the plotted relationship and could signal a static water level below which Las Moras Springs is more likely to stop flowing. The complete set of static water level and discharge cross-plots are provided in Section 6.05.

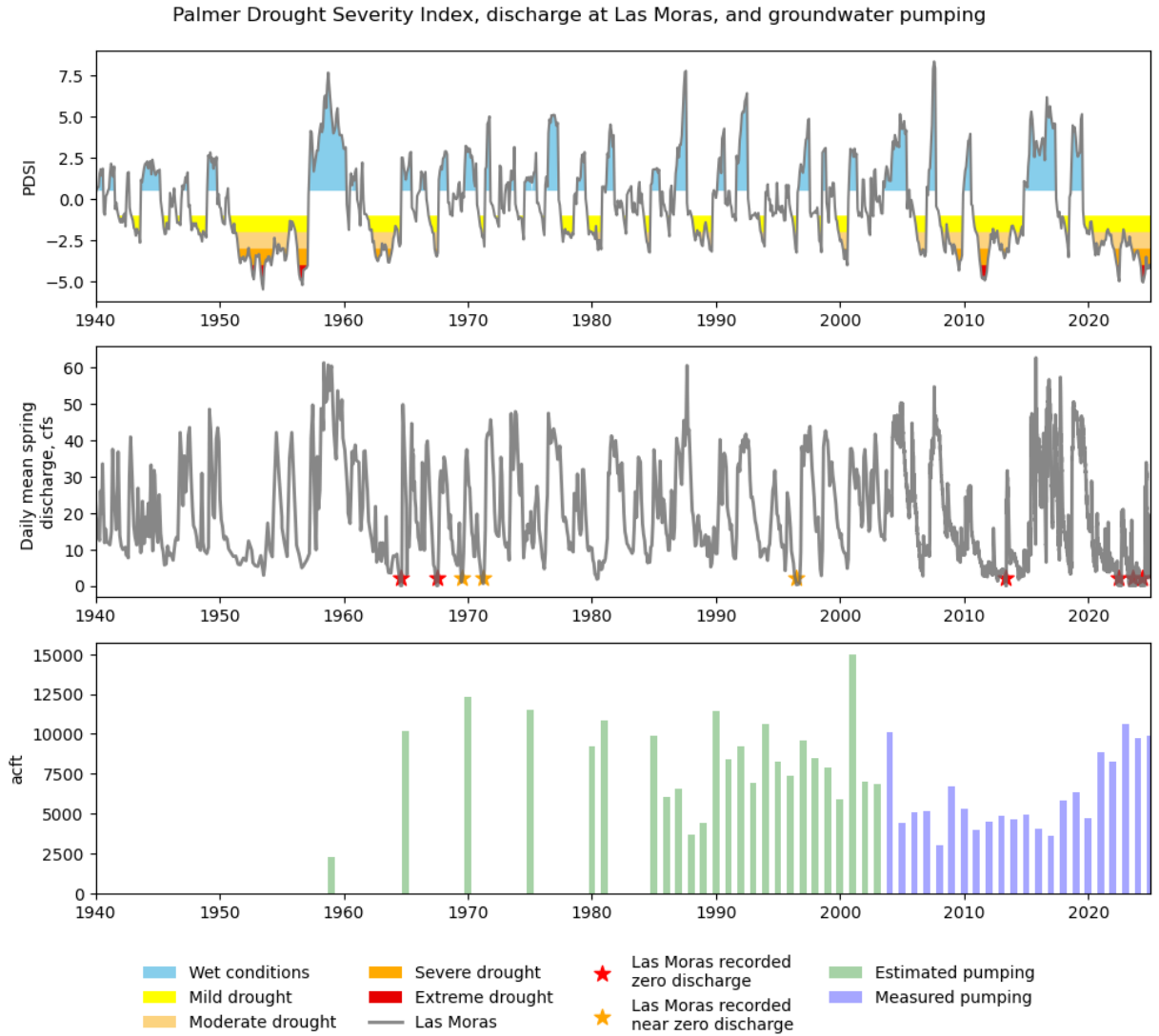
**2.07 STACKED GRAPHS DEMONSTRATING LAS MORAS SPRINGS DISCHARGE, CLIMATE DATA, AND GROUNDWATER PUMPING VOLUMES.**



**Figure 1.** Las Moras Springs discharge, gross evaporation, and precipitation.



**Figure 2.** Las Moras Springs discharge and groundwater pumping volumes.



**Figure 3.** Palmer Drought Severity Index, Las Moras Springs discharge, and groundwater pumping volumes.

### 3.00 DFC EXPLORATORY FRAMEWORKS FOR A REVISED DESIRED FUTURE CONDITION FOR THE EDWARDS-TRINITY (PLATEAU) IN GMA 7 (KINNEY COUNTY)

The frameworks below are provided to support Board discussion of potential revisions to the Desired Future Condition. These frameworks assume the Kinney County GCD Board is interested in a spring discharge-based Desired Future Condition tied to discharge at Las Moras Springs. If the Board does not wish to pursue a spring discharge-based Desired Future Condition, it may elect to develop alternative Desired Future Condition language not included in this memorandum.

**Implementation note (applies to all frameworks).** Each framework includes placeholders (e.g. ##.#, #-years) that should be populated with the Board-selected threshold(s), and evaluation period(s). The frameworks presented herein are based on, and constrained by, the datasets currently available to the District. Additional or alternative Desired Future Condition formulations may not be feasible without improved data coverage and/or enhanced monitoring. The set of frameworks is intentionally limited at this stage to promote focused, productive dialogue, without resolving implementation details (e.g. a 2080 planning horizon, Modeled Available Groundwater formulation, regulatory compliance procedures). Final Desired Future Condition language should be developed with careful attention to definitions, measurement methods, and compliance evaluation so that the adopted Desired Future Condition is clear, measurable, enforceable, and implementable.

**Desired Future Conditions definition.** Under 31 TAC §356.10(11), a DFC is “the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a groundwater management area at one or more specified future times as defined by district representatives within a groundwater management area as part of the joint planning process”.

**Plain language explanation.** A Desired Future Condition is a quantified management objective describing desired future aquifer conditions. Once adopted through joint planning, it serves as a policy goal that guides a GCD’s management strategies, planning assumptions, and development of rules and permitting criteria.

#### 3.01 DFC FRAMEWORKS TO EXPLORE

##### A. One-tiered spring discharge metric

*Daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cfs when averaged over #-years/months/days.*

##### Description

- A single, clearly defined spring discharge threshold over a defined averaging period (e.g., daily, monthly, annual, or multi-year moving average).

##### Example desired future condition statements (illustrative, for discussion only)

- Daily mean spring discharge measured at Las Moras Springs shall not be less than 17.7 cfs when averaged over 5-years.
- Monthly mean spring discharge measured at Las Moras Springs shall not be less than 7.0 cfs when averaged over a rolling 16-month period.

### Pros

- Straightforward metric and compliance determination.
- If a lower threshold target is selected (e.g., drought-period central tendency), the Desired Future Condition is more likely to be met during extended dry periods.
- Multi-year averaging reduces sensitivity to short-term variability and better accommodates climate-driven fluctuations.

### Cons

- If the threshold is set near long-term mean conditions, the Desired Future Condition may be difficult to achieve during drought.
- If the selected threshold is too low, it may inadvertently support less conservative groundwater use while still “meeting” the Desired Future Condition.
- Multi-year averaging may still not be achieved under prolonged moderate-to-exceptional droughts that persist beyond the averaging window.
- If compliance hinges on a long window, there may be less urgency to respond to early warning signals, while a short window may drive overly reactive management.
- An average-based metric may allow short-term duration “dry” or no-flow spring conditions while the average remains above the threshold.
- Due to measurement methods, runoff during rainfall events may temporarily inflate the actual spring discharge measurement over a short-time frame.

### Board-selectable alternatives

- Use different spring discharge statistics (e.g., median daily discharge, monthly mean, or percentile-based target such as the 25<sup>th</sup> percentile).
- Modify the compliance window (e.g., 1-year, 2-year, 7-year, or 10-year moving average).

### Example of similar DFC language (for reference)

- Clearwater UWCD in GMA 8 – “Maintain at least 100 acre-feet per month of stream/spring flow in Salado Creek during a repeat of the drought of record” (adopted 11/4/2021 for the Edwards (BFZ) Aquifer; TWDB, 2026)

## **B. Multi-tiered spring discharge metric with drought definition**

*Daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cfs when averaged over #-years/months/days, except during drought conditions. During drought conditions, as defined by a Palmer Drought Severity Index of less than # on average over a #-month period, daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cfs.*

### Description

- A spring discharge threshold evaluated over a defined averaging period under typical conditions, with an alternate (lower) spring-discharge threshold applied during clearly defined drought conditions (based on a specified drought indicator, threshold, and averaging window).

### Example desired future condition statements (illustrative, for discussion only)

- Daily mean spring discharge measured at Las Moras Springs shall not be less than 20 cfs when averaged over 5-years except during drought conditions. During drought conditions, as defined by a Palmer Drought Severity Index of less than -1 on average over a 12-month period, daily mean spring discharge measured at Las Moras Springs shall not be less than 5.7 cfs.

### Pros

- Allows differentiated targets for drought versus non-drought climatic conditions.
- Explicitly recognizes that spring discharge behavior differs between normal and drought periods, which can make the Desired Future Condition more attainable and technically defensible.
- Provides a defined basis for drought management actions (e.g., drought-stage triggers and groundwater production reductions) tied to a defined drought indicator.

### Cons

- More complex language and compliance determination than a one-tiered metric, which may be more difficult to communicate.
- PDSI responds slowly to changing conditions which may lead to disjointed management following extremely wet/dry shifts. For this reason, tier transition rules should also be considered (e.g., drought status persists for X months before switching tiers).
- Achieving the drought-tier target may require groundwater production reductions during drought conditions.
- An average-based metric may still allow short-term “dry” or no-flow spring conditions while the average remains above the threshold.
- Due to measurement methods, runoff during rainfall events may temporarily inflate the actual spring discharge measurement over a short-time frame.

### Board-selectable alternatives

- Use different spring discharge statistics (e.g., median daily discharge, monthly mean, or percentile-based target such as the 25<sup>th</sup> percentile).
- Use different drought indicators (e.g., Precipitation deficit), drought thresholds, and/or drought averaging windows.
- Modify the compliance window (e.g., 1-year, 2-year, 7-year, or 10-year moving average).
- If preventing “dry” or no-flow conditions is a priority, the Board can consider adding on “no more than # consecutive days or zero flow.”

### Example of similar DFC language (for reference)

- Barton Springs/Edwards CD in GMA 10 – “Springflow at Barton Springs during average recharge conditions shall be no less than 49.7 cfs averaged over an 84 month (7-year) period; and springflow of Barton Springs during extreme drought conditions, including those as severe as a recurrence of the 1950s drought of record, shall be no less than 6.5 cfs average on a monthly basis.” (adopted 10/26/2022 for the Edwards (BFZ) Aquifer; TWDB, 2026).

### **C. Static water level in index-wells metric**

The water level in [Well Name/ID] shall be greater than ##### feet above mean sea level when averaged over a #-year period.

**Framework C note.** Although this framework does not explicitly include spring discharge in the condition statement, several wells have been identified that correlate strongly with Las Moras Springs discharge.

### Description

- A Desired Future Condition based on maintaining groundwater levels in one or more clearly identified “index” wells above a specific threshold, evaluated over a defined averaging period.

### Example desired future condition statements (illustrative, for discussion only)

- The water level in well 70-45-503 (Monitor Well # 1 / City of Brackettville Well # 1) shall be greater than 1,105 feet above mean sea level on average over a 5-year period.

### Pros

- Relatively straightforward to interpret and evaluate for compliance.
- Can be directly tied to groundwater production management (e.g. drought state or curtailment triggers tied to measured/static water levels in monitor wells).
- Can be monitored/tracked real-time by District without reliance on external monitoring.
- Can be designed/selected to minimize pumping interference from nearby wells (e.g. interference that MUD wells currently exert on spring pool).
- A water level average considers conditions below the dry or no-flow spring stage, better highlighting the magnitude of drawdown during these periods.

### Cons

- Without a robust, calibrated groundwater flow model, translating a water level-based Desired Future Condition into Modeled Available Groundwater in a technically defensible manner may be challenging.
- Average-based water level metrics may still allow short-term “dry” or no-flow spring conditions while the average remains above the threshold.
- Index wells should ideally be owned by the District or other public entities, not private property owners.
- Additional analysis is needed to support index well selection, thresholds, and interference.

### Board-selectable alternatives

- The Board may select different wells or different static water level targets. The below wells appear to be suitable for a static water level based desired future condition that correlates well with Las Moras Springs discharge. **Note:** M002, M070, and M081 have static water levels that are influenced by pumping from the well or by a neighboring well. Ideally, a monitor well with minimal influence would be selected.
  - M002 – Lindsey Ranch: preliminary threshold ~1,110 feet above mean sea level
  - M070 – EH2B-02 Rose: preliminary threshold ~1,105 feet above mean sea level
  - M081 – Gomez No. 1: preliminary threshold ~1,110 feet above mean sea level
  - O001 – Tularosa Well: preliminary threshold ~1,193 feet above mean sea level.

### Example of similar DFC language (for reference)

- Kinney County GCD in GMA 10 – “The water level in well 70-38-902 shall not fall below 1,184 ft mean sea level” (adopted 10/26/2022 for the Edwards (BFZ) Aquifer; TWDB, 2026)

#### **D. Multi-statistic spring discharge metric (mean + median / percentile)**

Spring discharge at Las Moras Springs shall be maintained such that the annual average discharge is not less than ##.# cfs, and the median (or percentile-based statistic such as the 25<sup>th</sup> percentile) discharge is not less than ##.# cfs, evaluated over #-years/months.

**Framework D note.** Although this framework follows the existing Desired Future Condition structure for Kinney County in Groundwater Management Area – 7 for the Edwards Trinity (Plateau) Aquifer, with additional refinement, this approach can be improved.

##### Description

- A spring discharge-based Desired Future Condition that uses two complementary statistics (e.g. mean and median).

##### Pros

- Reduce the chance that compliance is driven by short-lived spikes (e.g. runoff-related measurement spikes) or masked by averaging.
- Retains the simplicity and clarity of a spring discharge-based Desired Future Condition while adding a second compliance check that better reflects typical conditions.

##### Cons

- More complex, mixed structure requires tracking of two metrics.
- May still allow short-term “dry” or no-flow spring conditions while the average/median remains above the threshold.

##### Board-selectable alternatives

- The Board may use a different secondary statistics (e.g., 25<sup>th</sup> percentile, or minimum monthly mean).
- The Board may choose a separate evaluation window(s) (e.g., mean over 5 years plus median over 5 years, or mean annual plus median monthly).
- If preventing “dry” or no-flow conditions the Board can consider adding on “no more than # consecutive days or zero flow”.

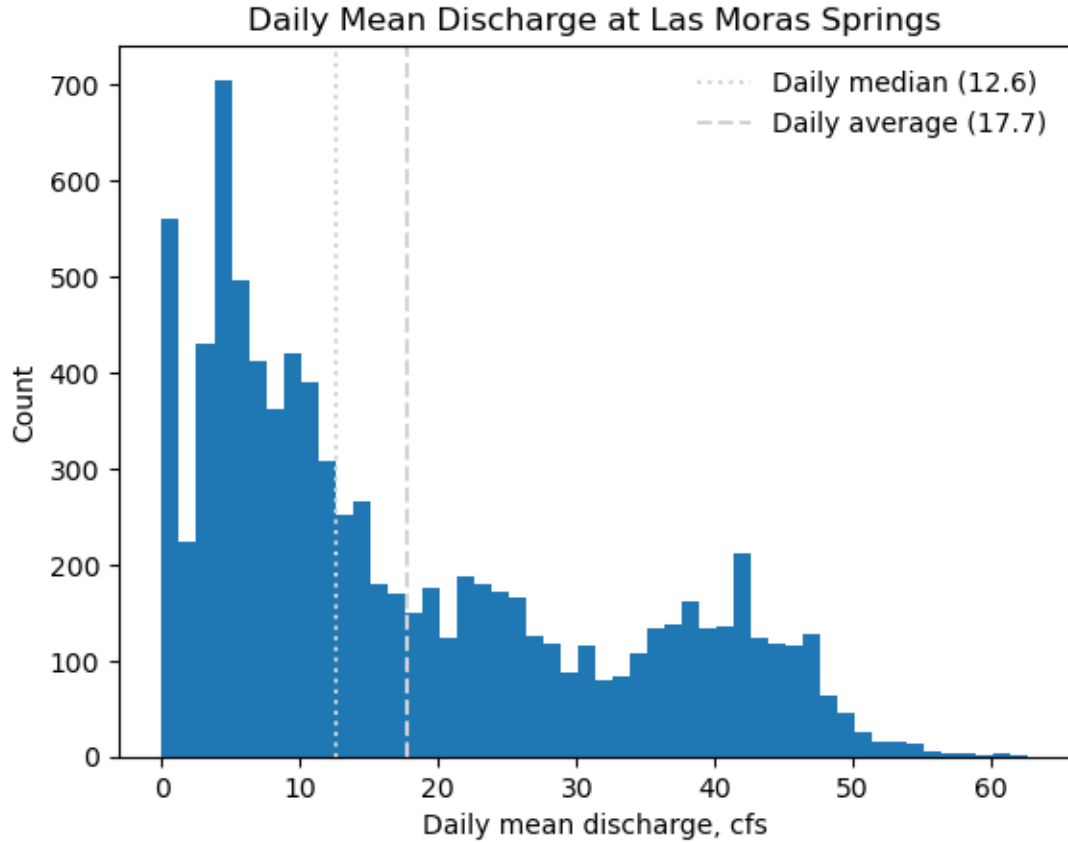
##### Example of similar DFC language (for reference)

- The existing GMA 7 Kinney County Desired Future Condition approach explicitly uses both average and median flow at Las Moras Springs.

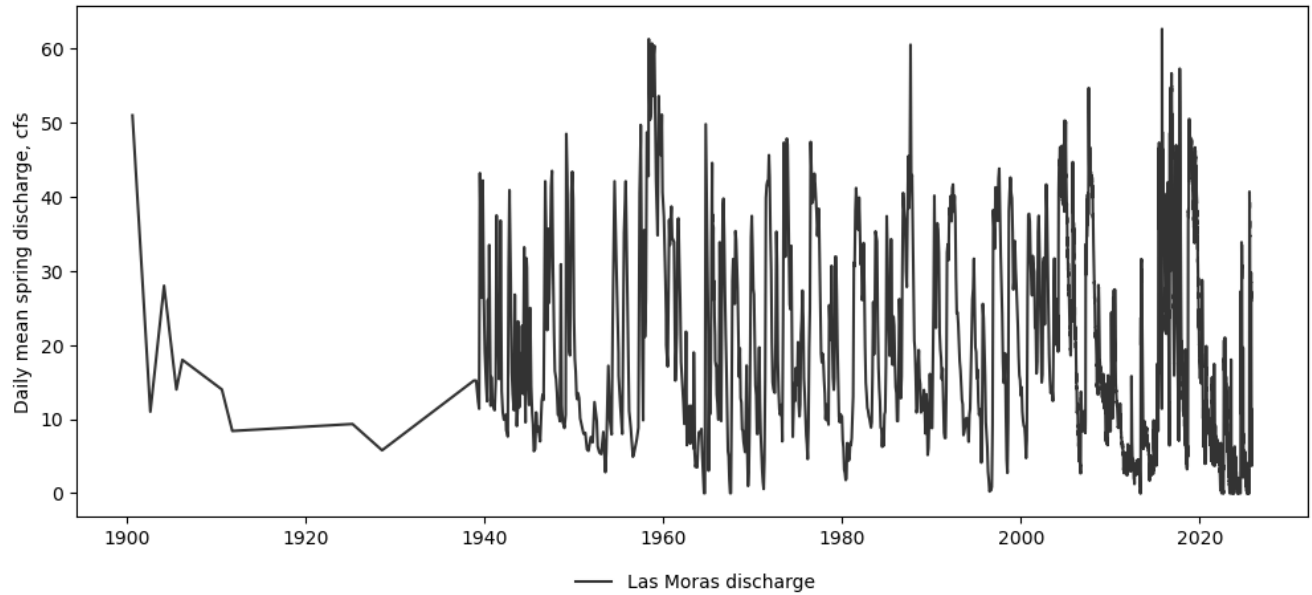
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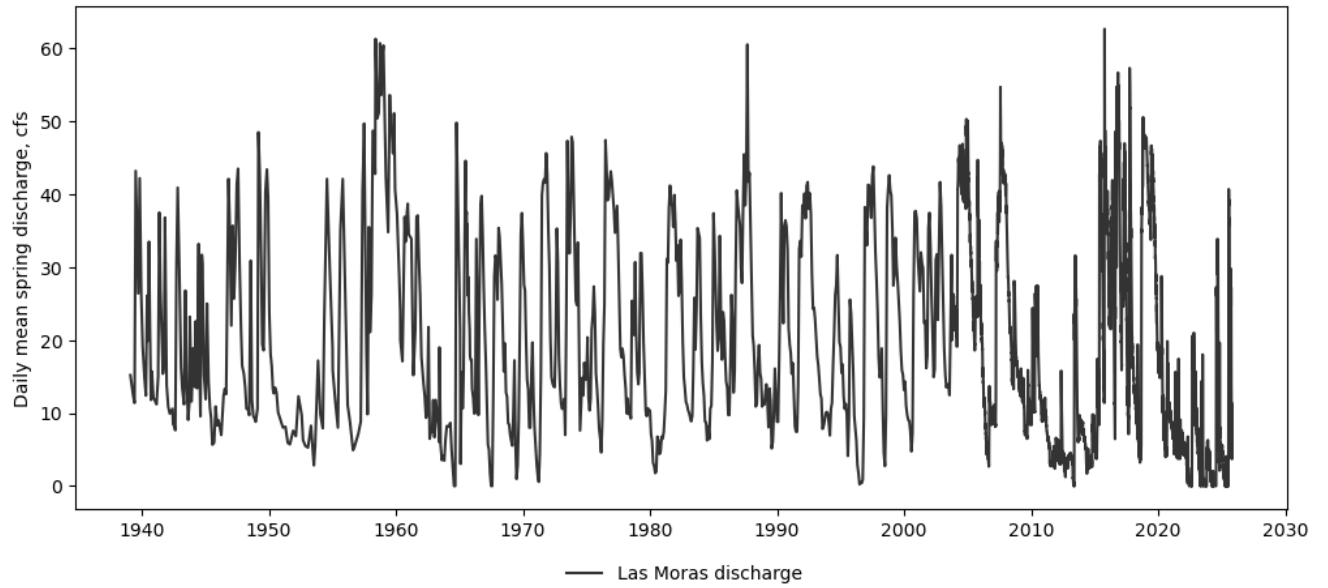
## 5.00 APPENDIX A – SUMMARY TABLES AND GRAPHS



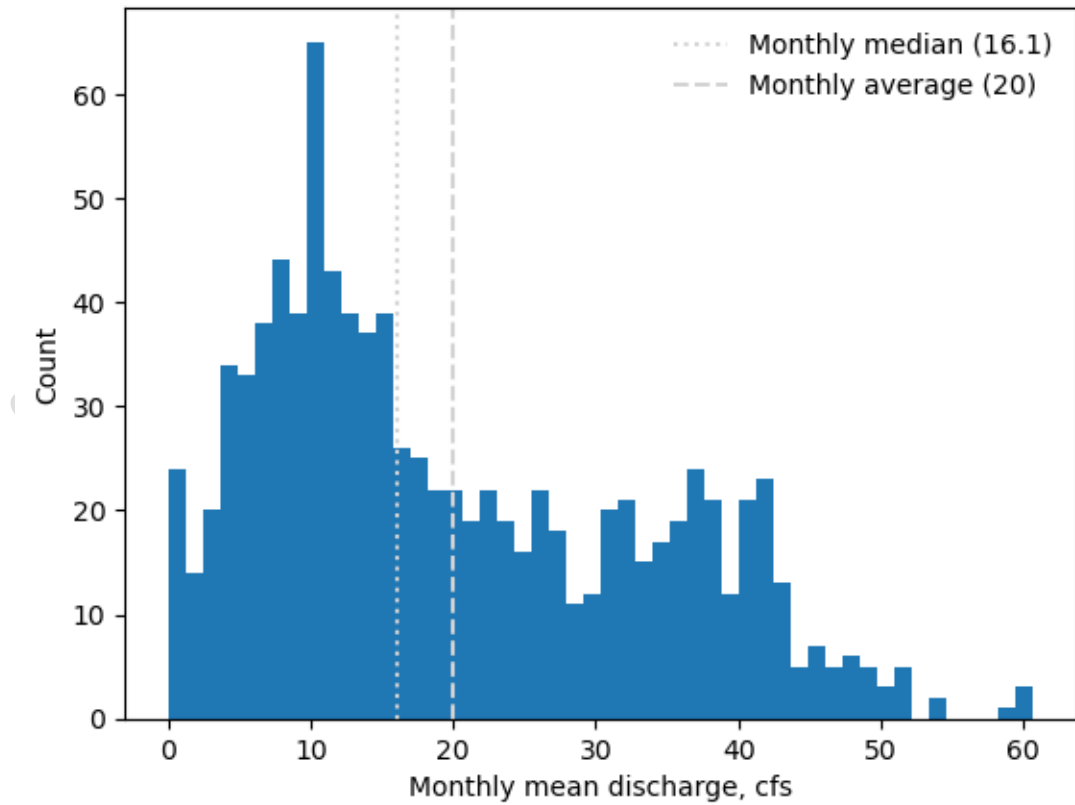
Daily Mean Discharge at Las Moras Springs, period of record



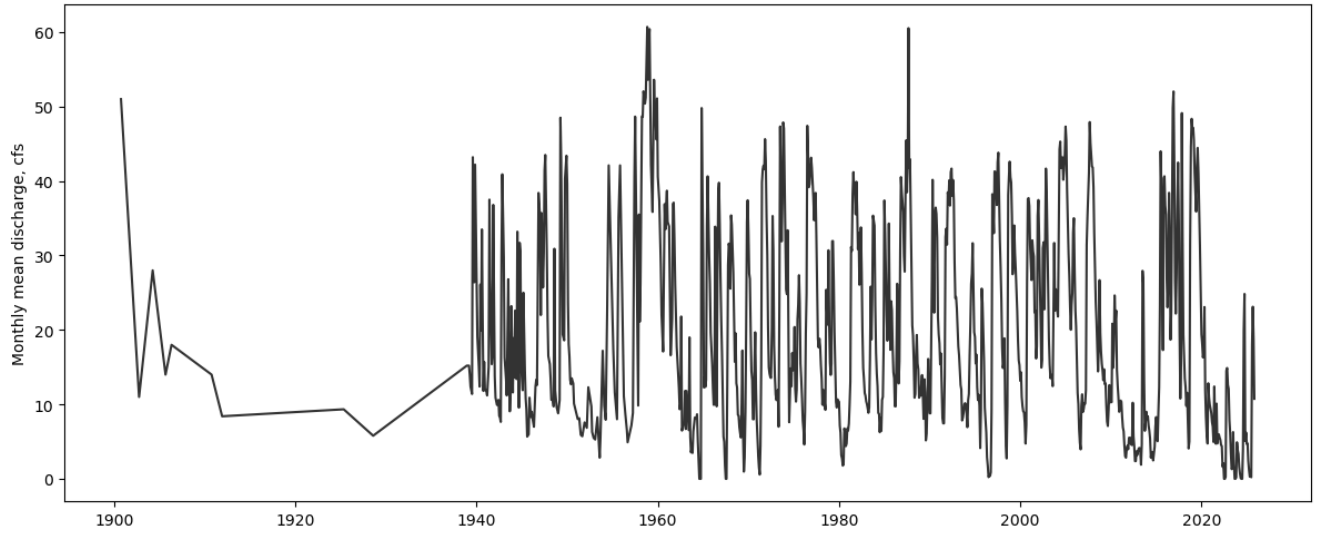
Daily Mean Discharge at Las Moras Springs, 1940 to 2025



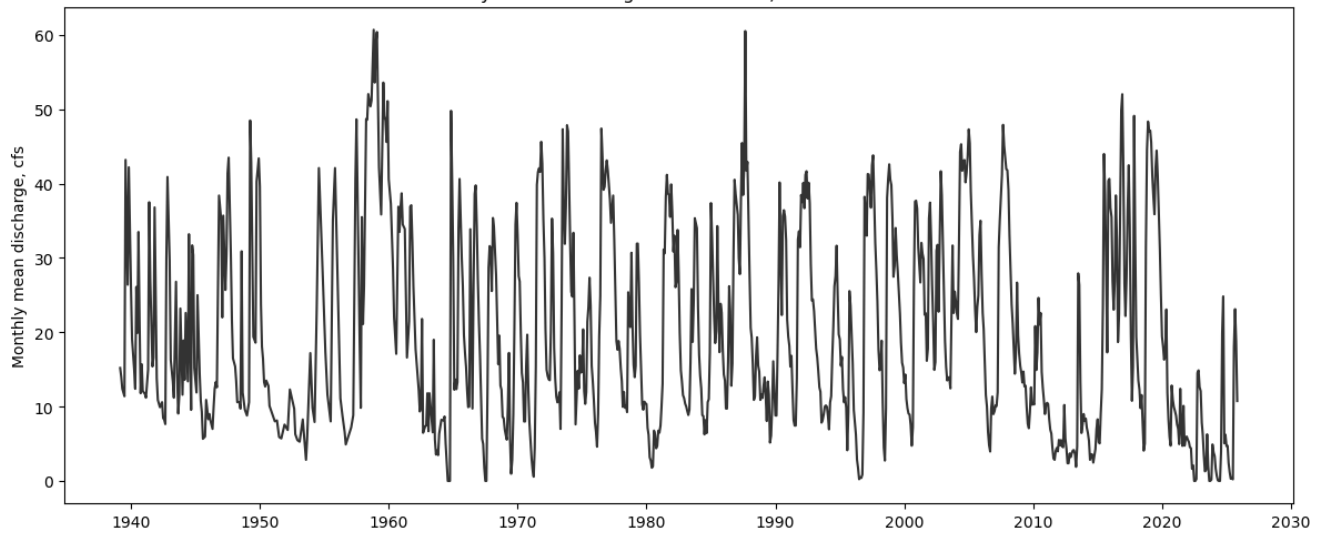
Monthly Mean Discharge at Las Moras Springs



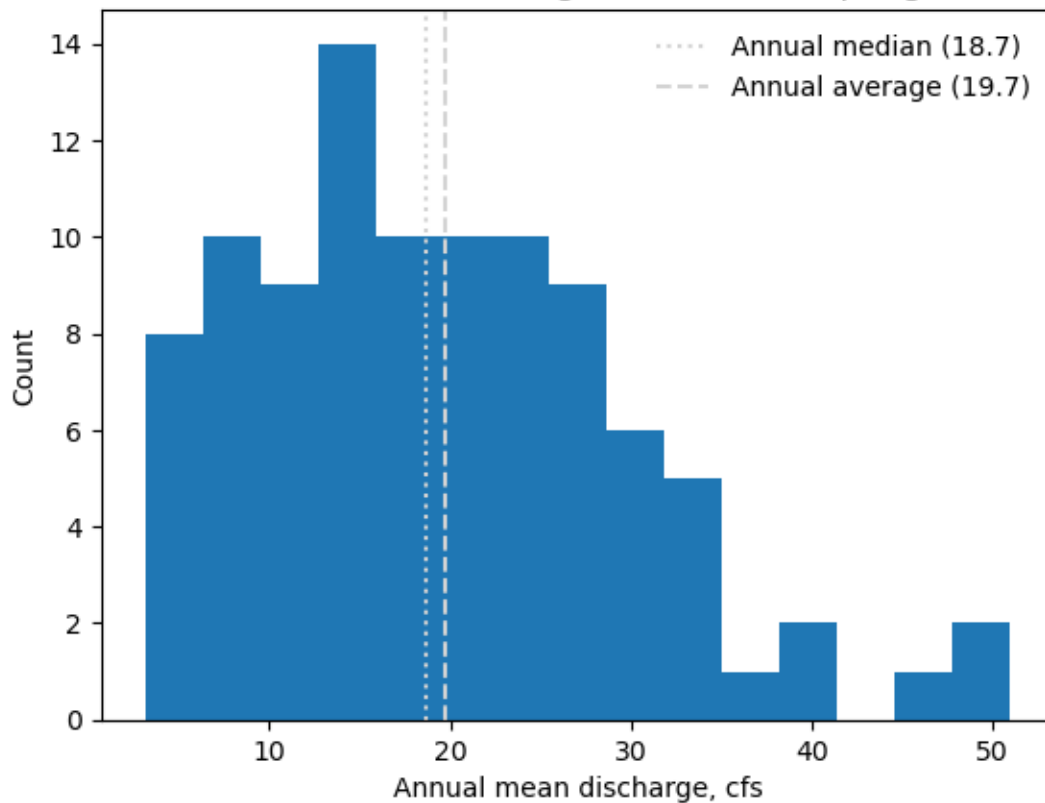
Monthly mean discharge at Las Moras, period of record



Monthly mean discharge at Las Moras, 1940 to 2025

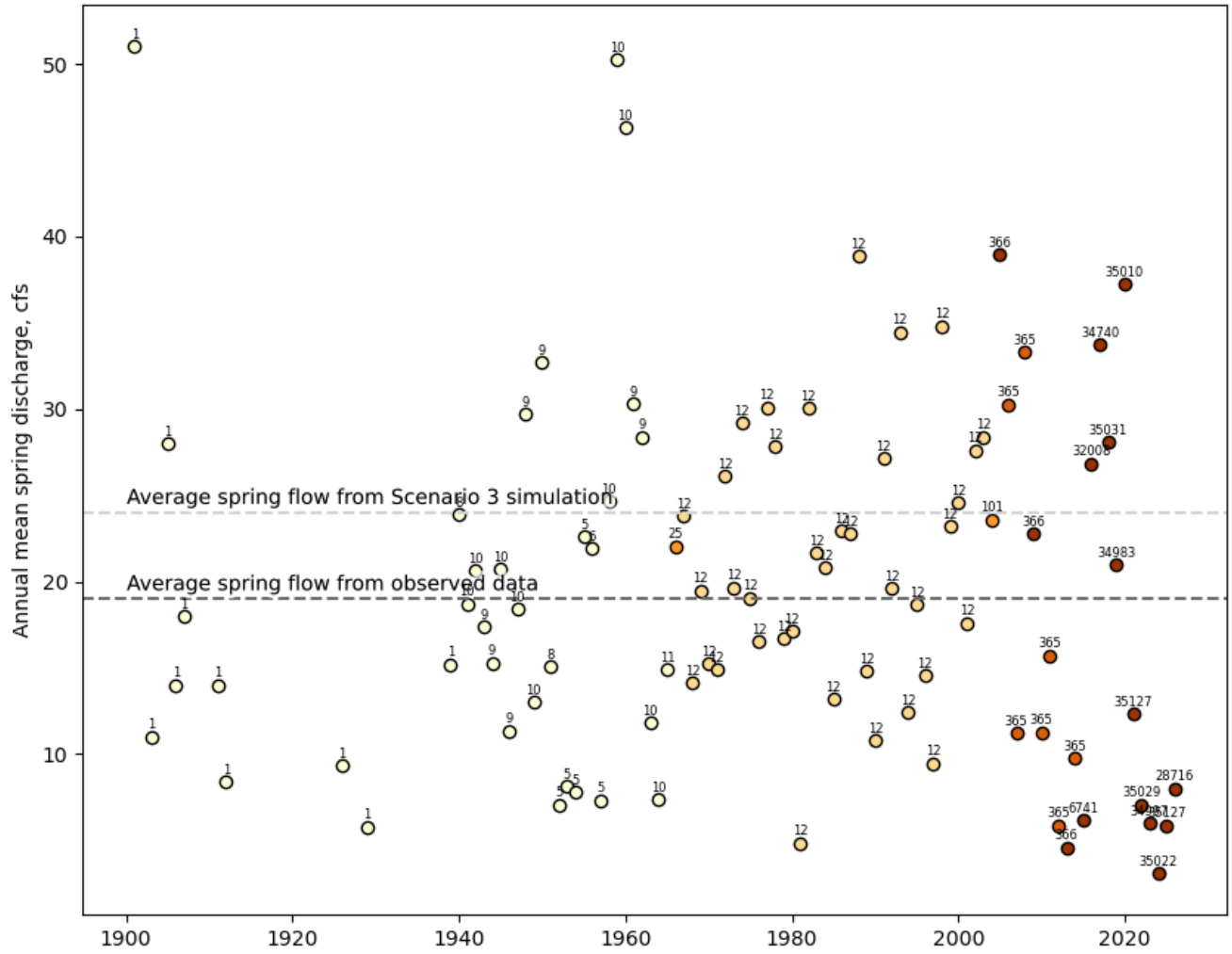


Annual Mean Discharge at Las Moras Springs



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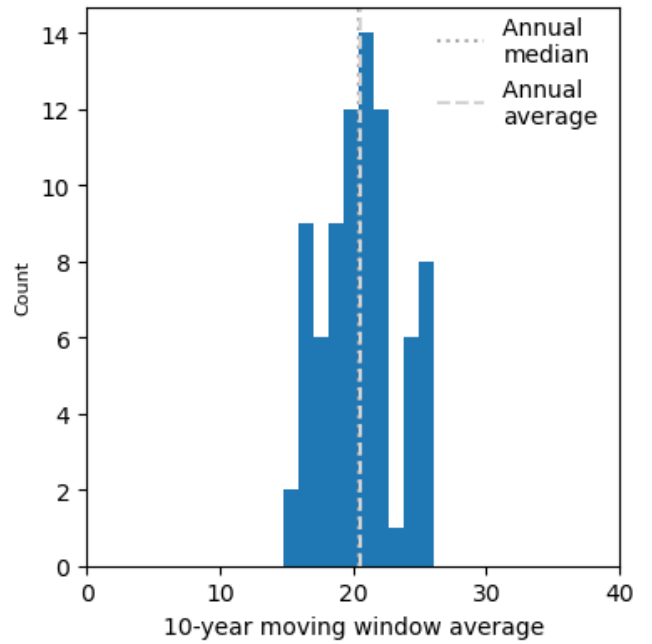
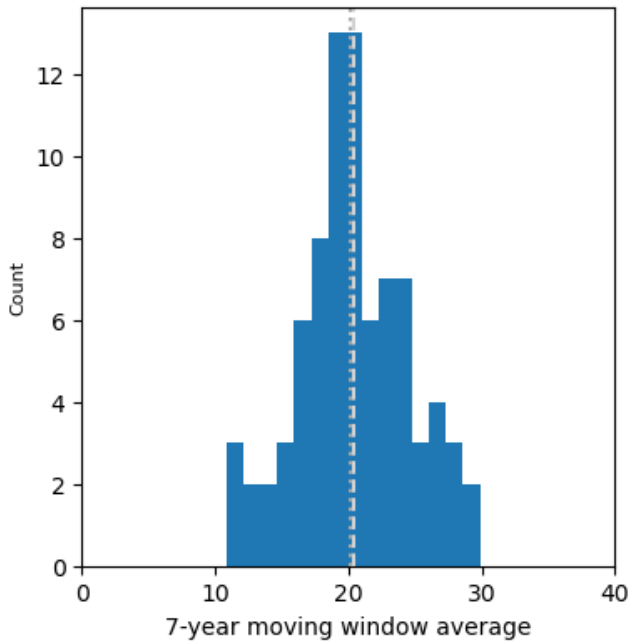
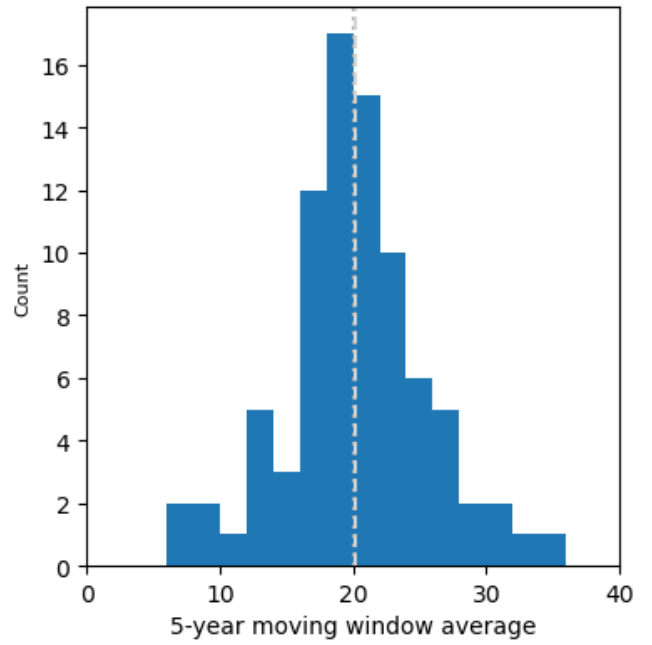
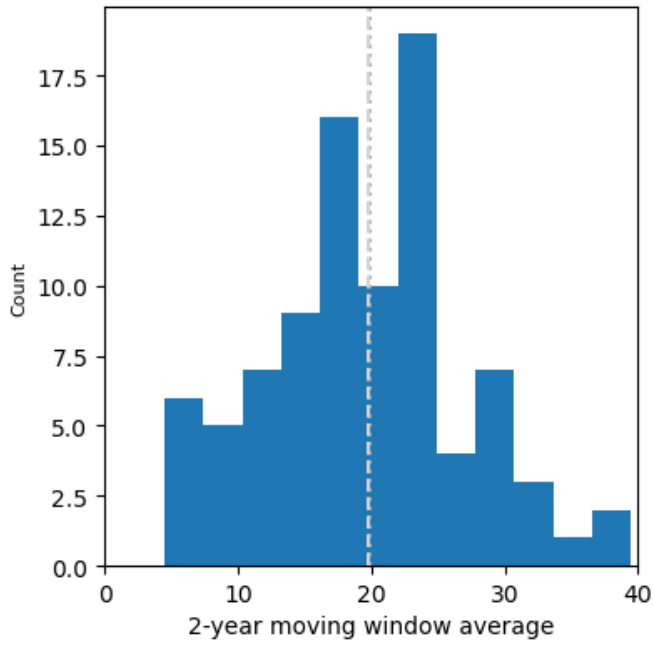
Annual Mean Discharge at Las Moras Springs



- Spring Flow Observation Frequency
- Less Than Monthly
  - Daily
  - ◐ Monthly
  - More Than Daily
  - ◑ Less Than Daily



### Average Las Moras discharge, cfs



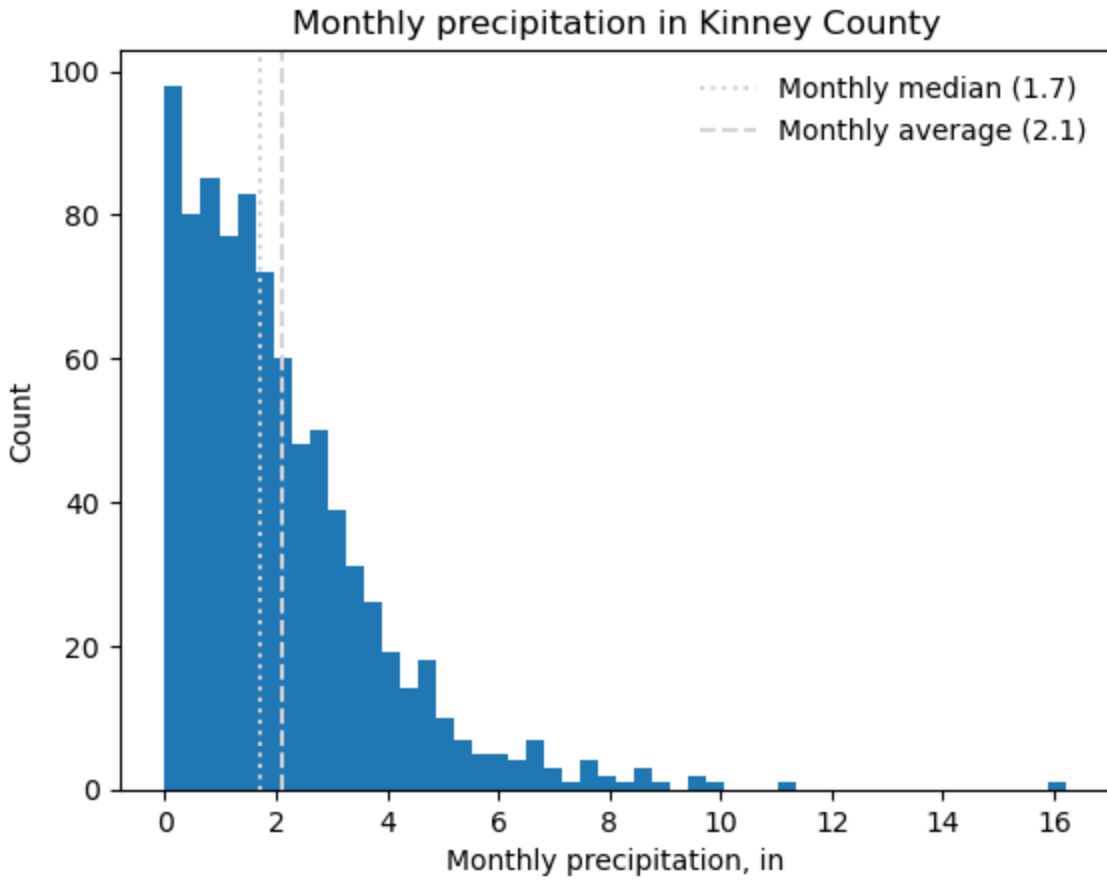
## 5.01 QUAD-807 CLIMATE DATA

**Table 8.** Summary statistics (1954 to 2025) for precipitation, gross evaporation, and net evaporation from Quad-807.

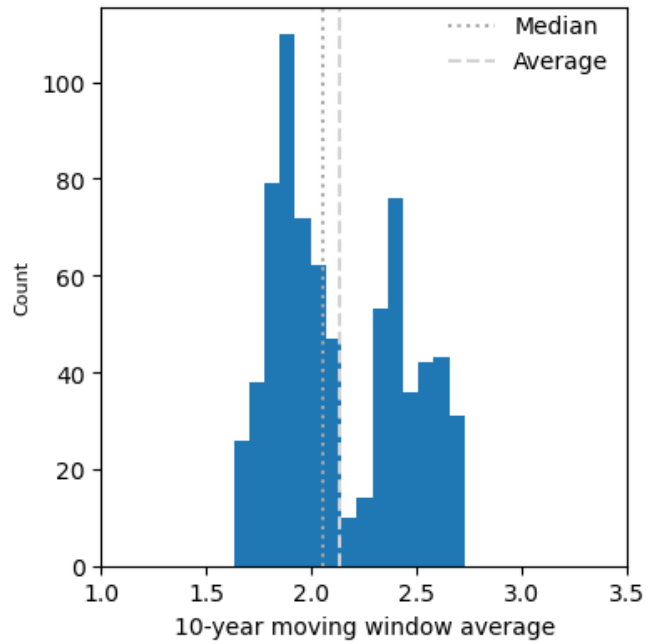
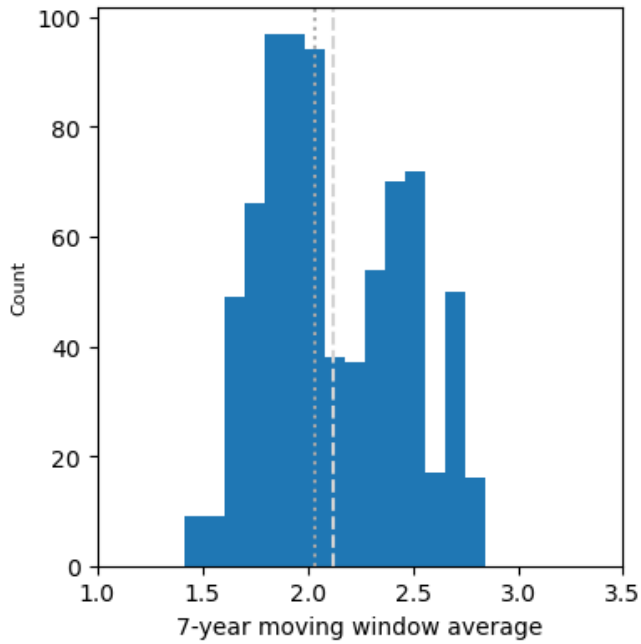
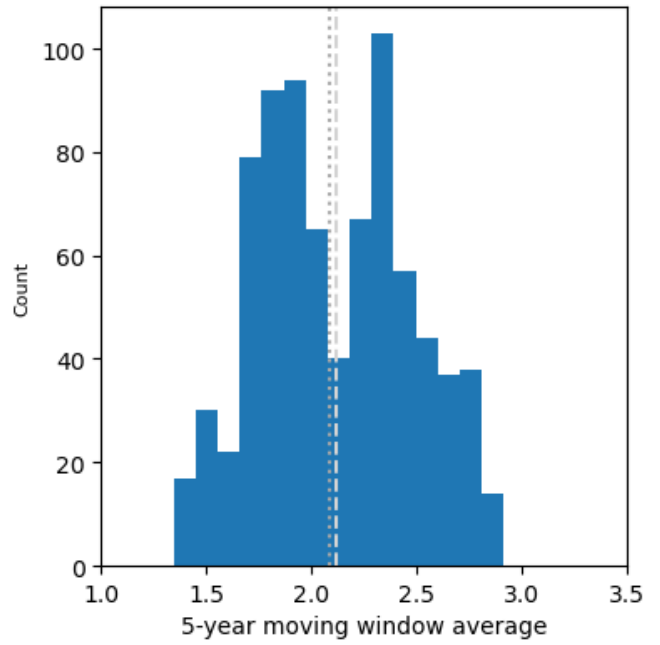
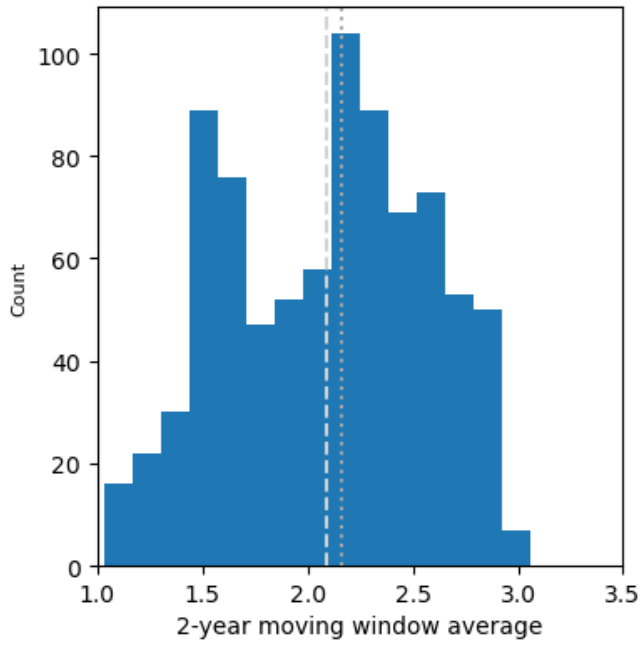
	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
Precipitation, in	858	0.0	0.8	1.7	2.1	2.9	16.2	1.8
Gross Evaporation, in	858	1.2	3.5	5.5	5.7	7.5	14.4	2.6
Net Evaporation, in	858	-8.3	1.5	3.3	3.6	5.6	13.7	3.1

**Table 9.** Summary statistics from moving window analyses from Quad-807 data.

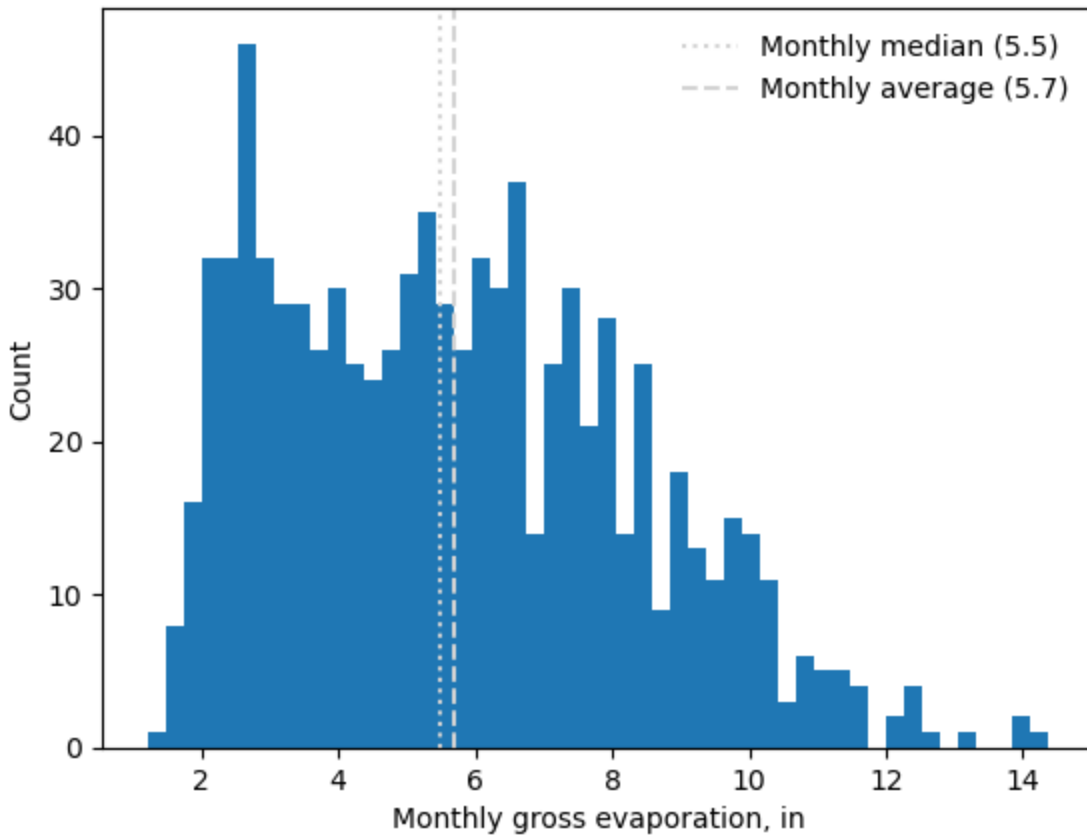
	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
Precipitation, 2-year	835	1.0	1.7	2.2	2.1	2.5	3.1	0.5
Precipitation, 5-year	799	1.3	1.8	2.1	2.1	2.4	2.9	0.4
Precipitation, 7-year	775	1.4	1.9	2.0	2.1	2.4	2.8	0.3
Precipitation, 10-year	739	1.6	1.9	2.1	2.1	2.4	2.7	0.3
Gross Evaporation, 2-year	835	4.6	5.3	5.6	5.7	6.0	7.9	0.6
Gross Evaporation, 5-year	799	4.7	5.3	5.5	5.7	6.0	7.5	0.5
Gross Evaporation, 7-year	775	5.0	5.4	5.6	5.7	5.9	7.0	0.4
Gross Evaporation, 10-year	739	5.2	5.4	5.6	5.6	5.8	6.8	0.3
Net Evaporation, 2-year	835	1.9	2.9	3.5	3.6	4.2	6.6	1.0
Net Evaporation, 5-year	799	2.4	2.9	3.5	3.6	4.0	6.0	0.7
Net Evaporation, 7-year	775	2.5	2.9	3.4	3.5	4.0	5.3	0.7
Net Evaporation, 10-year	739	2.6	3.0	3.5	3.5	3.9	5.1	0.6



### Monthly Average Quad-807 Precipitation, in

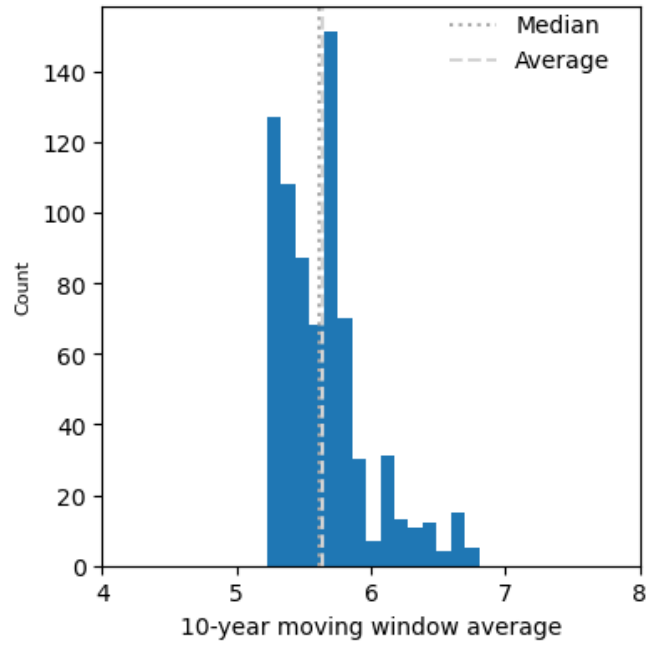
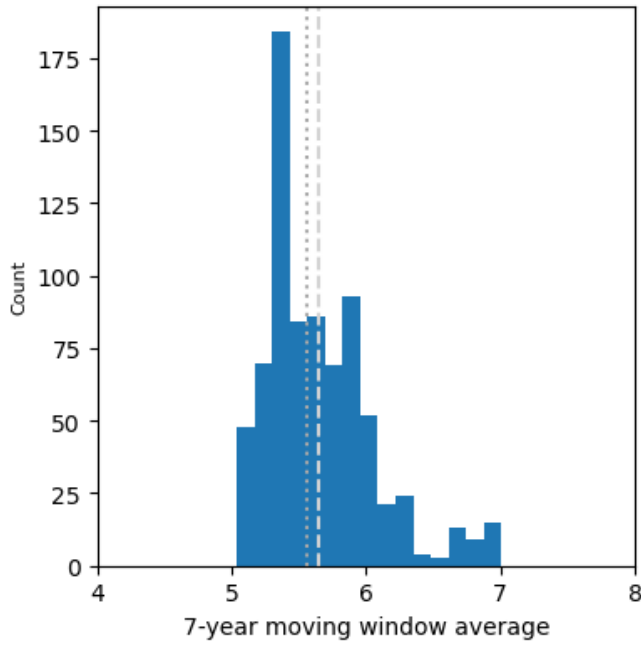
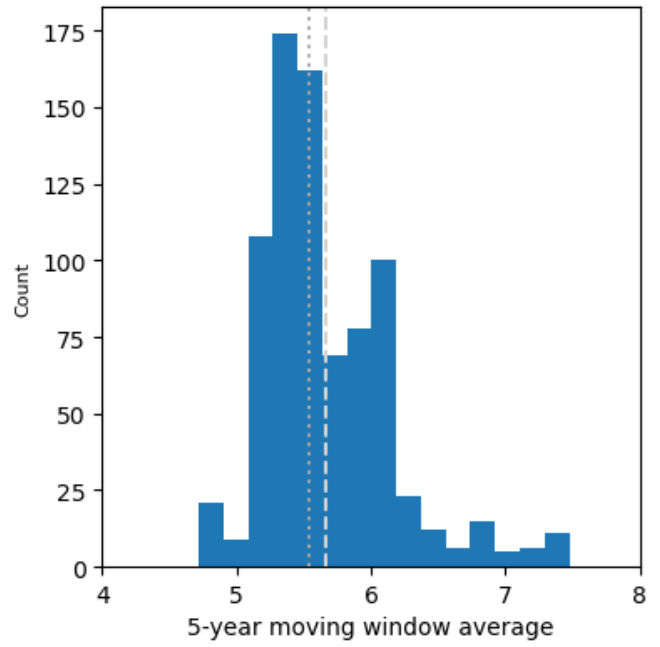
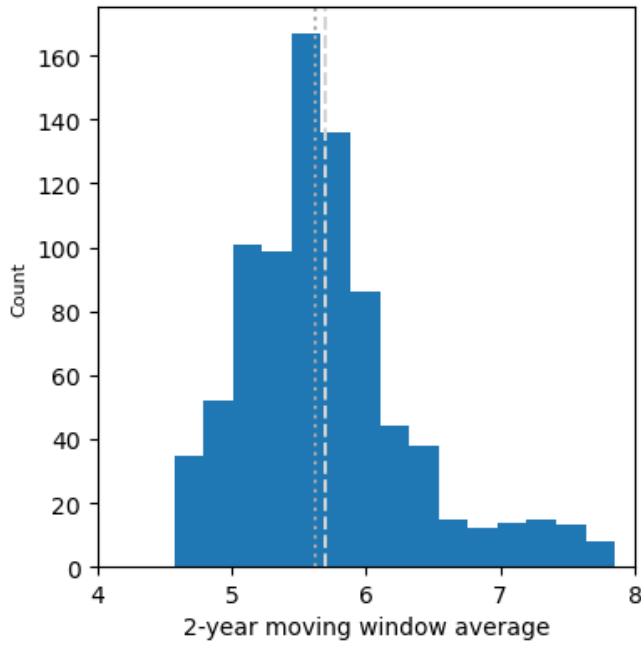


Monthly gross evaporation in Kinney County

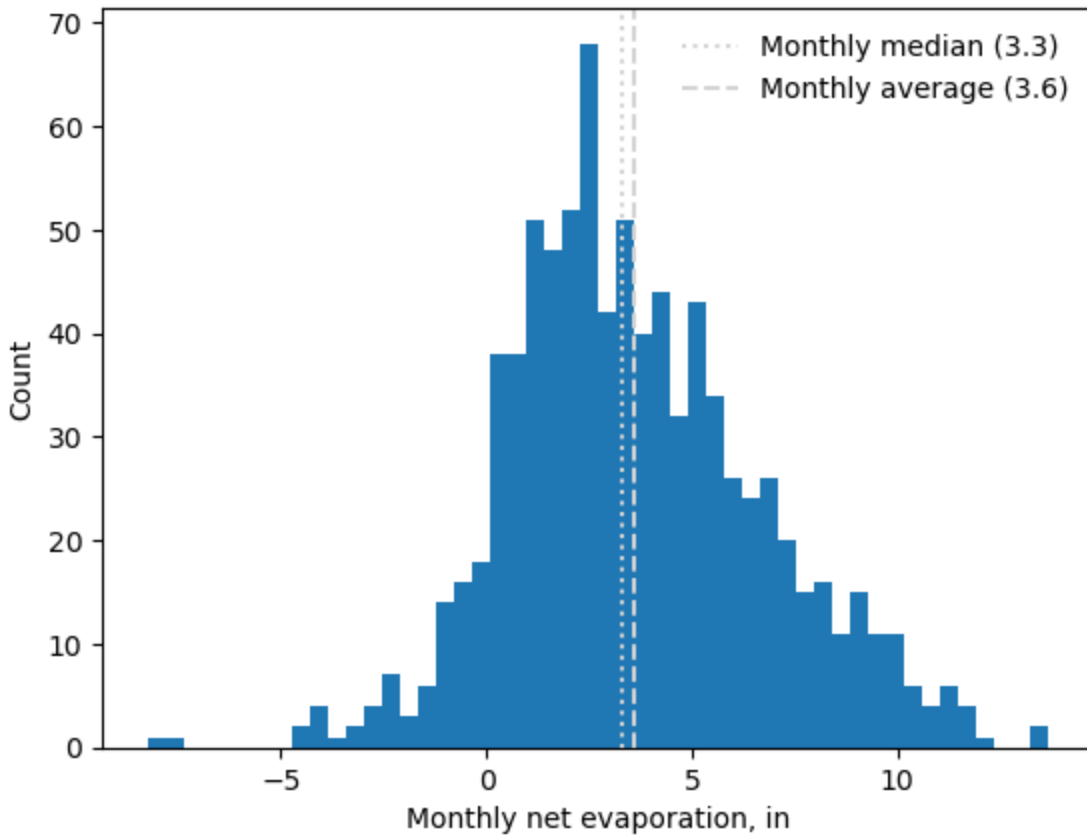


DRY

### Monthly Average Quad-807 Gross Evaporation, in

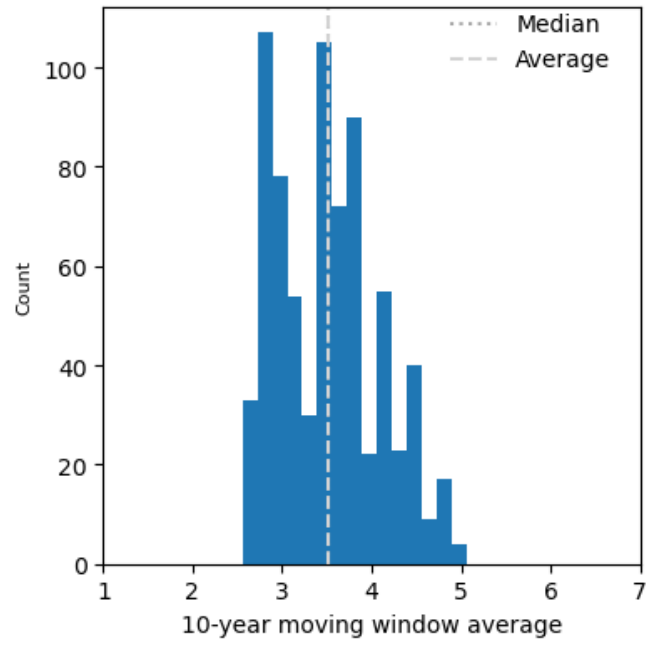
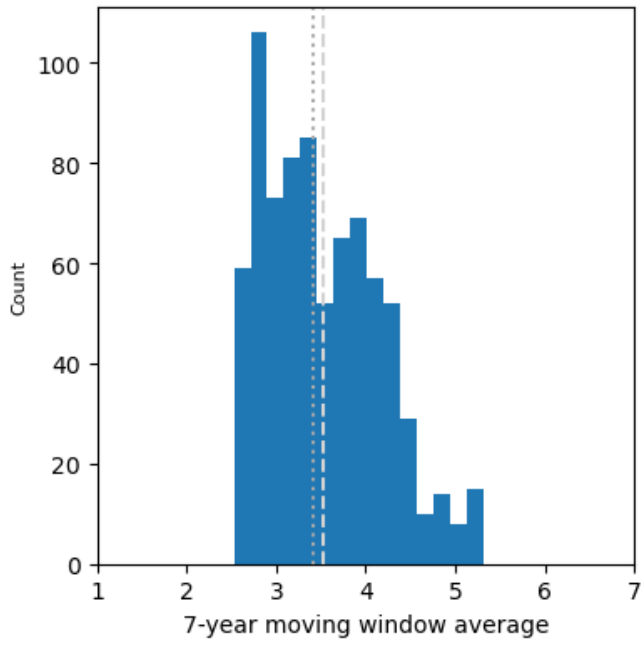
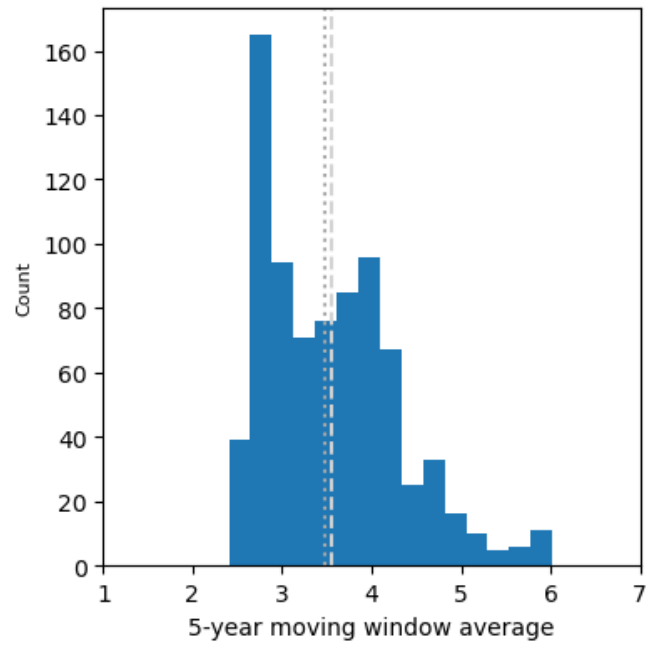
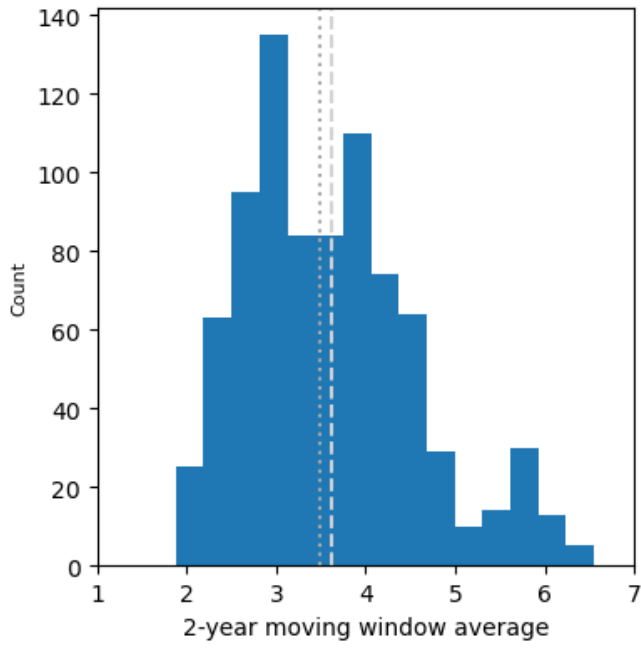


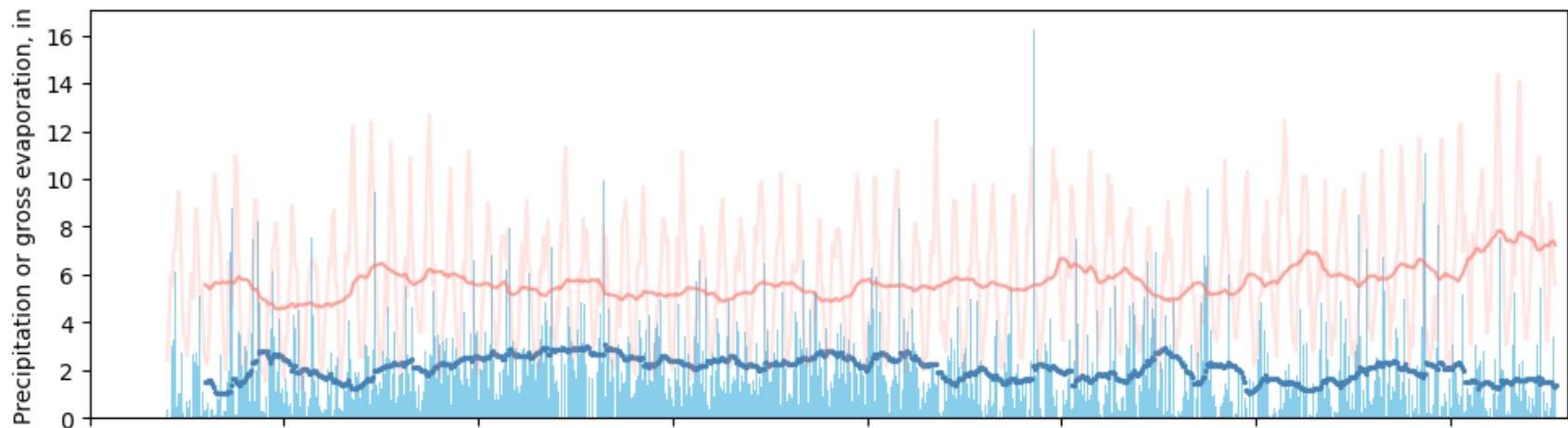
Monthly net evaporation in Kinney County



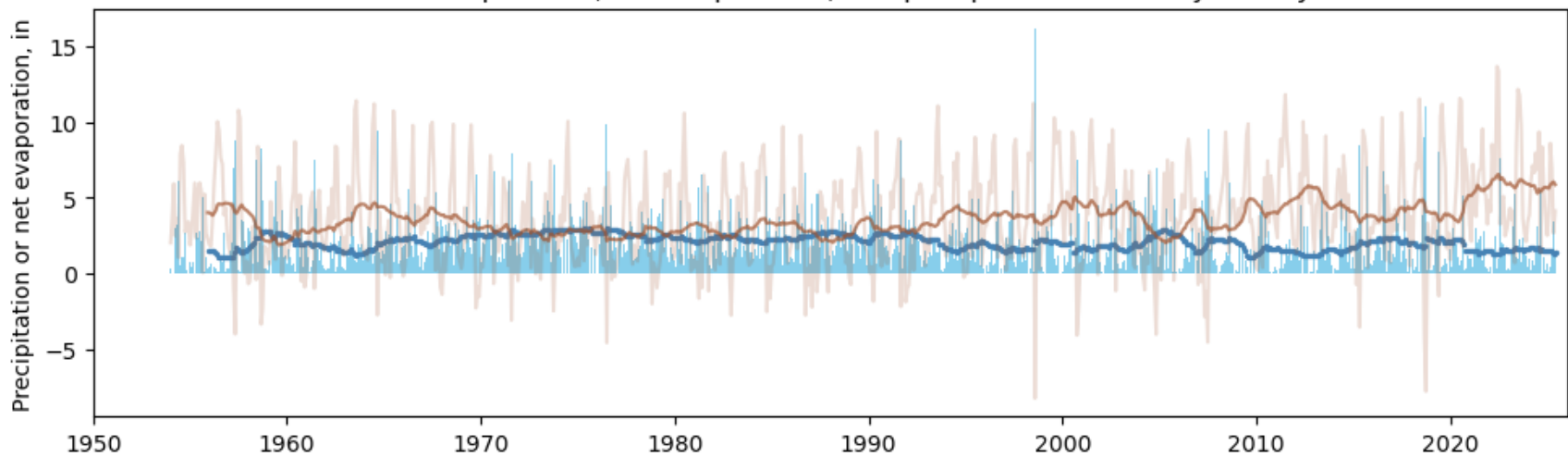
DRAFT

### Monthly Average Quad-807 Net Evaporation, in



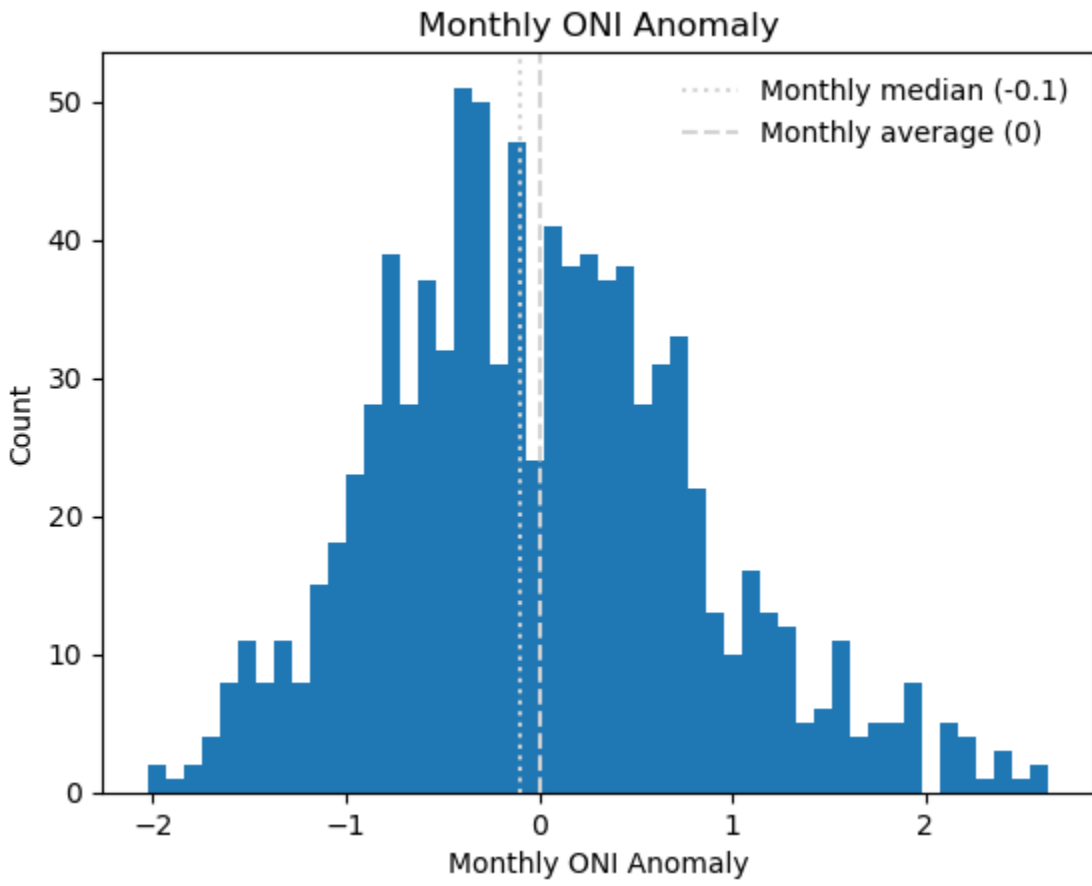


Gross evaporation, net evaporation, and precipitation in Kinney County

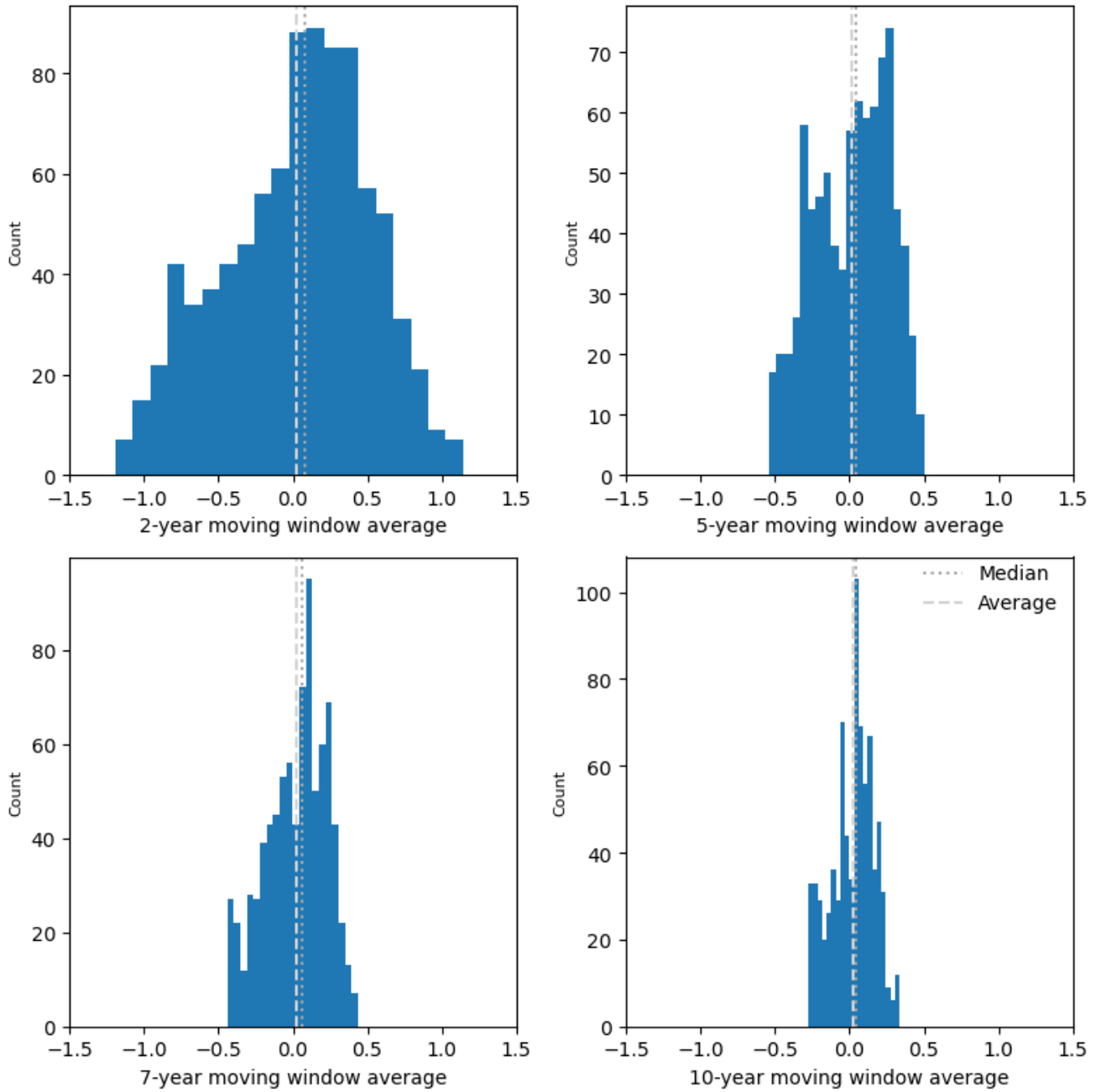


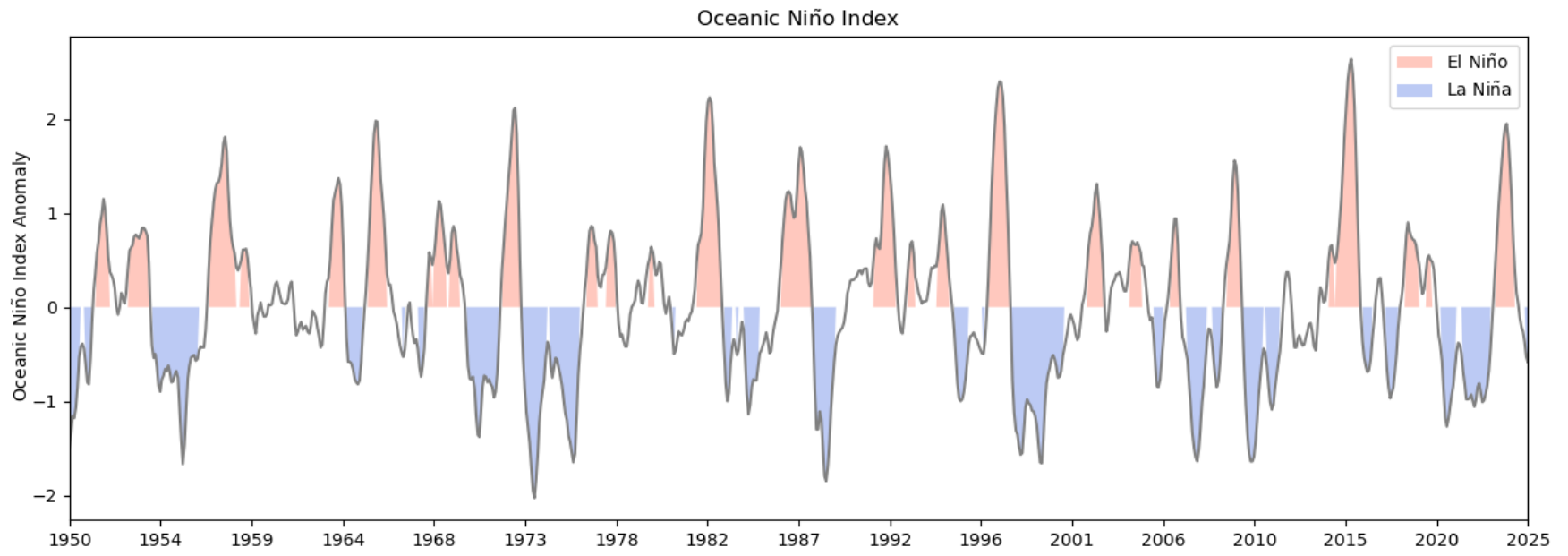
- Monthly gross evaporation
  - 2-year moving average gross evaporation
- 2-year moving average precipitation
  - Monthly precipitation
- Monthly net evaporation
  - 2-year moving average net evaporation

## 5.02 OCEANIC NIÑO INDEX ANOMALY

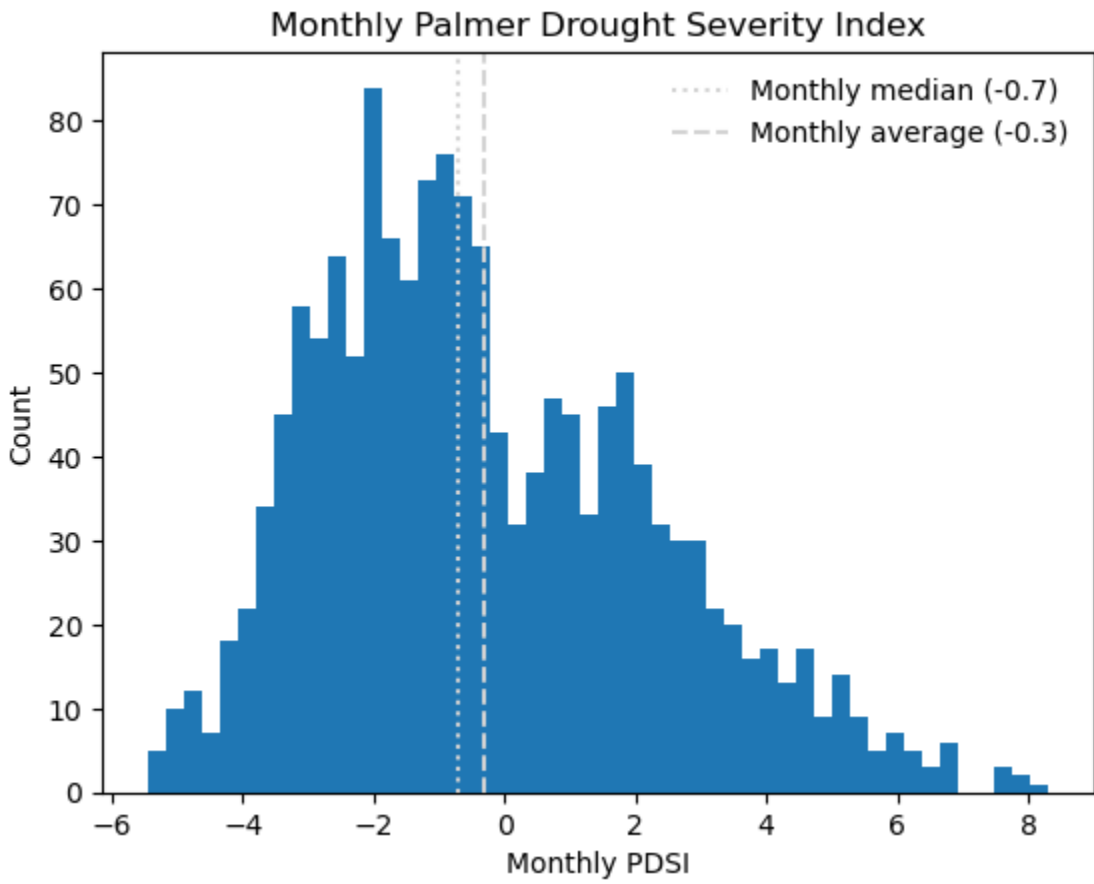


### Monthly Average ONI Anomaly

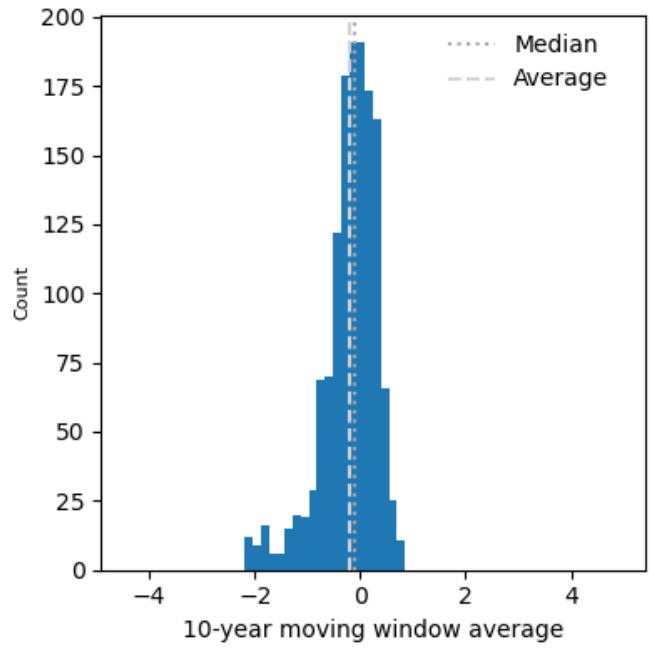
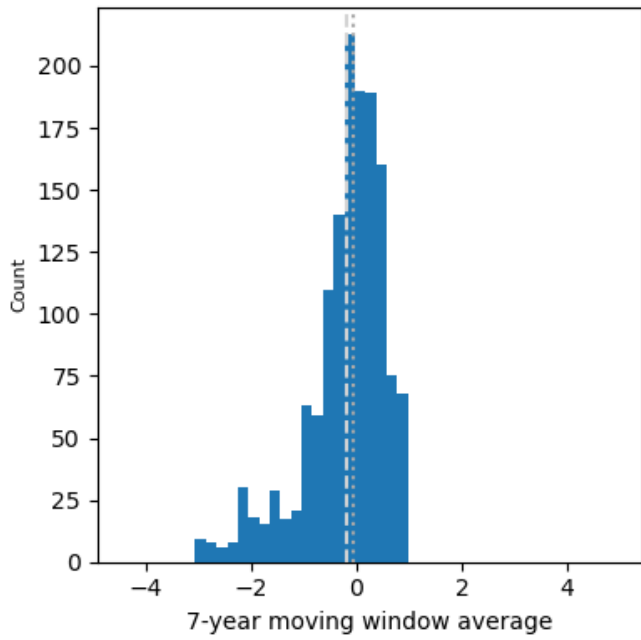
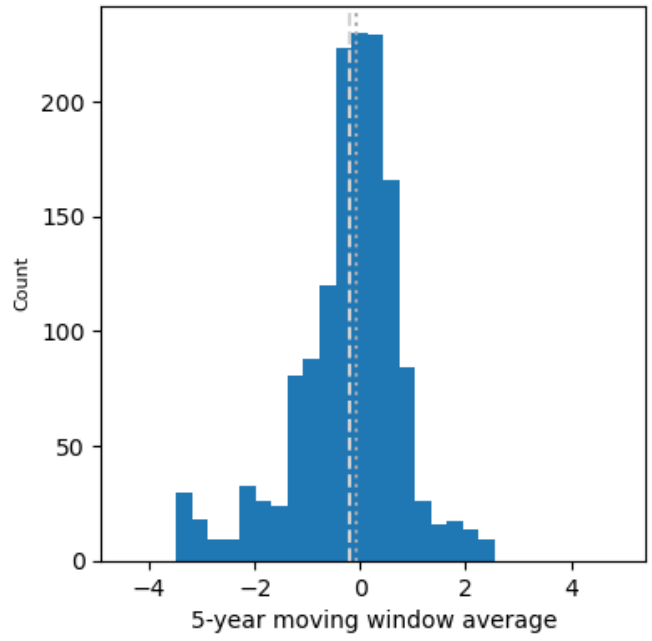
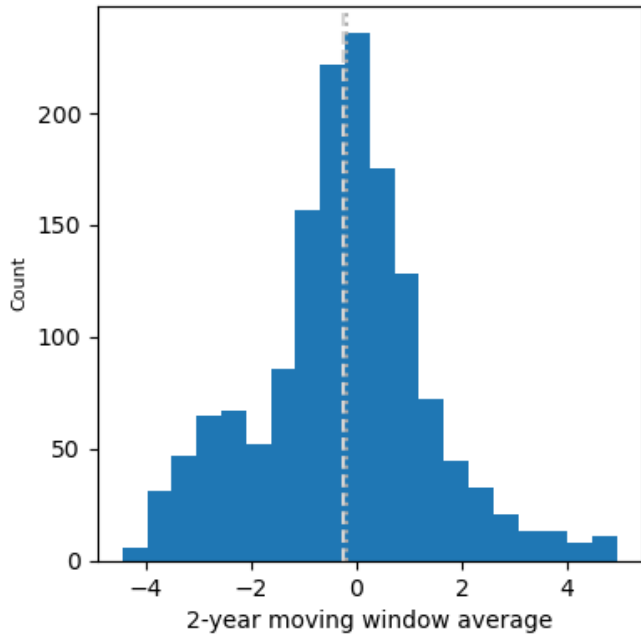




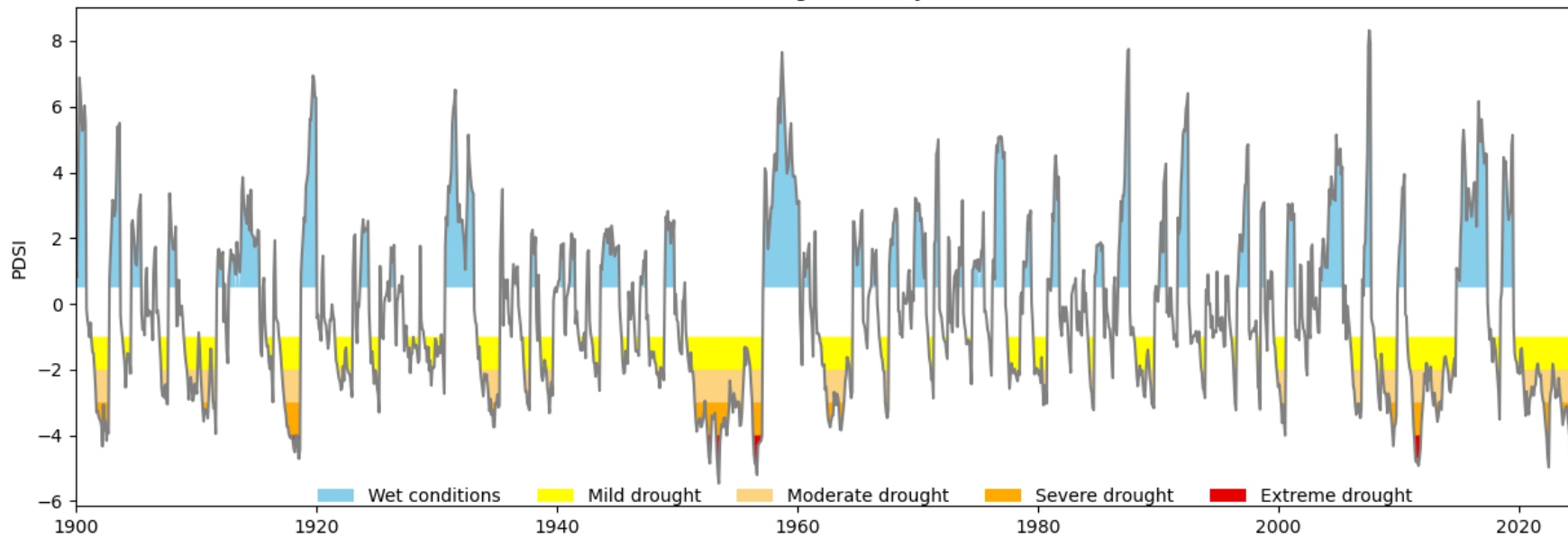
### 5.03 PALMER DROUGHT SEVERITY INDEX



### Monthly Average PDSI



Palmer Drought Severity Index

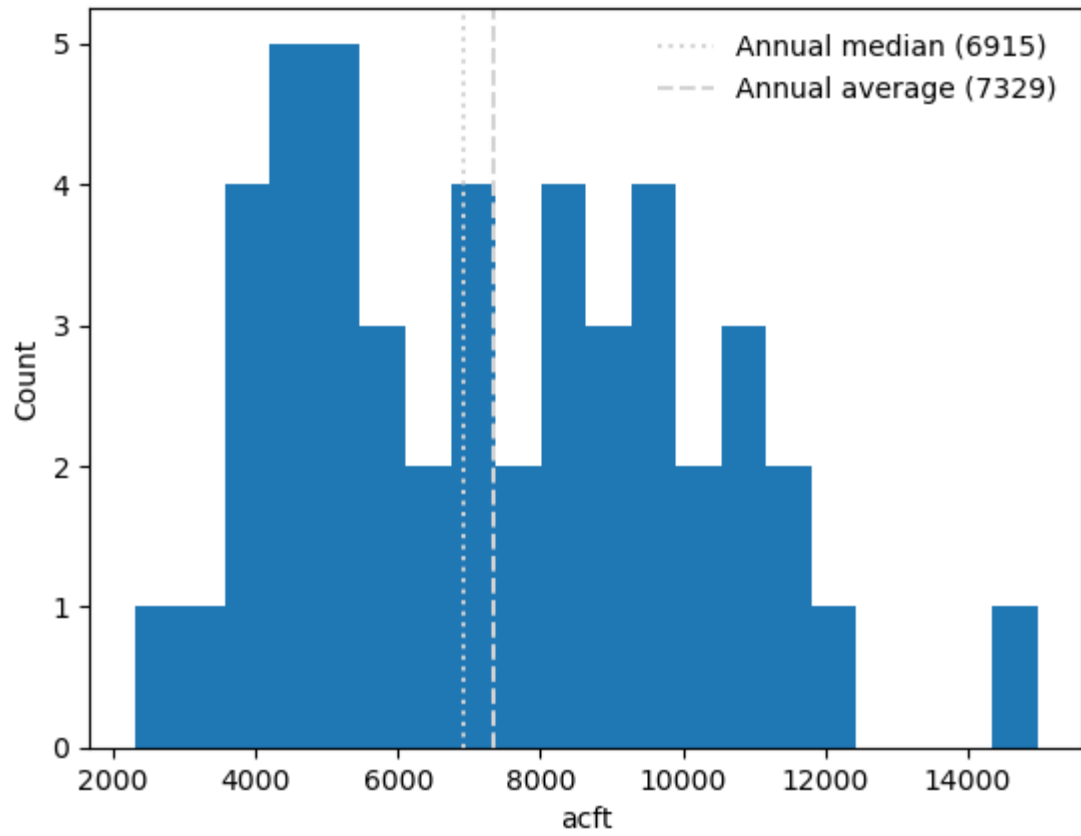


## 5.04 GROUNDWATER PUMPING VOLUMES

Summary statistics for measured groundwater volumes by aquifer and GMA 7 in Kinney County.

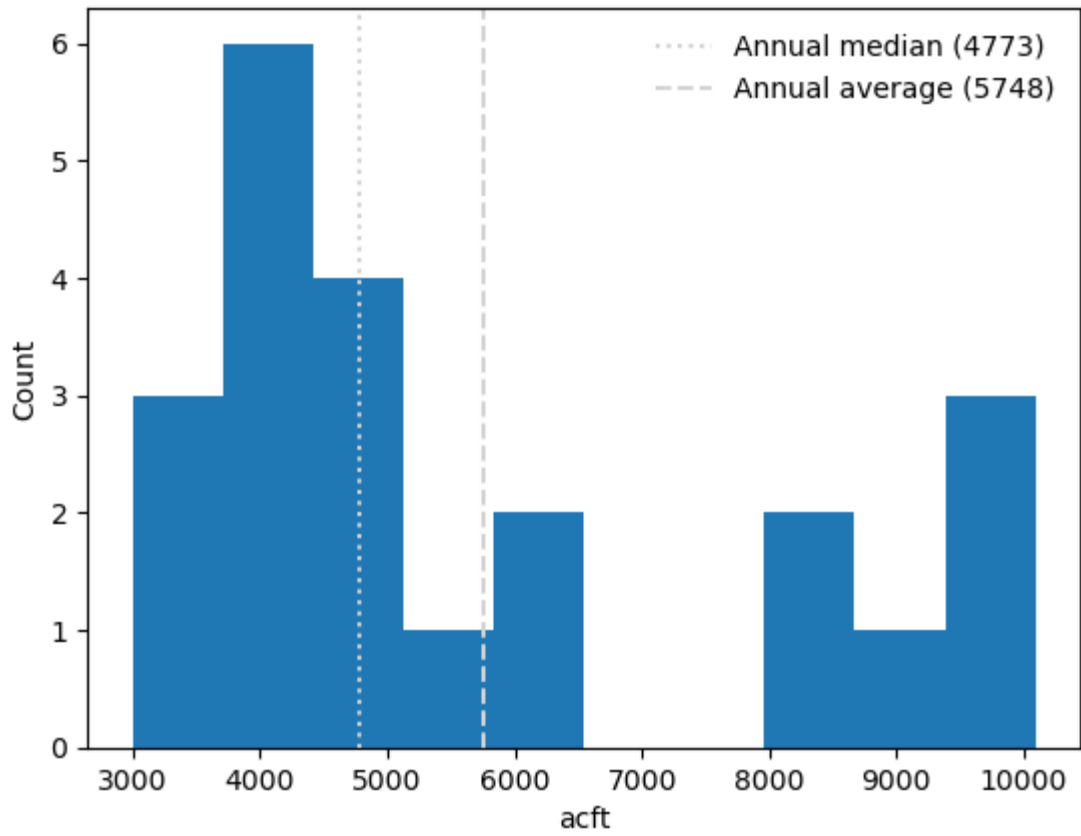
	Count	Min.	25%	Median	Mean	75%	Max.	Std. Dev.
Edwards	22	2,868	4,416	4,850	5,649	6,963	9,590	1,996
Austin Chalk	22	3	40	175	327	500	1,009	353
Other	22	5	12	42	68	119	222	66
Unknown	22	0	0	8	51	41	551	124
GMA 7 Edwards	22	2,824	3,886	4,643	5,288	6,744	9,071	1,927
GMA 7 Austin Chalk	22	3	40	175	316	487	1,009	351
GMA 7 Other	22	5	12	42	68	119	222	66
GMA 7 Unknown	22	0	0	8	51	41	551	124

Estimated and measured pumping in Kinney County



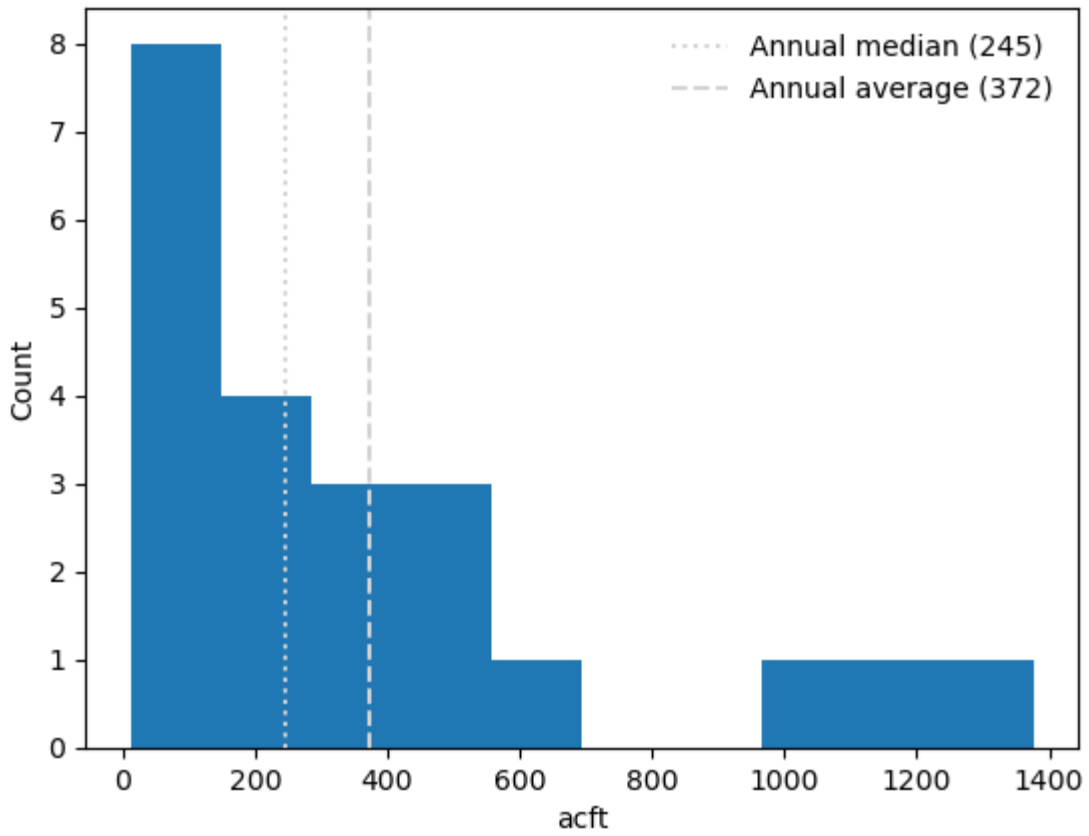
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Measured pumping in GMA7 in Kinney County



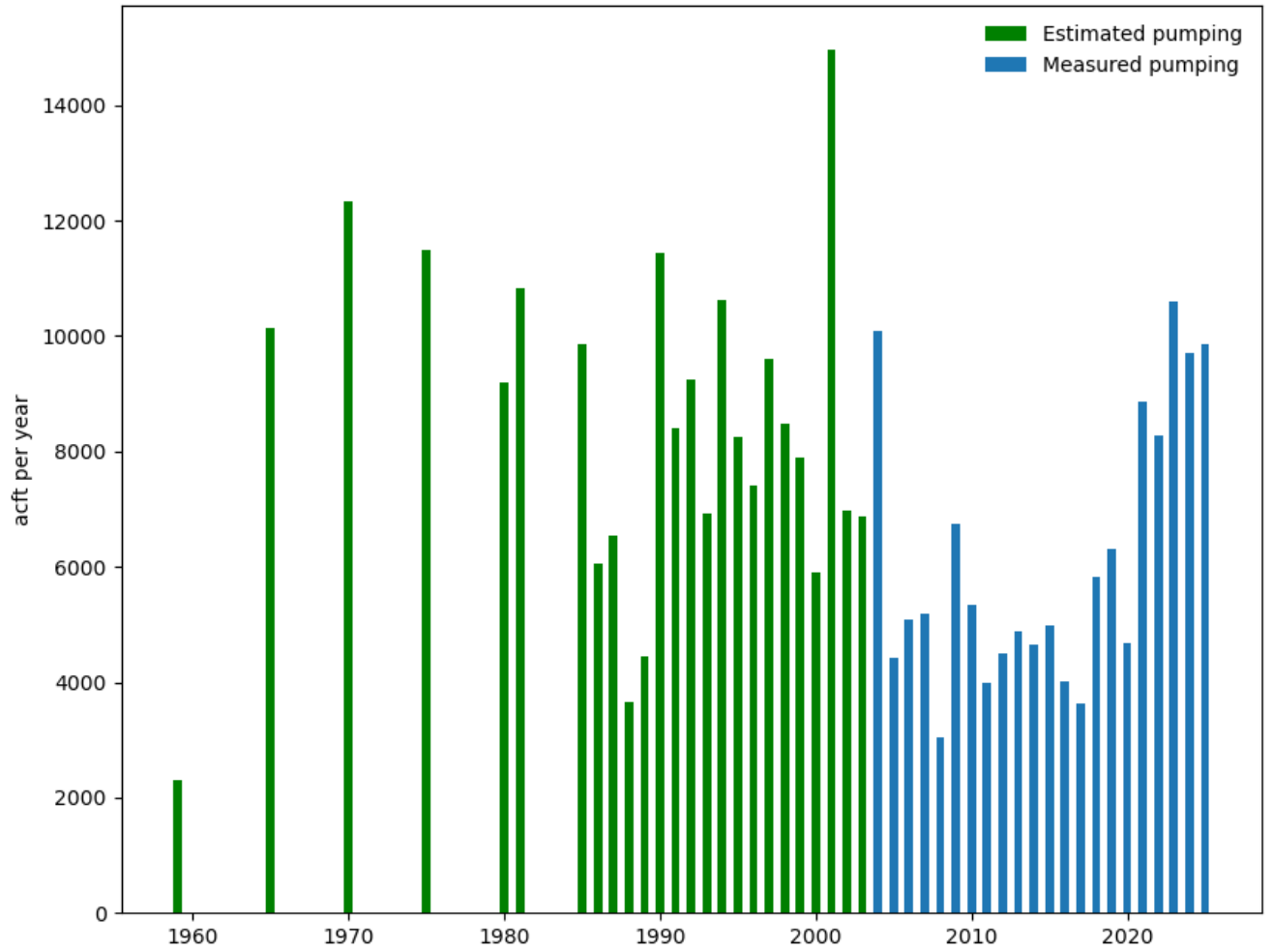
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Measured pumping in GMA10 in Kinney County

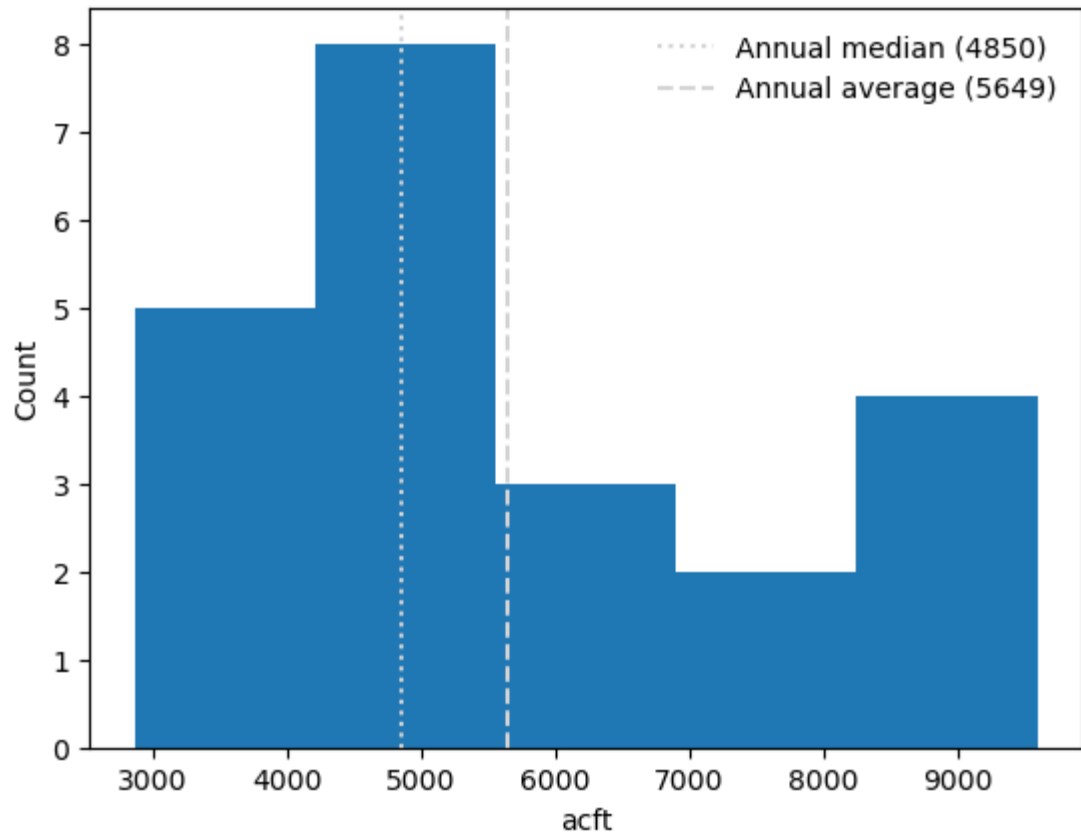


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Measured and estimated groundwater production in Kinney County

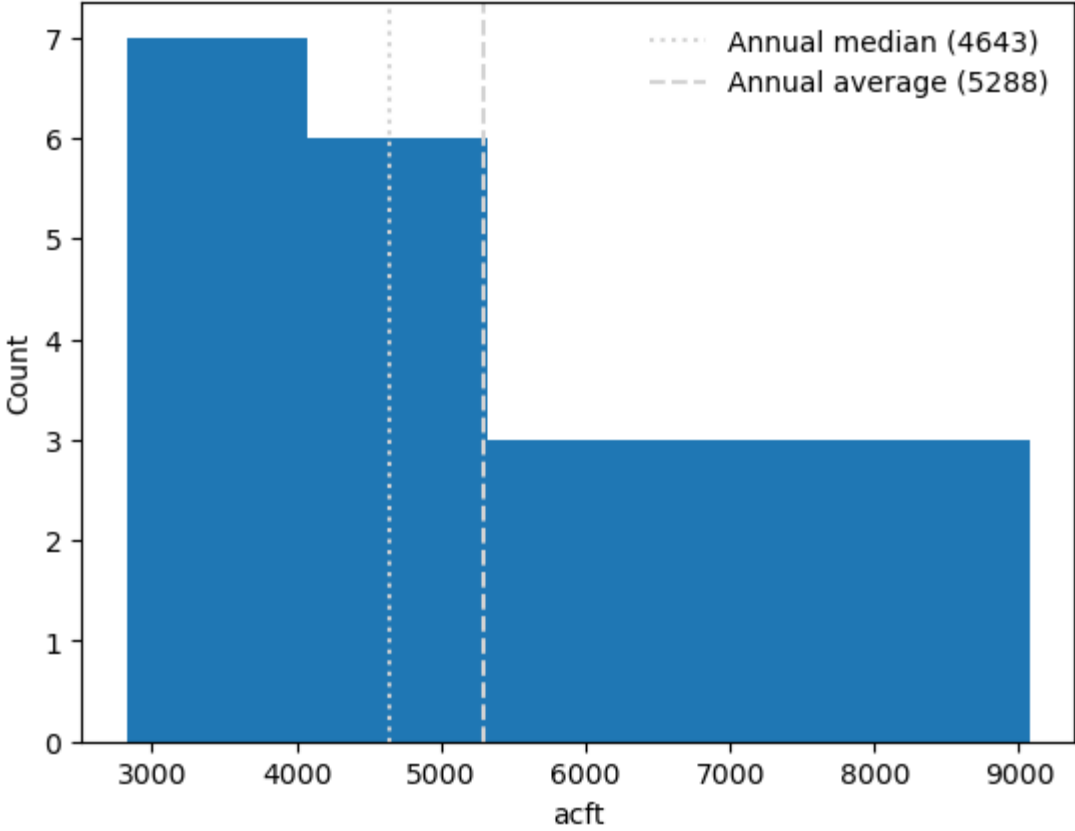


### Measured groundwater pumping from the Edwards in Kinney County



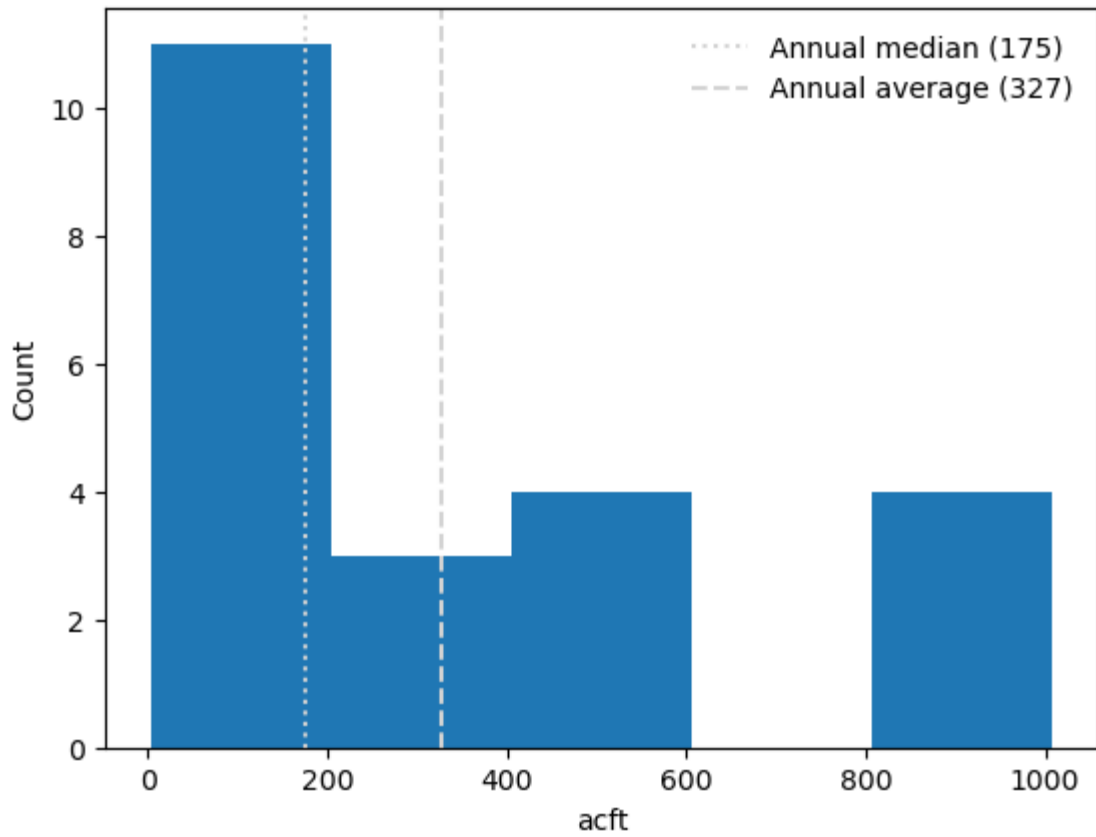
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Measured groundwater pumping from the Edwards in GMA7 in Kinney County

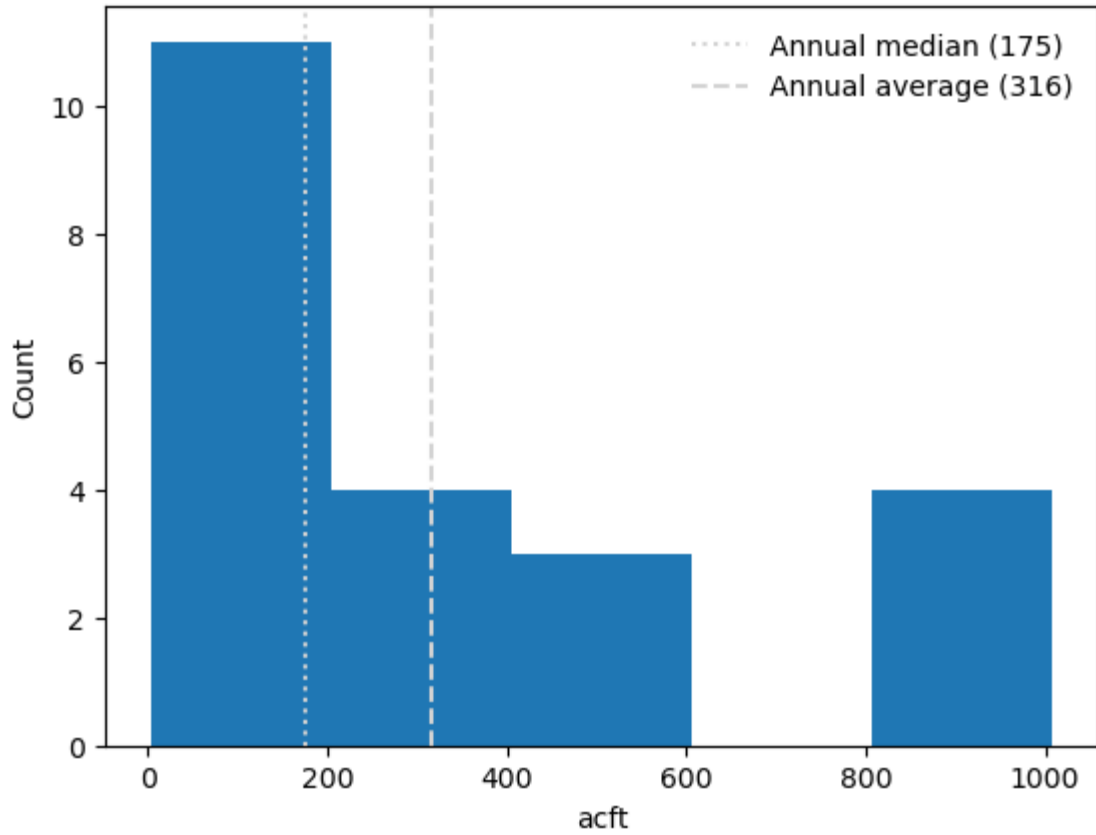


DKI

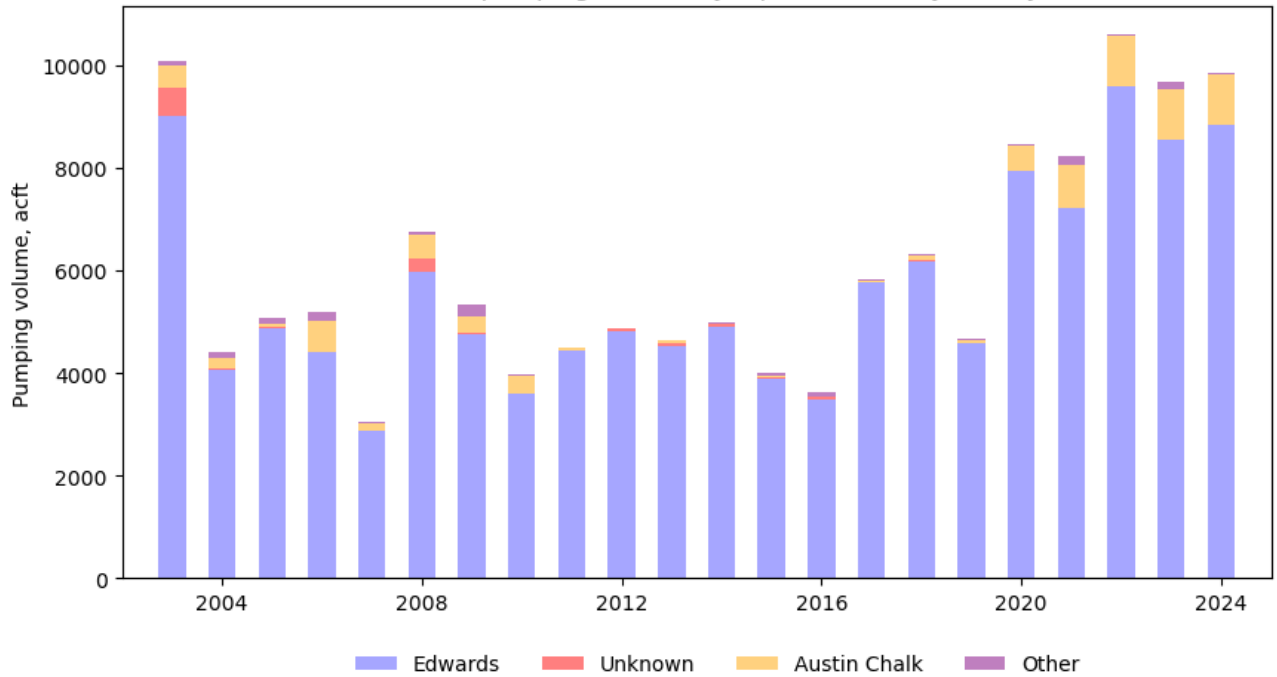
Measured groundwater pumping from the Austin Chalk in Kinney County

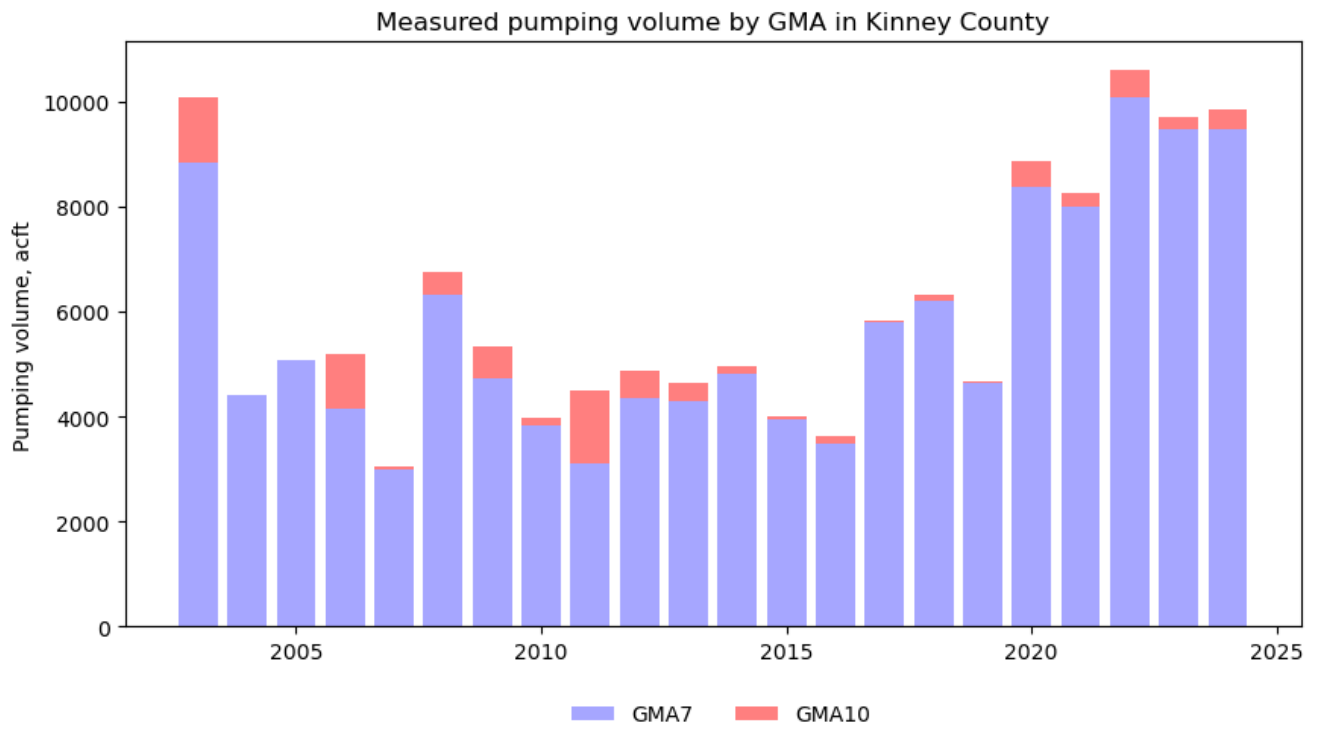
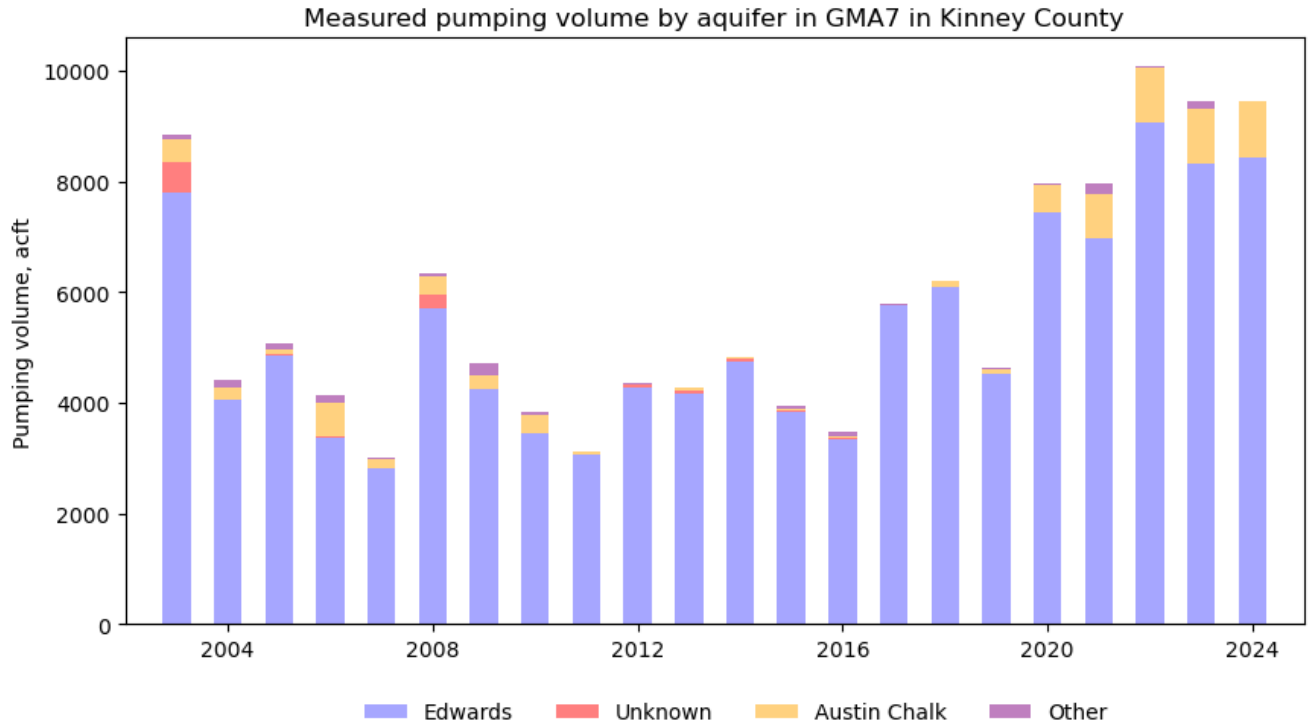


Measured groundwater pumping from the Austin Chalk in GMA7 in Kinney County



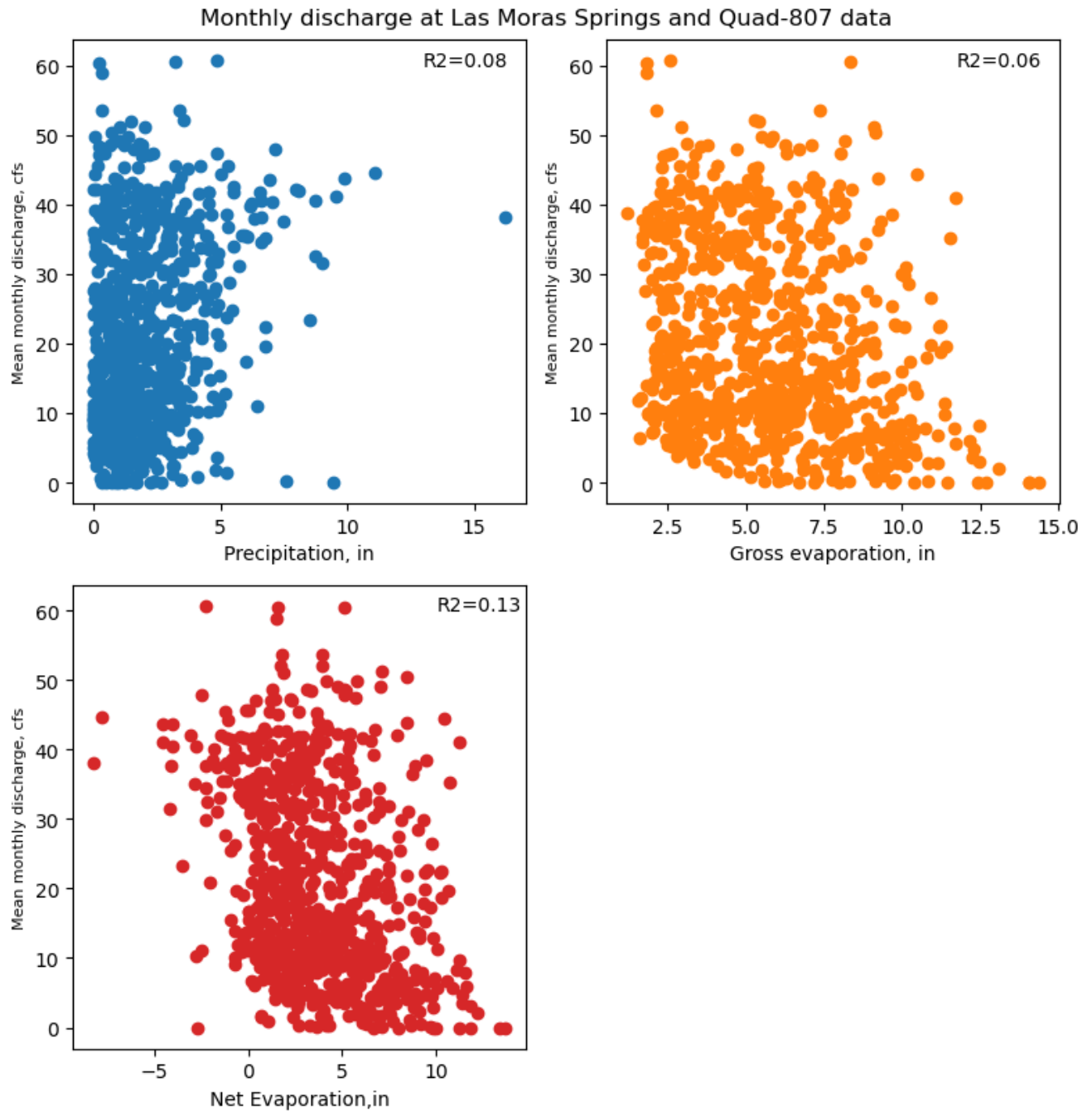
Measured pumping volume by aquifer in Kinney County



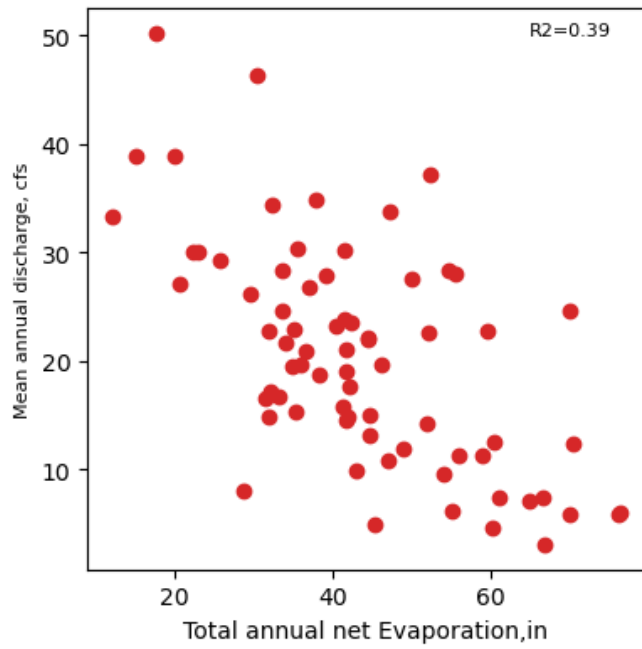
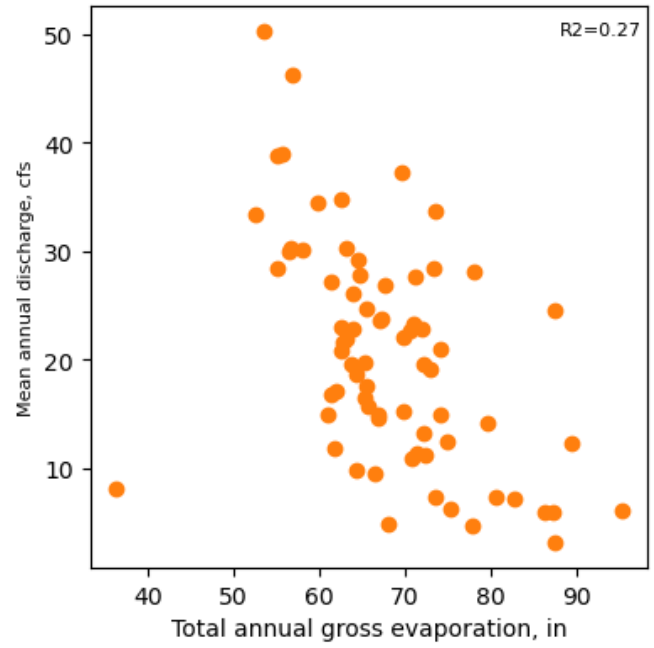
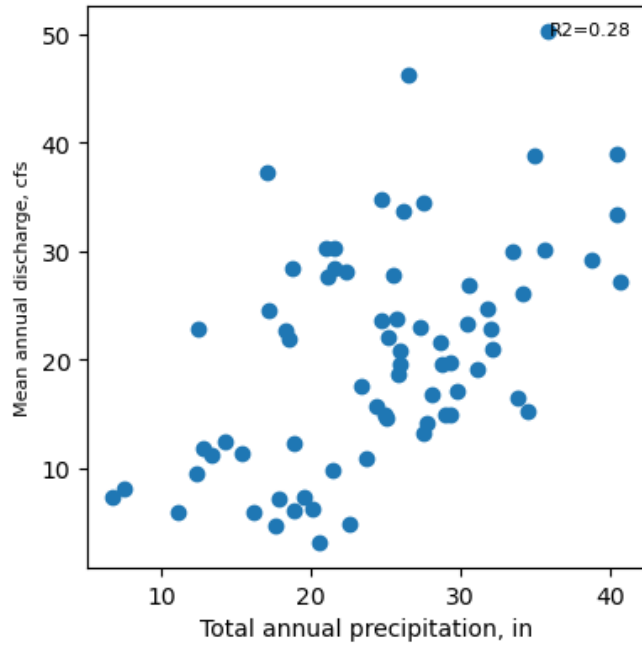


## 6.00 APPENDIX B – LAS MORAS SPRINGS DISCHARGE CORRELATION DATA AND GRAPHS

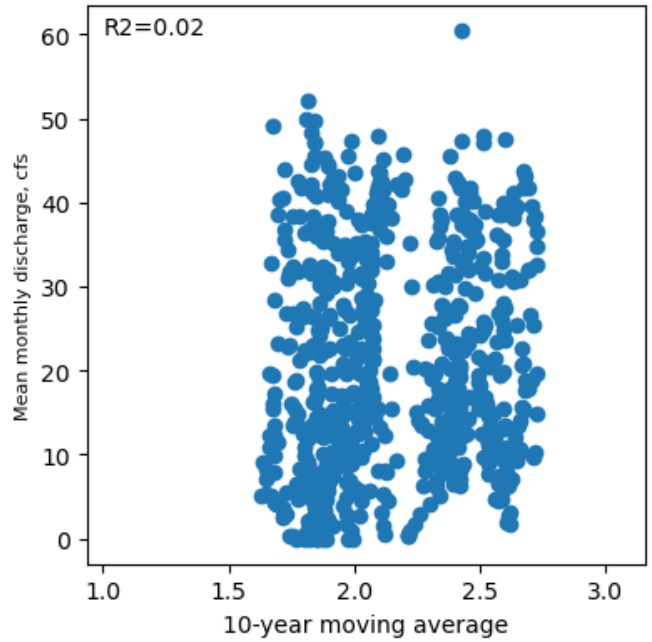
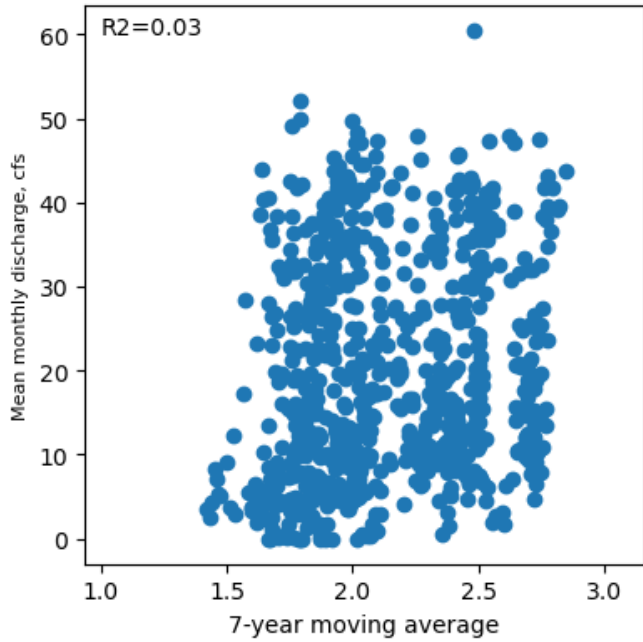
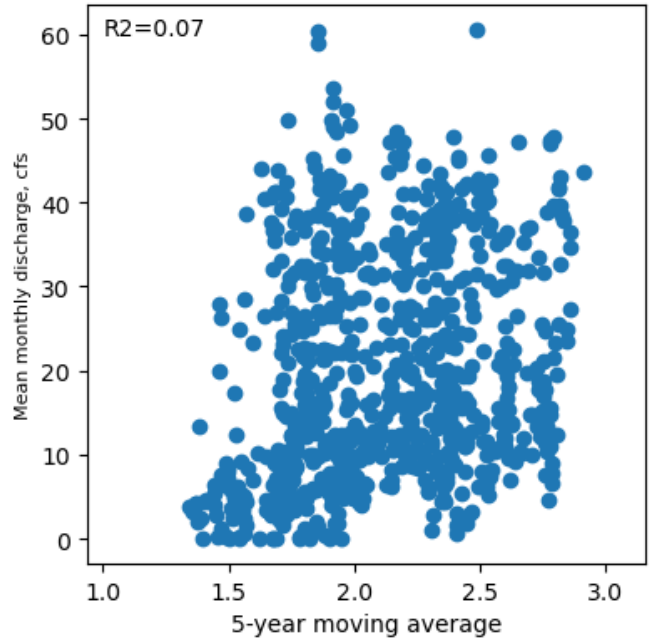
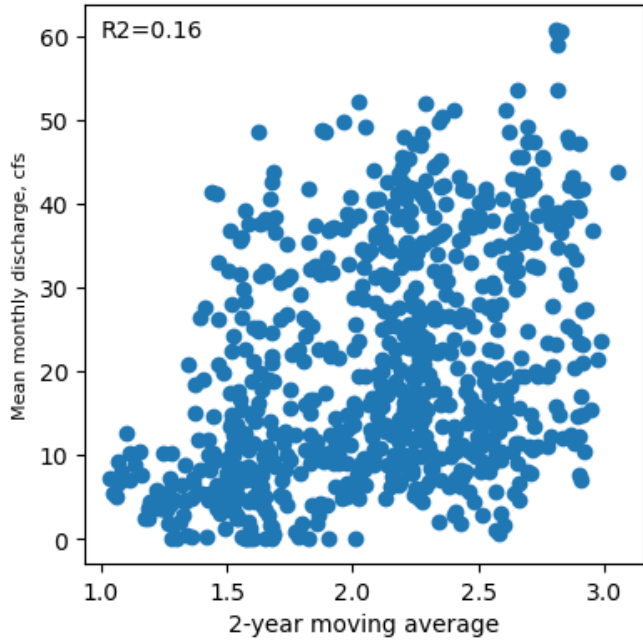
### 6.01 LAS MORAS AND QUAD-807



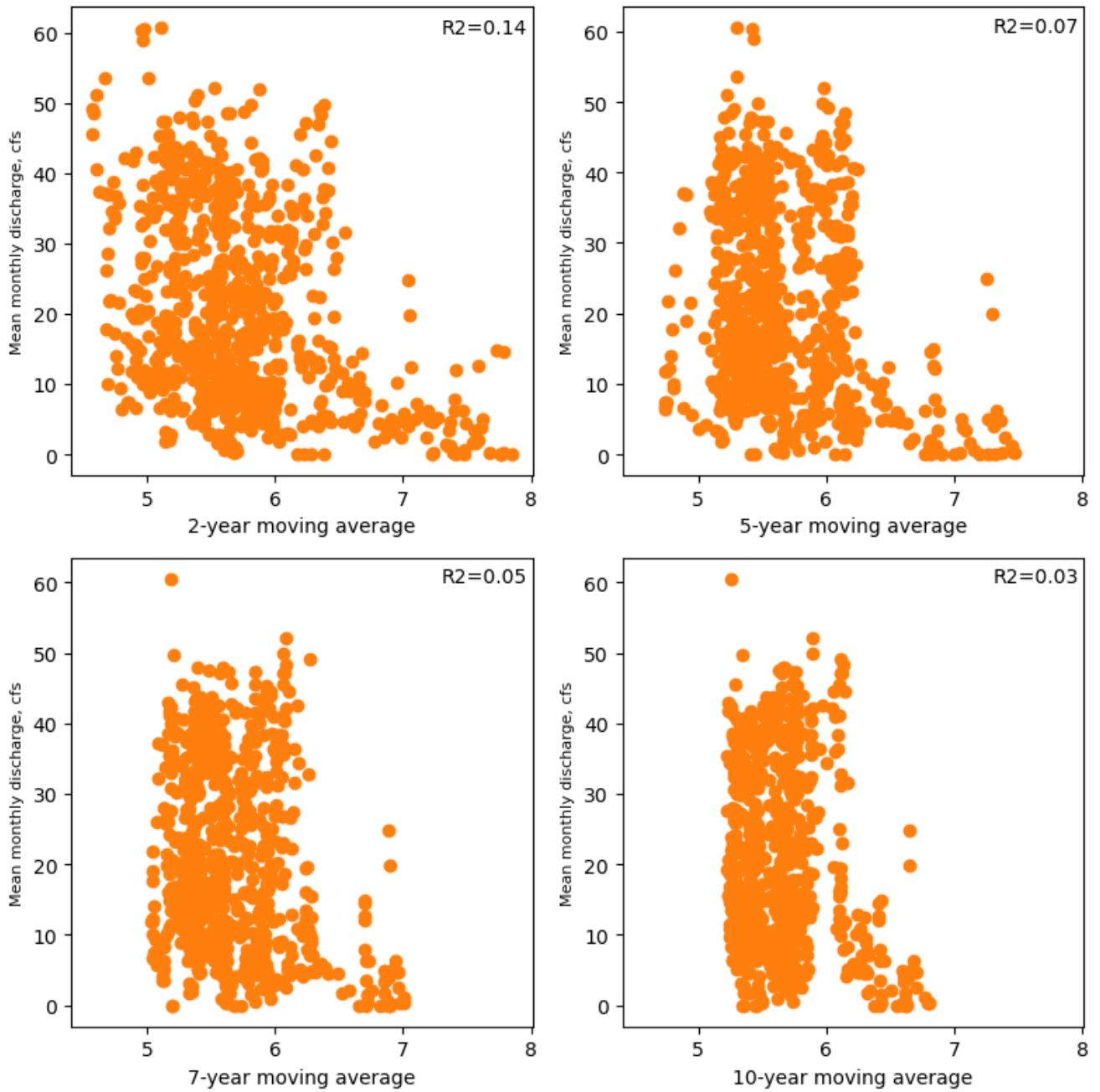
Annual discharge at Las Moras Springs and Quad-807 data



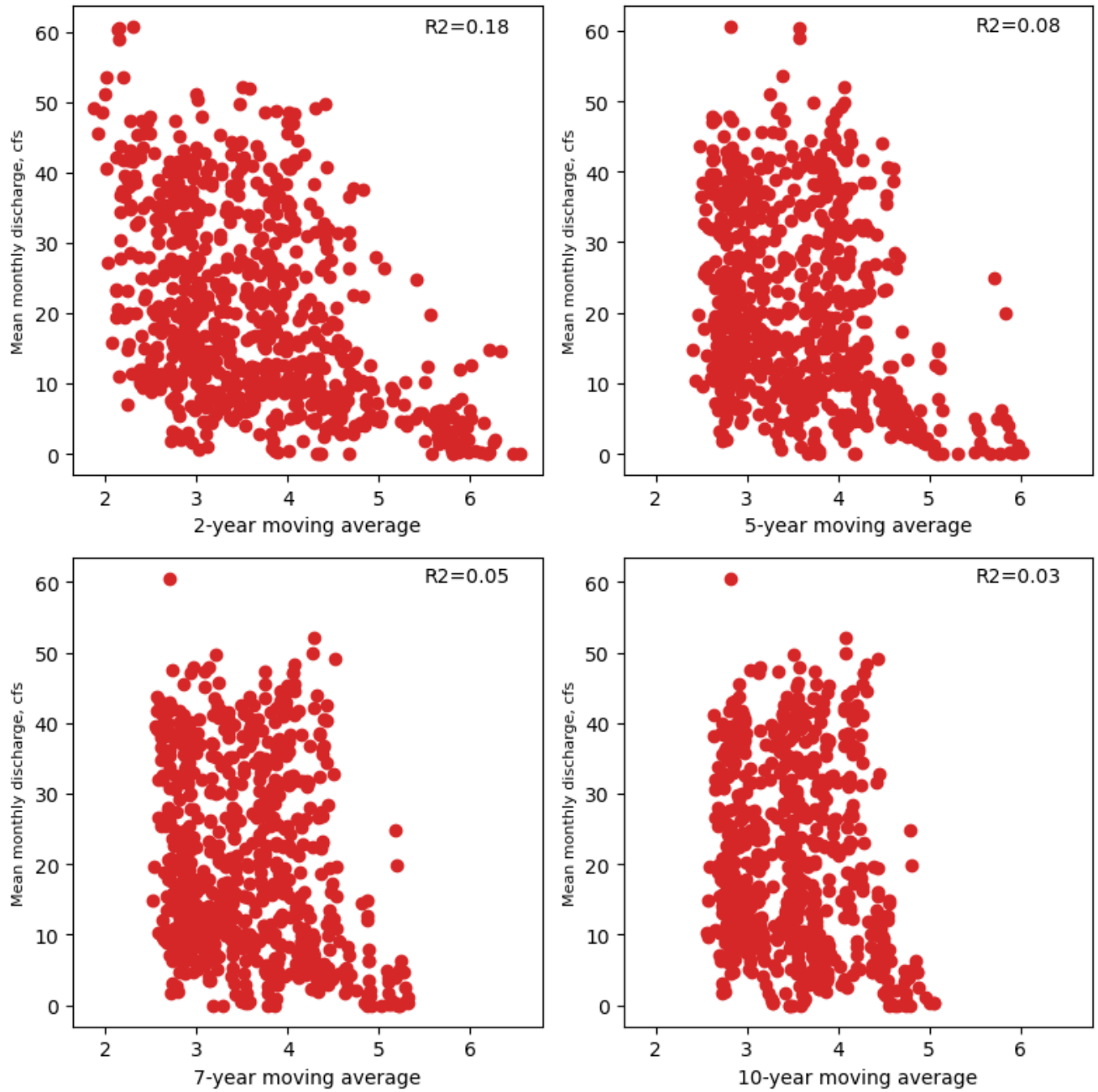
### Monthly discharge at Las Moras Springs and Monthly Precipitation



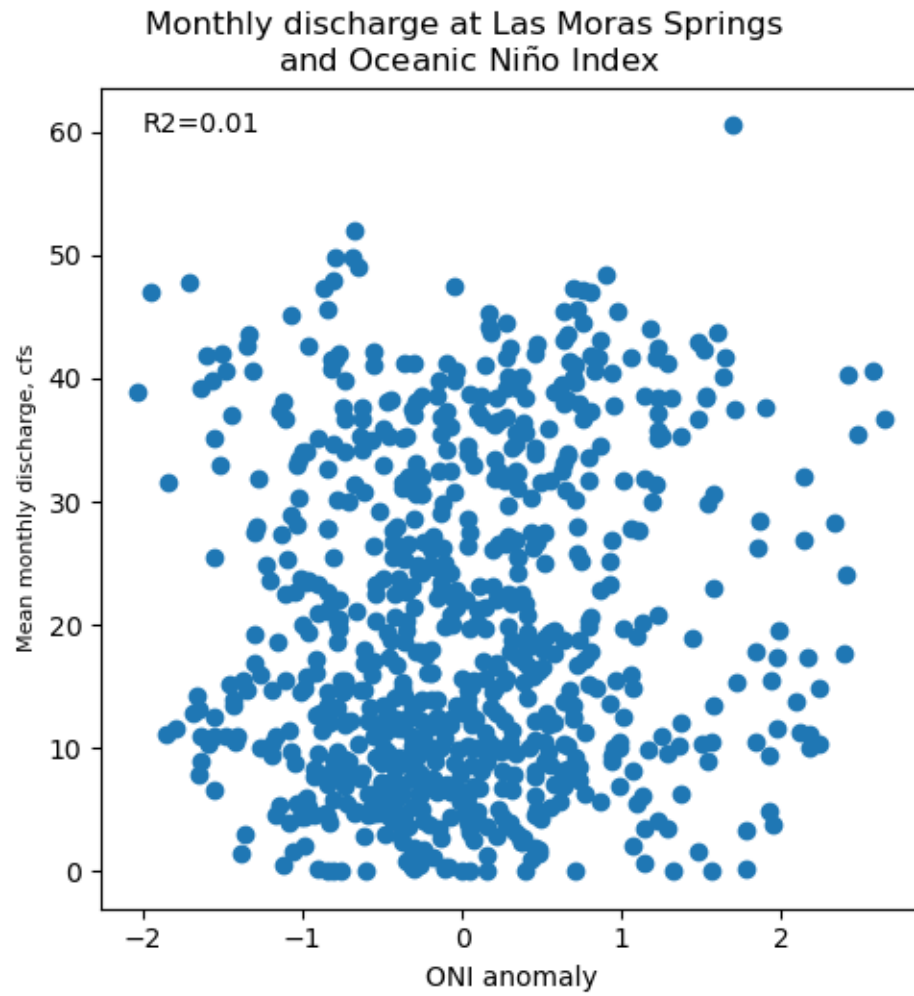
### Monthly discharge at Las Moras Springs and Monthly Gross Evaporation



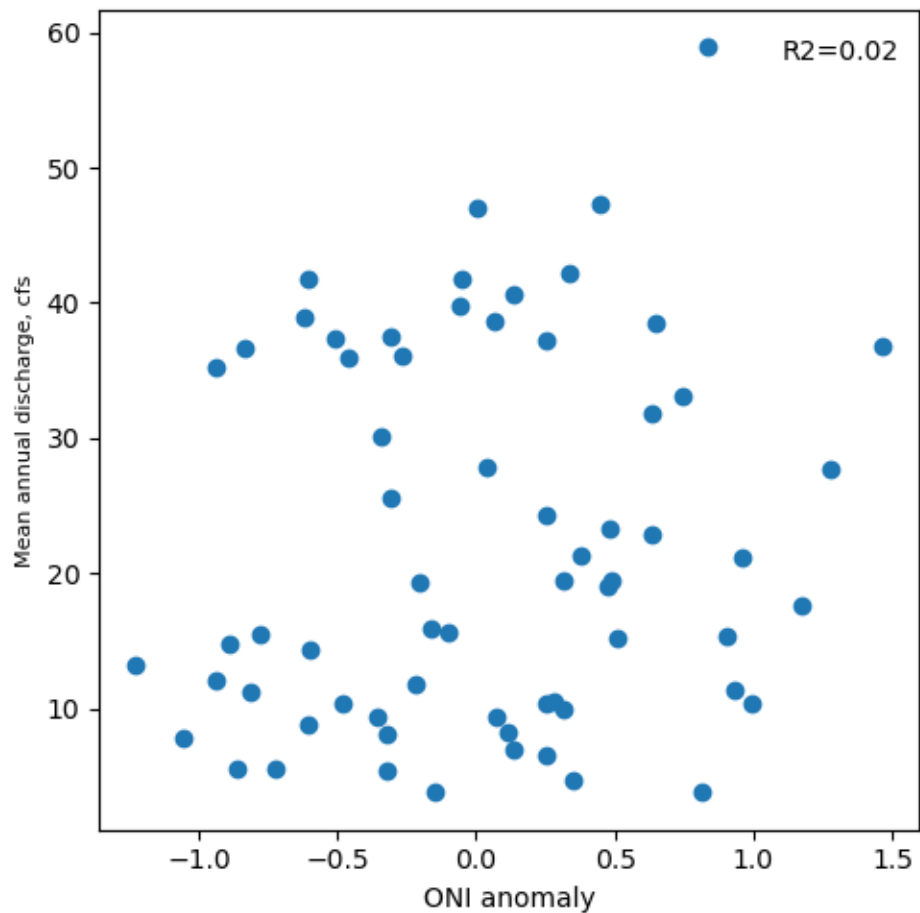
### Monthly discharge at Las Moras Springs and Monthly Net Evaporation



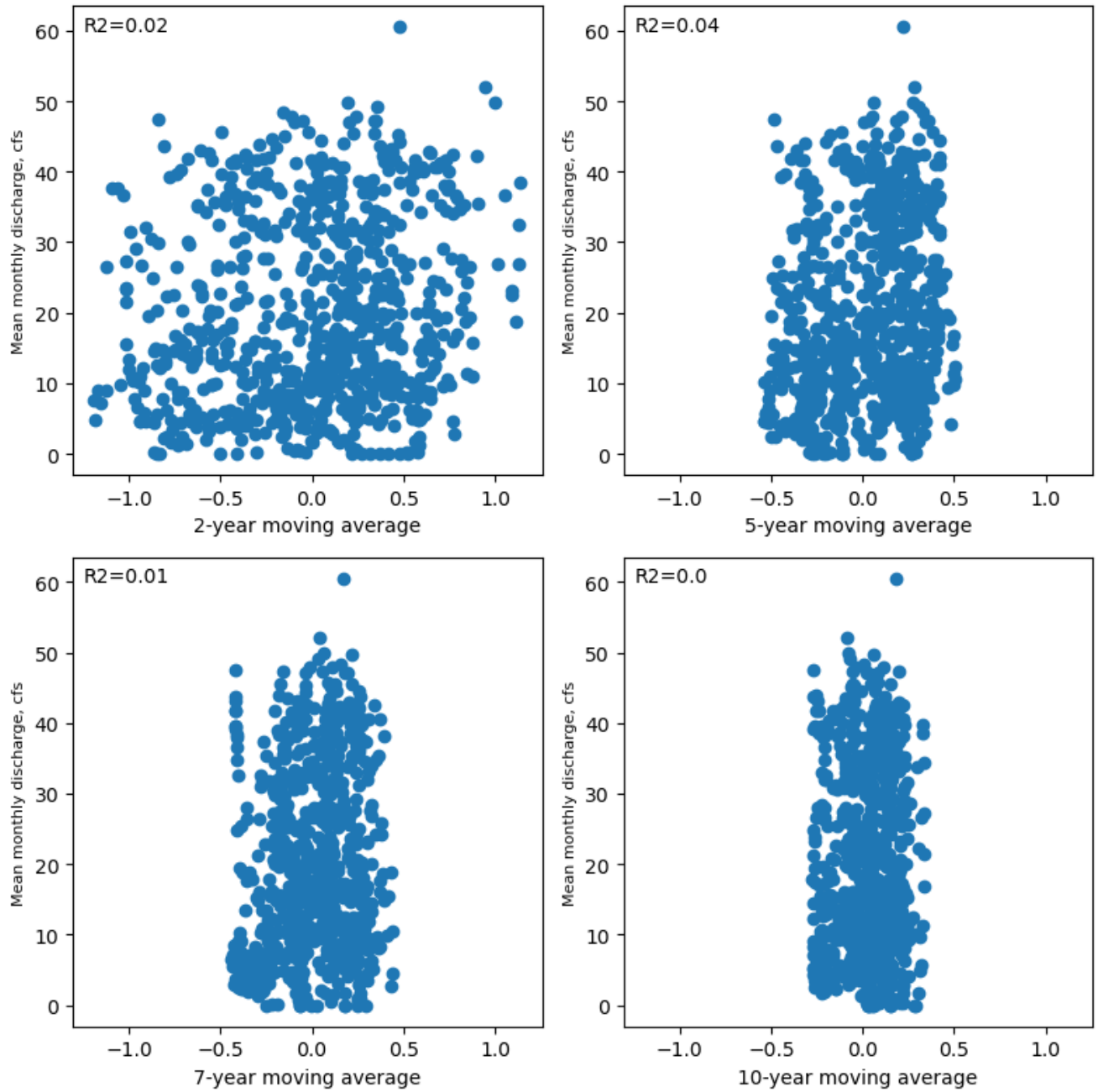
## 6.02 LAS MORAS AND OCEANIC NIÑO INDEX



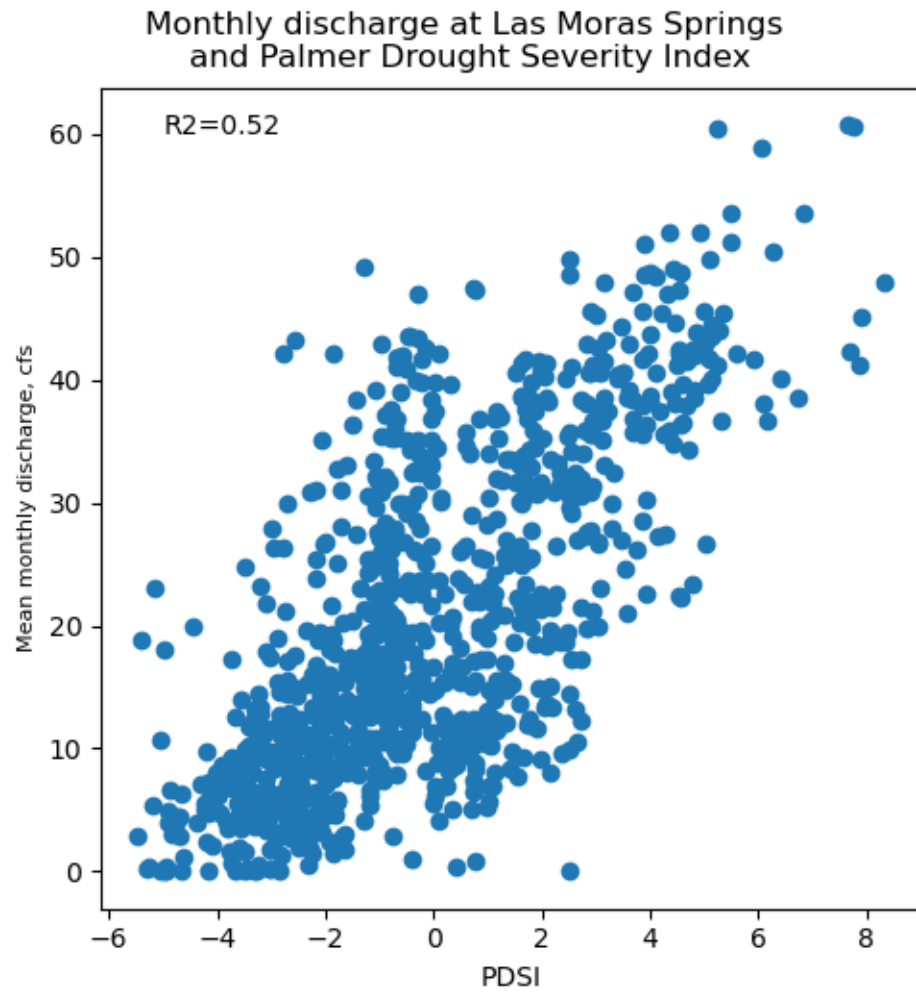
Annual discharge at Las Moras Springs and Oceanic Nino Index



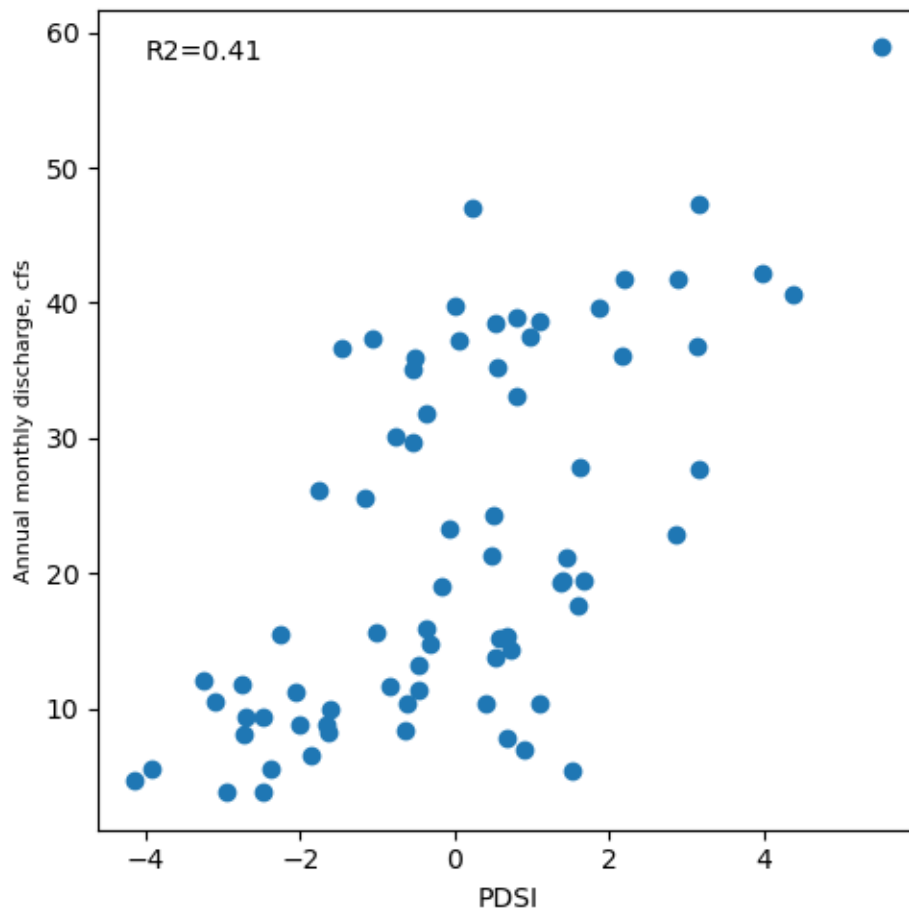
Monthly discharge at Las Moras Springs and Monthly ONI Anomaly



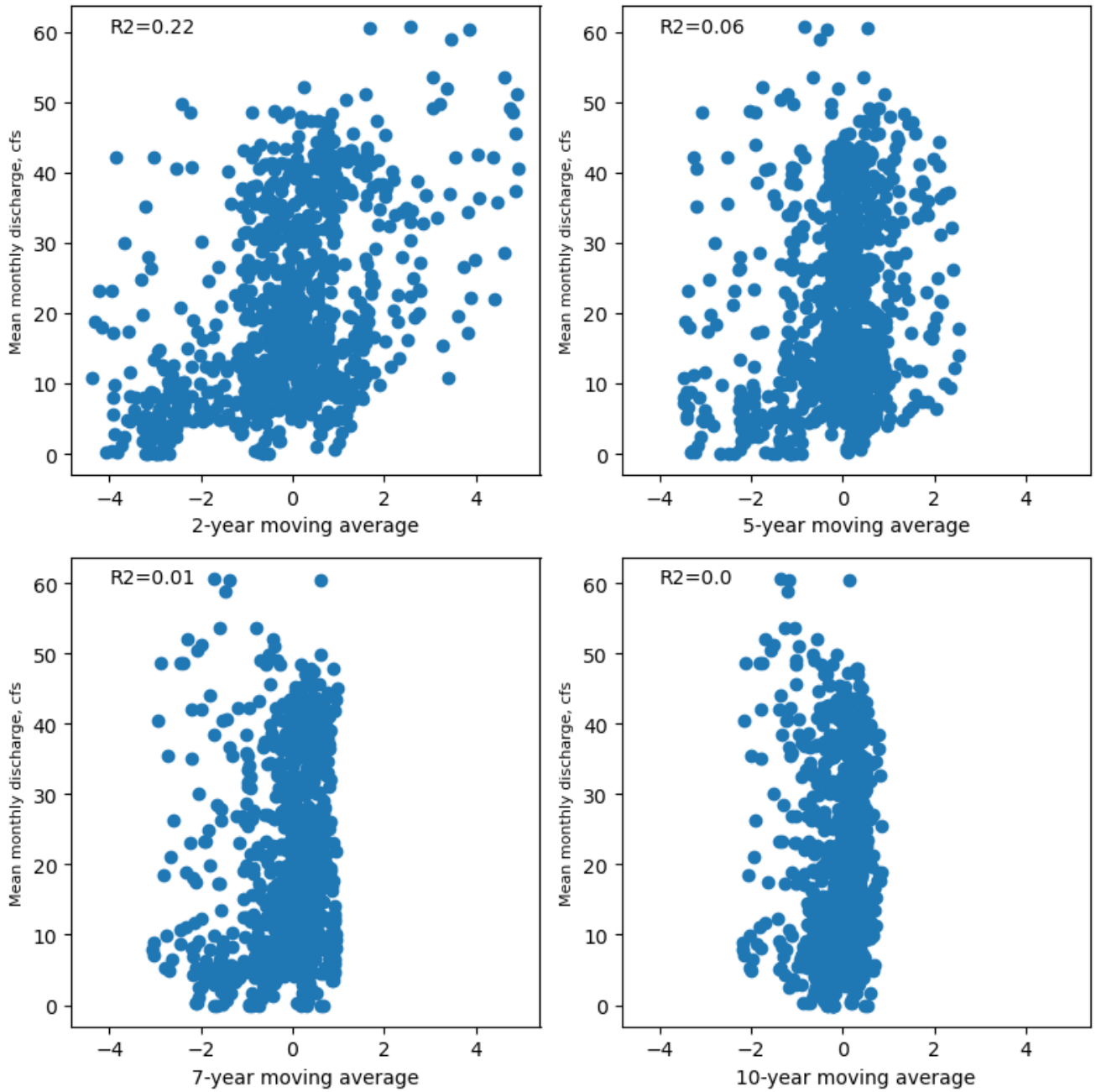
### 6.03 LAS MORAS AND PALMER DROUGHT SEVERITY INDEX



Annual discharge at Las Moras Springs and Palmer Drought Severity Index

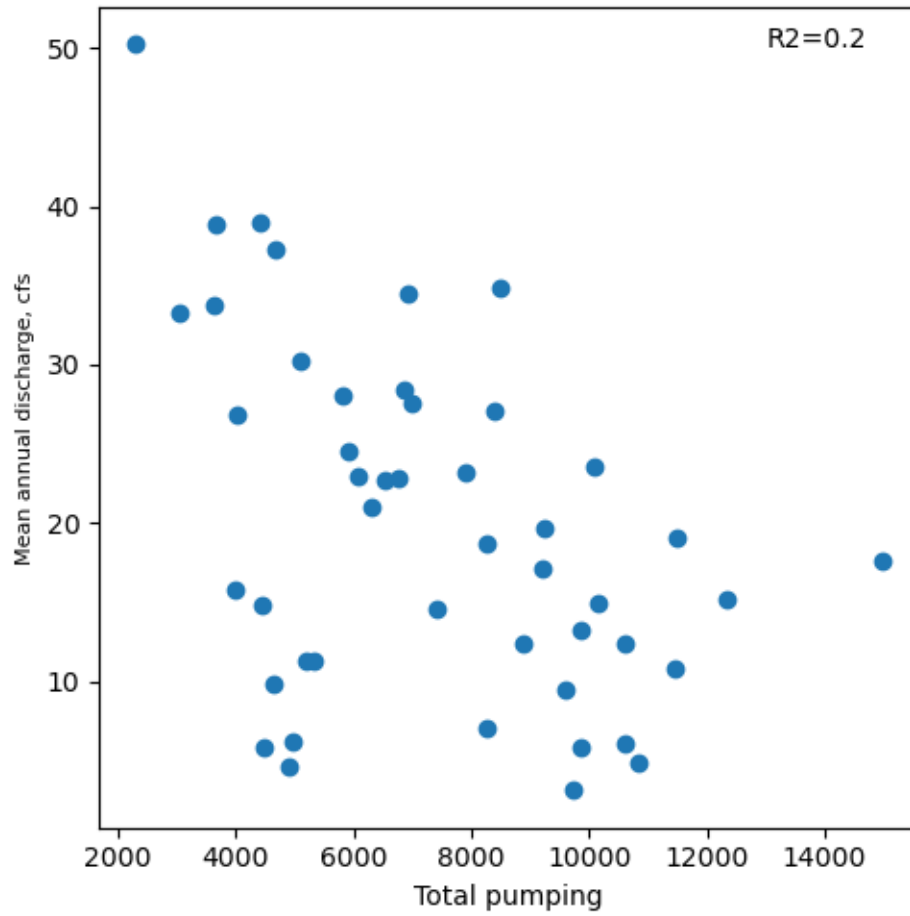


### Monthly discharge at Las Moras Springs and Monthly PDSI

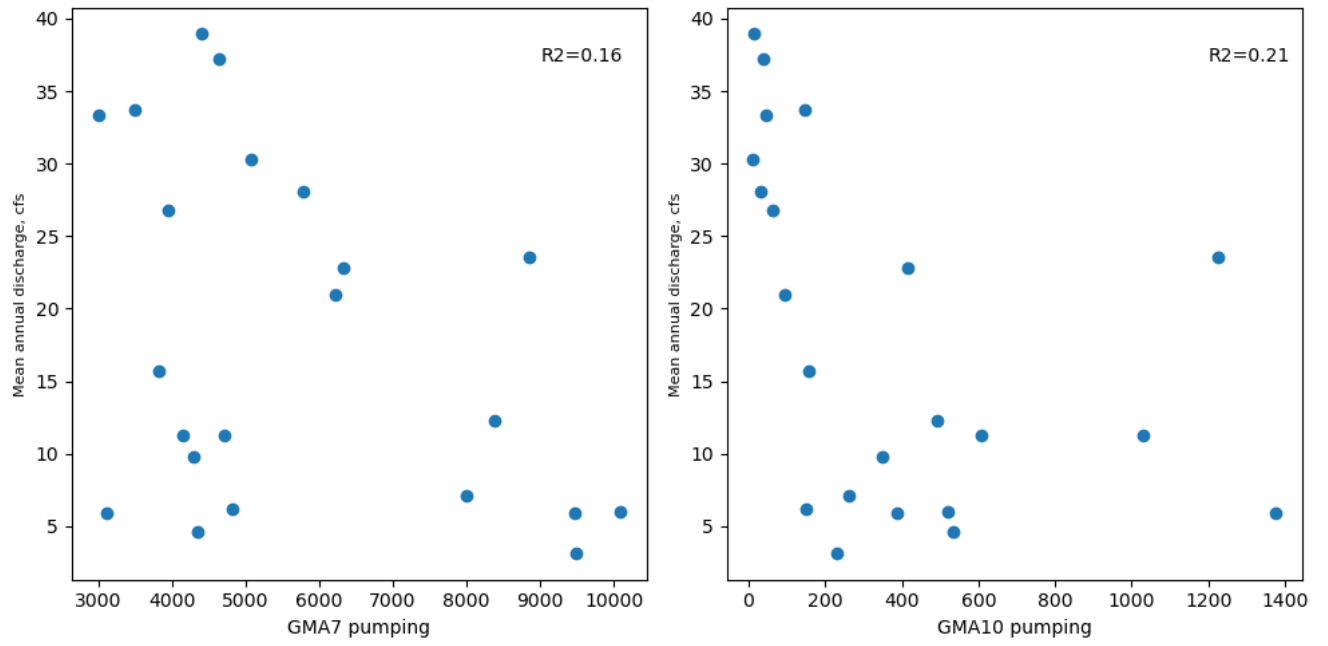


#### 6.04 LAS MORAS AND GROUNDWATER PUMPING VOLUMES

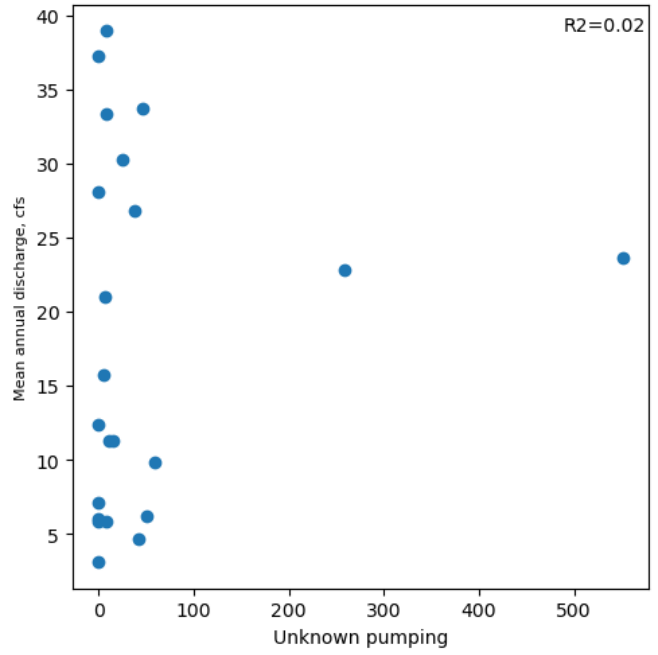
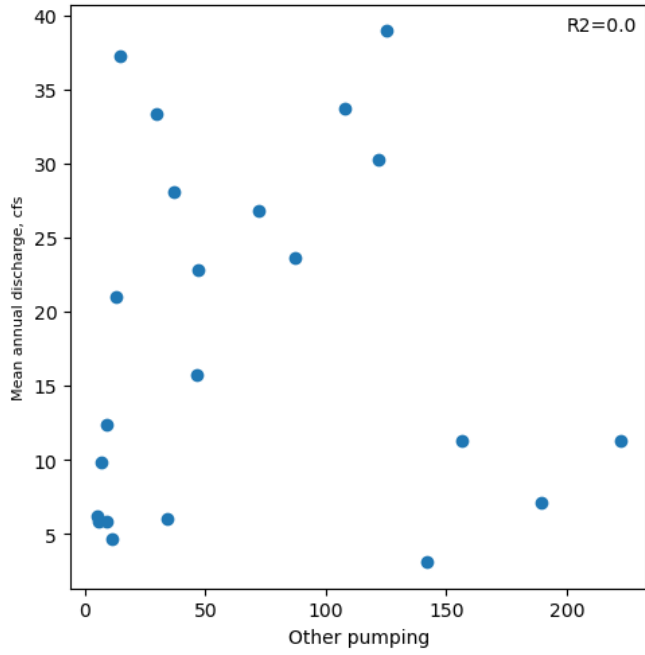
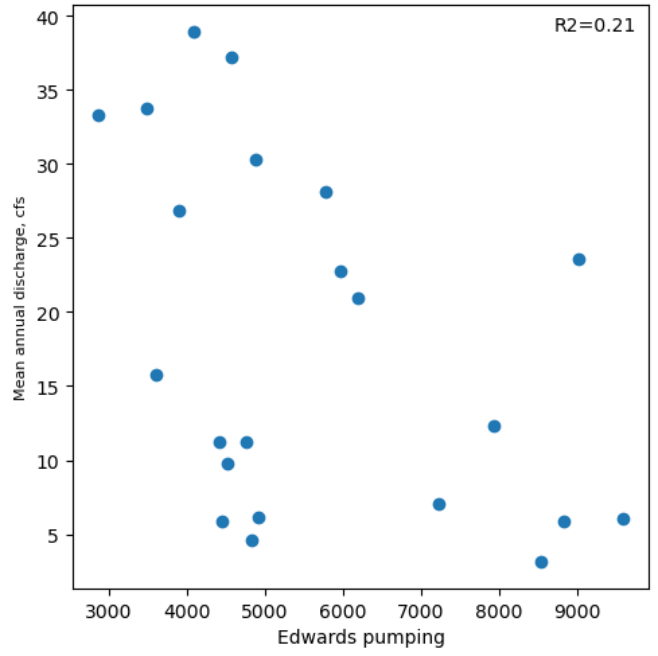
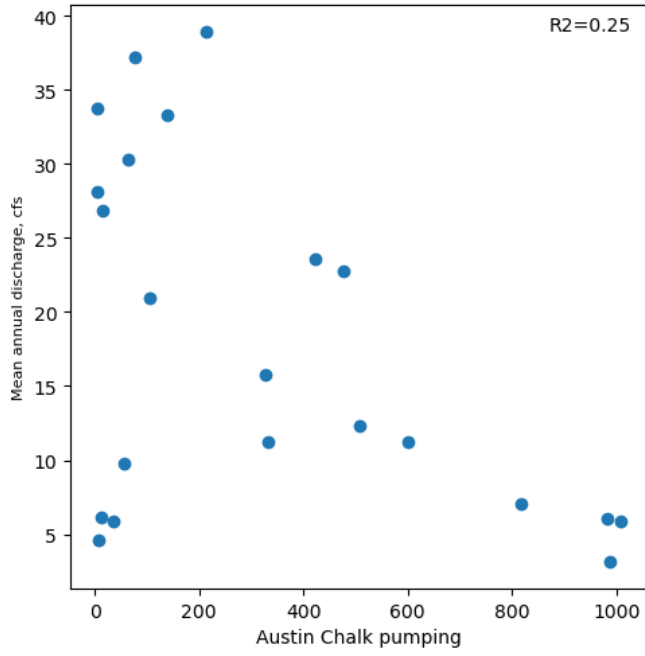
Annual discharge at Las Moras Springs  
and Total Groundwater Pumping in Kinney County



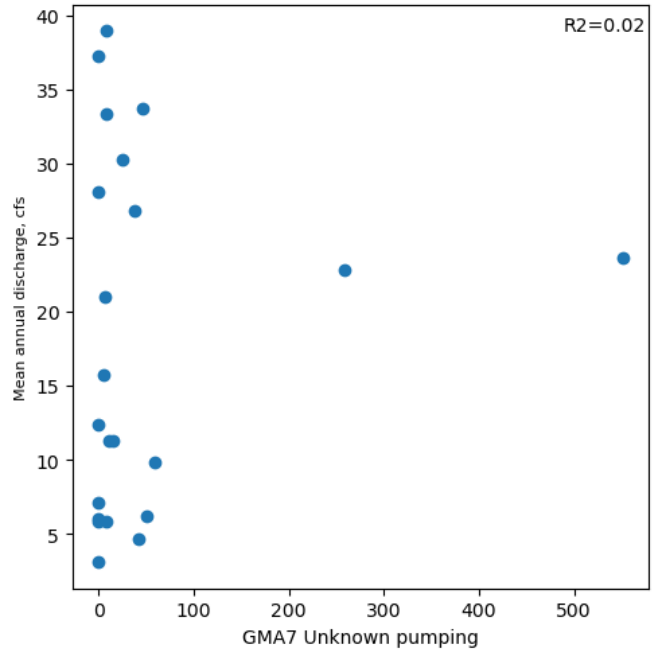
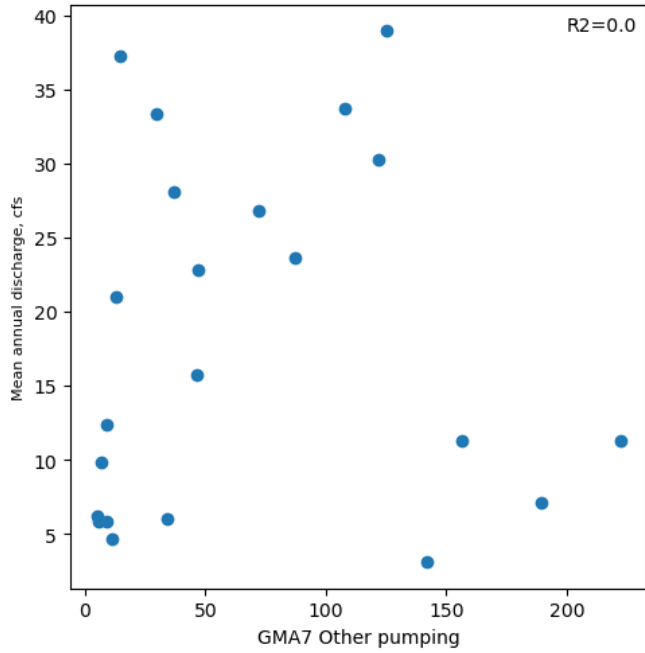
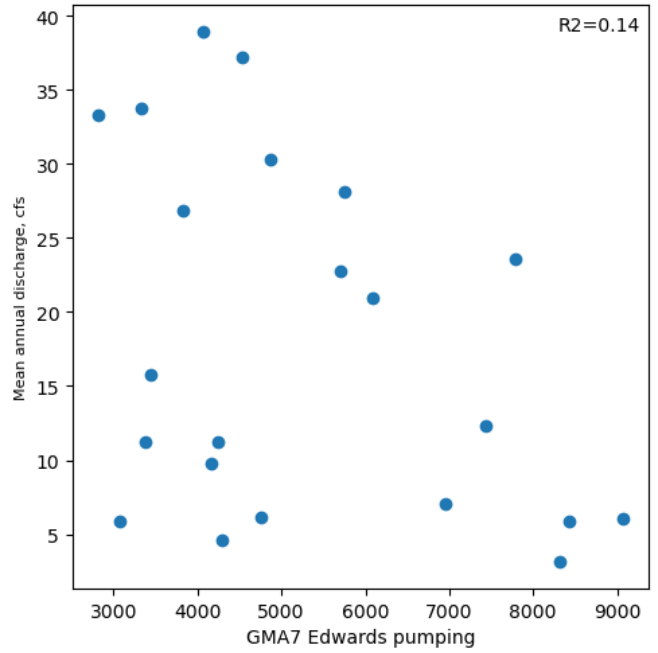
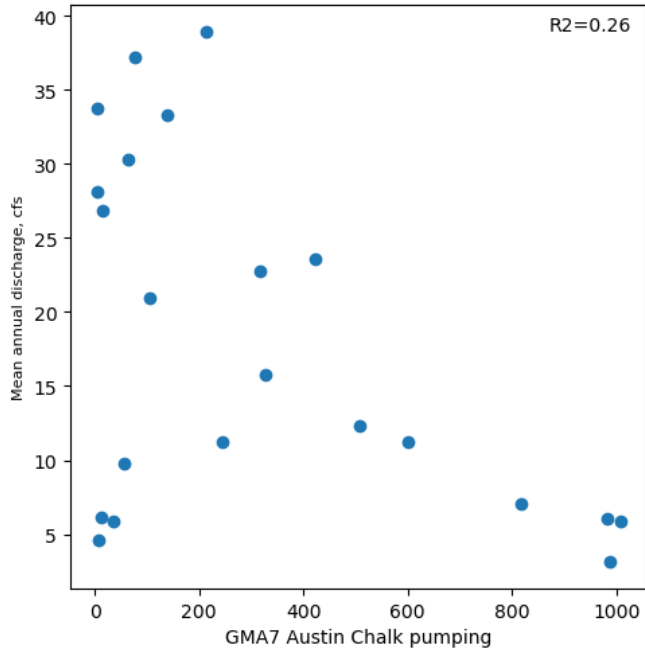
Annual discharge at Las Moras Springs and Groundwater Pumping in Kinney County by GMA



Annual discharge at Las Moras Springs and Groundwater Pumping by Aquifer in Kinney County

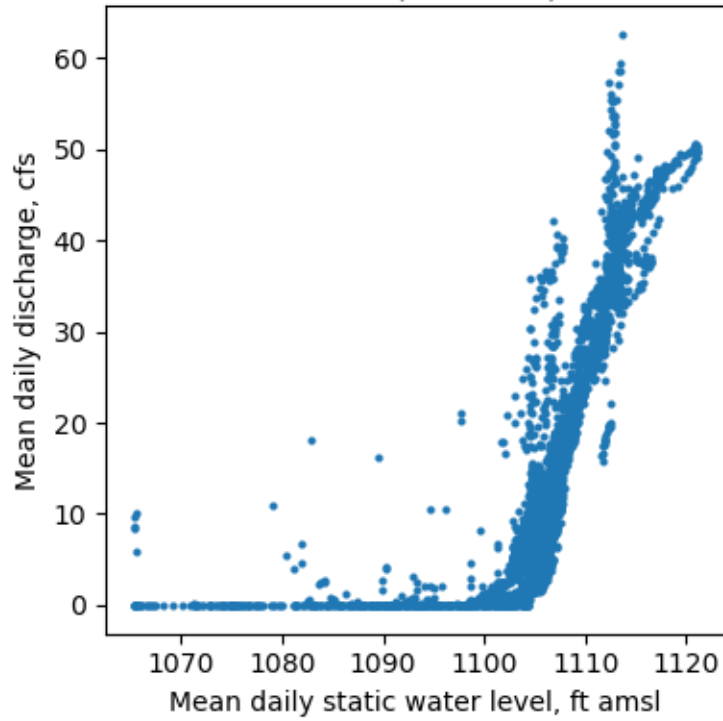


Annual discharge at Las Moras Springs and Groundwater Pumping by Aquifer in GMA7 in Kinney County

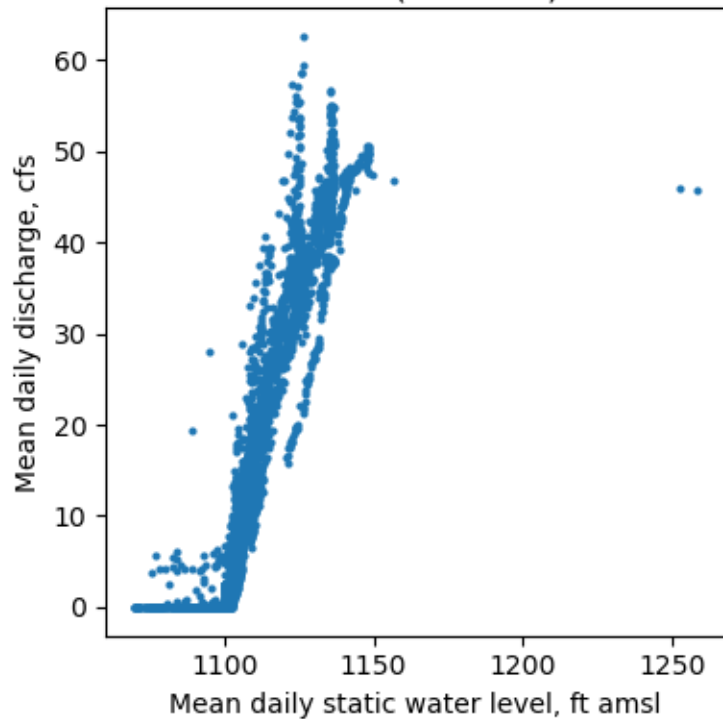


## 6.05 LAS MORAS AND STATIC WATER LEVEL

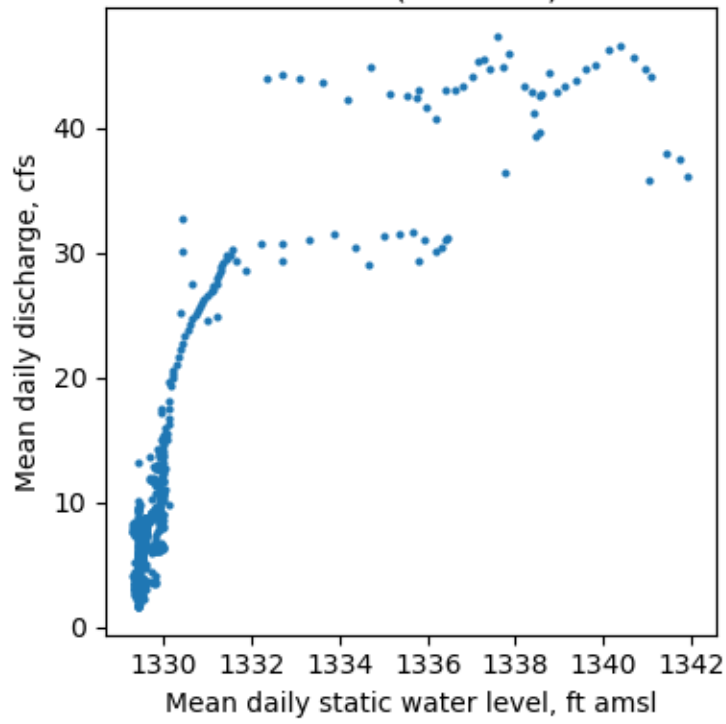
M001 static water level and discharge at Las Moras ( $R^2=0.44$ )



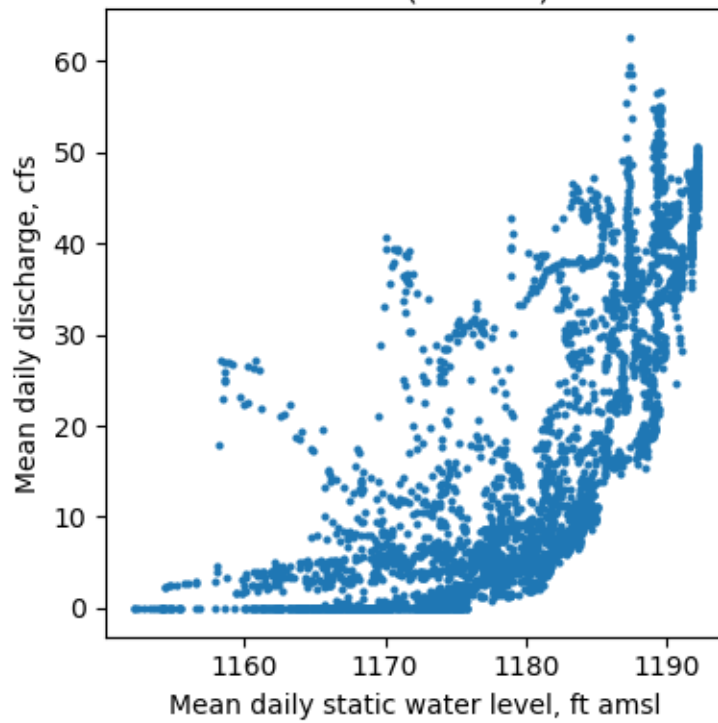
M002 static water level and discharge at Las Moras ( $R^2=0.82$ )



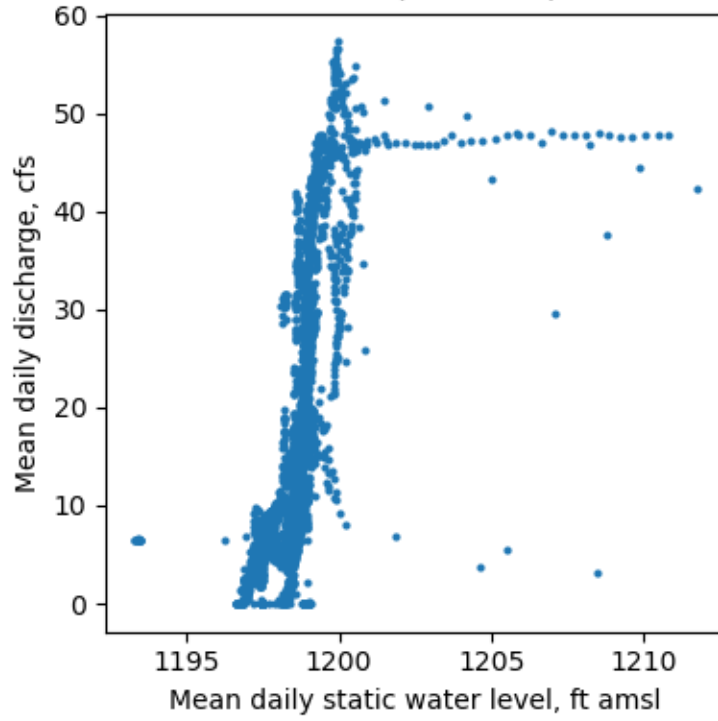
M003 static water level and discharge at Las Moras (R2=0.78)



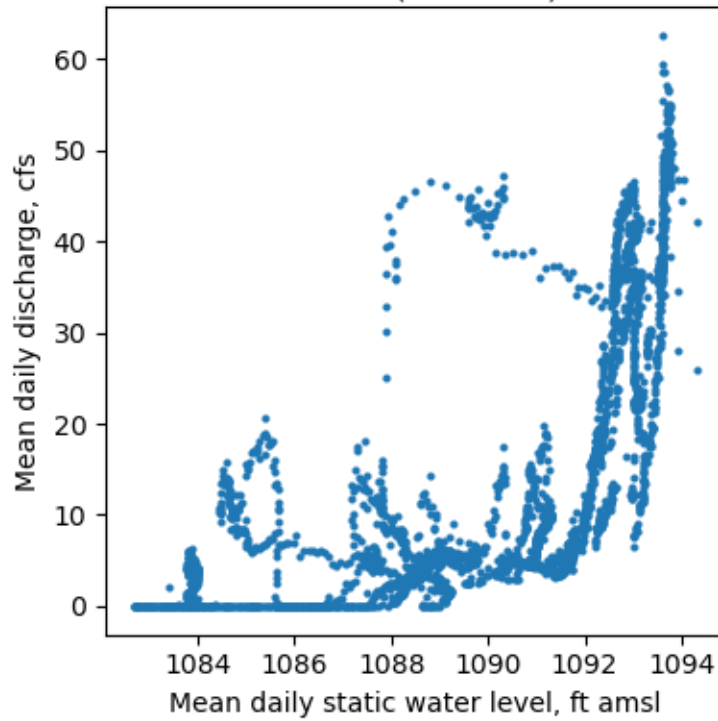
M004 static water level and discharge at Las Moras (R2=0.5)



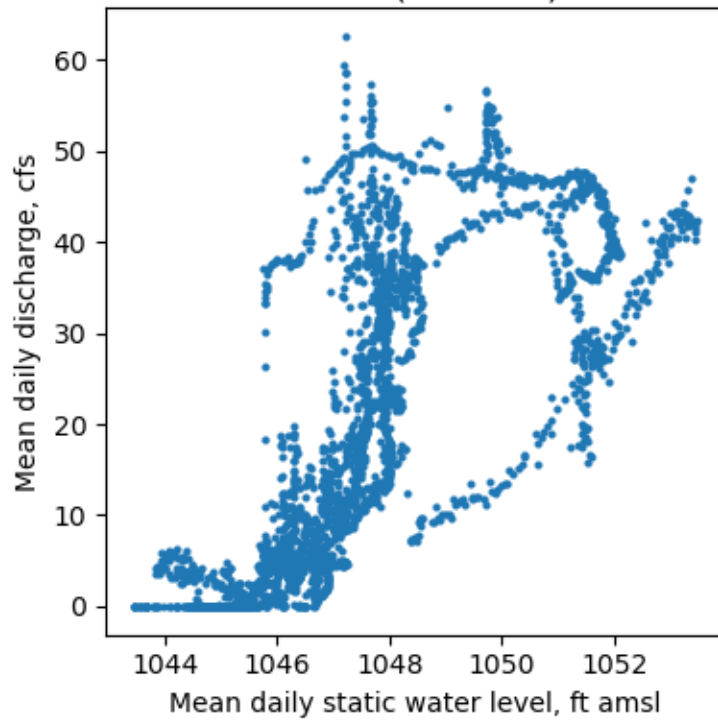
M005 static water level and discharge at Las Moras ( $R^2=0.39$ )



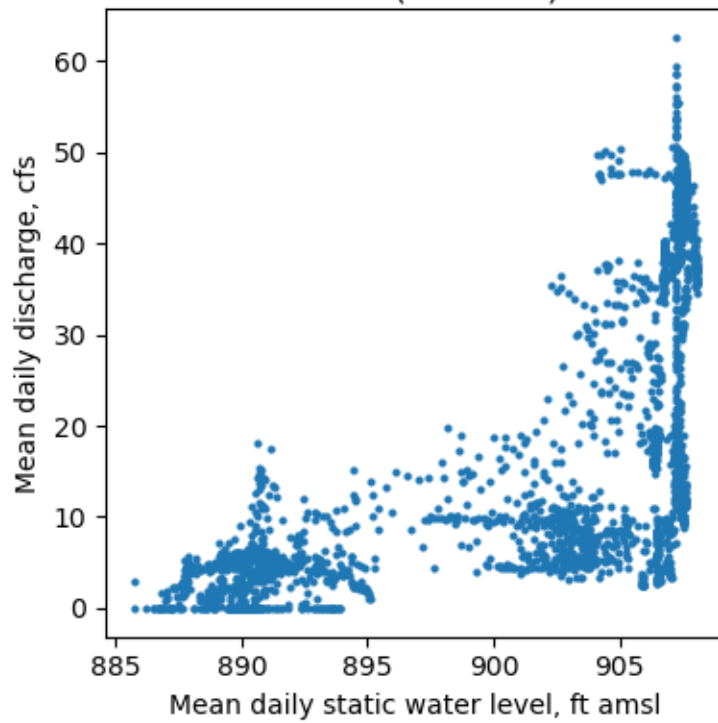
M006 static water level and discharge at Las Moras ( $R^2=0.44$ )



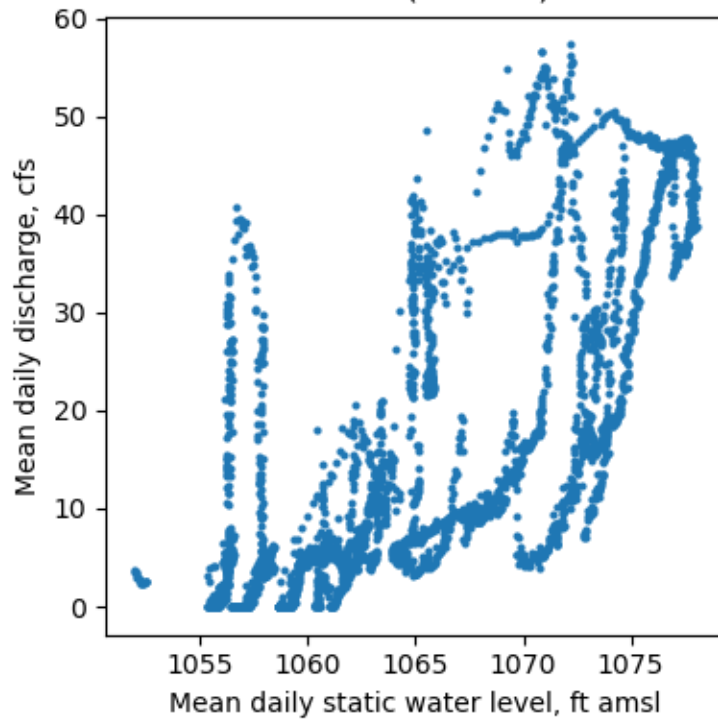
M008 static water level and discharge at Las Moras (R2=0.54)



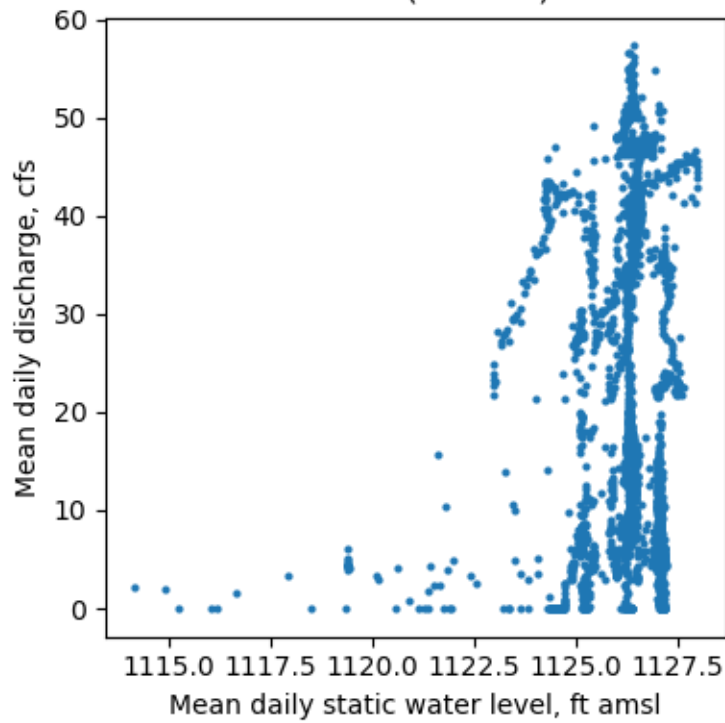
M009 static water level and discharge at Las Moras (R2=0.42)



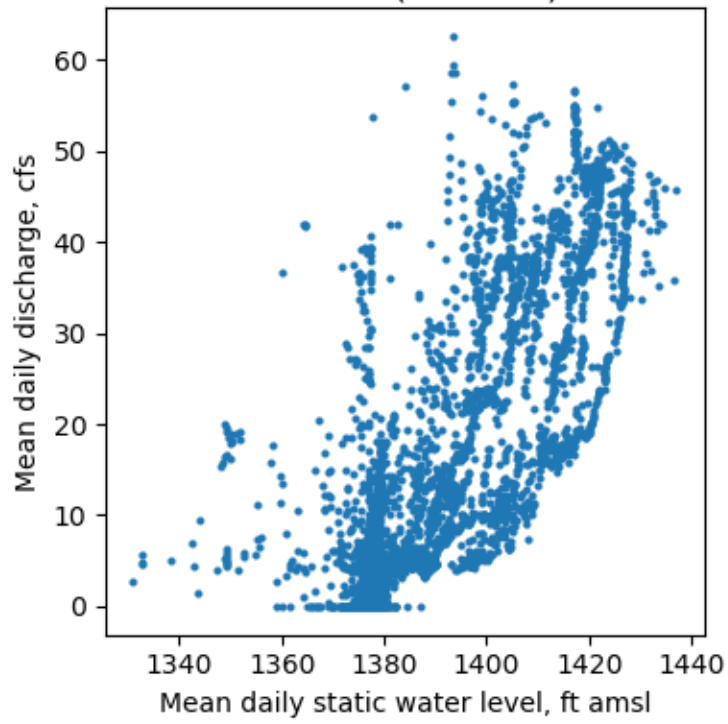
M010 static water level and discharge at Las Moras (R2=0.5)



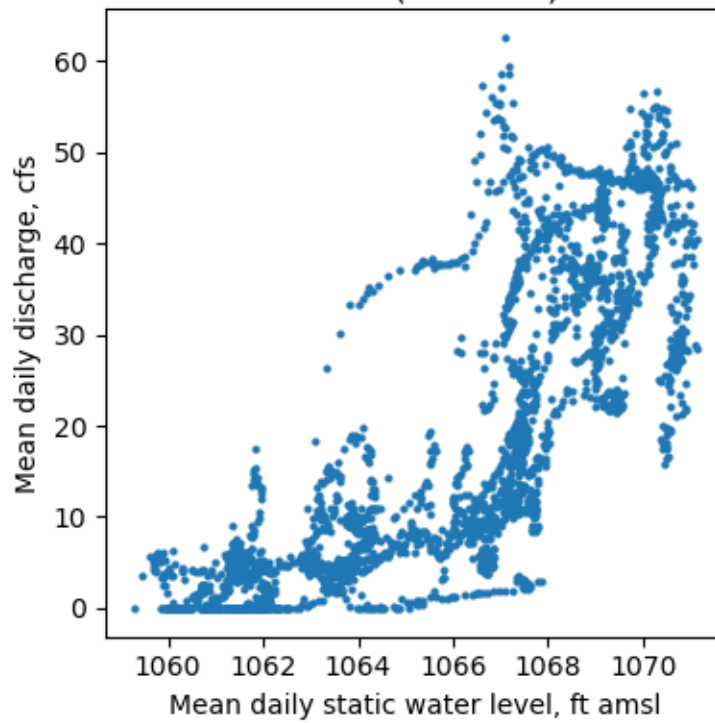
M011 static water level and discharge at Las Moras (R2=0.0)



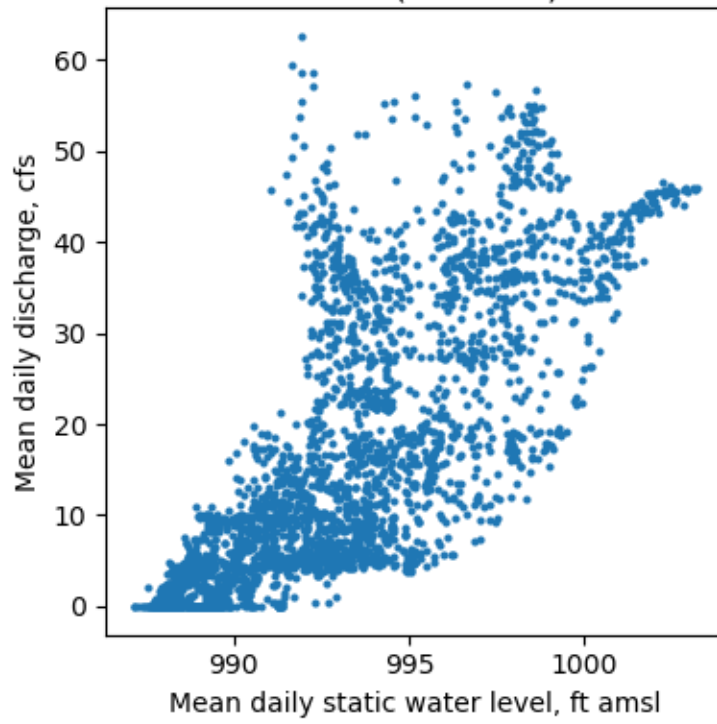
M012 static water level and discharge at Las Moras ( $R^2=0.59$ )



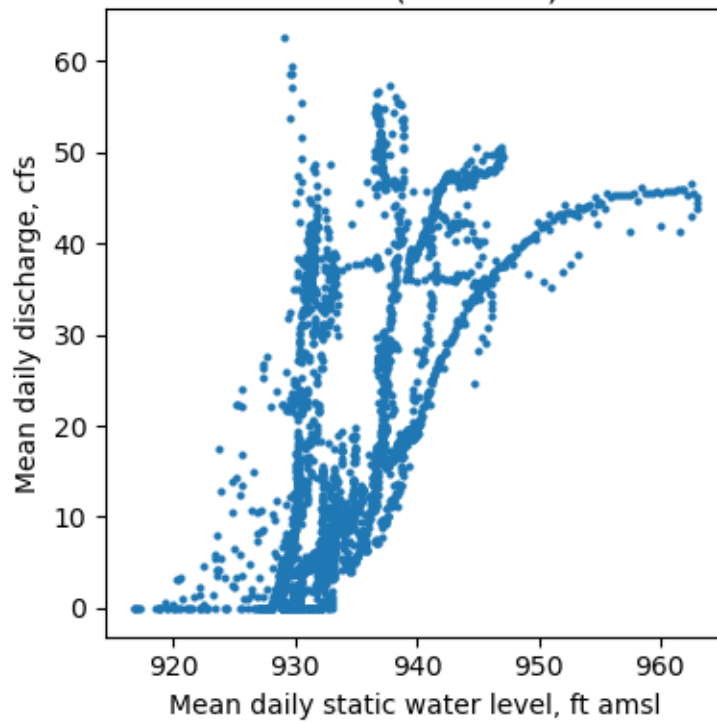
M014 static water level and discharge at Las Moras ( $R^2=0.63$ )



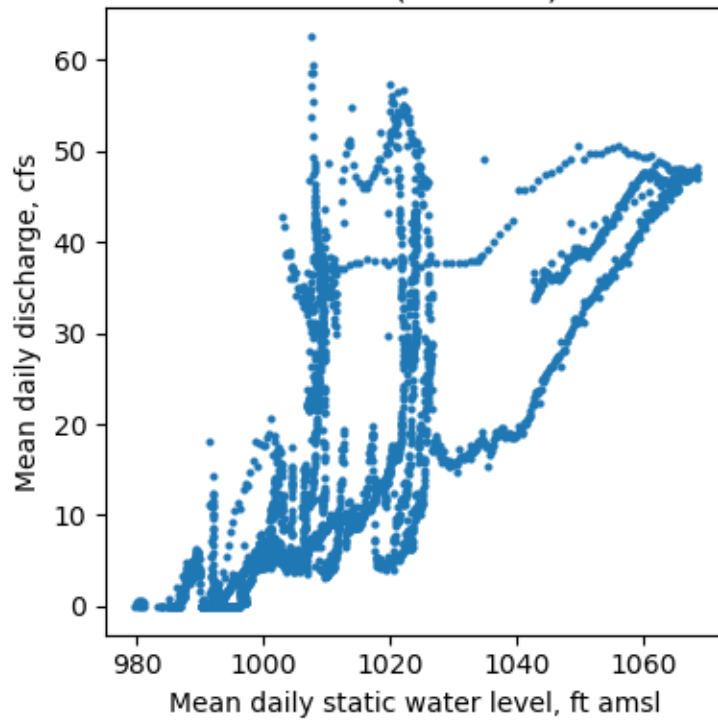
M015 static water level and discharge at Las Moras ( $R^2=0.55$ )



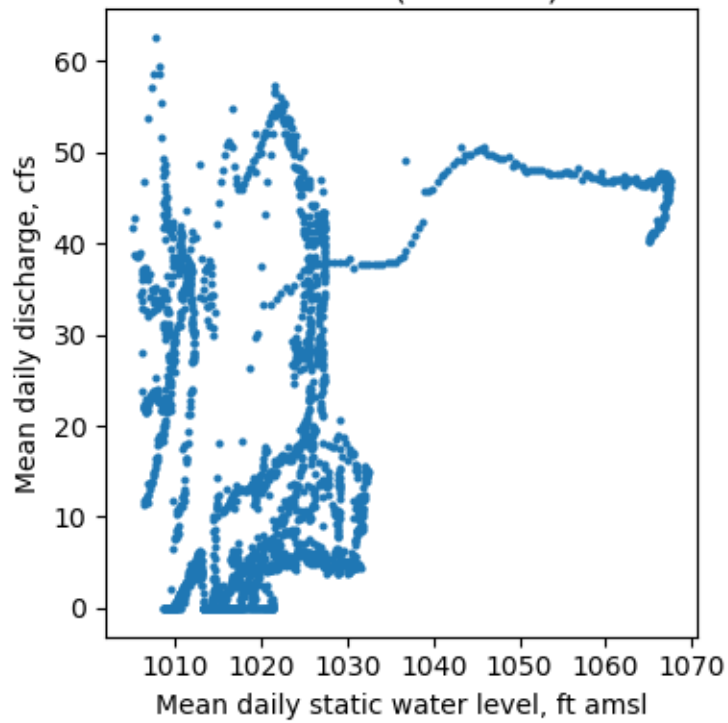
M016 static water level and discharge at Las Moras ( $R^2=0.43$ )



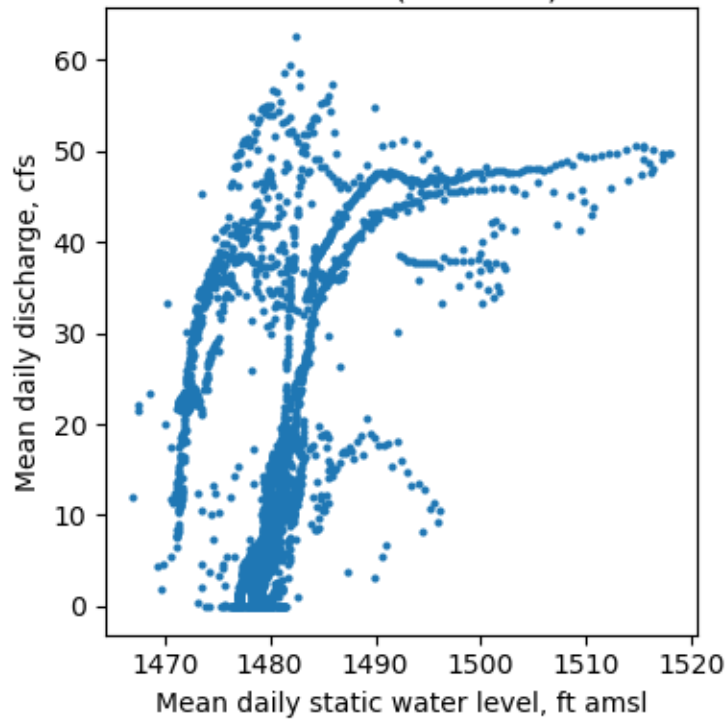
M017 static water level and discharge at Las Moras ( $R^2=0.52$ )



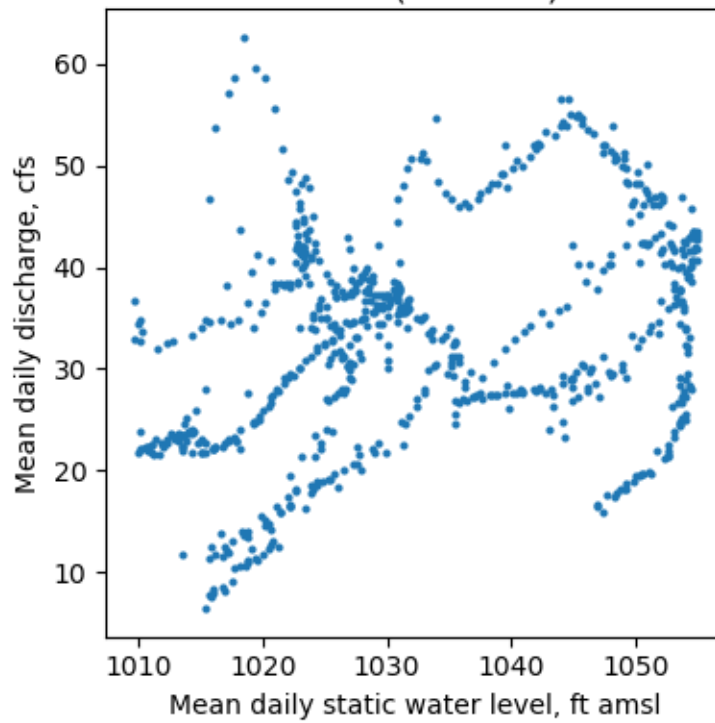
M018 static water level and discharge at Las Moras ( $R^2=0.14$ )



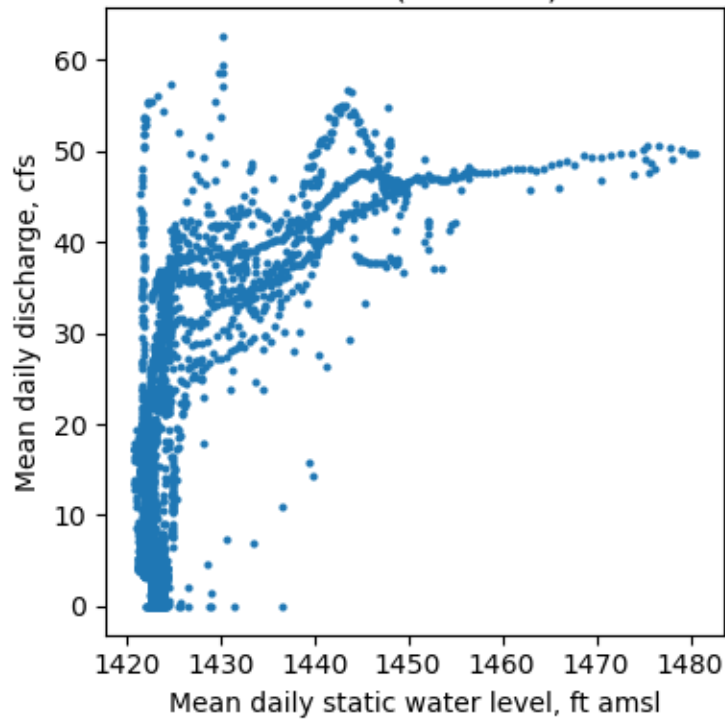
M019 static water level and discharge at Las Moras ( $R^2=0.22$ )



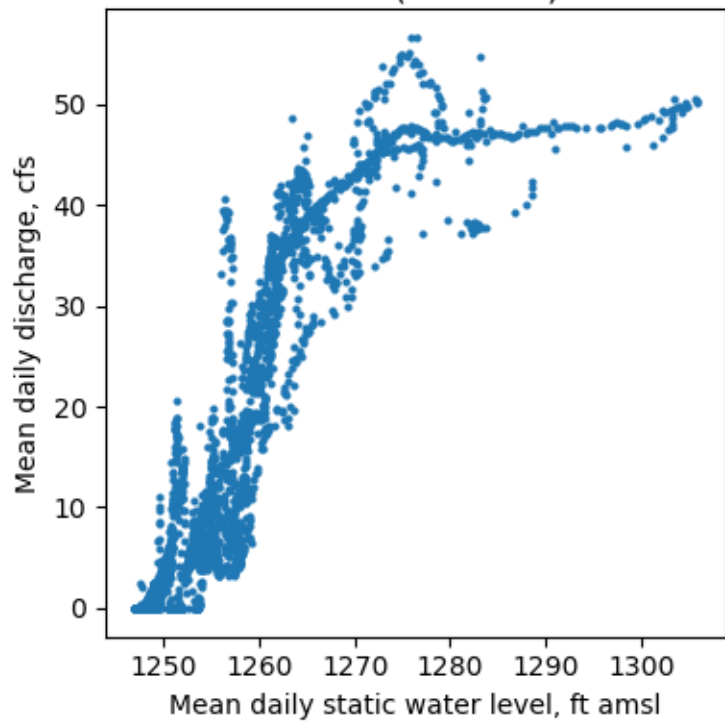
M020 static water level and discharge at Las Moras ( $R^2=0.12$ )



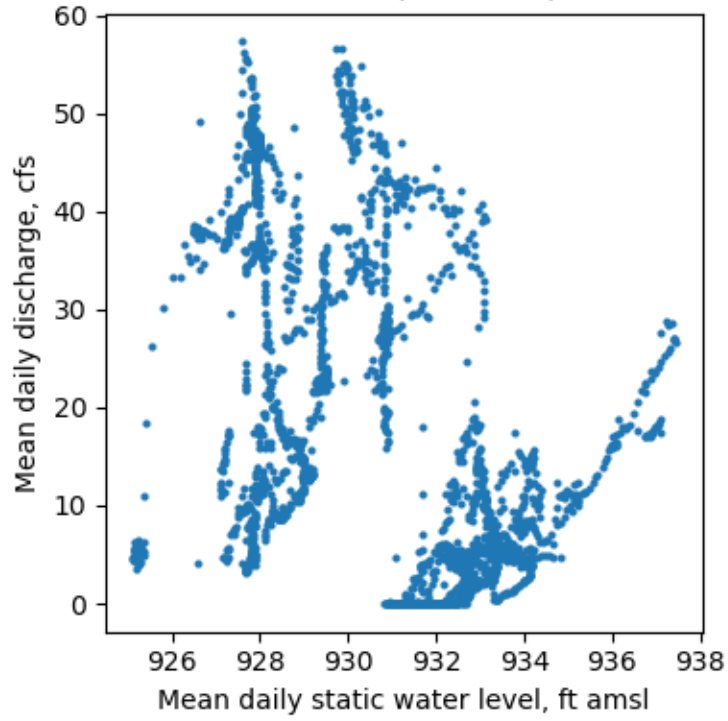
M021 static water level and discharge at Las Moras (R2=0.49)



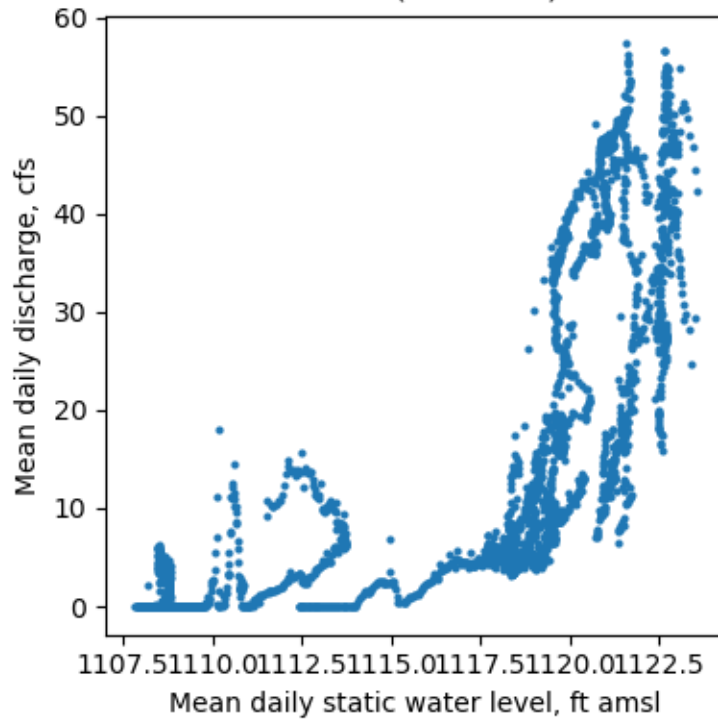
M022 static water level and discharge at Las Moras (R2=0.74)



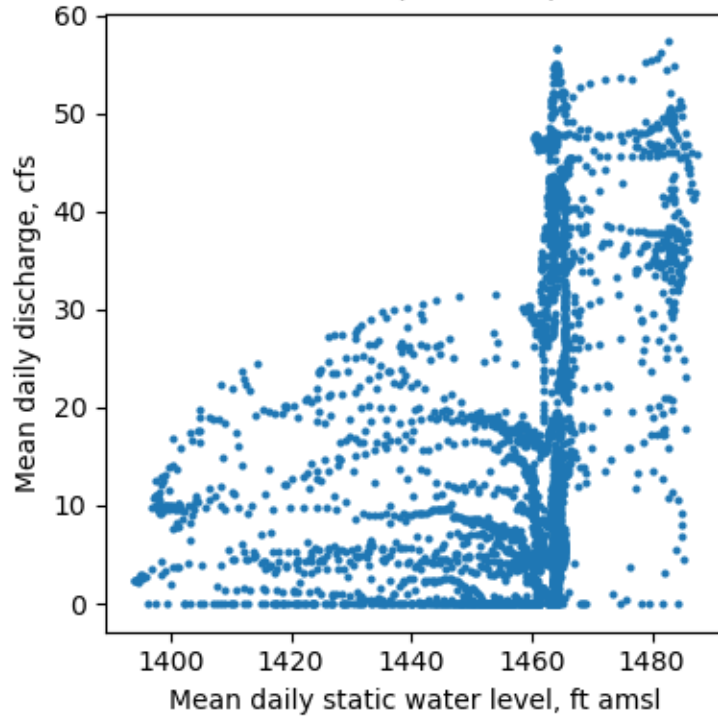
M023 static water level and discharge at Las Moras ( $R^2=0.24$ )



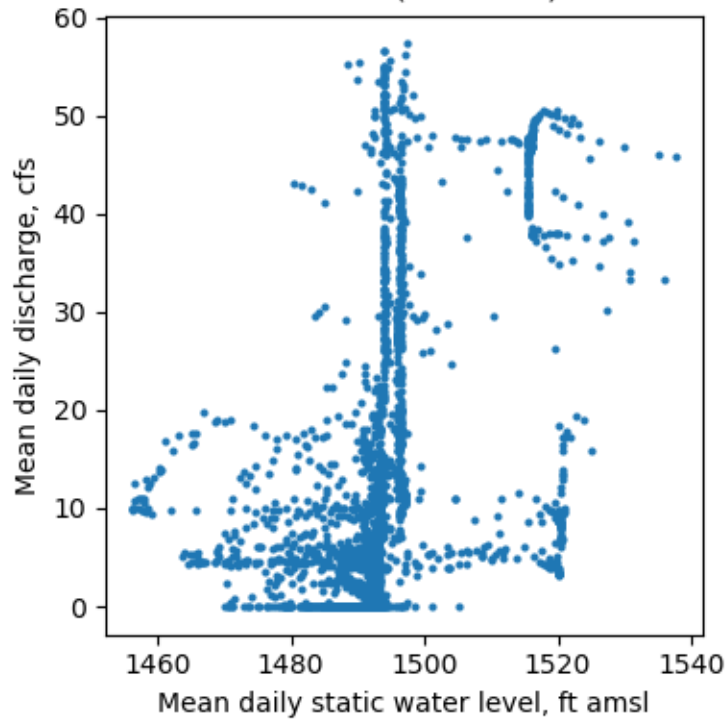
M025 static water level and discharge at Las Moras ( $R^2=0.44$ )



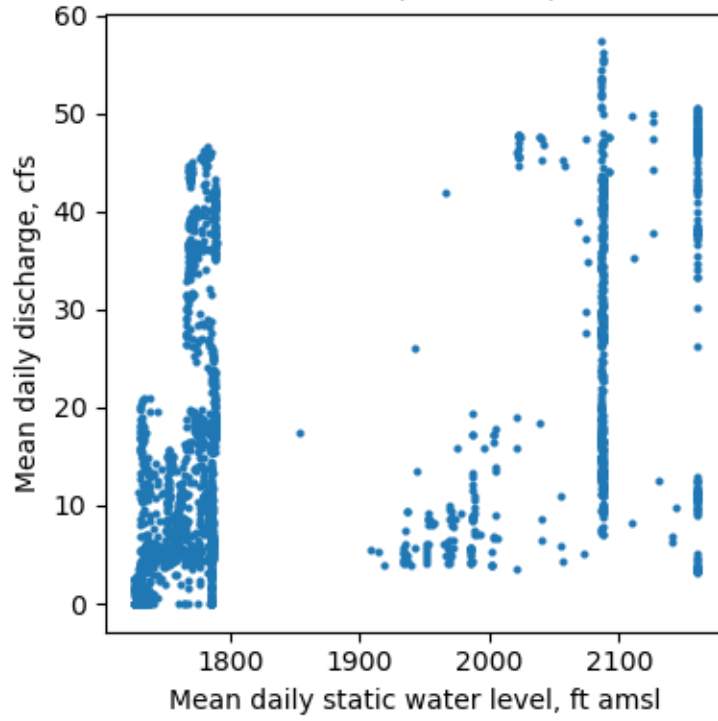
M026 static water level and discharge at Las Moras ( $R^2=0.13$ )



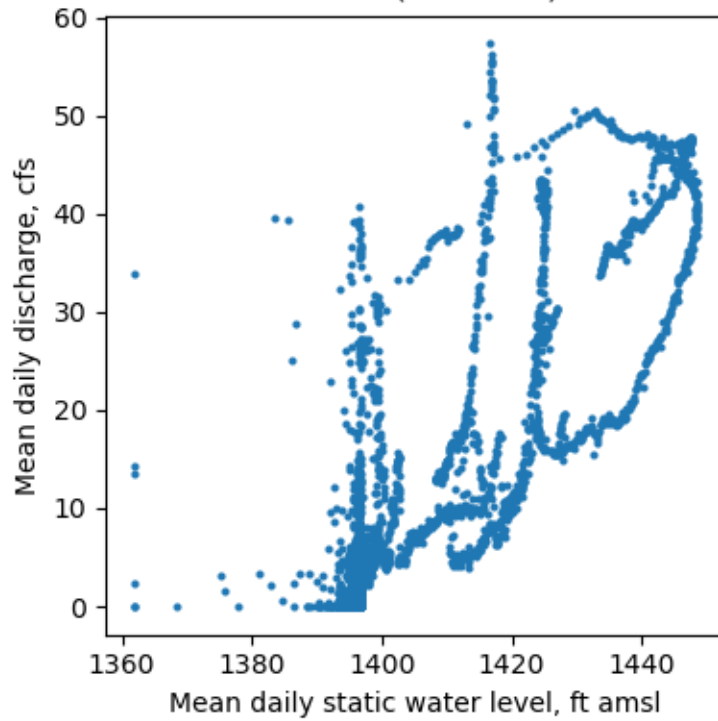
M027 static water level and discharge at Las Moras ( $R^2=0.21$ )



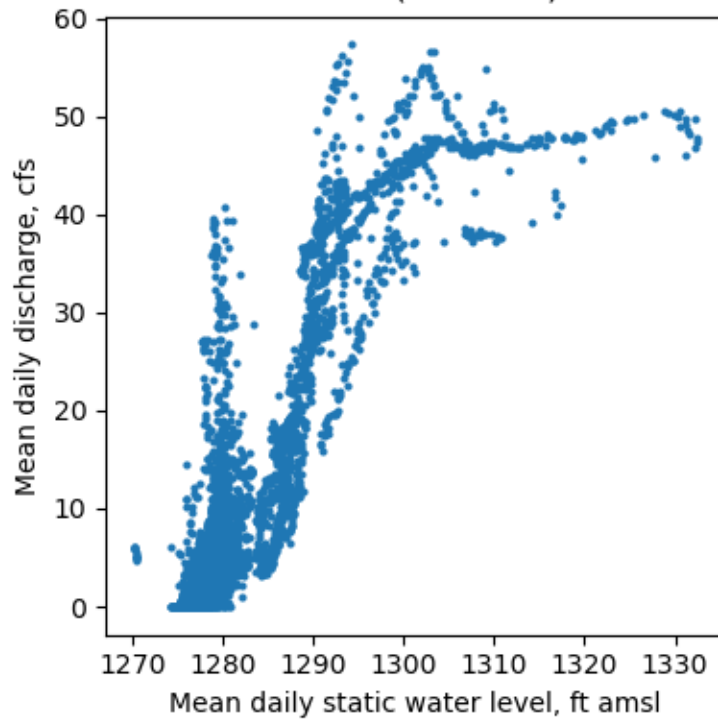
M028 static water level and discharge at Las Moras ( $R^2=0.26$ )



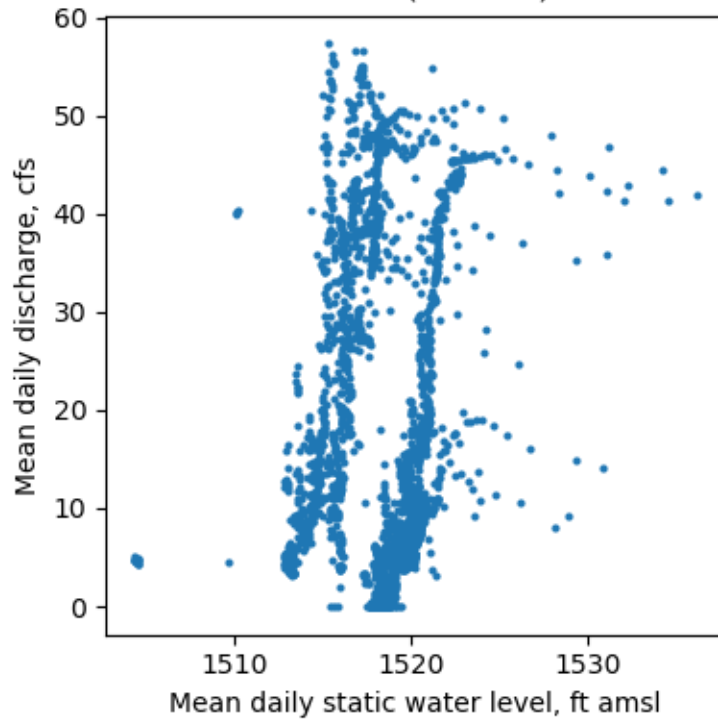
M029 static water level and discharge at Las Moras ( $R^2=0.63$ )



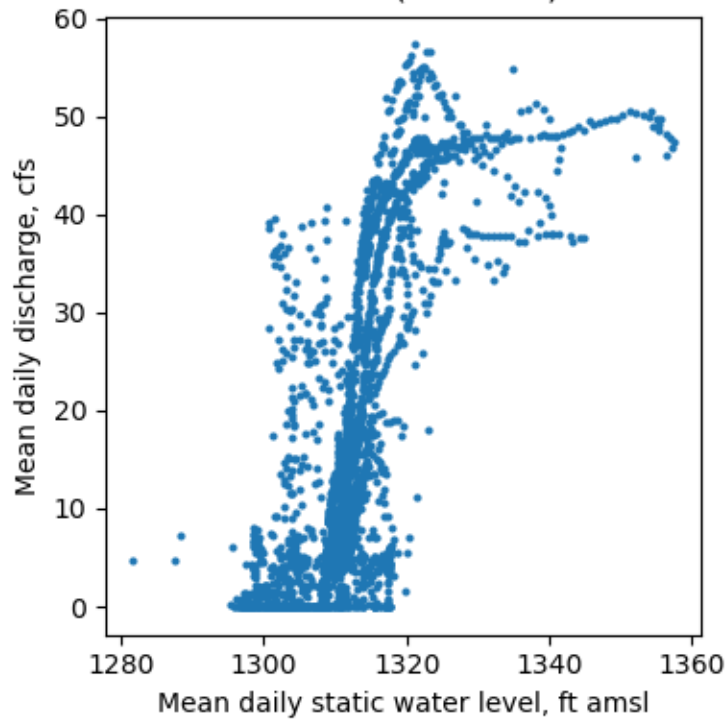
M030 static water level and discharge at Las Moras ( $R^2=0.73$ )



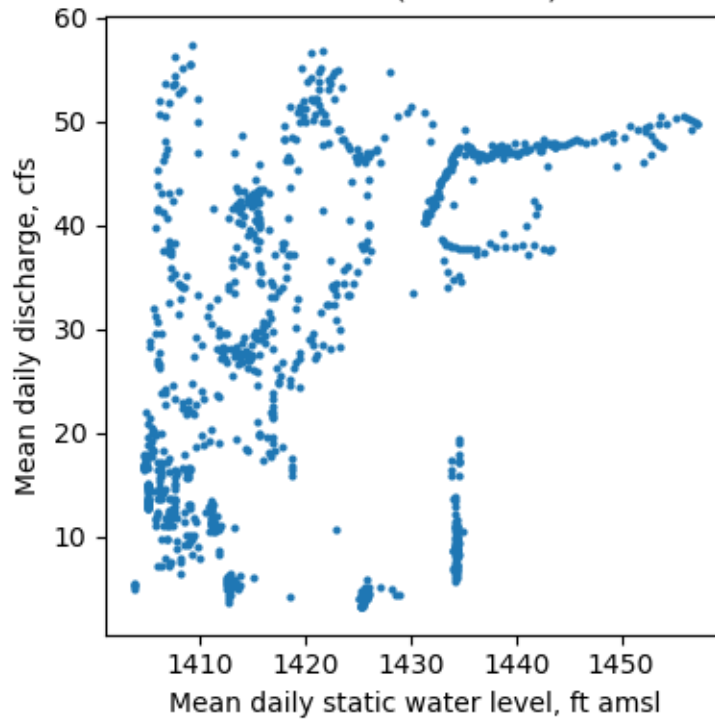
M031 static water level and discharge at Las Moras ( $R^2=0.0$ )



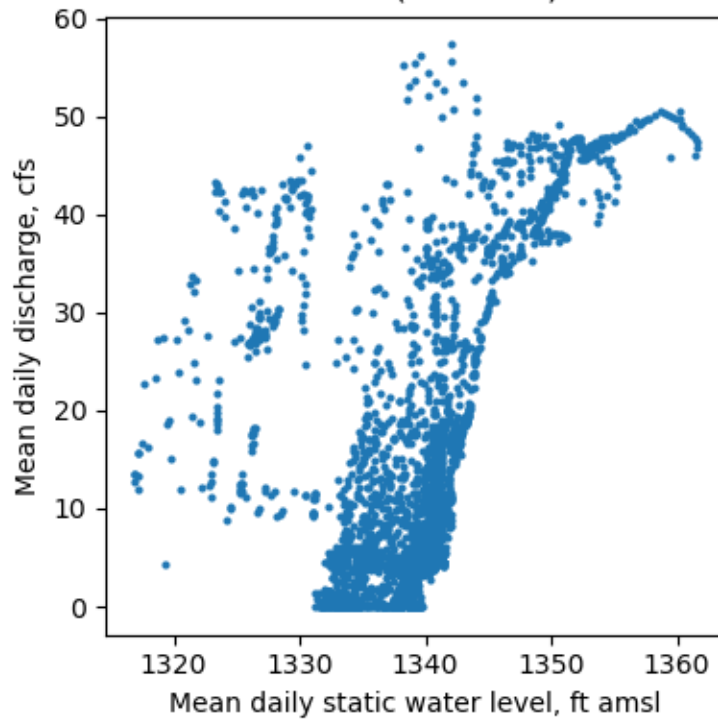
M032 static water level and discharge at Las Moras ( $R^2=0.47$ )



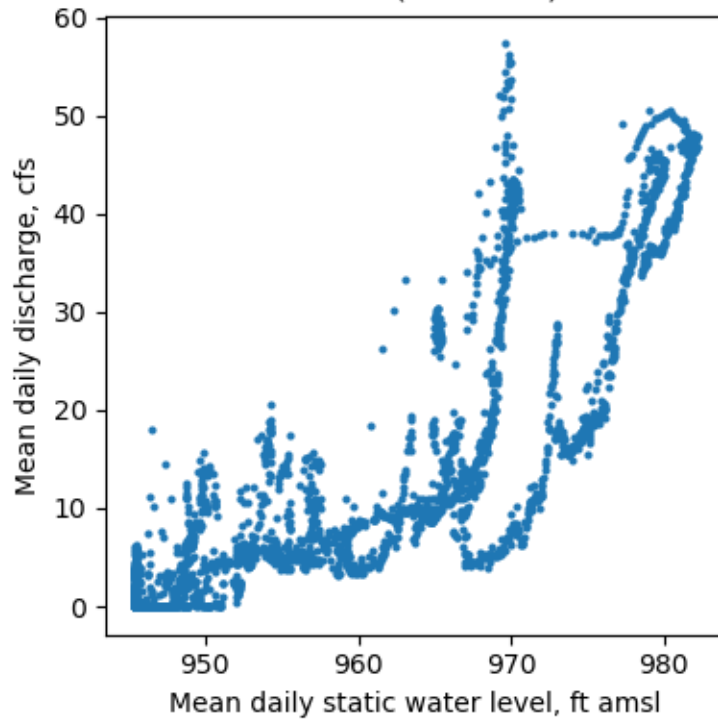
M033 static water level and discharge at Las Moras ( $R^2=0.16$ )



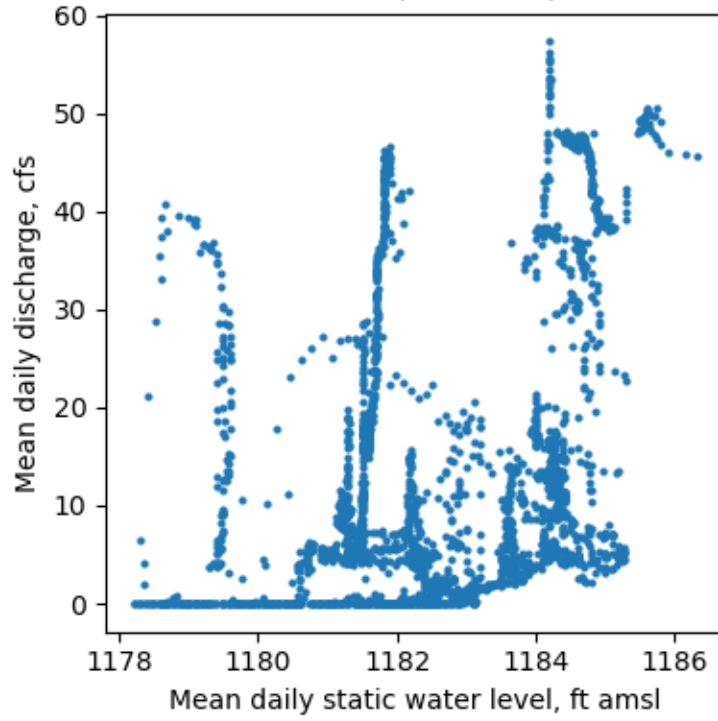
M034 static water level and discharge at Las Moras ( $R^2=0.19$ )



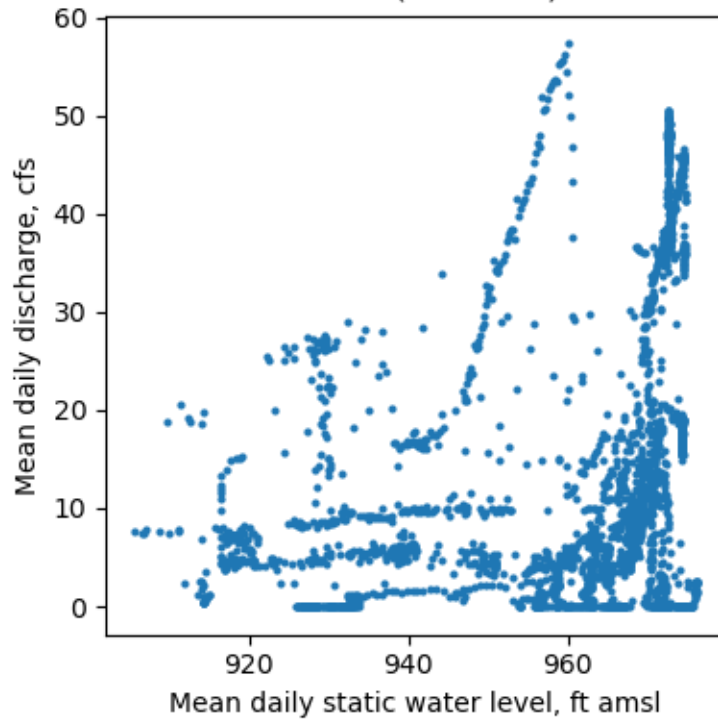
M035 static water level and discharge at Las Moras ( $R^2=0.69$ )



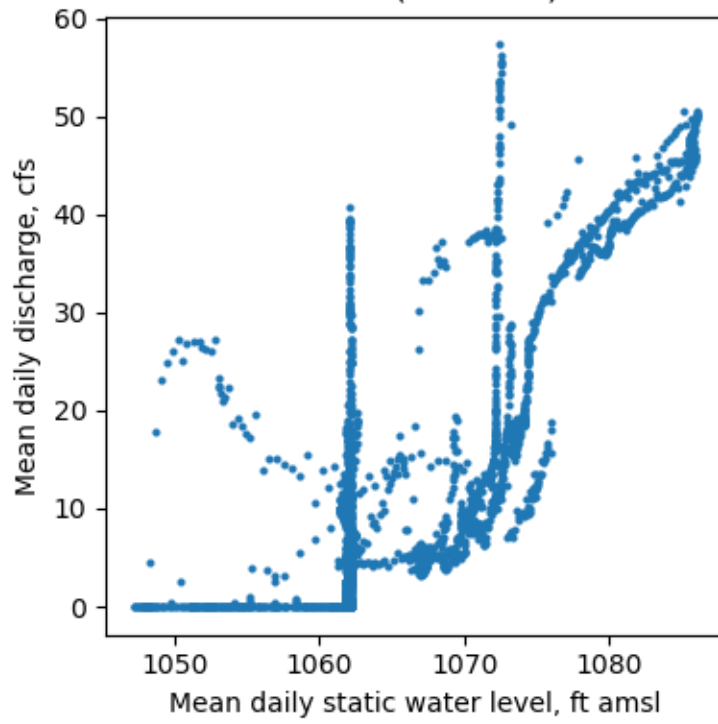
M036 static water level and discharge at Las Moras (R2=0.12)



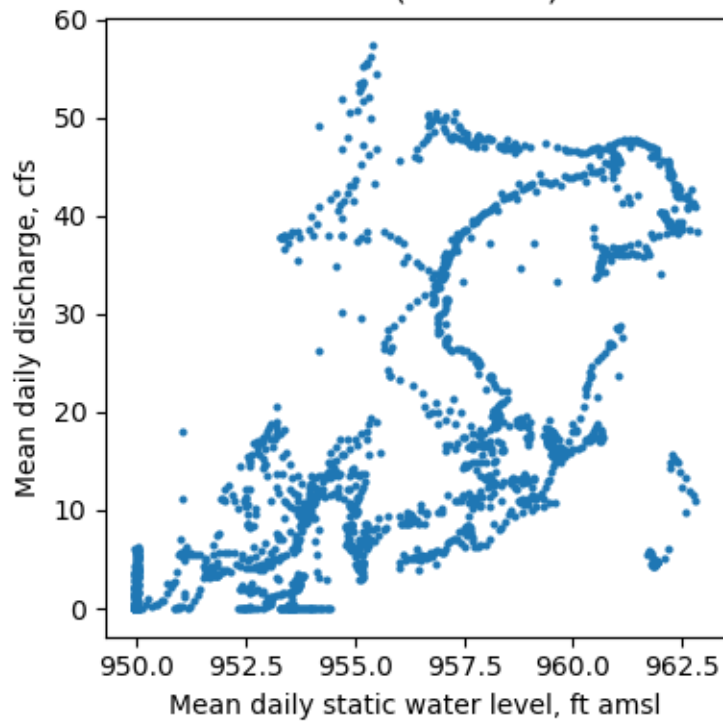
M037 static water level and discharge at Las Moras (R2=0.12)



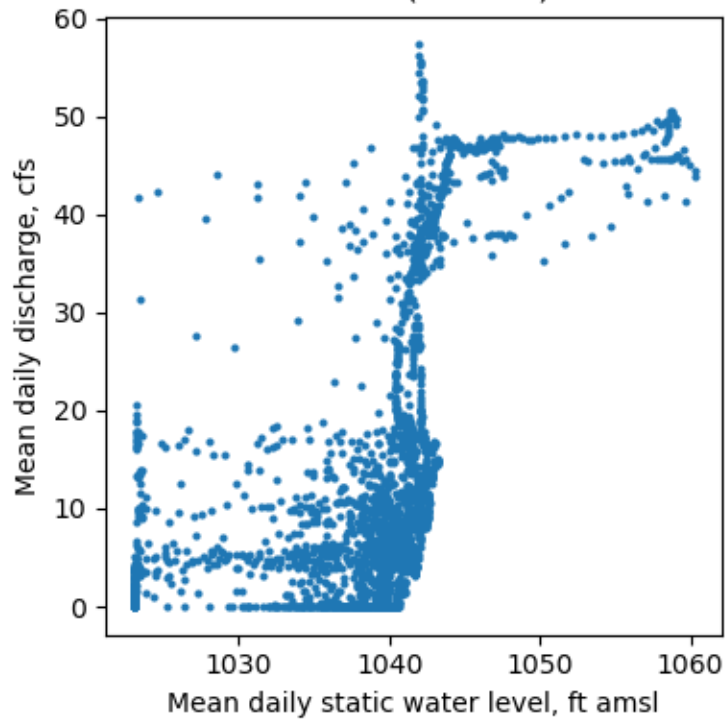
M038 static water level and discharge at Las Moras (R2=0.64)



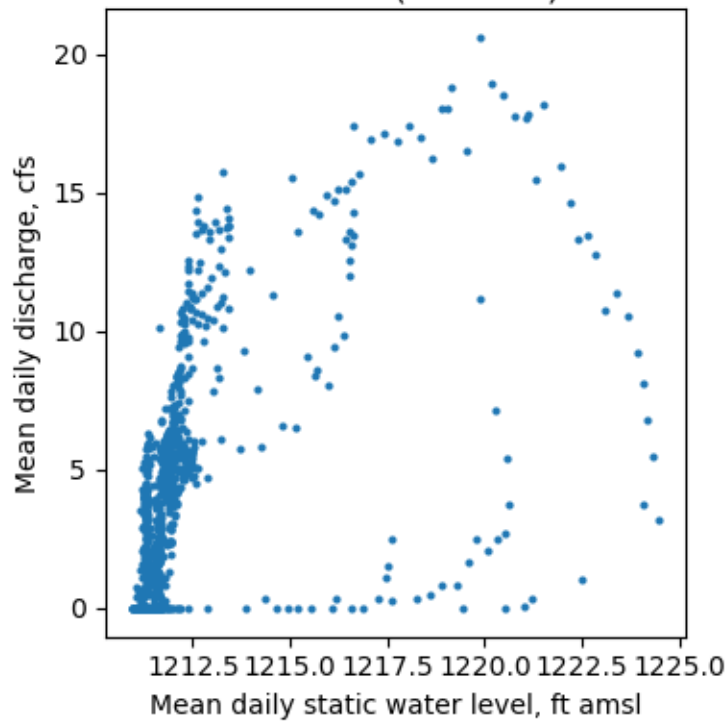
M039 static water level and discharge at Las Moras (R2=0.44)



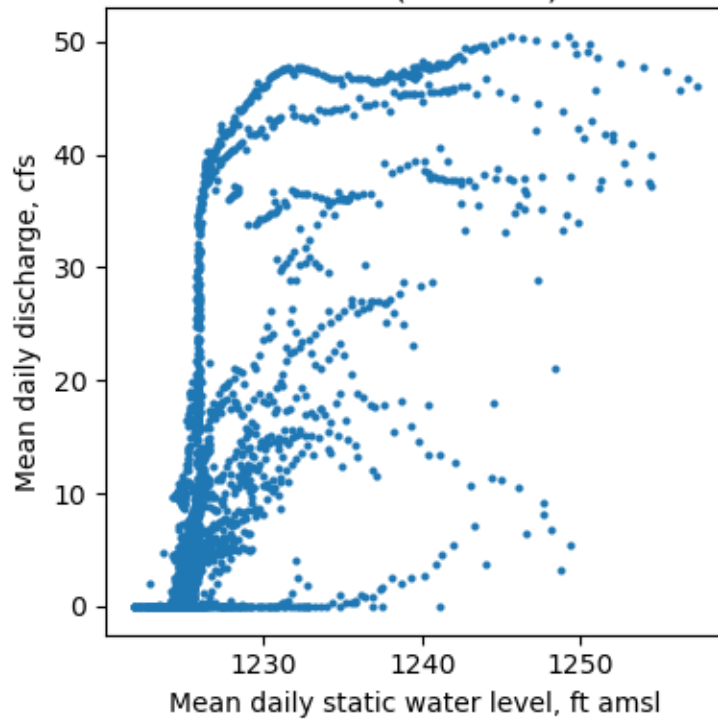
M040 static water level and discharge at Las Moras (R2=0.3)



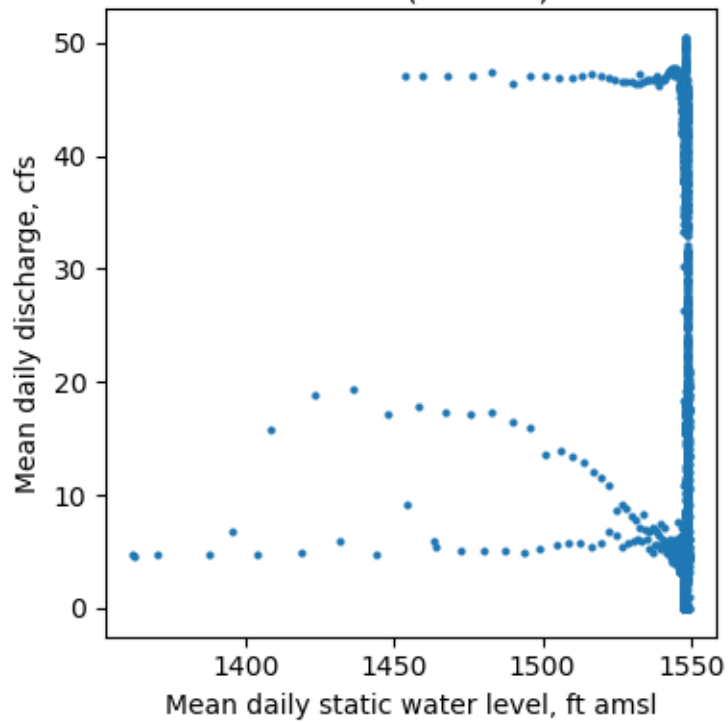
M041 static water level and discharge at Las Moras (R2=0.25)



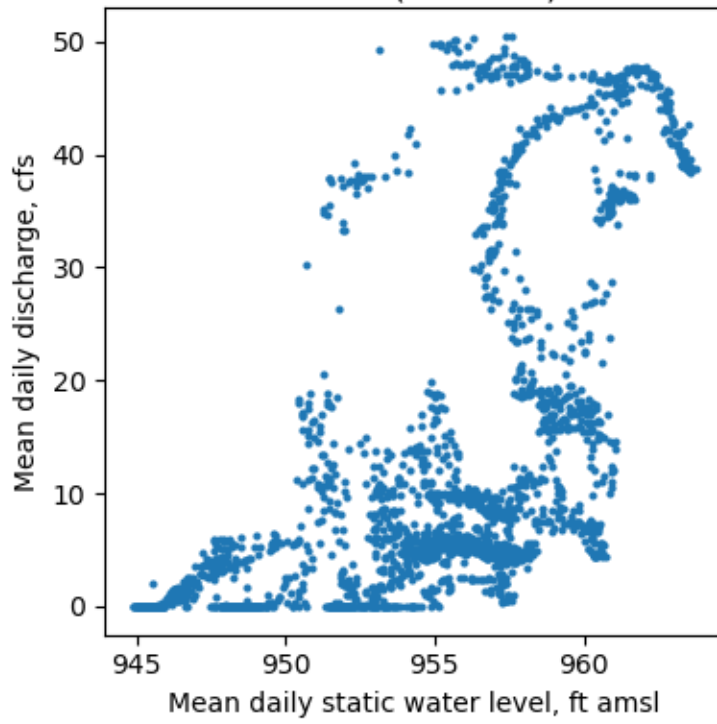
M042 static water level and discharge at Las Moras (R2=0.42)



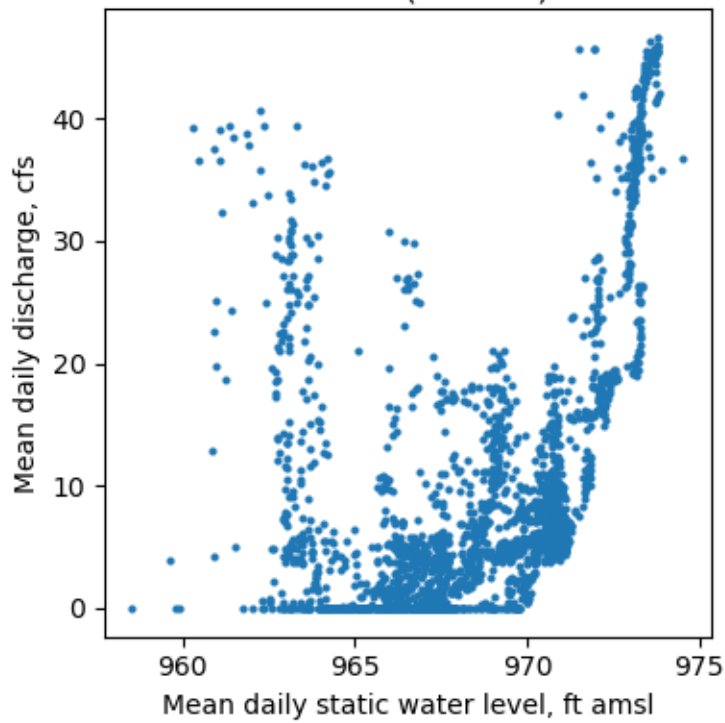
M043 static water level and discharge at Las Moras (R2=0.0)



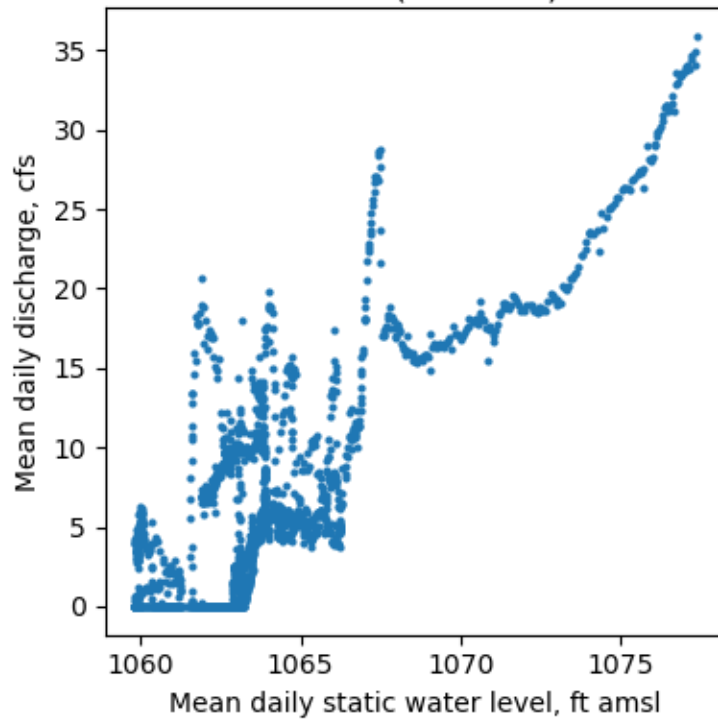
M044 static water level and discharge at Las Moras ( $R^2=0.35$ )



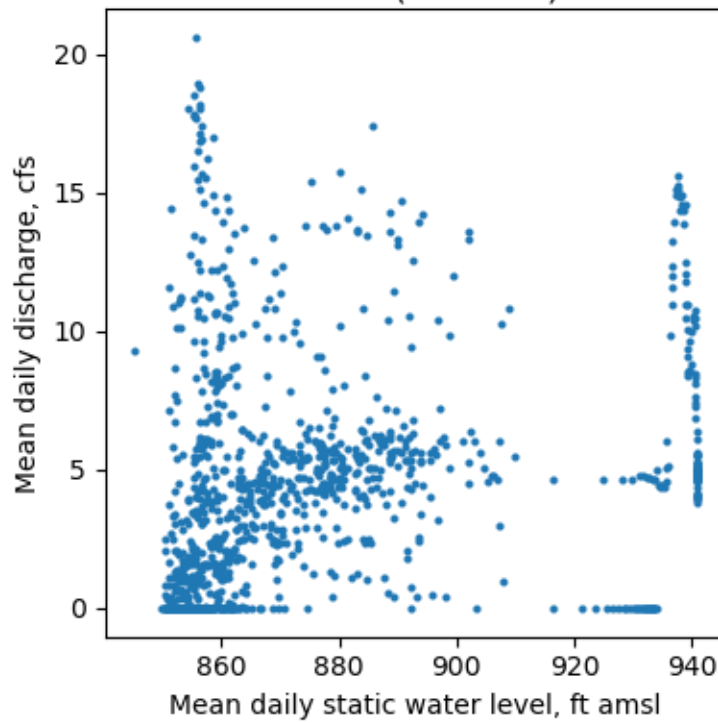
M045 static water level and discharge at Las Moras ( $R^2=0.2$ )



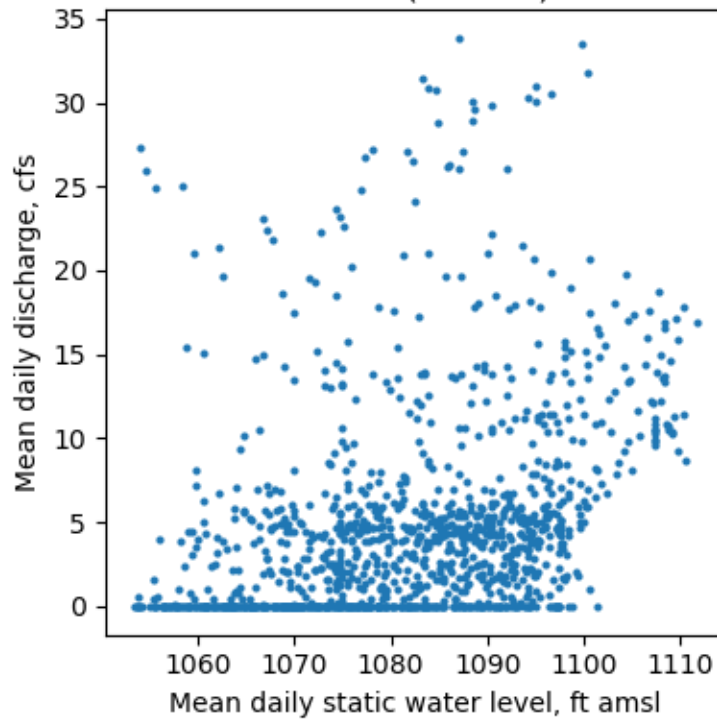
M046 static water level and discharge at Las Moras (R2=0.65)



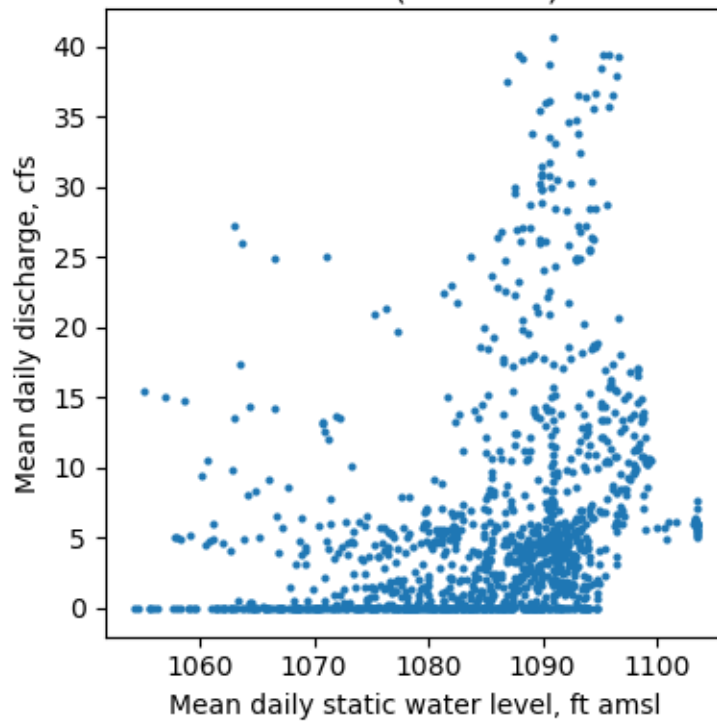
M047 static water level and discharge at Las Moras (R2=0.08)



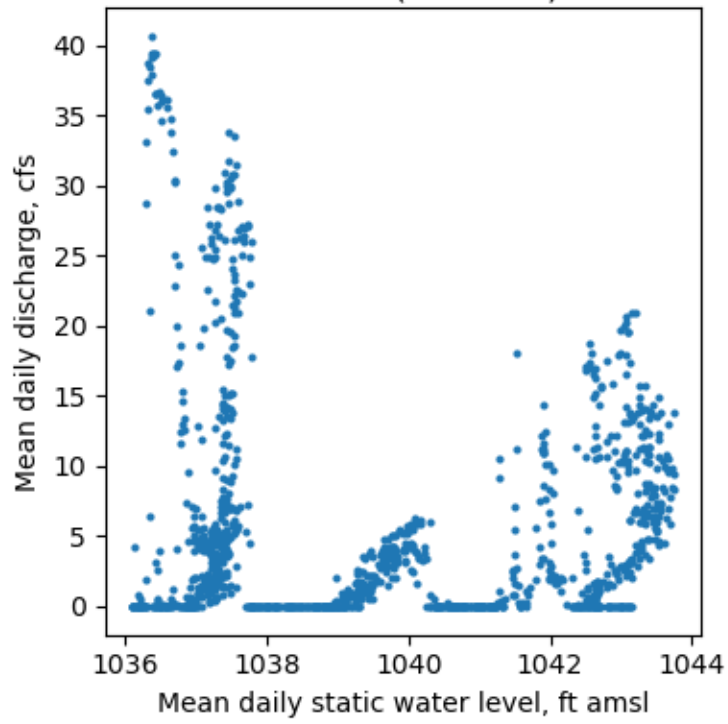
M048 static water level and discharge at Las Moras (R2=0.1)



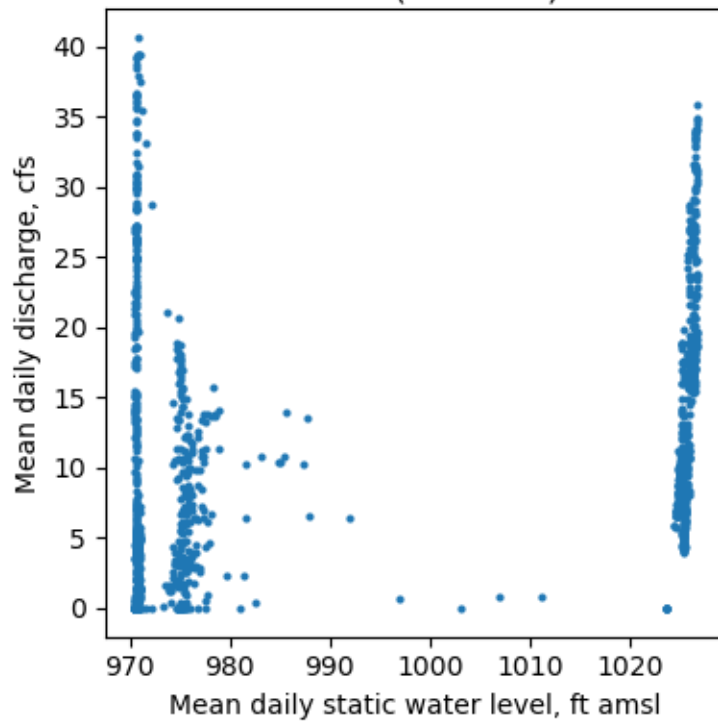
M049 static water level and discharge at Las Moras (R2=0.09)



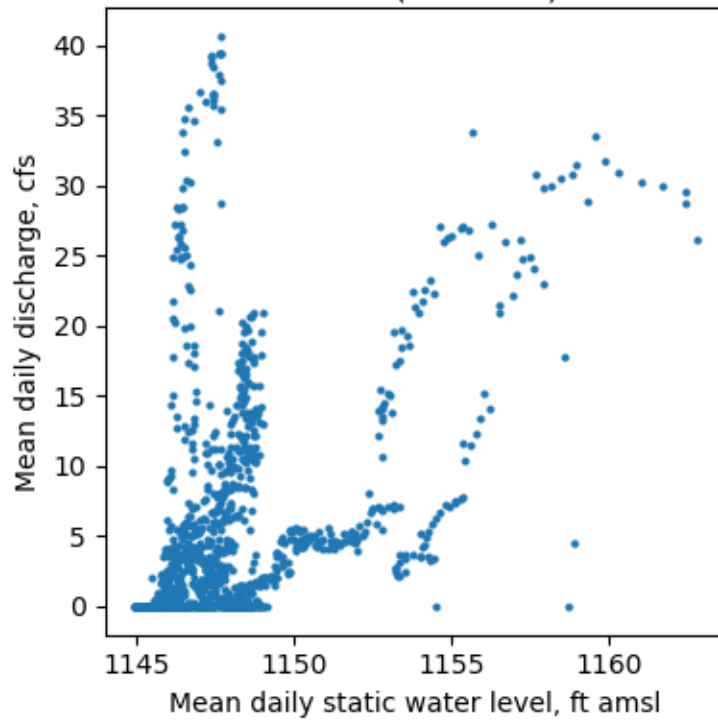
M050 static water level and discharge at Las Moras (R2=0.01)



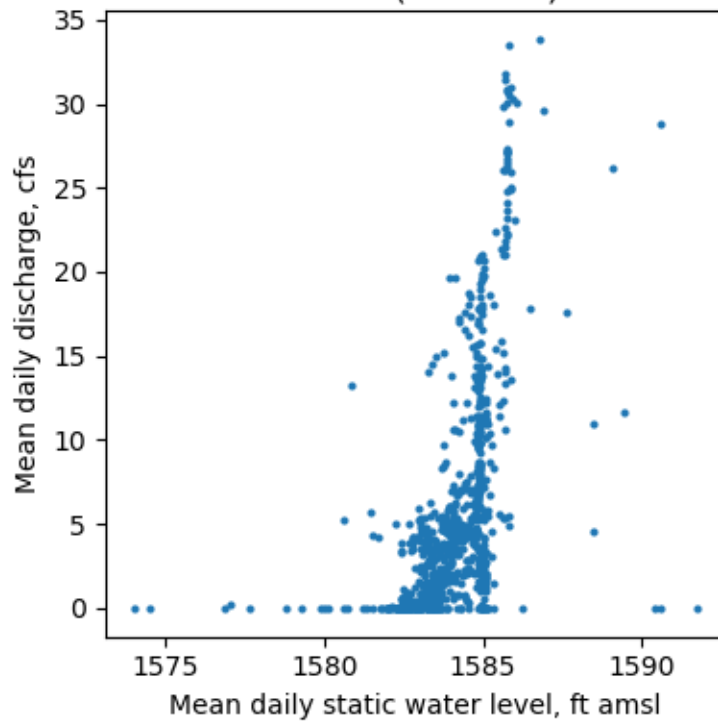
M051 static water level and discharge at Las Moras (R2=0.09)



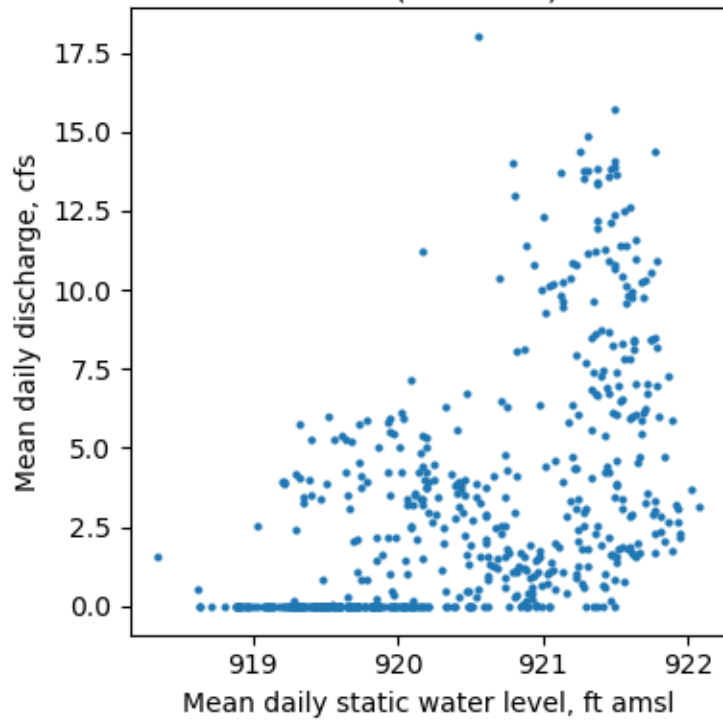
M052 static water level and discharge at Las Moras ( $R^2=0.17$ )



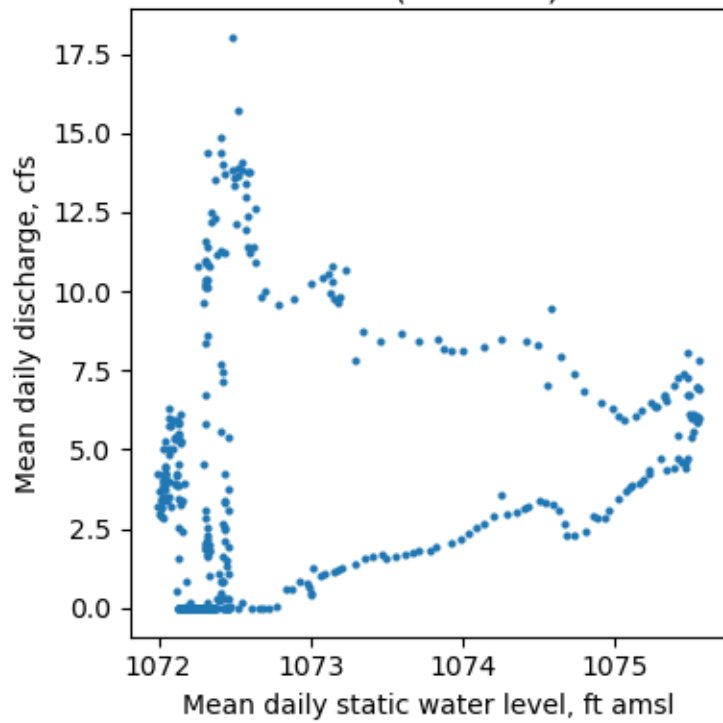
M053 static water level and discharge at Las Moras ( $R^2=0.34$ )



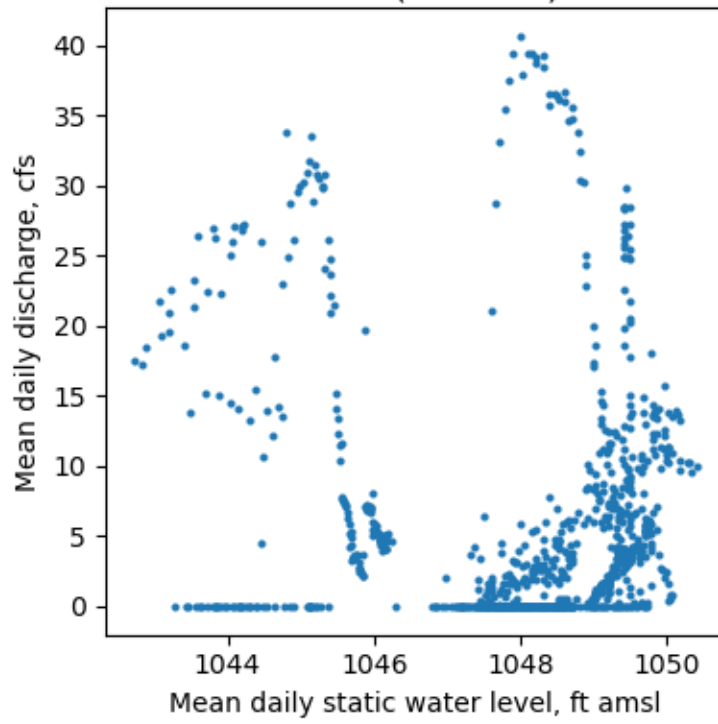
M054 static water level and discharge at Las Moras ( $R^2=0.29$ )



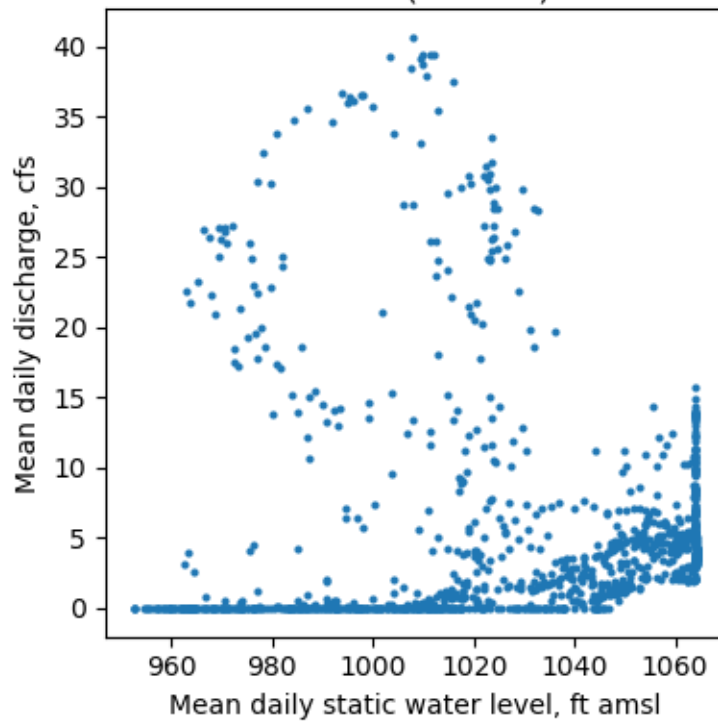
M055 static water level and discharge at Las Moras ( $R^2=0.04$ )



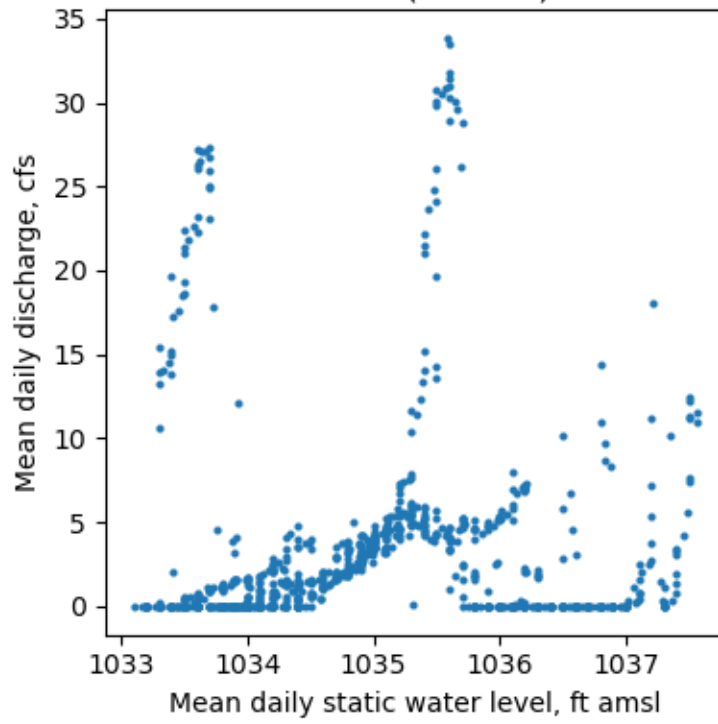
M056 static water level and discharge at Las Moras (R2=0.02)



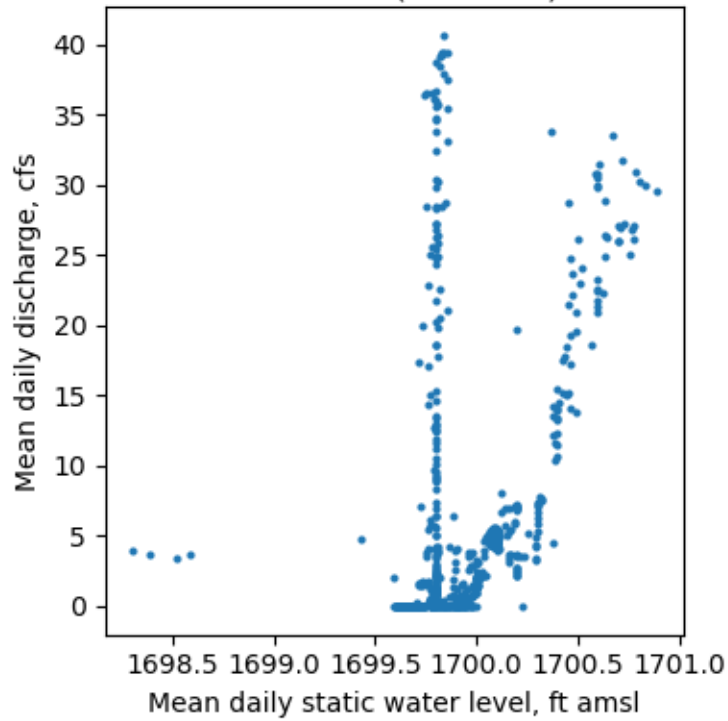
M057 static water level and discharge at Las Moras (R2=0.0)



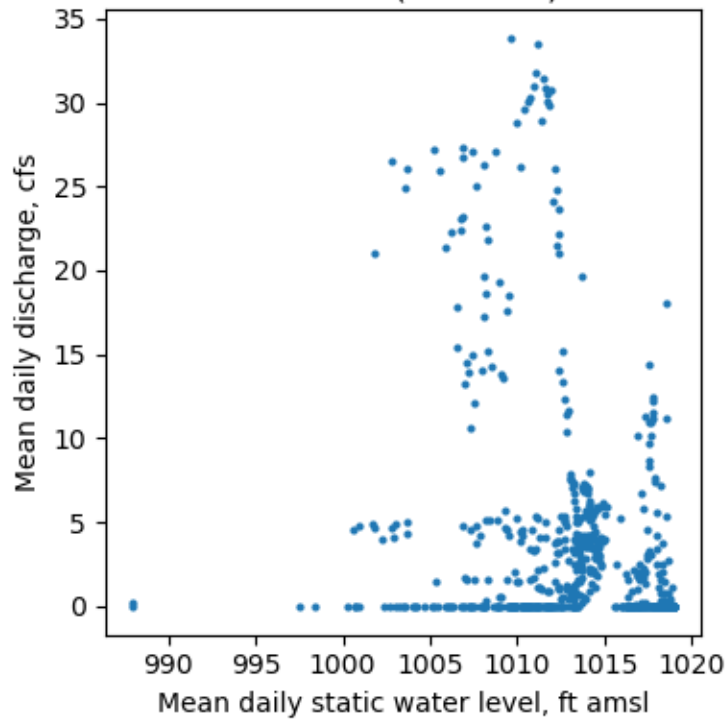
M058 static water level and discharge at Las Moras (R2=0.0)



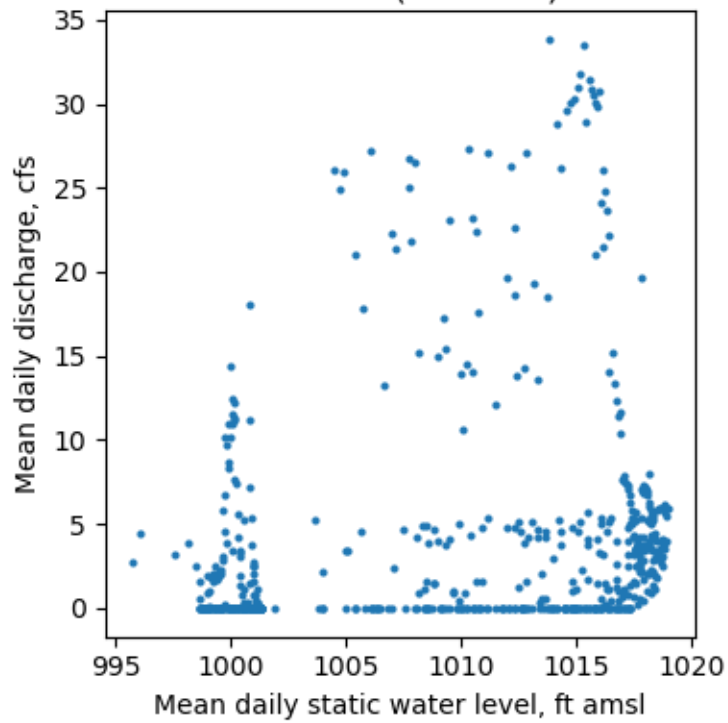
M059 static water level and discharge at Las Moras (R2=0.15)



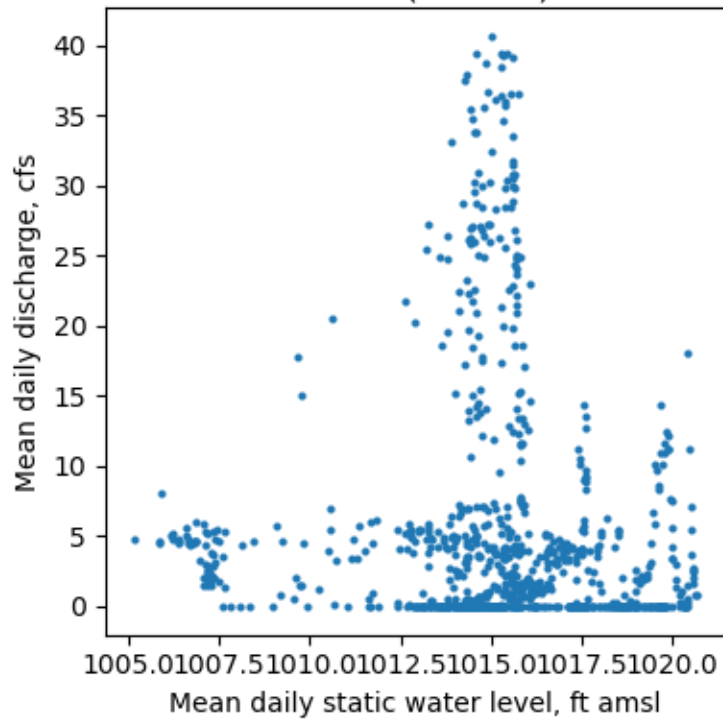
M061 static water level and discharge at Las Moras ( $R^2=0.05$ )



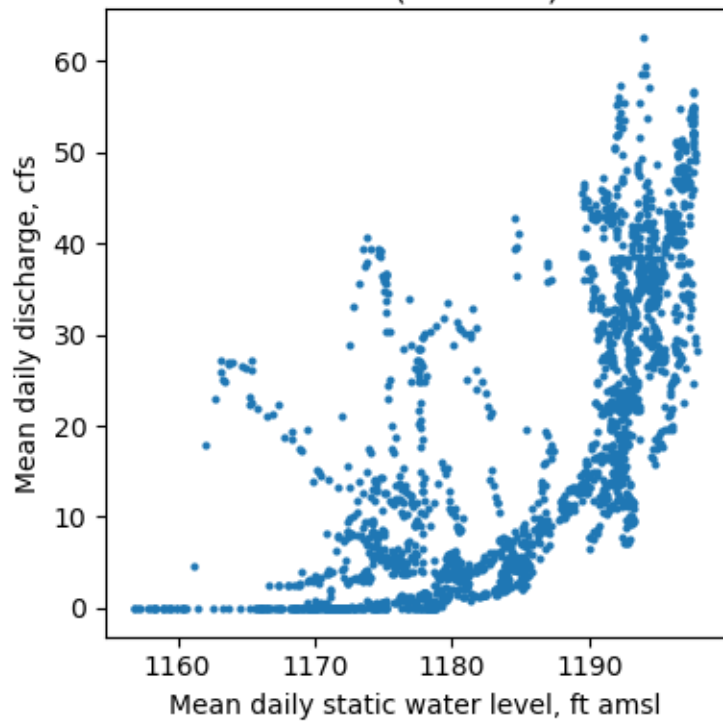
M062 static water level and discharge at Las Moras ( $R^2=0.04$ )



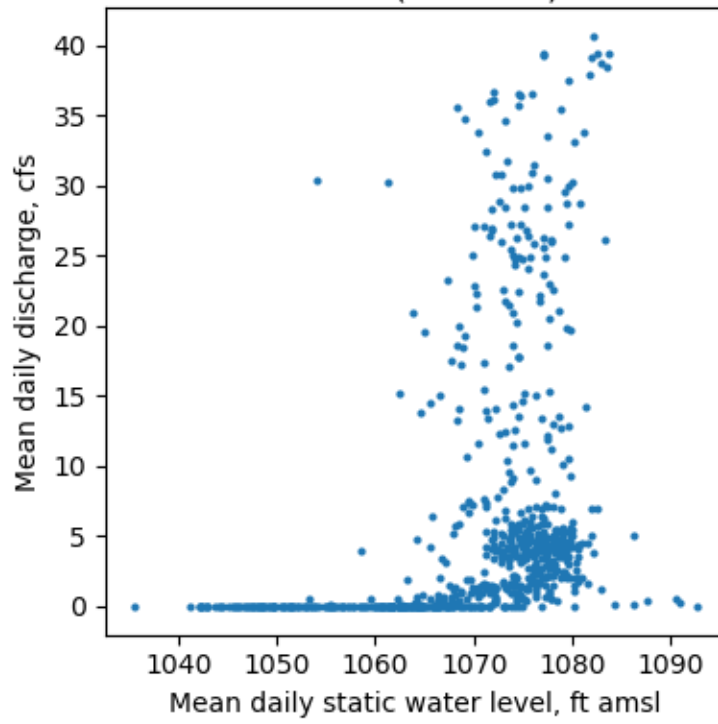
M063 static water level and discharge at Las Moras (R2=0.0)



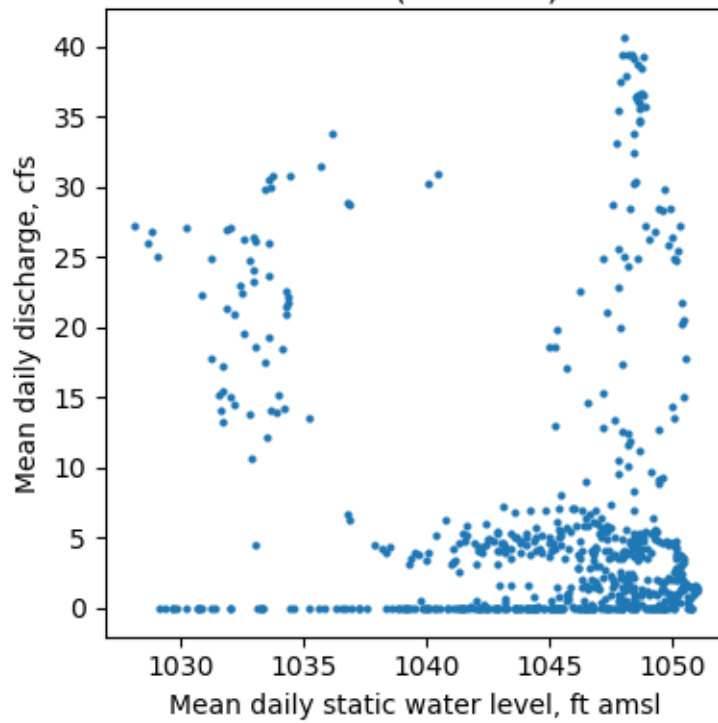
M064 static water level and discharge at Las Moras (R2=0.49)



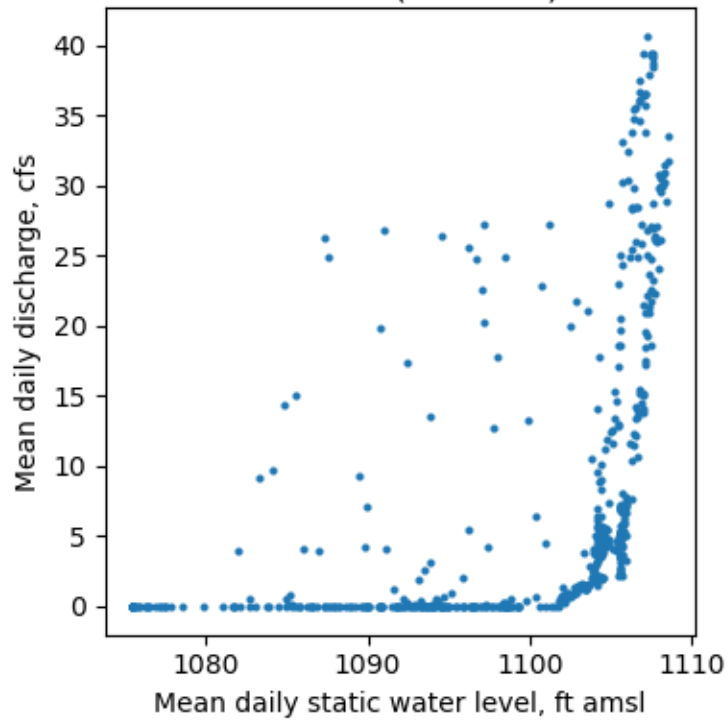
M065 static water level and discharge at Las Moras (R2=0.11)



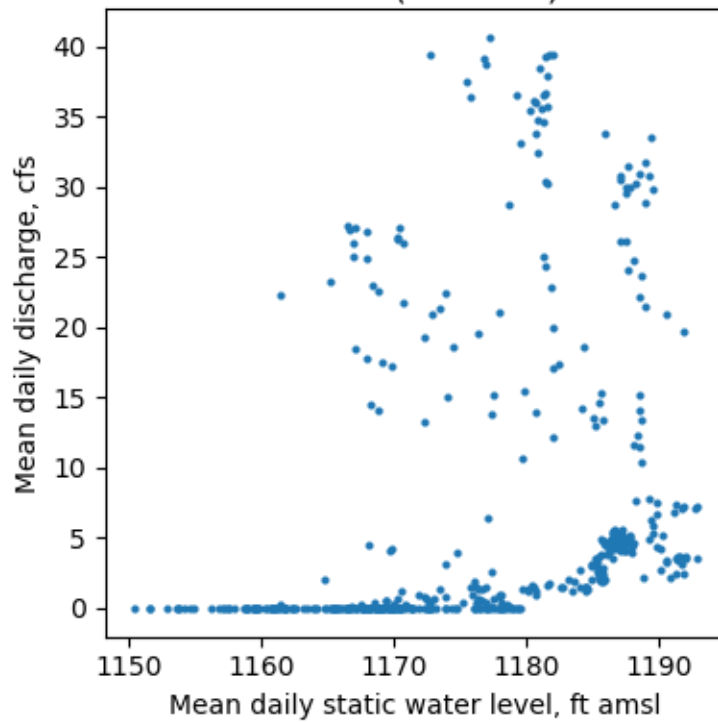
M066 static water level and discharge at Las Moras (R2=0.03)



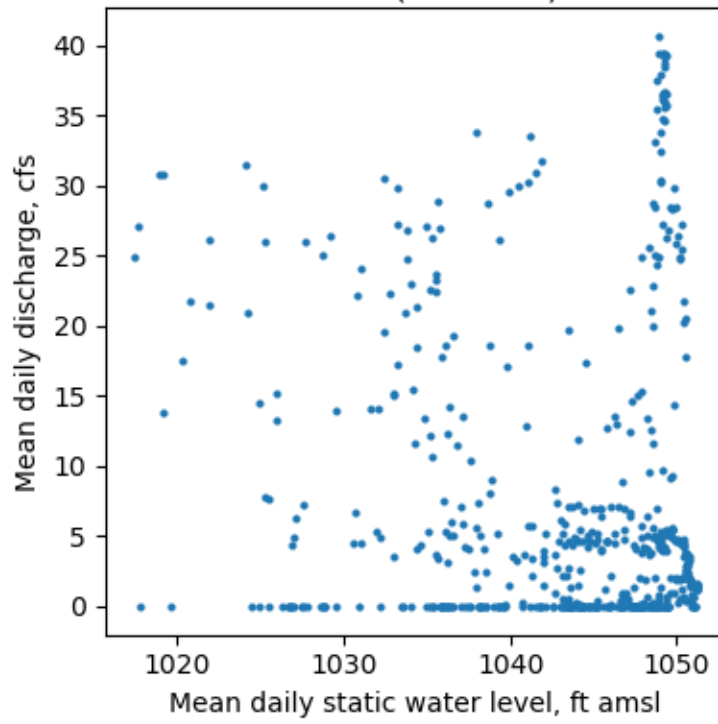
M070 static water level and discharge at Las Moras ( $R^2=0.23$ )



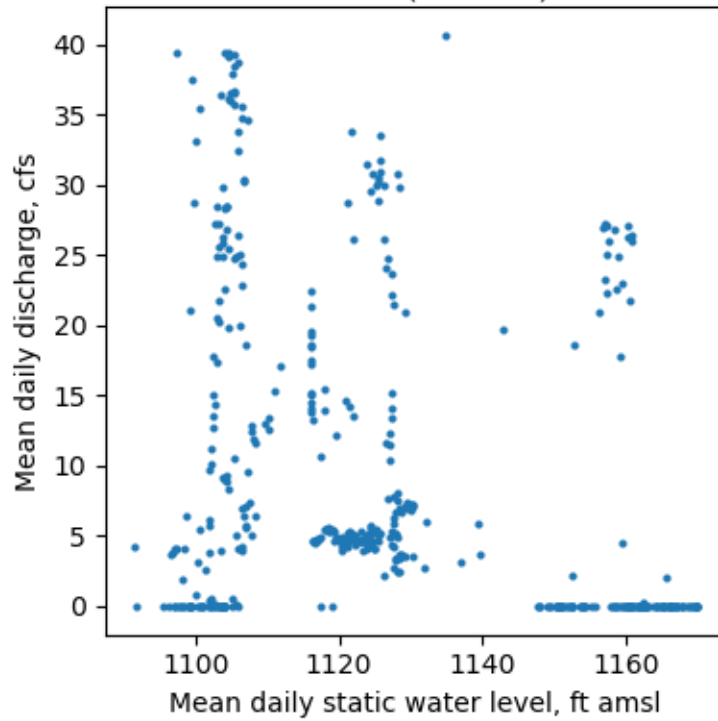
M071 static water level and discharge at Las Moras ( $R^2=0.08$ )



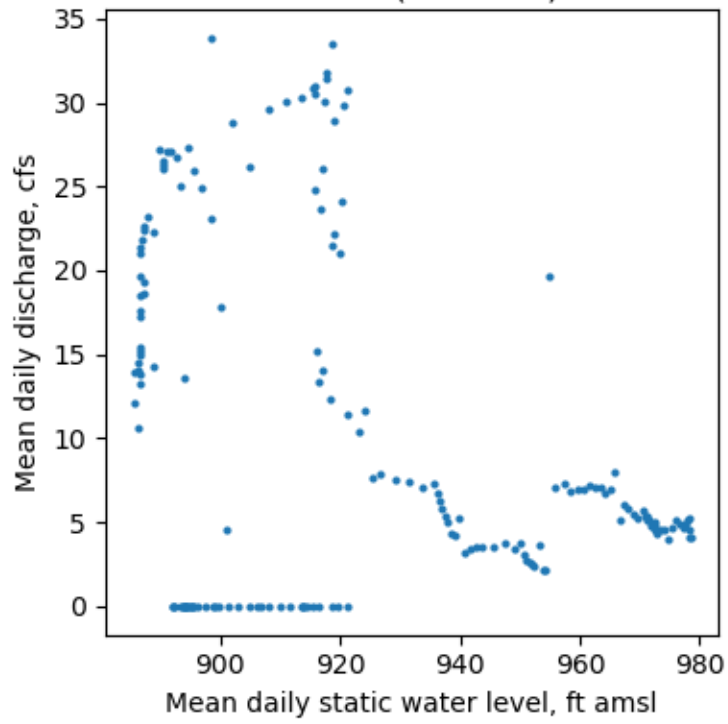
M073 static water level and discharge at Las Moras (R2=0.01)



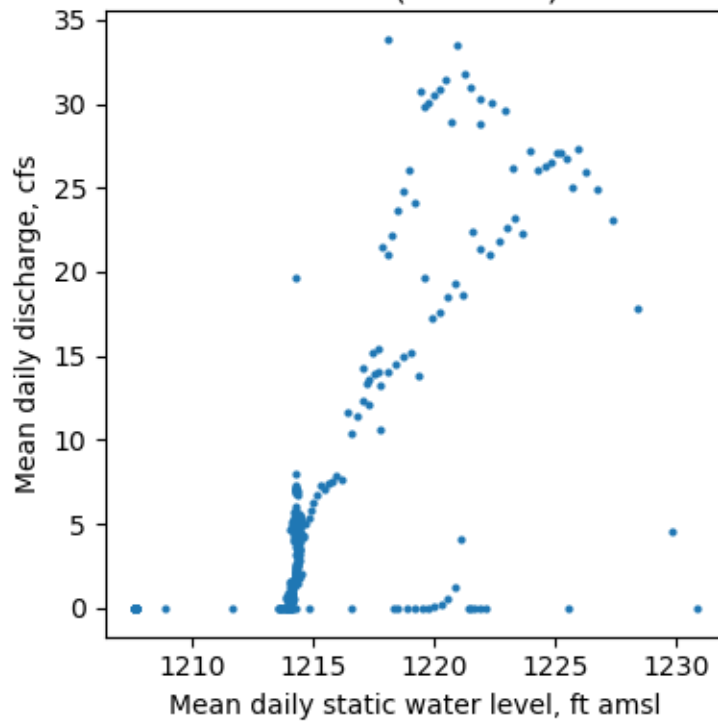
M075 static water level and discharge at Las Moras (R2=0.1)



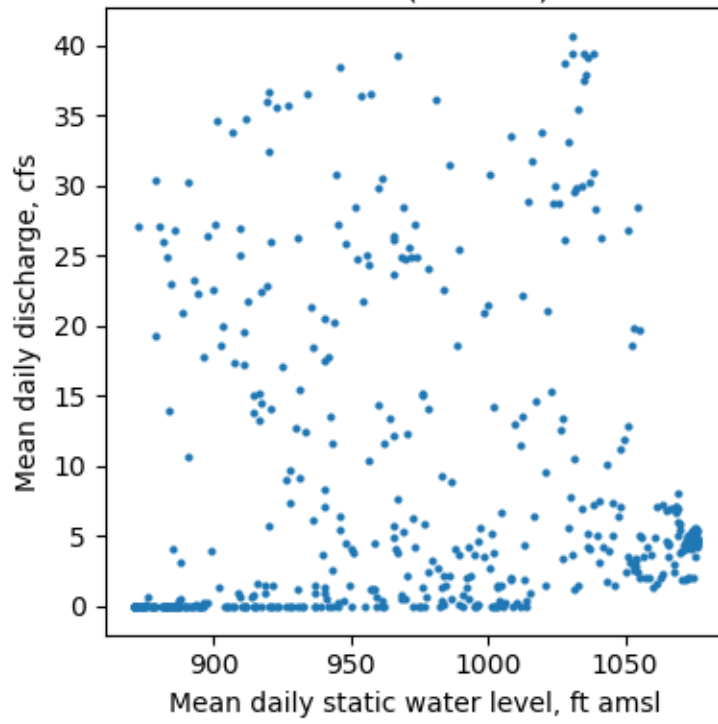
M076 static water level and discharge at Las Moras ( $R^2=0.13$ )



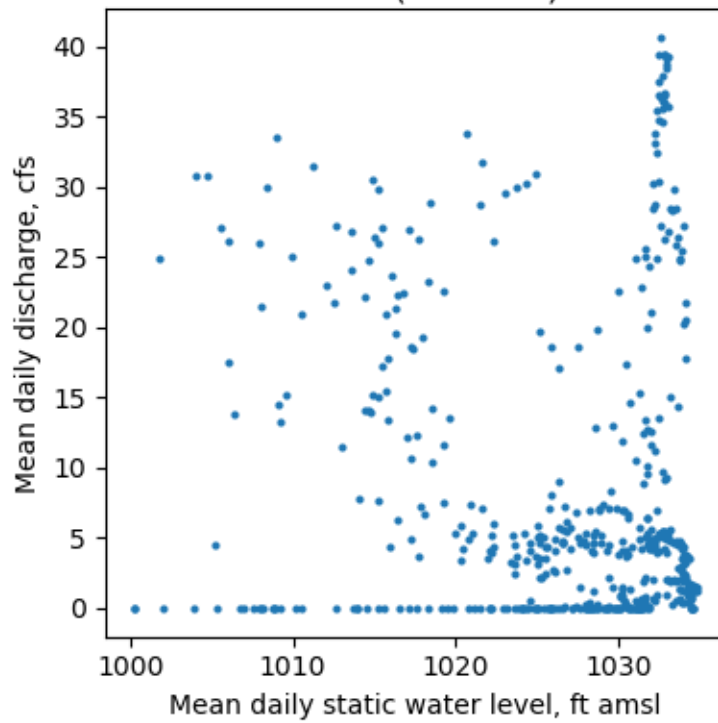
M077 static water level and discharge at Las Moras ( $R^2=0.47$ )



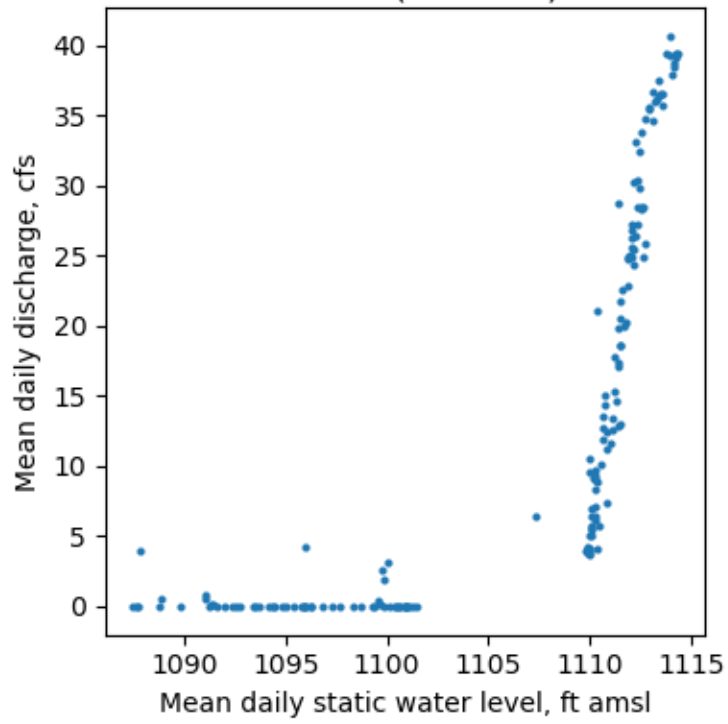
M078 static water level and discharge at Las Moras (R2=0.0)



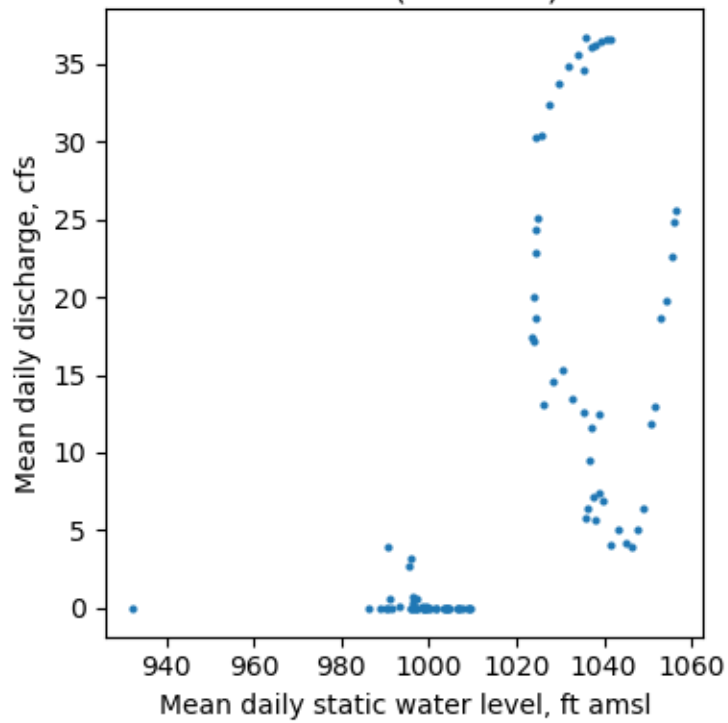
M080 static water level and discharge at Las Moras (R2=0.01)



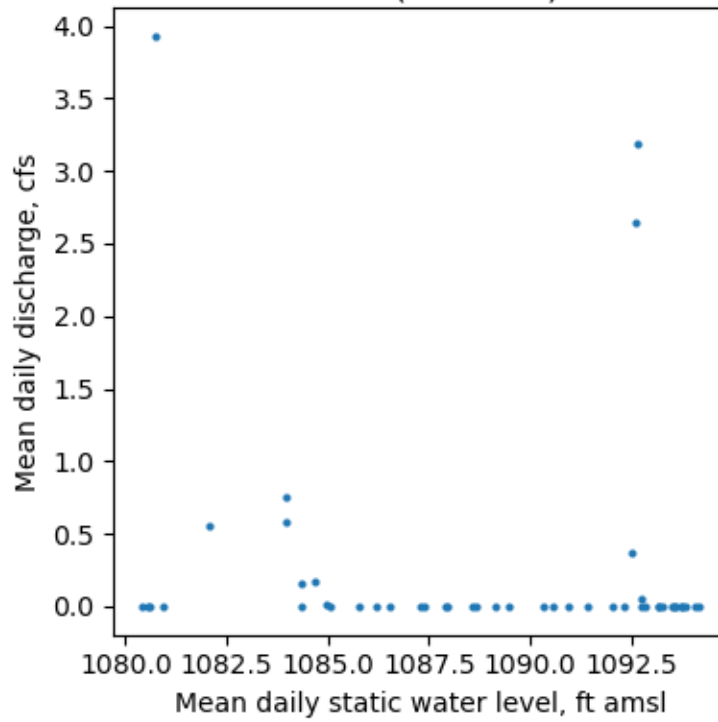
M081 static water level and discharge at Las Moras (R2=0.58)



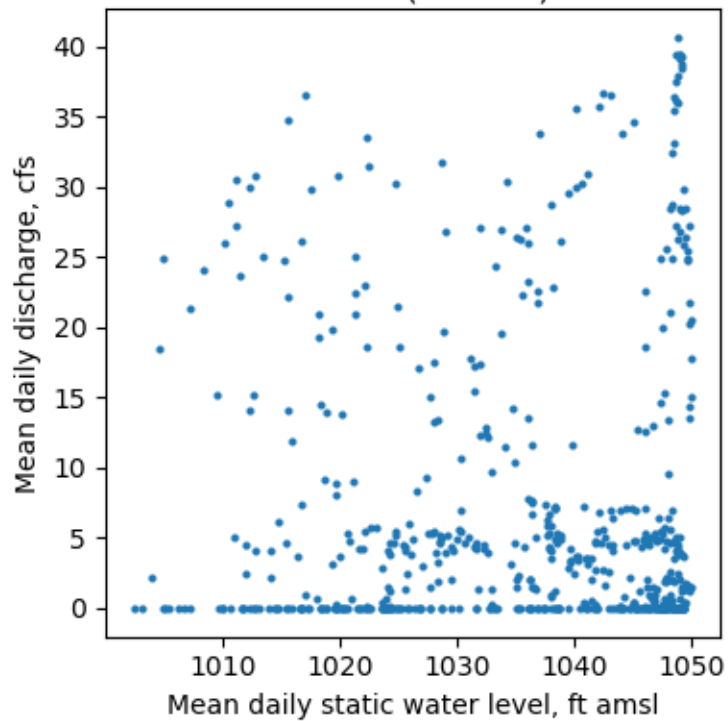
M083 static water level and discharge at Las Moras (R2=0.39)



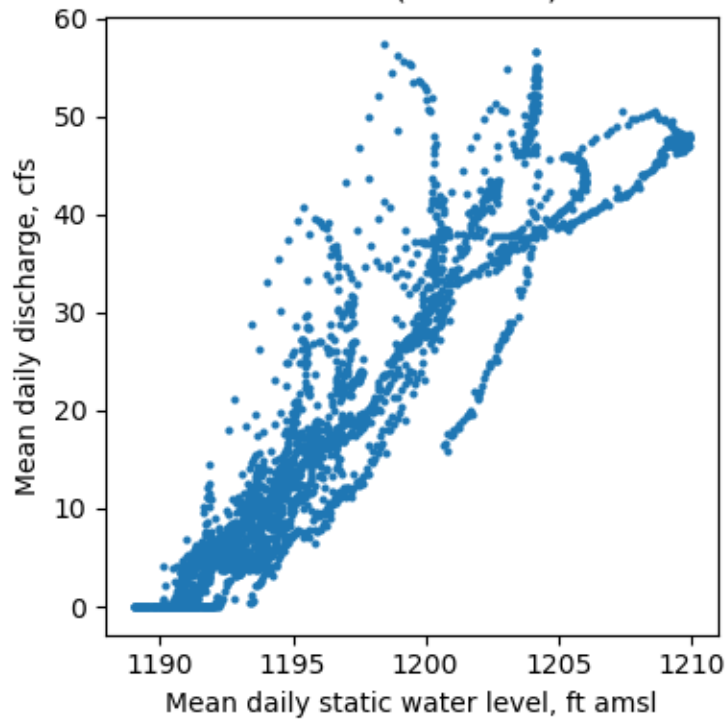
M085 static water level and discharge at Las Moras (R2=0.01)



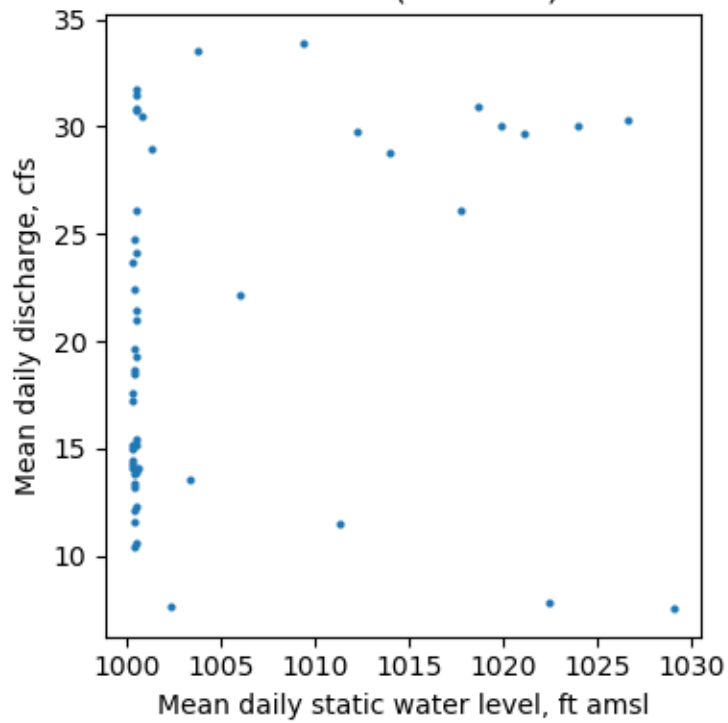
M109 static water level and discharge at Las Moras (R2=0.0)



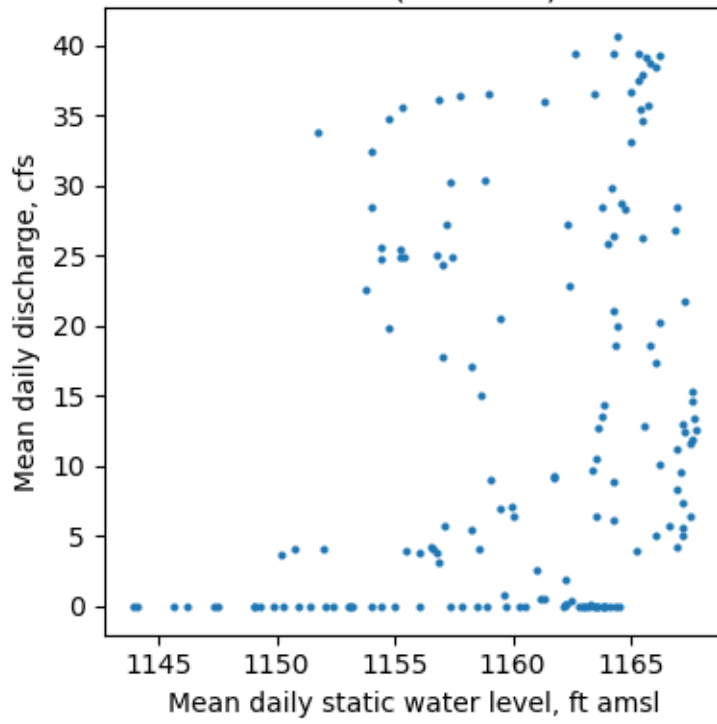
O001 static water level and discharge at Las Moras (R2=0.88)



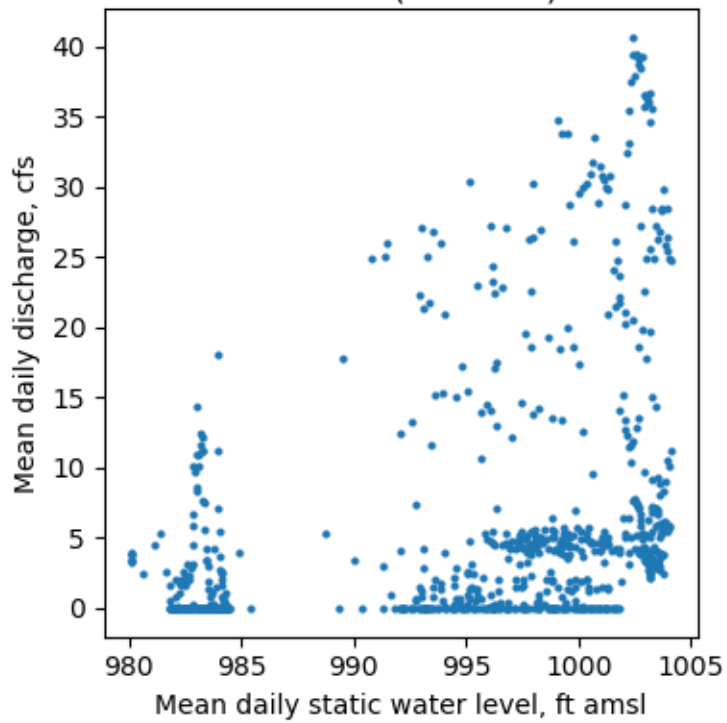
P012 static water level and discharge at Las Moras (R2=0.05)



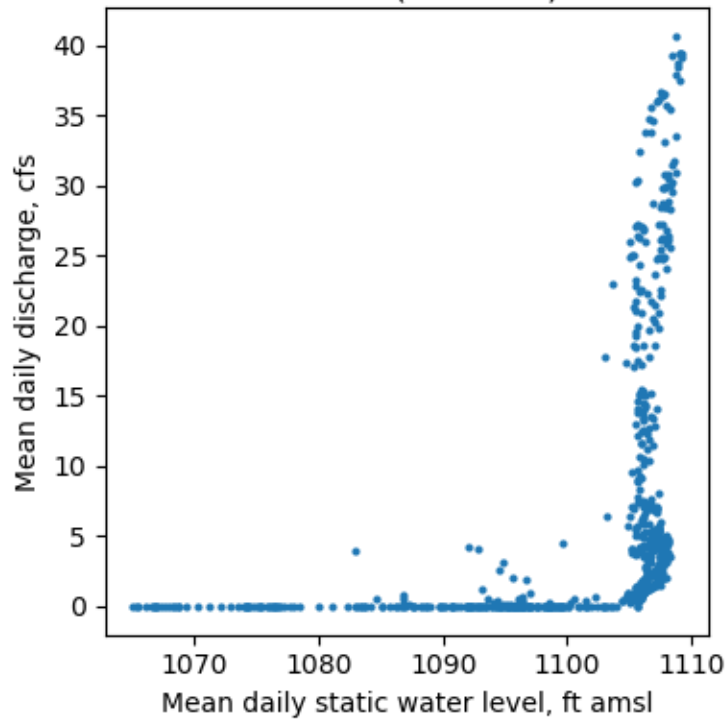
P045 static water level and discharge at Las Moras ( $R^2=0.08$ )



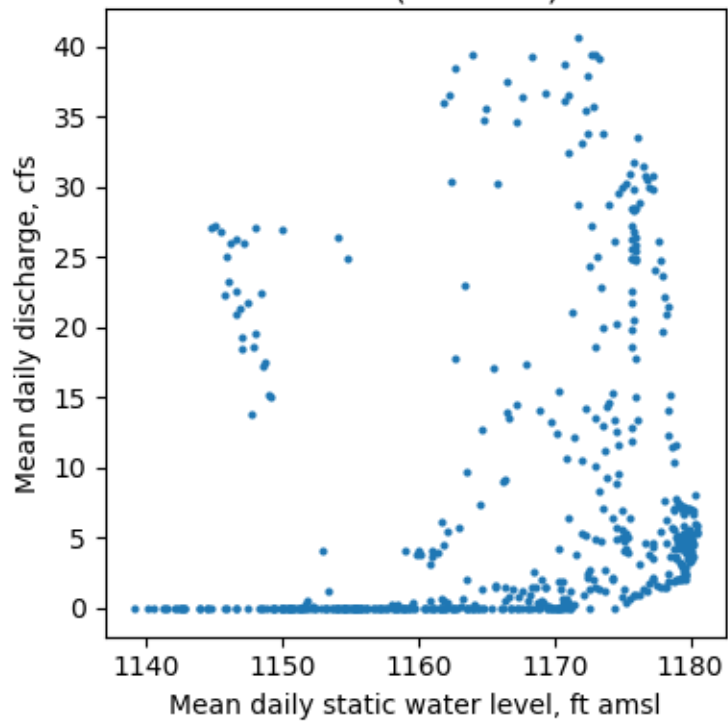
P048 static water level and discharge at Las Moras ( $R^2=0.14$ )



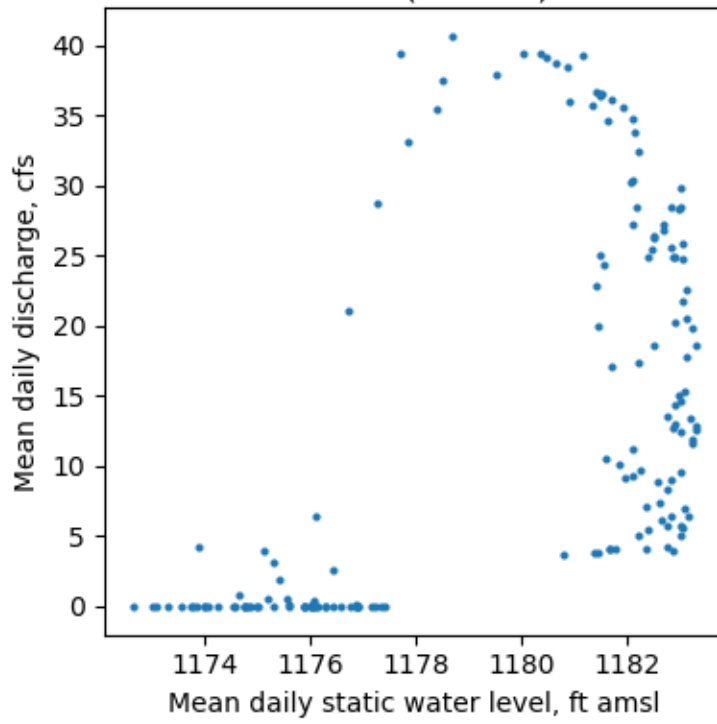
P058 static water level and discharge at Las Moras (R2=0.15)



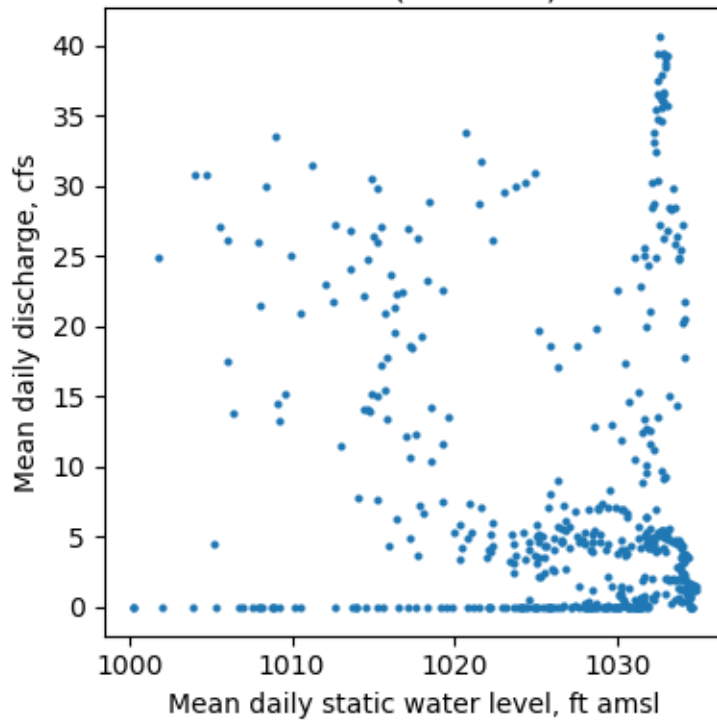
P074 static water level and discharge at Las Moras (R2=0.03)



P101 static water level and discharge at Las Moras (R2=0.3)

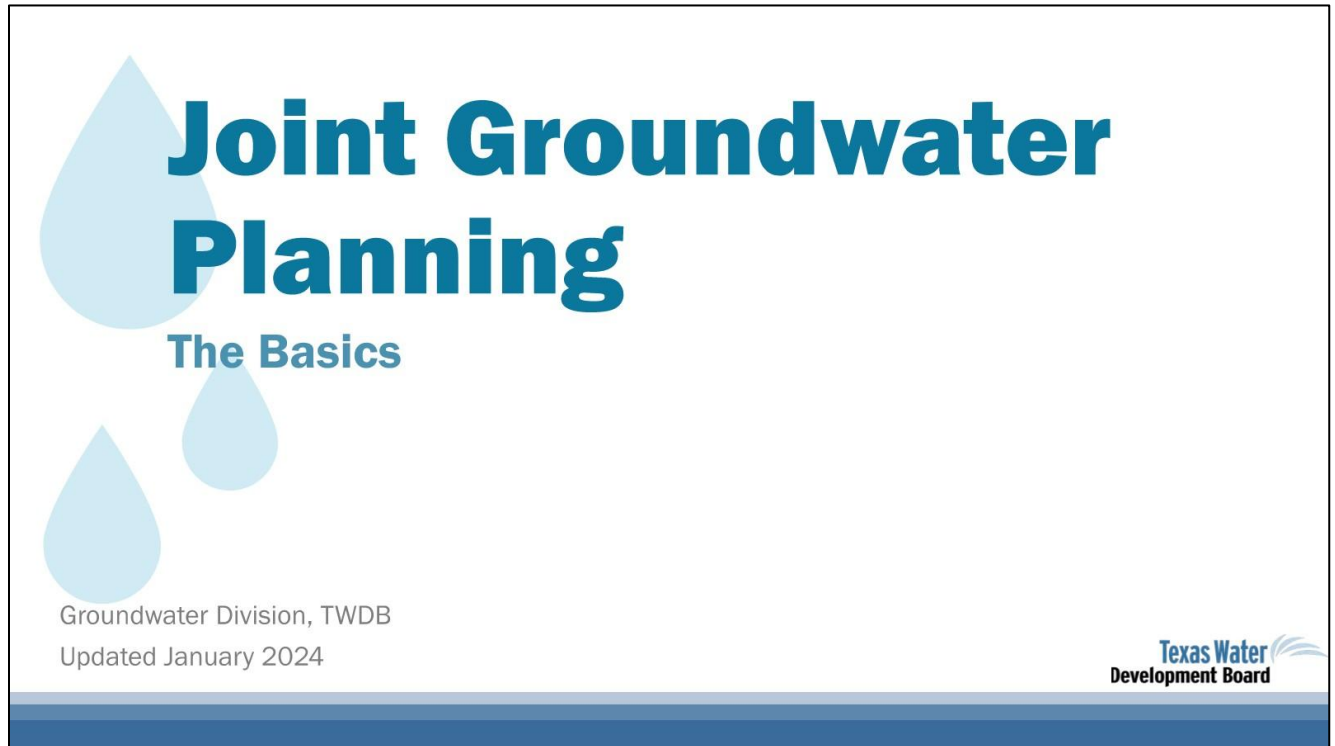


P107 static water level and discharge at Las Moras (R2=0.01)



**7.00 APPENDIX C – TEXAS WATER DEVELOPMENT BOARD PRESENTATION  
ENTITLED “JOINT GROUNDWATER PLANNING – THE BASICS”**

[https://www.twdb.texas.gov/groundwater/docs/JointGroundwaterPlanningBasics\\_2024\\_acc.pdf](https://www.twdb.texas.gov/groundwater/docs/JointGroundwaterPlanningBasics_2024_acc.pdf)



**This presentation was created by TWDB Groundwater Division staff for general educational purposes.**

**We hope this slide deck is useful in communicating the joint groundwater planning process, and the steps required to get from desired future conditions to modeled available groundwater.**

DRAFT

## We'll cover...



Groundwater management areas



What is joint groundwater planning?



What does the desired future condition process look like?

DRAFT

## **GMAs, GAMs, MAGs...OMG!**

- GCD** Groundwater conservation district
- GMA** Groundwater management area
- DFC** Desired future condition
- TWDB** Texas Water Development Board
- GAM** Groundwater availability model
- MAG** Modeled available groundwater
- RWPG** Regional water planning group

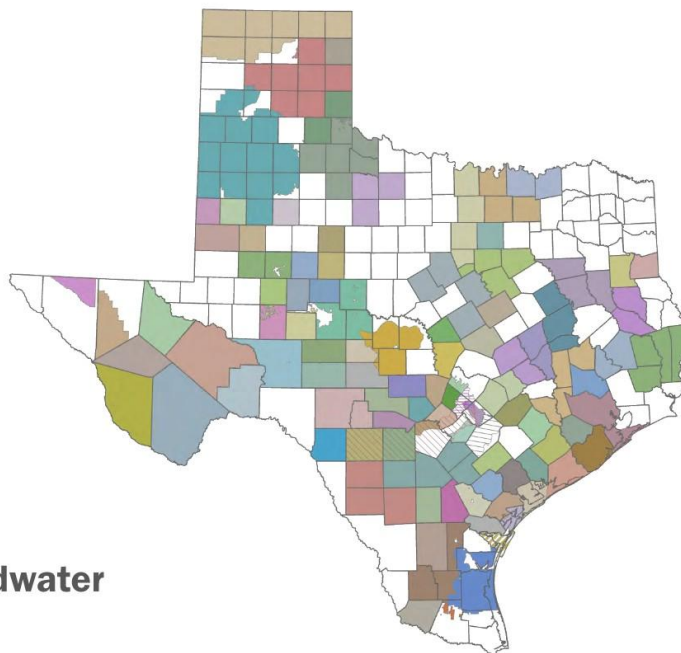
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# Groundwater management areas



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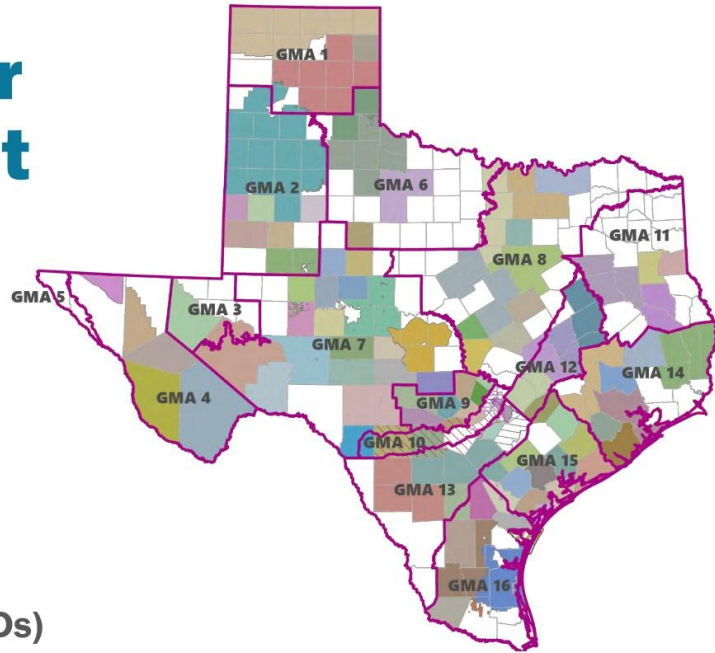
# Groundwater conservation districts (GCDs)



Preferred method of groundwater management in Texas

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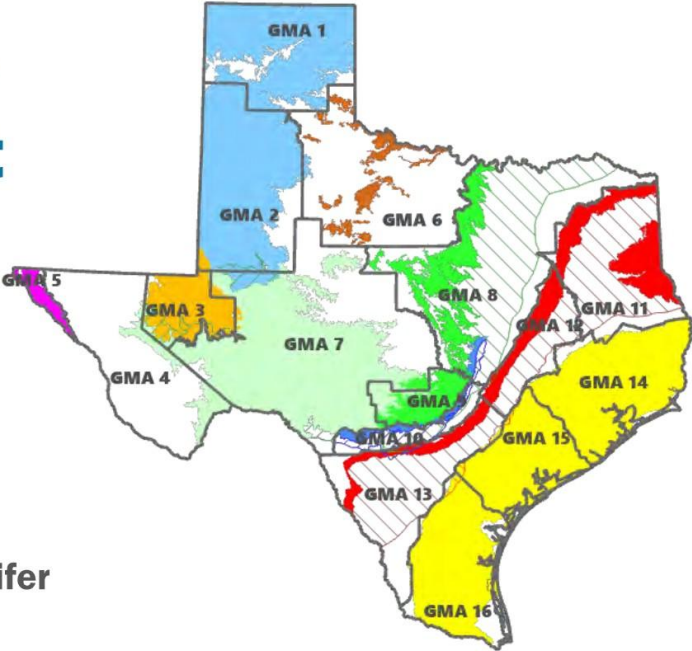
# Groundwater management areas (GMAs)



Groups of groundwater conservation district (GCDs)

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# Groundwater management areas (GMAs)



Generally follow major aquifer boundaries

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The TWDB maintains [webpages for each groundwater management area.](#)

And many GMAs also have their own websites to share information with the public.

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# Joint Groundwater Planning



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## What is joint planning?

District representatives in a GMA meet at least annually to:

- conduct joint planning
- propose to adopt new or amended desired future conditions
- review management plans and GMA accomplishments

[Texas Water Code § 36.108](#)

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Most joint planning activities are  
related to  
**desired future conditions (DFCs)**

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# Desired future conditions

## DFCs

Broad policy goal

Quantitative description

Updated at least every 5 years

Used to determine future groundwater availability

[Texas Water Code § 36.108](#)

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# Desired future conditions

## DFCs

Drawdown, springflow, storage volume, etc.

For relevant aquifers

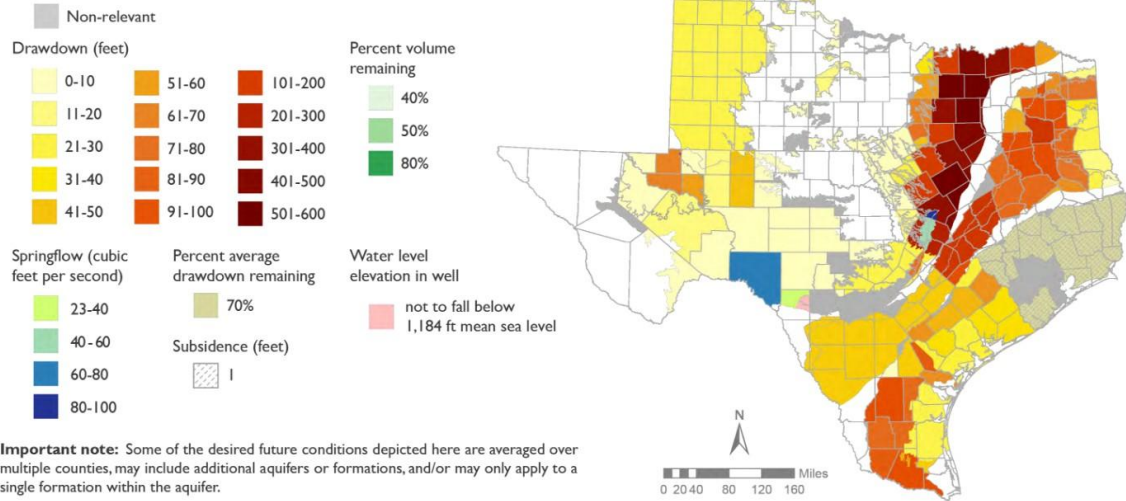
May be established for:

- aquifer
- aquifer subdivision
- geologic strata
- geographic area

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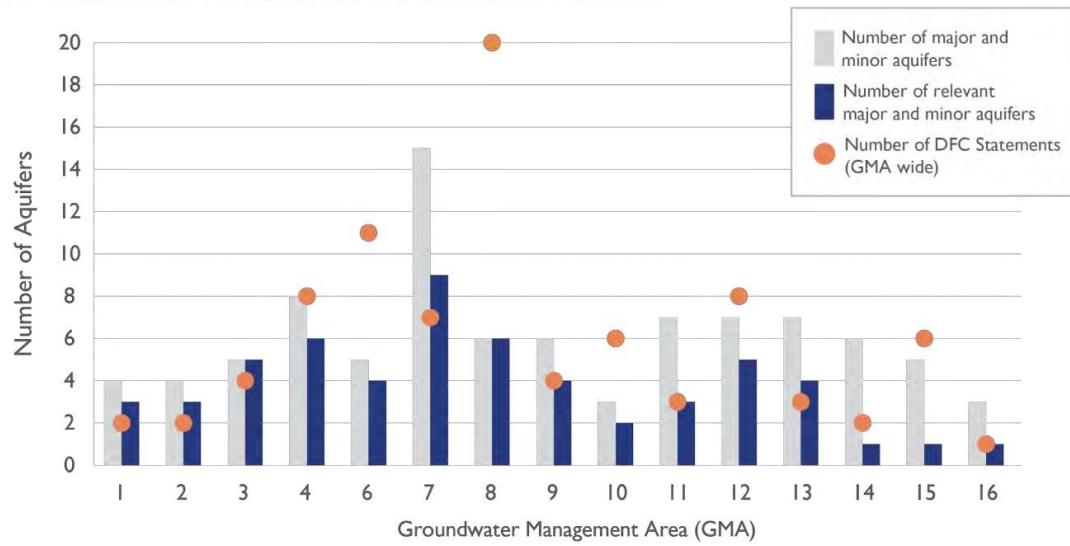
# 2021 DESIRED FUTURE CONDITIONS BY COUNTY

ADOPTED FOR MAJOR AQUIFERS



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## NUMBER OF AQUIFERS WITH DESIRED FUTURE CONDITIONS BY GROUNDWATER MANAGEMENT AREA



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## **Relevant vs. Non-relevant for joint planning purposes**

### **Relevant**

Official major or minor aquifers or any local aquifers deemed relevant by GMA

### **Non-relevant**

Parts of a relevant aquifer that do not warrant a DFC based on aquifer characteristics, GW demands, and current GW uses

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## **Non-relevant an unfortunate name**

Technical justification required

Local aquifer management is still  
happening

Regional water planning groups determine  
groundwater availability

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## **Why DFCs matter**

Districts must manage production to achieve desired future conditions

A criteria for GCD planning and rule making

Results in modeled available groundwater that can be used to evaluate permit applications

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## **Why DFCs matter**

Modeled available groundwater = water availability components that feed into regional water plans and state water plan

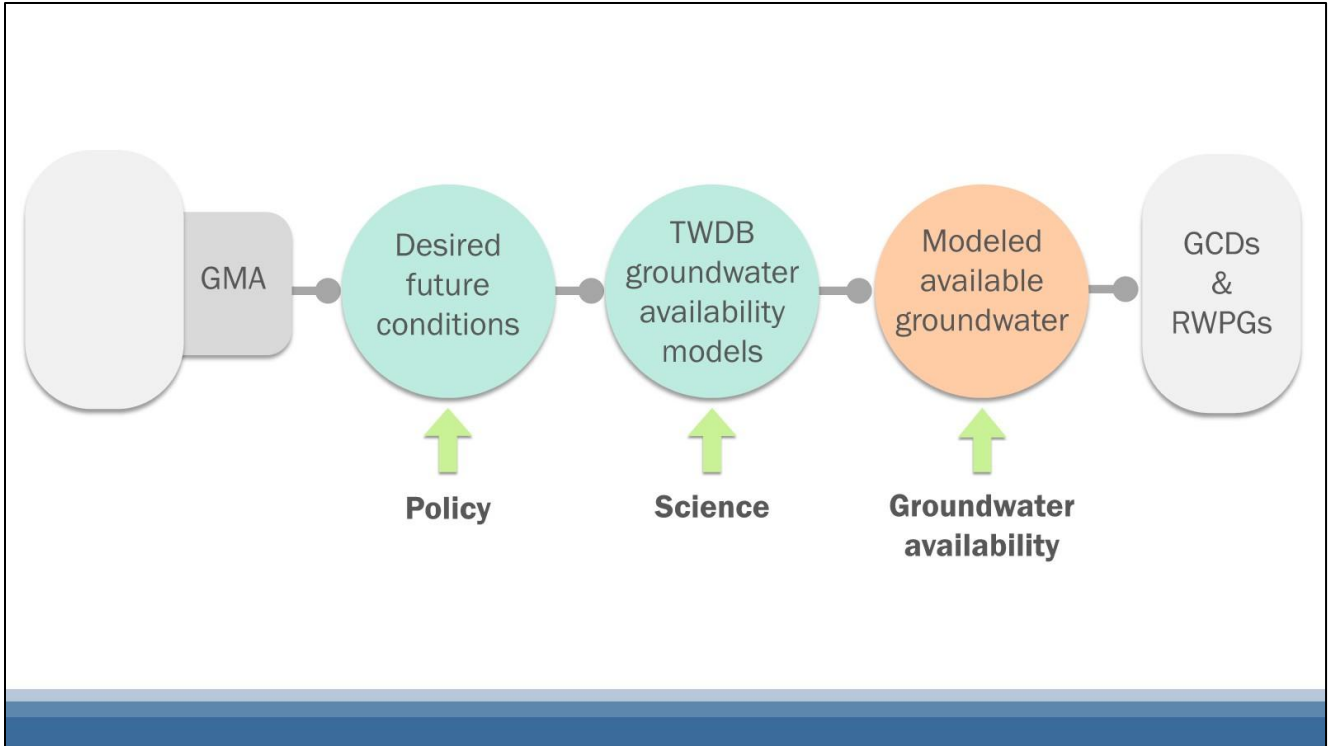
Influence policy and resource management decisions that affect all Texans

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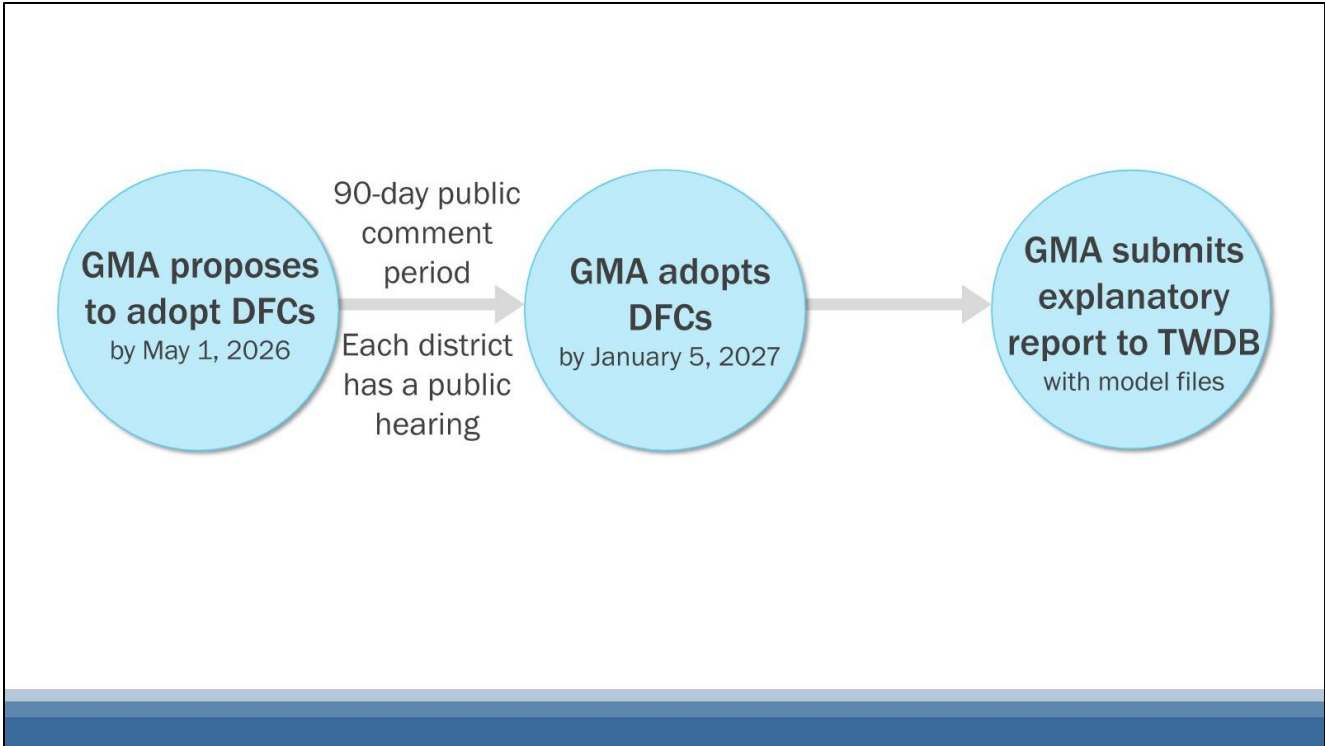
# DFC Process



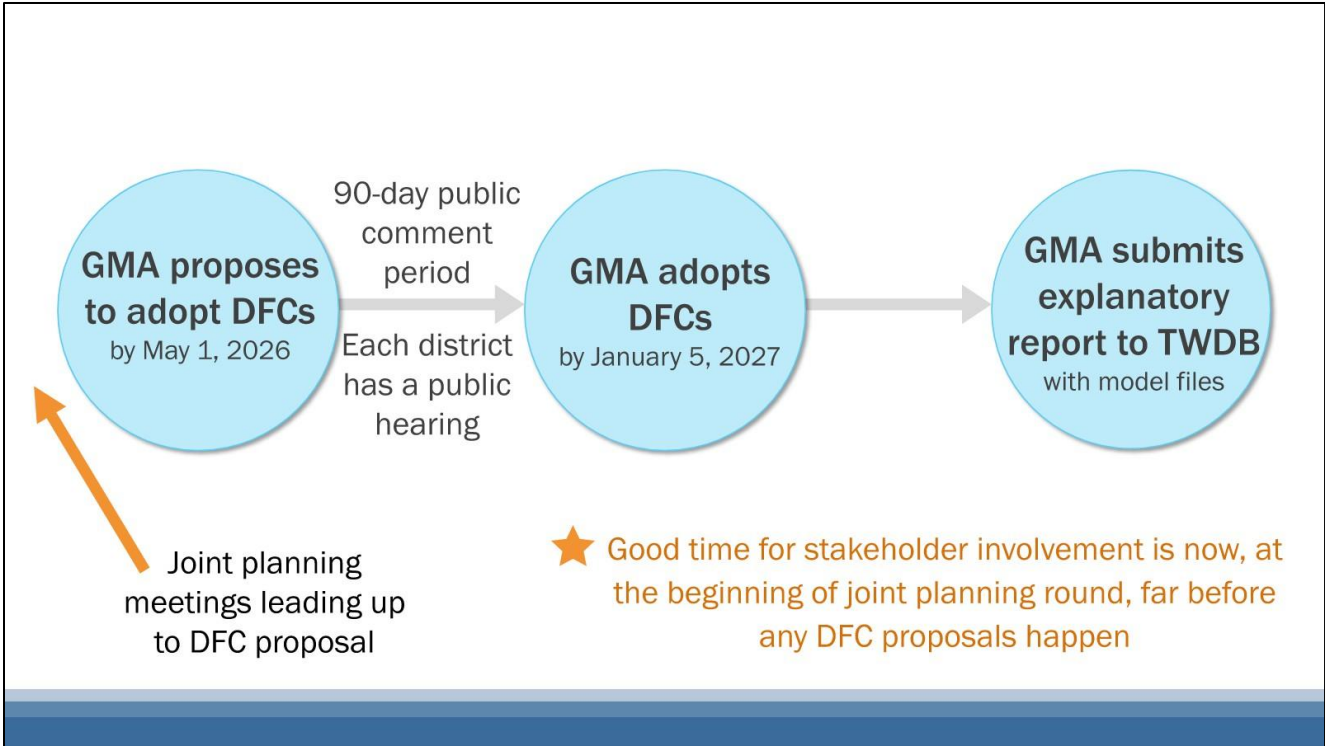
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**GMA proposes  
to adopt DFCs**  
by May 1, 2026

## 9 factors

**Aquifer uses and  
conditions**

**Environmental  
impacts**

**Property rights**

**State water plan**

**Land subsidence**

**Feasibility**

**Hydrologic  
conditions**

**Socioeconomics**

**Any other  
information**

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**GMA proposes  
to adopt DFCs**  
by May 1, 2026

## **A balancing act**

Highest practicable level of  
groundwater production

Conservation, preservation,  
protection, recharging,  
prevention of waste of  
groundwater, and control of  
subsidence

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GMA proposes  
to adopt DFCs  
by May 1, 2026

## Assessing DFC scenarios

GMA often hire consultants to use groundwater availability models to assess various DFC scenarios

★ Active participation in the process could get a scenario you want to see on the decision table.

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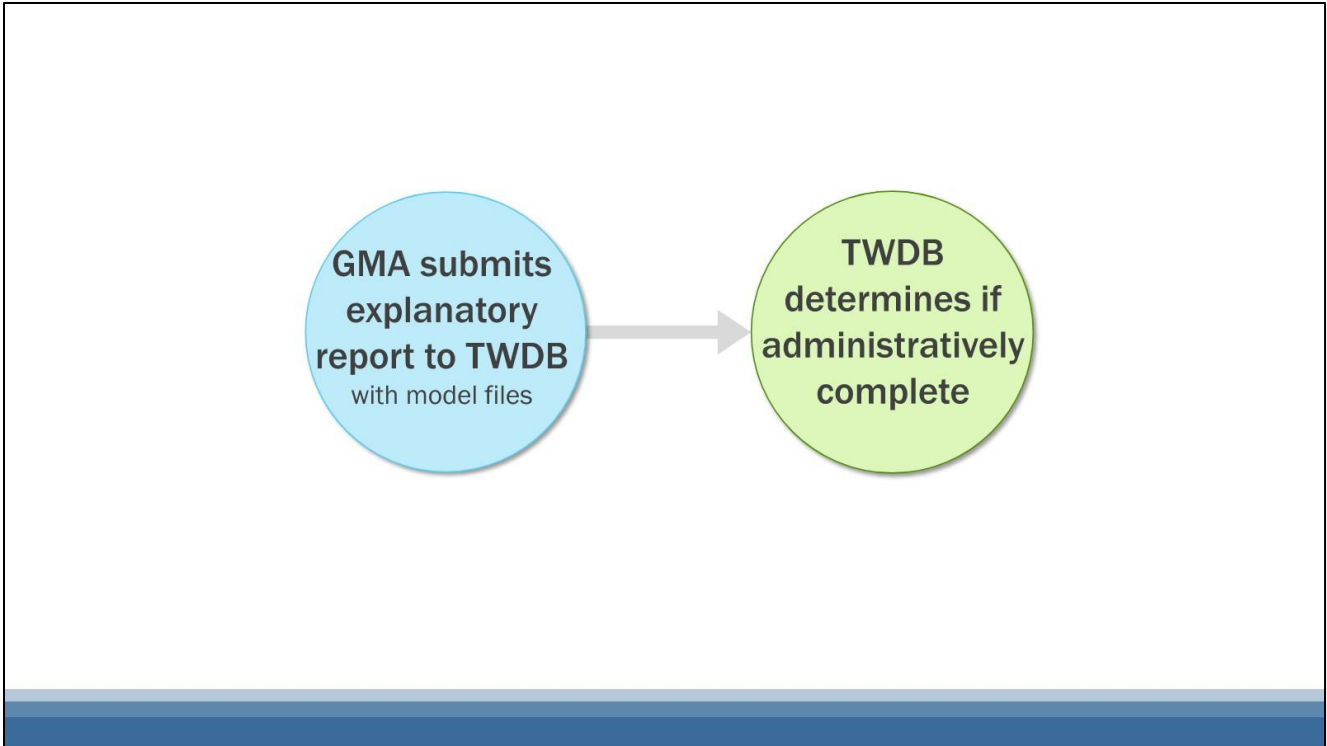
**GMA submits  
explanatory  
report to TWDB**  
with model files

## **DFC Explanatory Report**

Needs to include

- Each desired future condition
- Policy and technical justification
- Consideration of 9 factors
- Other desired future conditions considered and why those were not adopted
- Discussion of recommendations from advisory committees and relevant public comments
- Non-relevant aquifer documentation

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**TWDB  
determines if  
administratively  
complete**



**MAGs**

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## **Modeled available groundwater MAG**

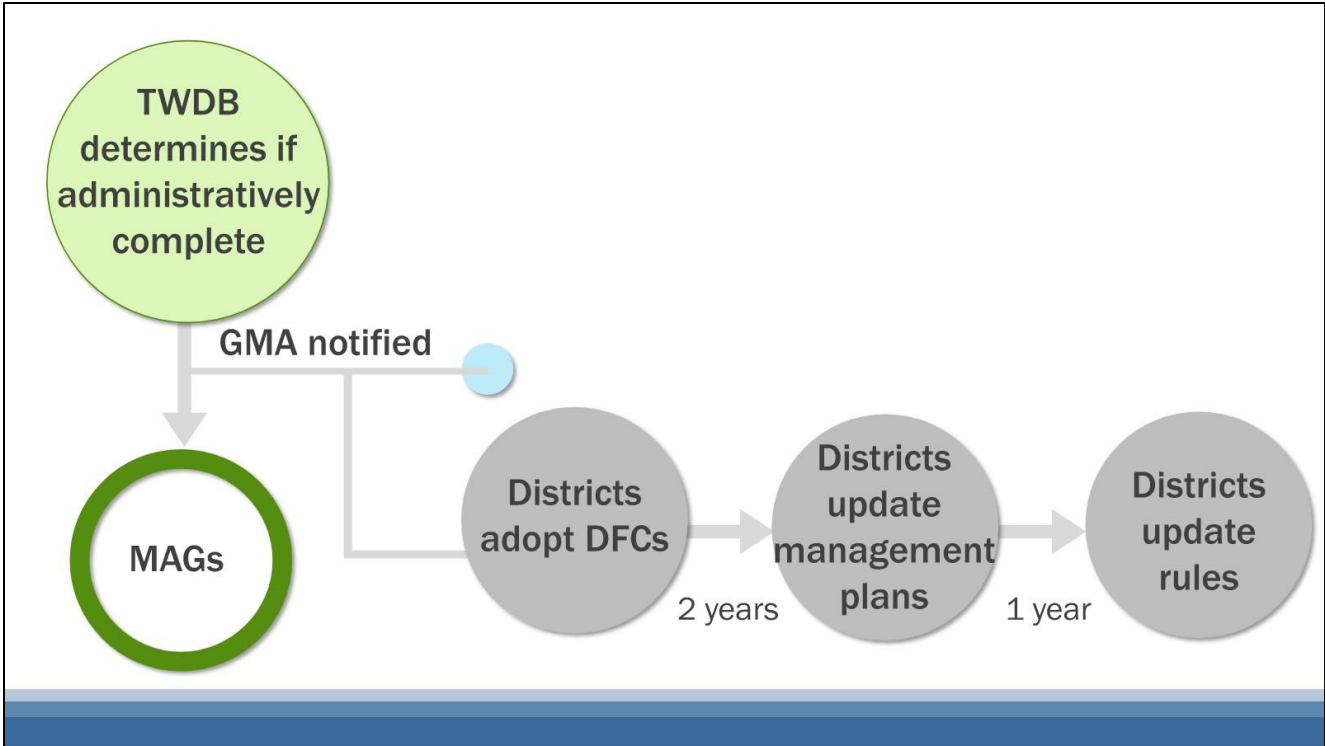
Amount of water that may be produced on an average annual basis to achieve a desired future condition

Calculated by the TWDB using GAMs

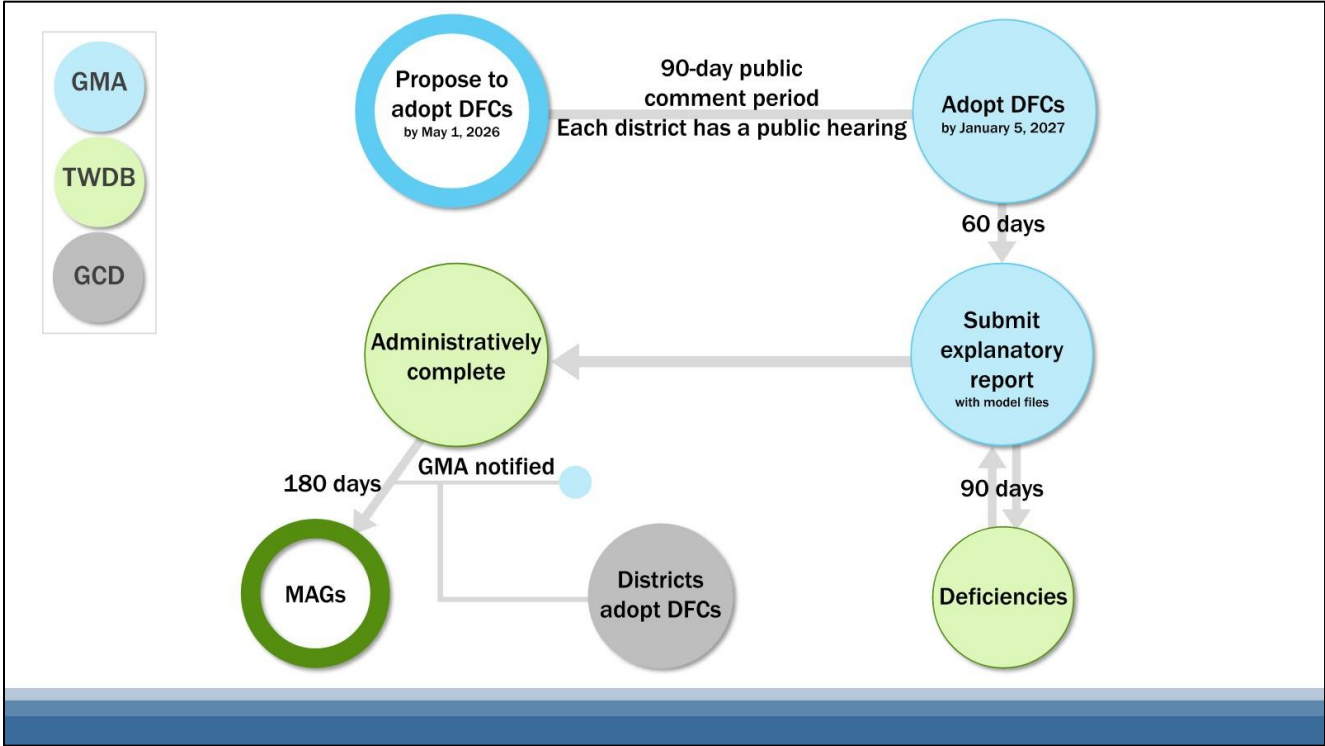
Used in permitting decisions, among other information

Provided to regional water planning areas as groundwater availability

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## **TWDB DFC Resources**

[DFC webpage](#)

[Guidance documents](#)

[2021 joint planning documents](#)

[Groundwater Technical Assistance staff](#)

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Slides prepared by

## **Natalie Ballew, P.G.**

Groundwater Division Director, TWDB

512-463-2779

[natalie.ballew@twdb.texas.gov](mailto:natalie.ballew@twdb.texas.gov)



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## **APPENDIX C**

“Desired Future Conditions – Demonstration with historical data”

# DRAFT TECHNICAL MEMORANDUM



Innovative approaches  
Practical results  
Outstanding service

10431 Morado Circle, Bldg. 5; Suite 300 + Austin, Texas 78759 + 512-617-3100 + FAX 817-735-7491

www.freese.com

<b>TO:</b>	Kinney County Groundwater Conservation District, Board of Directors
<b>FROM:</b>	Vince Clause, PG, Alysa Sule, PG, Freese and Nichols, Inc.
<b>SUBJECT:</b>	Desired Future Conditions – Demonstration with historical data
<b>PROJECT:</b>	KGD25636 – FY26 Hydrogeological Consulting Services
<b>DATE:</b>	February 18, 2026

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THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF <u>VINCE CLAUSE, P.G.</u> , TEXAS NO. <u>15512</u> ON <u>02/18/2026</u> . IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES. FREESE AND NICHOLS, INC. TEXAS REGISTERED GEOSCIENCE FIRM F- 50655

## 1.00 INTRODUCTION

Freese and Nichols, Inc. (FNI) has prepared this technical memorandum for the Kinney County Groundwater Conservation District (KCGCD) to support continued use of best available science in the joint planning process for Desired Future Conditions (DFCs). This memorandum evaluates the historical performance of two DFC statements for the Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area (GMA) 7 in Kinney County using historical data.

This work was completed under FY26 Hydrogeological Consulting Services, Task 2: Support Desired Future Conditions Joint Planning, authorized on August 23, 2025, under the Master Services Agreement between KCGCD and FNI.

## 2.00 DESIRED FUTURE CONDITIONS PERFORMANCE DEMONSTRATION

FNI developed an Excel workbook-based screening tool to demonstrate how alternative DFC statements would have performed during the period from 1940 through 2025 using historical daily mean discharge measurements at Las Moras Springs and Palmer Drought Severity Index (PDSI) data for Kinney County. The tool was developed to increase transparency by establishing a repeatable evaluation method to support DFC discussions.

The tool evaluates DFC attainment on an annual basis by computing rolling averages over user-defined averaging windows and comparing those rolling averages to the selected metric(s). Additionally, the inclusion of PDSI data provides context for interpreting periods of higher or lower spring discharge relative to drought severity and supports discussion of how climate-driven variability may influence attainment under different DFC formulations.

A live demonstration of the tool will be provided at the District's February meeting to facilitate discussion of the tradeoffs among alternative DFC threshold, averaging windows, and compliance frequency. Rather than recommending a specific DFC, this memorandum summarizes high-level differences in historical performance between the two DFC statement frameworks and summarizes the primary sensitivities observed in the historical record.

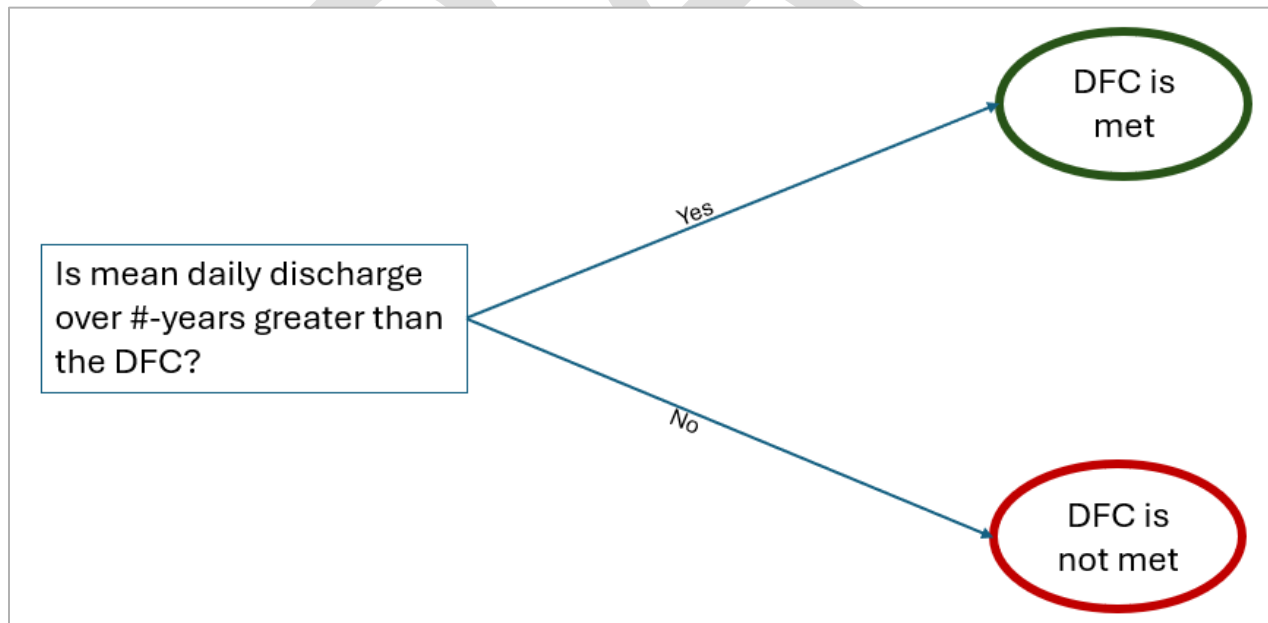
## 2.01 ONE-TIER DESIRED FUTURE CONDITIONS STATEMENT

The one-tier desired future conditions framework evaluated with the screening tool is restated below:

*Daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cubic feet per second (cfs) when averaged over #-years/months/days.*

For purposes of this demonstration, the tool assumes the Board selects an averaging window of at least one year and evaluates compliance on an annual basis. To illustrate how this framework would have performed historically, the tool was tested across a range of potential DFC inputs, including averaging windows from 1 to 10 years and minimum spring discharge thresholds from 1 to 35 cfs. Figure 1 summarizes the compliance logic used to evaluate attainment under the one-tier statement. Figure 2 summarizes historical performance by showing the percentage of years from 1940 to 2025 that would have met the desired future condition for each combination of averaging window and discharge threshold.

Results demonstrate that the selected averaging window materially affects attainment because longer averaging periods smooth short-term variability associated with multi-year drought cycles. For example, if the minimum rolling-average discharge was 15 cfs, this DFC would be met approximately 66% of the time if the averaging window was 1-year, compared to approximately 87% of the time if the averaging window was 4-years. This sensitivity highlights an important tradeoff: shorter averaging windows respond more quickly to changing conditions but may result in more frequent nonattainment during drought periods, while longer averaging windows reduce year-to-year variability in the compliance metric but may lag changes in underlying hydrologic conditions.



**Figure 1.** Decision logic for assessing compliance with the one-tier desired future conditions statement.

One-tier metric, % of time DFC is met from 1940 to 2025											
		# years in averaging window									
		1	2	3	4	5	6	7	8	9	10
Minimum spring discharge (cfs)	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	4	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	5	97%	98%	99%	100%	100%	100%	100%	100%	100%	100%
	6	93%	96%	96%	98%	99%	100%	100%	100%	100%	100%
	7	92%	94%	94%	96%	98%	100%	100%	100%	100%	100%
	8	85%	89%	93%	95%	98%	99%	100%	100%	100%	100%
	9	84%	89%	90%	94%	96%	98%	100%	100%	100%	100%
	10	81%	87%	90%	93%	95%	98%	100%	100%	100%	100%
	11	80%	86%	88%	92%	94%	98%	99%	100%	100%	100%
	12	76%	82%	87%	89%	94%	94%	96%	100%	100%	100%
	13	73%	80%	85%	89%	91%	93%	96%	97%	100%	100%
	14	71%	79%	85%	87%	88%	93%	94%	96%	99%	100%
	15	66%	79%	82%	87%	88%	89%	90%	94%	97%	99%
	16	60%	73%	79%	81%	88%	86%	89%	91%	94%	97%
	17	58%	66%	75%	76%	82%	84%	85%	87%	88%	94%
	18	55%	60%	65%	75%	72%	78%	79%	82%	85%	84%
	19	51%	54%	58%	60%	61%	60%	68%	72%	73%	70%
	20	47%	51%	51%	51%	52%	53%	54%	57%	60%	60%
	21	43%	46%	44%	43%	46%	40%	41%	48%	47%	44%
	22	40%	44%	37%	39%	33%	33%	36%	33%	29%	27%
	23	34%	33%	31%	31%	23%	28%	28%	23%	21%	21%
	24	30%	27%	26%	22%	20%	20%	23%	16%	18%	19%
	25	28%	20%	17%	14%	16%	17%	14%	15%	17%	16%
	26	28%	19%	15%	13%	15%	17%	14%	14%	13%	12%
	27	26%	18%	14%	12%	12%	11%	13%	10%	9%	8%
	28	22%	15%	11%	11%	11%	10%	10%	9%	8%	4%
	29	19%	13%	8%	10%	9%	9%	8%	6%	4%	3%
	30	16%	9%	7%	6%	7%	7%	8%	5%	3%	3%
	31	12%	6%	7%	6%	7%	7%	5%	4%	3%	3%
	32	12%	6%	6%	6%	7%	7%	5%	3%	3%	3%
	33	10%	6%	6%	6%	7%	4%	1%	1%	1%	1%
	34	8%	6%	5%	5%	4%	1%	1%	1%	0%	0%
	35	6%	5%	5%	5%	1%	0%	0%	0%	0%	0%

**Figure 2.** A demonstration of the desired future conditions tool documenting the DFC attainment rate for the one-tier DFC statement at different spring discharges and different annual averaging windows.

## 2.02 TWO-TIER DESIRED FUTURE CONDITIONS STATEMENT

The two-tier DFC framework evaluated in the screening tool is restated below:

*Daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cubic feet per second (cfs) when averaged over #-years/months/days, except during drought conditions. During drought conditions, as defined by a Palmer Drought Severity Index of less than # on average over a #-month period, daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cfs.*

### Key Variables Evaluated

This two-tier framework introduces a drought-based decision point that determines which discharge threshold applies. As implemented, the two-tier DFC includes five user-defined variables:

- **Normal-condition discharge (cfs) threshold (“high” cfs):** minimum discharge under non-drought conditions (10 cfs to 30 cfs tested).
- **Normal-condition averaging window:** rolling period used to compute discharge under non-drought conditions (assumed 1 to 10 years)
- **Drought-condition discharge (cfs) threshold (“low” cfs):** minimum discharge under drought conditions (1 cfs to 15 cfs tested)
- **Drought metric averaging window:** rolling period used to define whether drought conditions are occurring, evaluated either monthly or annually (1 to 72 months or 1 to 10 years tested)
- **Drought trigger threshold (PDSI):** the PDSI value that determines whether the normal-condition or drought condition discharge threshold applies (PDSI -1, -2, -3, or -4 tested)

For this demonstration, PDSI was selected as the drought indicator because it provides a long period of record, is readily available at the county scale, and exhibits strong correlation with spring discharge in the historical dataset. The PDSI threshold can also be interpreted as the “drought trigger” that is, how severe drought conditions must be before the DFC shifts from the normal condition threshold to the drought condition threshold.

### Compliance Logic

The compliance logic for assessing the two-tier DFC is summarized in Figure 3 and follows a two-step process.

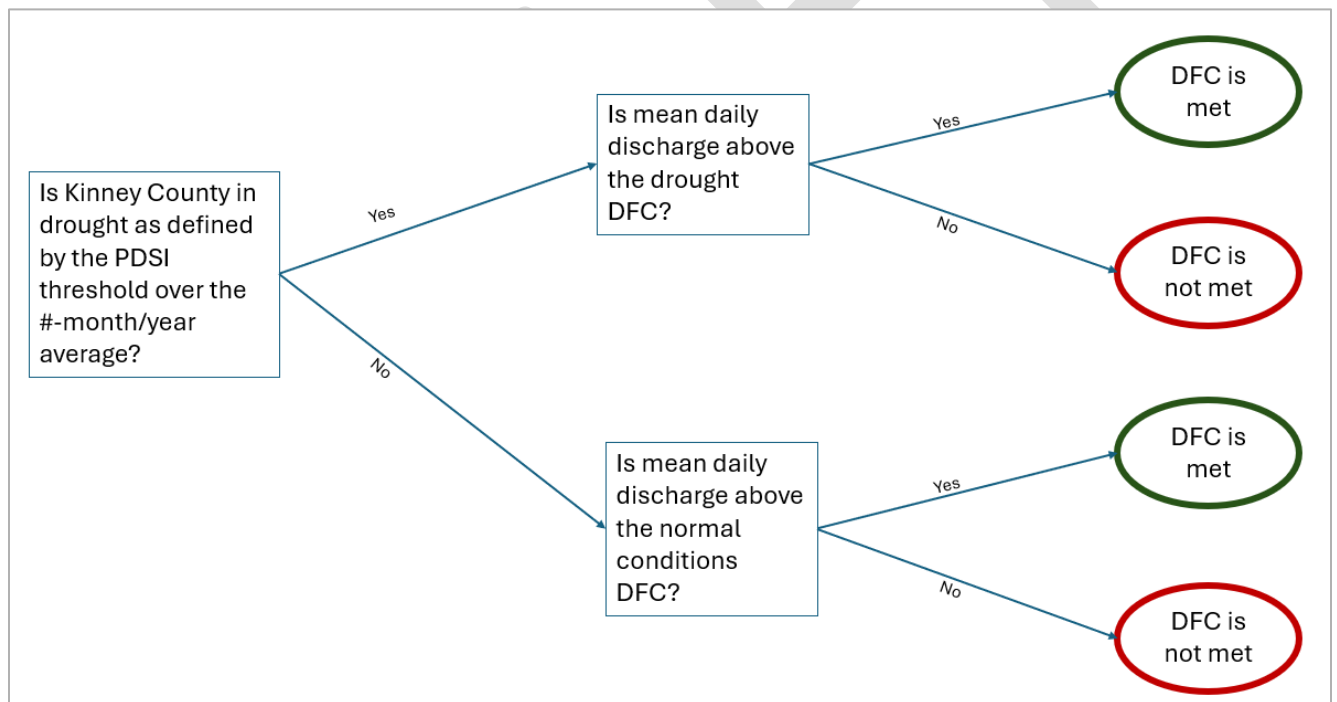
1. **Determine Whether the District is in Drought** for the evaluation period based on the drought trigger (PDSI threshold) and the selected drought averaging window. This determination may be made on a monthly or annual basis depending on the selected drought metric window and compliance evaluation frequency.
2. **Evaluate spring discharge against the appropriate tier:**
  - a. **If drought conditions are met:** calculate mean daily discharge at Las Moras Springs over the selected drought-condition discharge averaging window and compare it to the drought condition (“low”) cfs threshold.
  - b. **If drought conditions are not met:** calculate mean daily discharge at Las Moras Springs over the selected normal-condition discharge averaging window and compare it to the normal-condition (“high”) cfs threshold.

This structure is intended to acknowledge climate-driven variability by allowing a different (lower) discharge threshold to apply during objectively defined drought conditions, while retaining a higher protective threshold during non-drought periods.

Because the two-tier framework includes five variables, there are many potential combinations (greater than 200,000 across the tested parameter ranges). Accordingly, the memorandum documents a representative subset of combinations to illustrate how key choices influence historical performance, while additional combinations can be explored during the live tool demonstration.

Use of the normal-conditions discharge threshold (“high” cfs) is essentially analogous to the one-tier DFC framework. The two-tier approach primarily affects performance by altering how often the District is considered to be operating under drought conditions versus normal conditions. Based on initial testing, the following high-level observations apply:

- **Less sensitive drought triggers result in using the normal-condition threshold more often.** For example, a trigger of PDSI < -4 is less frequently met than PDSI < -1, so the framework will remain in the normal-condition tier more often at -4 than at -1.
- **Longer drought metric averaging windows tend to reduce the frequency of drought designation.** Increasing the drought averaging windows smooths short-term drought fluctuations and requires sustained drought severity before the drought tier is activated. As a result, longer drought windows typically lead to the normal-condition tier being used more frequently than shorter drought windows.



**Figure 3.** Decision logic for assessing compliance with the two-tier desired future conditions statement.

### 3.00 COMPARISON OF THE DESIRED FUTURE CONDITIONS FRAMEWORKS

Figure 4 below demonstrates the performance of different DFC statements. For this comparison, we selected 15 cfs as the one-tier or normal conditions in the two-tier value, as 15 cfs appears to be an achievable target (one of the nine DFC factors, see Section 4) under a drying climate as predicted by climate projection models (AdaptWest Project, 2022). Figure 4 compares the performance of the one-tier and two-tier DFC statement if 15 cfs is the normal conditions target and 5 cfs is the drought target.

		# of years in normal averaging window									
one-tier or normal cfs = 15 cfs		1	2	3	4	5	6	7	8	9	10
<b>One-tier met rate</b>		66%	79%	82%	87%	88%	89%	90%	94%	97%	99%
<b>Two-tier met rate</b>	PDSI < -1; drought cfs = 5; drought window = 1 month	65%	71%	72%	72%	72%	70%	70%	70%	73%	71%
	PDSI < -4; drought cfs = 5; drought window = 1 month	66%	78%	81%	84%	84%	85%	86%	87%	91%	91%
	PDSI < -1; drought cfs = 5; drought window = 6 month	72%	80%	81%	81%	81%	80%	80%	80%	82%	81%
	PDSI < -4; drought cfs = 5; drought window = 6 month	66%	79%	82%	87%	85%	85%	88%	89%	92%	92%
	PDSI < -1; drought cfs = 5; drought window = 1 year	92%	93%	93%	94%	95%	94%	94%	94%	96%	95%
	PDSI < -4; drought cfs = 5; drought window = 1 year	70%	82%	86%	90%	90%	91%	93%	95%	99%	99%
	PDSI < -1; drought cfs = 5; drought window = 5 year	78%	91%	98%	99%	100%	99%	99%	99%	100%	100%
	PDSI < -4; drought cfs = 5; drought window = 5 year	65%	78%	82%	87%	88%	89%	90%	94%	97%	99%

**Figure 4.** A demonstration of the DFC tool comparing the attainment rate for the one- and two-tier DFC statements.

From this analysis, the following observations were made:

- **Compliance evaluation is simpler under a one-tier DFC.** The one-tier framework relies on a single discharge threshold and averaging window, resulting in a straightforward annual compliance determination.
- **A two-tier DFC does not necessarily increase annual DFC performance.** Introducing a drought tier may increase, decrease, or have little effect on the percent of years meeting the DFC depending on how the drought trigger and drought averaging window are defined and how frequently tier selection is reassessed
- **When drought status is evaluated using monthly averages:**
  - The DFC is generally met less often compared to annual averaging windows because historically spring discharge is also low on a monthly basis during drought
  - Selecting a less sensitive drought trigger (PDSI = -4) has a higher percent of years that met the DFC because the long-term spring discharge averages are assessed

- **When drought status is evaluated using annual averages:**
  - Compliance determination is simpler than under monthly evaluation because tier selection and compliance assessment occur once per year rather than requiring month-by-month drought classification.
  - A more sensitive drought trigger (PDSI -1) can result in a higher percentage of years meeting the DFC because low spring discharge is typically concentrated in specific months while the annual average also considered higher springflow months.

**Alternative two-tier approach.** An alternative two-tier framework could be implemented without an explicit drought trigger. Under this approach, the District would evaluate Las Moras Springs discharge against two concurrent discharge thresholds, a normal condition (“high”) cfs target and a minimum (“low”) cfs threshold, rather than switching between tiers based on a drought index.

Conceptually, the “high” cfs threshold would represent the desired performance under typical conditions, while the “low” cfs threshold would define a minimum acceptable discharge during periods of reduced springflow. Depending on how the statement is structured, compliance could be assessed by requiring discharge to remain above the “high” threshold over a specified period of time while not falling below the “low” threshold on a monthly or annual basis. This structure removes the need to define and defend a specific drought trigger, while still distinguishing between normal conditions and low-flow periods in a transparent way.

#### **4.00 DESIRED FUTURE CONDITIONS – NINE FACTORS**

Any newly adopted DFC statement will need to be voted on by GMA 7. As they consider the desired future conditions statement, per Texas Water Code Sec. 36.108(d), “before voting on the desired future conditions of the aquifers under Subsection (d-2), the districts shall consider” nine factors:

1. “aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another”
2. “the water supply needs and water management strategies included in the state water plan”
3. “hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge”
4. “other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water”
5. “the impact on subsidence”
6. “socioeconomic impacts reasonably expected to occur”
7. “the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002”
8. “feasibility of achieving the desired future condition”
9. “any other information relevant to the specific desired future conditions”

Of these factors, Factor 8 (feasibility) may become a key consideration during GMA 7 deliberations because it directly links the proposed DFC statement(s) to (1) the ability to evaluate compliance using available data and (2) whether the DFC can realistically be achieved and maintained given historical aquifer trends, climatic variability, and available management tools.

## 5.00 REFERENCES

- AdaptWest Project. 2022. Gridded current and projected climate data for North America at 1km resolution, generated using the *ClimateNA v7.30* software (T. Wang et al., 2022). Available at [adaptwest.databasin.org](http://adaptwest.databasin.org).
- Wang, T., A. Hamann, D. Spittlehouse, C. Carroll. 2016. Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. PLoS One 11(6): e0156720 <https://doi.org/10.1371/journal.pone.0156720>
- Mahony, C.R., T. Wang, A. Hamann, and A.J. Cannon. 2022. A global climate model ensemble for downscaled monthly climate normals over North America. International Journal of Climatology. 1-21. <https://doi.org/10.1002/joc.7566>

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