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MOJAVE WATER AGENCY

NO FEE PER GOV'T. CODE SEC. 6103

SUPERIOR COURT OF THE STATE OF CALIFORNIA

IN AND FOR THE COUNTY OF RIVERSIDE

Coordination Proceeding Special Title
(Cal. Rules of Court, Rule 3.550)

MOJAVE BASIN WATER CASES

CITY OF BARSTOW, et al.,

Plaintiff,

v.

CITY OF ADELANTO, et al.,

Defendant.

AND RELATED CROSS ACTIONS

CASE NO.: CIV 208568 / JCCP5265

Dept. 1. Riverside Superior Court
Hon. Craig G. Riemer, Retired

NOTICE OF MOTION AND MOTION FOR APPROVAL OF (1) PRODUCTION SAFE YIELD CLASSIFICATIONS, AND (2) FREE PRODUCTION ALLOWANCE RECOMMENDATIONS FOR WATER YEAR 2026-2027; MEMORANDUM OF POINTS AND AUTHORITIES; SUPPORTING DECLARATION OF ROBERT C. WAGNER (WATERMASTER ENGINEER)

Date: August 12, 2026
Time: 10:00 a.m.
Dept: 1
Reservation ID: Pursuant to court order dated May 12, 2026

TO ALL PARTIES AND THEIR RESPECTIVE ATTORNEYS OF RECORD:

PLEASE TAKE NOTICE THAT on August 12, 2026 at 10:00 a.m., or as soon thereafter as the matter may be heard, in Department 1 of the above entitled court located at 4050 Main Street, Riverside, California, Defendant/Cross-Complainant, Mojave Water Agency, acting in its capacity as the Mojave Basin Area Watermaster, will move, and hereby moves, pursuant to paragraph 24(o) and Exhibit H of the Judgment in the above entitled case, for approval of (1) Watermaster's proposed Production Safe Yield (PSY) re-classifications; and (2) Watermaster's recommendation in its Thirty-Second Annual Report for Free Production Allowance (FPA) for the 2026-2027 Water Year for each of the five (5) Subareas (Alto, Baja, Centro, Este and Oeste) of the Mojave Basin.

This motion is based upon this notice of motion, the attached Memorandum of Points and Authorities, the Watermaster's Thirty-Second Annual Report lodged concurrently herewith, the Declaration of Robert C. Wagner attached hereto, the Exhibits referenced in Mr. Wagner's declaration which also are attached hereto, the pleadings, papers, and records on file in this Action and upon such other further evidence, both oral and documentary, that may be presented at the hearing on the motion.

Dated: July 6, 2026

BRUNICK, McELHANEY & KENNEDY PLC

BY: _____

Leland P. McElhaney
Attorneys for Defendant/Cross-Complainant,
MOJAVE WATER AGENCY

MEMORANDUM OF POINTS AND AUTHORITIES

I.

BACKGROUND

The original complaint was filed by the City of Barstow et al. on May 30, 1990, alleging that the cumulative water production upstream of the City of Barstow had over-drafted the Mojave River System. The complaint requested that the Mojave Water Agency (MWA) be ordered to obtain and provide supplemental water for use within the Mojave Basin Area (Basin). Thereafter, MWA filed its First Amended Cross-Complaint naming substantially all producers of water within the Basin, (including parties downstream of the City of Barstow), and requested a determination of all water production from whatever source within the Basin.

After extensive negotiations, parties representing over 80% of the verified water production in the Basin agreed to a stipulated Judgment which, among other things, established a Physical Solution to the water supply problems. A trial was conducted as to claims of non-stipulating parties, and the final Judgment after trial adopted the Physical Solution set forth in the stipulated Judgment.

The Cardozo Group of the non-stipulating parties appealed the Judgment. Following opinions by the Court of Appeal and Supreme Court, the Judgment as to the stipulating parties was affirmed, but reversed as to the Cardozo Group of non-stipulating parties. As of August 23, 2002, Jess Ranch Water Co. (JRWC), previously a non-stipulating party, entered into a settlement agreement in which it also stipulated to the Judgment. An amendment to the Judgment was filed on December 5, 2002, which incorporated the changes with respect to the Cardozo Group and JRWC.

II.

THE JUDGMENT'S PHYSICAL SOLUTION

On January 10, 1996, the Court entered its Judgment which addressed the overdraft existing in the Basin by the creation of a Physical Solution for the Basin's five distinct, but hydrologically interrelated Subareas (Alto, Baja, Centro, Este, and Oeste). The Court determined that all five (5) Subareas of the Basin had been in a state of overdraft since at least the 1950's, that the economy and population overlying the Basin had dramatically grown in reliance upon the overdraft, and that all

producers had contributed to the overdraft. The Court's Physical Solution established a limit on the amount of water each Producer could produce in one year before having to purchase replacement water. This is known as the Free Production Allowance (FPA). The Judgment also established each producer's Base Annual Production (BAP). A producer's BAP was based upon that producer's highest year of water production during the period of 1986-1990. A producer's BAP serves as the basis for the producer's Base Annual Production Right (BAPR). BAPR is the right of each producer to a percentage of the FPA within a given Subarea.

Although the serious nature of the overdraft warranted an immediate reduction for all water production within the Basin, the Court approved a gradual reduction in production in order to soften the economic impact upon producers. The Judgment sets forth the terms for a gradual reduction or Rampdown of the FPA for all parties. After the first five years of the Judgment, the FPA for all parties was set at eighty percent (80%) of their original BAP. The Judgment also provides that the Court may review and adjust, as necessary, the FPA for each Subarea on an annual basis.

Since entry of Judgment in January of 1996, the Parties to the Adjudication and the Court have attempted to achieve sustainability and equilibrium in the Basin by using the tools within the Judgment to, among other things, finance the importation of supplemental water.

The waters derived from the Mojave River constitute a common source, but not the only source, of groundwater supply for the five Subareas. Each stipulating Party has a declared production right in his or her respective Subarea to produce water for his or her use against other Parties located in the Subarea. In addition, Producers within certain Subareas have rights as against those in adjoining upstream Subareas to receive average annual water supplies and in any one year to receive minimum annual water supplies equal to the amounts set forth in Exhibit G of the Judgment in addition to any storm flows. Exhibit G establishes these Subarea rights and obligations to ensure historical flows to each Subarea within the Basin. Producers in the respective Subareas have the obligation to provide the following average annual and minimum annual subsurface flows and/or base flow per year:

Subsurface Obligations

Este to Alto	200 acre-feet
Oeste to Alto	800 acre-feet
Alto to TZ	2,000 acre-feet (and 21,000 acre-feet surface obligation)
Centro to Baja	1,200 acre-feet
Baja to Afton	0 acre-feet (400 acre-feet obligation was relieved by Court, 2006)

In summary, each Party's Production Right is to be exercised within the respective Subarea in which the Party's property is located. Until recently, the sixty-year (1931-1990) average storm flow was assumed to be available to the Subareas from the Mojave River system. In 2026, the Court directed Watermaster to again utilize the 1931-1990 base period to determine long-term average water supply. The water supply is episodic and assumed to repeat in the future as in the past. Each respective Subarea is assumed to receive the historic storm flow, as supply, on a long-term average basis, but not in any given year. The Subarea rights and obligations were decreed by the Judgment. A fundamental premise of the Physical Solution is that all Parties will be allowed, subject to the Judgment, to produce sufficient water to meet their reasonable beneficial use requirements. To the extent that production by a Producer in any Subarea exceeds such Producer's share of the Free Production Allowance of that Subarea, Watermaster will provide replacement water to replace such excess production, with the Producer producing more than his share of the FPA being obligated to pay for such "replacement" water at the current replacement water rate. To the extent any Subarea incurs a Makeup Obligation, Watermaster will provide supplemental water to satisfy such Makeup Obligation at the current makeup water rate.

III.

NECESSITY FOR FPA ADJUSTMENT

Pursuant to the gradual reduction required in the Judgment, by the 1997-98 Water Year, each producer's FPA was set at eighty percent (80%) of that producer's BAP specified by the Judgment. Exhibit H of the Judgment requires that Watermaster recommend a decrease in the FPA for a Subarea when that Subarea's FPA exceeds its estimated Production Safe Yield (PSY) by five percent (5%) or

more. Pursuant to Paragraph 24(o) of the Judgment, the Watermaster is required to make a recommendation to the Court for adjusting the FPA of each Subarea, if necessary.

In its October 23, 2024 Order (Exhibit 2, pp. 21-30 hereto), the Court ordered Watermaster to: (a) re-calculate PSY for the Alto, Centro, Baja and Oeste Subareas; (b) recommend a plan to improve the collection of hydrologic data and, in doing so, to consider the recommendations contained in Section 6.0 of the report of Anthony Brown marked Exhibit 1 to Golden State's September 5, 2024 motion; and (c) determine whether Producers in Alto have met, are currently meeting, and in the future are likely to continue to meet their Subarea obligations under the Judgment.

For Water Year 2024-25, Watermaster recommended the following FPA values: 53.2 percent of BAP for Alto, 60.0 percent of BAP for Centro, 20.5 percent of BAP for Baja, 50 percent of BAP for Este, and 50 percent of BAP for Oeste. However, the Court rejected these values and set FPA as follows: 50.4 percent of BAP for Alto; 19.5 percent of BAP for Baja; 56 percent of BAP for Centro; 45 percent of BAP for Este; and 45 percent of BAP for Oeste.

In its Order dated August 5, 2025 (Exhibit 1, pp. 15-20 hereto), for Water Year 2025-2026, the Court granted Watermaster's proposal to maintain the same FPA values as follows: 50.4 percent of BAP for Alto; 19.5 percent of BAP for Baja; 56 percent of BAP for Centro; 45 percent of BAP for Este; and 45 percent of BAP for Oeste. The Court also approved for Water Year 2025-2026 only, the following PSY values: 62,005 AFY for Alto; 31,420 AFY for Centro; 6,582 AFY for Este; 3,287 AFY for Oeste; and 12,189 AFY for Baja.

Recommended values for PSY and FPA. Watermaster's report regarding its PSY re-calculations is included in Watermaster's Annual Report for Water-Year 2024-2025 and, along with Watermaster's FPA recommendations, is discussed in detail in Mr. Wagner's declaration (Exhibit 3 hereto, at pp. 31-51). Based upon the analyses and explanations in Mr. Wagner's declaration and supporting exhibits, Watermaster now recommends that the Court approve Watermaster's PSY and FPA calculated values for each Subarea, as follows:

(1) **ALTO:** PSY of 63,442 acre-feet, and FPA at 54.5% of BAP;

(2) **BAJA**: PSY of 16,211 acre-feet, and FPA at 19.5% of BAP;

(3) **CENTRO**: PSY of 28,473 acre-feet, and FPA at 55.8% of BAP;

(4) **ESTE**: PSY of 6,677 acre-feet, and FPA at 40% of BAP; and

(5) **OESTE**: PSY of 3,685 acre-feet, and FPA at 51.9% of BAP.

These values differ from those approved by the Court for Water Year 2025-2026, for several reasons. First, the current PSY values are calculated based upon the 1931-1990 base period average water supply, *which is approximately 6% "wetter"* than the 2001-2020 base period data Watermaster used to calculate its recommended PSY values for Water Years 2024-2025 and 2025-2026. Accordingly, Watermaster's current PSY calculations (based upon 1931-1990 base period water supply data) result in higher PSY values than the PSY values last approved by the Court. Second, utilization of the 2001 USGS groundwater model by Stamos et al. [hereafter, "2001 USGS model"] for estimates of ungaged water supply and subsurface flows between subareas. The 2001 USGS model is the only analytical tool that captures both the entire Mojave Basin Area (MBA) and the Court ordered 1931-1990 base period. The 2001 USGS model also will allow for a direct model-to-model comparison of the elements of water supply, use, and disposal when MWA finalizes the Regional Mojave Basin Model.

Third, utilization of recent data of production and consumptive uses, following Watermaster Engineer's determination that Water Year 2024-25 is representative of current and near future land uses and cultural conditions of the Mojave Basin Area.

PSY values. For Alto, Centro, and Baja, the indicated PSY values are the result of simple arithmetical calculations predicated upon average annual water supply during the 1931-1990 base period as reported in the Table 5-1 (Exhibit 4, p. 72 hereto) which (a) indicates water supply from USGS stream flow gages, (b) estimates from the 2001 USGS model, (c) imported water, and (d) recent pumping and consumptive use data.

For Alto, the indicated PSY of 63,442 acre-feet annually (based upon the long term average adjusted for current consumptive use within the TZ) is the result of Alto's average annual water supply of 78,986 acre-feet, less consumptive uses and outflow of 91,873 acre-feet, resulting in a projected annual deficit of negative 12,887. Thus, the PSY for Alto is total pumping (76,329 acre-feet) less the

deficit (12,887 acre-feet), resulting in 63,442 acre-feet (Table 5-1, Exhibit 4, p. 72; Wagner Dec., Exhibit 3, p. 43 hereto).

For Centro, the indicated PSY of 28,473 acre-feet annually is the sum of Centro's total pumping (15,884 acre-feet) and the calculated surplus (9,763 acre-feet) plus a portion of surplus (equal to 28.9% which is the return flow percentage). The surplus value is the average annual water supply of 41,917 acre-feet minus consumptive uses and outflow of 32,154 acre-feet (Table 5-1 in Exhibit 4, p. 72, and Wagner Dec., Exhibit 3, pp. 43-44 hereto).

For Baja, the indicated PSY of 16,211 acre-feet annually is the sum of Baja's total pumping (10,481 acre-feet) and the calculated surplus (4,501 acre-feet) plus a portion of surplus (equal to 27.3% which is the return flow percentage). The surplus value is the average annual water supply of 22,320 acre-feet minus consumptive uses and outflow of 17,819 acre-feet (Table 5-1 in Exhibit 4, p. 72, and Wagner Dec., Exhibit 3, p. 44 hereto).

Based on these arithmetical calculations, the indicated PSY values for Alto, Centro and Baja are more likely than not true. Mr. Wagner's declaration also provides an alternative analysis of PSY for Baja based upon a comparison of water level observations pointing to a reversal of storage decline and recent pumping trends (Wagner Dec., Exhibit 3, at pp. 44-46.)

For the reasons explained in Mr. Wagner's declaration, the indicated PSY values for Este and Oeste are based upon a comparison of recent pumping and changes in groundwater storage for a given period of time indicating that change in storage is near zero (Wagner Dec., Exhibit 3, pp. 40-43). Watermaster's analysis of water levels in Este indicates no appreciable loss in storage as a result of the current and reduced pumping levels, indicating PSY for Este is equal to the average annual pumping of 6,677 acre-feet during the last 30 years (1996-2025) (Wagner Dec., Exhibit 3, pp. 40-41). The analysis for Oeste also indicates no appreciable loss in storage as a result of current and reduced pumping levels, indicating that PSY for Oeste is equal to the average annual pumping of 3,685 acre-feet during the last sixteen years (2010-2025) (Wagner Dec., Exhibit 3, pp. 41-43). Based upon this logical and equally straightforward analysis, the indicated PSY values for Este and Oeste also are more likely than not accurate and true. (Wagner Dec., Exhibit 3, pp. 40-43.)

Increased FPA values for Alto and Oeste. Watermaster understands the Court's preference for a "conservative" approach to approving increases in FPA values. However, the indicated FPA values for Alto and Oeste are increased from 50.4% to 54.5% of BAP for Alto, and from 45% to 51.9% of BAP for Oeste. For Alto, the indicated FPA is the result of dividing the PSY of 63,442 acre-feet by the Base Annual Production of 116,412 acre-feet. For Oeste, the indicated FPA is also the result of dividing the indicated PSY of 3,685 acre-feet by the Base Annual Production of 7,095 acre-feet. In 2024, Watermaster recommended FPA for Alto of 53.3% and the FPA for Oeste of 46.3%. Based upon the calculated PSY values for these subareas (for Alto, total pumping less the deficit; and for Oeste average pumping with no appreciable long-term loss in storage), the indicated FPA values for Alto and Oeste are more likely than not true (Wagner Dec., Exhibit 3, pp. 35-36).

Recommendation that Baja FPA remain at 19.5% of BAP. In making its FPA recommendations, Watermaster is required to give "consideration" to the "protection of public trust resources" (Exhibit H, paragraph 2(a)). The California Department of Fish & Wildlife has submitted evidence that public trust resources in the Baja "Camp Cady" area are under particular stress because of a lack of sufficient near surface groundwater at a depth needed to support the riparian vegetation. As a result and taking into consideration the protection of public trust resources, Watermaster recommends continuing FPA for Baja at 19.5% of BAP (even though the annual average water supply data from the 1931-1990 base period, coupled with recent pumping and consumptive use data, indicates a PSY value that otherwise would warrant a higher FPA value). (Wagner Dec., Exhibit 3, p. 36.)

5% reduction of FPA for Este. For Este, although the data indicates a slightly higher PSY value (6,677 acre-feet), FPA continues to exceed PSY by more than 5% (i.e., FPA of 9,092 acre-feet [which is 45% of BAP] compared to PSY of 6,677 acre-feet. Accordingly, based upon paragraph 24(o) of the Judgment, Watermaster recommends reducing FPA for Este from 45% to 40% of BAP. (Wagner Dec., Exhibit 3, p. 36.)

For Centro decrease in both PSY and FPA. For Centro, the data indicates a decrease in PSY (from 31,420 acre-feet to 28,473 acre-feet), and a corresponding reduction in FPA (from 56% to 55.8%

of BAP). As explained above, for Centro, the indicated PSY of 28,473 acre-feet annually is the result of Centro's total pumping (15,884 acre-feet) plus a calculated surplus (9,763 acre-feet), plus a portion of surplus corresponding to return flows percentage (28.95% of surplus is 2,826 acre-feet) (Wagner Dec., Exhibit 3 hereto, pp. 36-37, and Exhibit 4 hereto, p. 65). The indicated FPA (55.8% of BAP) is calculated as follows: indicated PSY of 28,473 acre-feet divided by the Base Annual Production of 51,030 acre-feet. Based upon this analysis, the recommended PSY and FPA values for Centro also are more likely than not true. (Wagner Dec., Exhibit 3, pp. 36-37.)

IV.

PLAN FOR IMPROVING COLLECTION OF HYDROLOGIC DATA

Watermaster's plan to improve collection of hydrologic data includes the following:

1. Following completion and calibration of the Regional groundwater modeling, study and utilize its resulting data and information (completion date is unknown, total expenditure expected to be approximately $2,000,000.00).
2. Continuing ongoing analysis of the extensive network of monitoring wells. The Mojave Water Agency monitors more than 408 wells located within the Basin boundaries and 214 of those wells have transducers with continuous recorders. The approximate cost for MWA to implement this monitoring program is approximately $800,000.00 annually, including the cost for support from USGS. The cost for installing a new monitoring well to enhance this extensive network ranges from $150,000 to $1,000,000.00 depending on the depth and complexity of the well.
3. Continuing ongoing study of riparian vegetation using satellite-based remote sensing tools to update consumptive use values for phreatophytes.
4. MWA to develop and implement, by December 31, 2027, a program to identify, monitor and quantify production by Minimal Producers.
5. Identification of any data gaps, and providing a strategy to fill the remaining data gaps. Data gaps include water supply elements such as mountain front recharge, un-gaged inflow, ephemeral stream contributions are complicated and difficult to evaluate. The USGS 2001

model makes estimates of these elements; the RMBM will also make such estimates. MWA has investigated ephemeral stream contributions with actual measurements. Water level data monitoring is already extensive and can be expanded, although the cost of doing so can be elevated. MWA has taken on the financial and staffing burden of providing an ongoing program of water level collection and monitoring well installation, however future efforts may be borne by the Watermaster parties. There is no immediate time frame specified by MWA or any of the parties to expand the existing program for monitoring well data collection. With respect to stream gages, particularly at Barstow, Watermaster will consider in its coming budget cycle a request that USGS investigate and recommend improvements to enhance data collection, and reliability of reported values. Direct measurements have been made weekly at Lower Narrows for approximately 30 years, and twice monthly near the Forks. These measurements are not likely to be improved; however, we can request that USGS provide a cost to review its data and measurement methodology.

6. The Mojave Water Agency currently is investigating recharge from ephemeral streams which should be completed by May of 2027, at an approximate cost of $800,000.00, plus ongoing expenses, yet to be determined.
7. Geophysical investigation and collection of data for evaluation of basin hydrogeology. Since 2023, MWA has expended about $500,000.00 on geophysical investigations, to be completed in June 2028.

Mr. Wagner's declaration also addresses each of the recommendations in Section 6.0 of Mr. Brown's report, including: Consumptive Use by Agriculture in Alto, the Transition Zone, and Centro [which are reliably determined]; Consumptive use by phreatophytes for Alto, the TZ, and Centro; Subsurface flow between Alto and the TZ and thence to Centro; Surface water flows between the TZ and Centro; and Storage losses in the TZ. (Wagner Dec., Exhibit 3, pp. 50-51.).

Watermaster acknowledges that remote sensing techniques are available for estimating surface water flow in desert environments. However, there are limitations in the ability of remote sensing to accurately determine the quantity of river flows, particularly in the environment existing at the

Helendale Fault, compounded with the relative infrequency of significant storm events resulting in detectable storm flow at the HF. (Wagner Dec., Exhibit 3, pp. 47-49.) Watermaster also noted that:

(1) GSWC proposes using Upstream Tech's AI modeling to estimate water flow through the Helendale Fault. This is another model – not a direct measurement—similar to the RMBM model being developed at considerable expense by the Mojave Water Agency which, among other things, will produce a modeled outflow at the HF.

(2) Watermaster considered Upstream Tech's presentation, but was not persuaded its modeling services would be useful at this time.

(3) Watermaster suggests that if GSWC continues to advocate for the additional modeling available through Upstream Tech and believes that additional modeling would be worth the additional cost involved, GSWC should fund and conduct the modeling itself and then share the results with Watermaster – just as the Mojave Water Agency has done in funding the RMBM and the other hydrologic data collection projects described above. This also would be consistent with the "beneficiary pays" principle of local government fees and assessments.

(4) The Watermaster budget funded by assessments is limited. Among other significant costs incurred by the Mojave Water Agency that are directly related to Watermaster's management of the Basin, Watermaster also relies on the Mojave Water Agency for the costly RMBM modeling currently being developed, which can be used to provide estimates of groundwater flow rates between the Transition Zone and Centro, estimates of groundwater storage over time, etc. Watermaster believes the additional data and information that will be derived from the RMBM, together with other information available to and known by the Watermaster, will be adequate for Watermaster's future recommendations and reports to the Court. Watermaster also believes the additional hydrologic data and information that will be provided by the RMBM will be superior to that available through Upstream Tech's modeling and, therefore, the additional cost of the Upstream Tech modeling at this time is unreasonable and unwarranted. (Wagner Dec., Exhibit 3, pp. 48-49.)

V.

WHETHER ALTO SUBAREA OBLIGATION SATISFIED

The calculations shown in Table 4-3 from the Thirty-Second Annual Report of the Mojave Basin Area Watermaster (Exhibit 5, pp. 159-161 hereto) demonstrate that Alto Producers have met their subarea obligation for the past ten years. Table 4-2 in each annual report has the calculation of the Makeup Obligation that is required by the Judgment for that year. The Subarea Obligation is 23,000 acre-feet annually to the Transition Zone. There is no other requirement in the Judgment for satisfying the Makeup Obligation. Consequently, based on the calculations contained in Table 4-2 and Table 4-3 of each annual report of the Watermaster, the Alto Subarea Producers have met, are currently meeting and will continue to meet their subarea obligations in the future under the Judgment. (Wagner Dec., Exhibit 3, p. 49 hereto).

In 2025, Watermaster conducted an analysis of the groundwater levels in the Transition Zone and in the Centro Subarea near the Helendale Fault. The average depth to water from the pre-overdraft conditions (1930-1950) was 15.56 feet, which is virtually the same as the average depth to water of 15.57 feet after implementation of the Judgment (1996-2024). (Wagner Dec., Exhibit 3, p. 49.)

In 2025, the Mojave Water Agency also performed a Mann-Kendall (MK) statistical test to establish groundwater level trends for all wells located in the TZ and to determine whether there is a trend of water levels over time. For the shallow wells in the TZ, about 70% (during 1996-2004) to 80% (during 1990-2024) show either a rise, or no change in groundwater levels. (Wagner Dec., Exhibit 3, pp. 49-50.)

The test results confirm Watermaster's prior finding that the Alto producers have met, are continuing to meet, and are likely to continue to meet their Subarea Obligation to Centro. Hydrographs and calculation of subsurface flows between Alto and Centro also confirm this conclusion. (Wagner Dec., Exhibit 3, p. 50.)

VI.

REASONS FOR WATER LEVEL DECLINE IN GOLDEN STATE WELLS

The most likely reasons for the water level decline observed in GSWC's production wells in Centro are: (a) significantly below average water supply to the Basin during the drought conditions experienced from 2012 to 2022 (i.e., an average supply of only 27,614 AFY or about 40-percent of the 68,635 AFY long-term average supply during 1931-2025); (b) concentrated pumping in the relatively small area within Centro where GSWC's production wells are located (i.e., almost 80% of all groundwater production in Centro occurs within the area of concentrating pumping where GSWC's wells are located [between the Hodge and Barstow gages]); (c) water level stability indicates no unaccounted water losses in the Transition Zone; and (d) production wells in Centro located near the Helendale Fault and upstream of GSWC's well sites show relatively stable water levels. (Wagner Dec., Exhibit 3, p. 50 hereto.)

Dated: July 6, 2026

BRUNICK, McELHANEY & KENNEDY PLC

BY: _____

Leland P. McElhaney
Attorneys for Defendant/Cross-Complainant,
MOJAVE WATER AGENCY

EXHIBIT 1

SUPERIOR COURT OF THE STATE OF CALIFORNIA, COUNTY OF RIVERSIDE

CASE TITLE: Mojave Basin Water Cases / City of Barstow v. City of Adelanto	Department 1	FILED SUPERIOR COURT OF CALIFORNIA COUNTY OF RIVERSIDE AUG 0 6 2025 2M L Howell
CASE NO.: ~~JCCP5265~~ / CIV208568		
DATE: August 5, 2025		

PROCEEDING: Order Granting in Part the Watermaster's Motion (1) for Approval of Production Safe Yield Calculations and (2) for Adjustment of Free Production Allowance

At the August 4, 2025, hearing on the Watermaster's motion, the Court heard all arguments from all parties wishing to address the Court. After considering those arguments, the Court rules that the Watermaster's motion is granted in part. Specifically:

The Watermaster's request to adjust the free production (FPA) for water year 2025-2026 for each of the five subareas is granted as follows:

- The FPA for the producers in Alto shall continue to be 50.4 percent of BAP, as recommended by the Watermaster.
- The FPA for the producers in Baja shall continue to be 19.5 percent of BAP, as recommended by the Watermaster.
- The FPA for the producers in Centro shall continue to be 56 percent of BAP, as recommended by the Watermaster.
- The FPA for the producers in Este shall be reduced from 50 percent to 45 percent of BAP, as recommended by the Watermaster.
- The FPA for the producers in Oeste shall continue to be 45 percent of BAP, as recommended by the Watermaster.

The Watermaster's request for approval of production safe yield (PSY) calculations is granted as modified. The PSY calculations by the Watermaster are approved as to Alto (62,005 AFY), Centro (31,420 AFY), Este (6,582 AFY), and Oeste (3,287 AFY). As to Baja, PSY is set at 12,189 AFY. Those calculations are approved only for water year 2025-2026.

The objections of Victorville Water District, the Watermaster, and the City of Hesperia to the requests for affirmative relief made by the California Department of Fish and Wildlife and Golden State Water Company are sustained. At the hearing, Mitsubishi Cement Corporation and Robertson's Ready Mix, Ltd., made similar requests. All those requests are denied without prejudice to the same requests being made pursuant to a properly noticed motion.

Analysis:

The Court has read and considered:

- The Mojave Water Agency's motion, together with its supporting memorandum and the declaration of Mr. Wagner, and relevant portions of the Watermaster's Annual Report;
- The DF&W's memorandum in response, and its two supporting declarations of Mr. Johnson and Mr. Blanke;
- The opposition by Mitsubishi and Robertson's;
- The opposition by Golden State and its supporting declaration of Mr. Hastings;

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- Victorville Water District's objection to the response of the DF&W and the opposition of Golden State;
- The MWA's reply memorandum and supporting declaration; and
- The joinder of the City of Hesperia to the objections to the requests of the DF&W and Golden State for affirmative relief.

The Watermaster's Request to Adjust FPA

The only opposition to the Watermaster's recommended FPA for each of the five subareas was from Mitsubishi and Robertson's. They disagree with the Watermaster's recommendation only as to the proposed five percent reduction of the FPA in Este.

Free Production Allowance in Este

Mitsubishi and Robertson's argue that no reduction is justified because production is well below FPA and there has been no significant loss of storage. Their argument misses the point. The issue is not whether the current level of production results in a loss of storage, but whether production up to the current FPA -- 50 percent of BAP -- would result in a loss of storage.

As the Court explained in 2019 regarding the Este subarea, when a subarea's FPA exceeds its PSY, there is good reason to reduce the FPA even if the current level of production does not exceed PSY. (Order filed 7-23-2019, p. 2.) Indeed, the 7-23-2019 order expressly notified the "producers in Este that the Court intends to impose a rampdown of 5% per year until FPA is approximately equal to PSY." (*Ibid.*) That reasoning was followed in 2020 and 2021 (orders filed 6-12-2020 and 6-4-2021), and reiterated in 2022, 2023, and 2024 (orders filed 6-3-2022, 6-9-2023, and 7-3-2024).

Mitsubishi and Robertson's do not explain why that reasoning does not apply with equal force this year. Nor do they contend that the FPA in Este is approximately equal to PSY. Indeed, it is not. At 50% of BAP, the FPA is equal to 11,568 AFY. By contrast, the PSY is only 6,582 AFY. Therefore, the fact that the current level of pumping (3,547 AFY) has not resulted in a loss of storage does not lead the Court to conclude that the FPA should remain at 50%.

Those parties also contend that the manner by which the Watermaster decided to recommend a decrease in Este's FPA did not comply with the Judgment. Assuming arguendo that their assertion is correct, the error is harmless.

When the Watermaster takes an action or makes a decision that is thereafter the subject of a motion by some party, or the Court's own motion, the Court's review of that action or decision is de novo. (Judgment, para. 36(d).) The recommendation to adjust FPA is an action or decision of the Watermaster, and is the subject of a motion seeking the Court's review of that action or decision. Therefore, the de novo review specified in paragraph 36(d) applies. (The Court rejects the Watermaster's argument to the contrary.) Thus, even if the final recommendation had been to leave the FPA unchanged, the Court would have decided for itself whether to adopt that recommendation or to continue to comply with its order from 2019. As noted above, the Court sees no reason to abandon the policy it adopted six years ago.

For all of these reasons, Este's FPA is reduced by five percent to 45 percent of BAP.

Free Production Allowance in Baja

The Watermaster recommended that the FPA for Baja be left unchanged at 19.5 percent. Although none of the parties opposed that recommendation, the Court proposed to decrease it to 19.0. Upon objection by Newberry Springs Recreational Lake Association and further explanation by Mr. Wagner, the Watermaster's engineer, the Court adopted the Watermaster's recommendation. In 2026, the Court will be looking for additional evidence that the subarea as a whole has reached equilibrium.

The Watermaster's Request for Approval of Revised PSY

The Watermaster asks the Court to approve PSY calculations. For four of the subareas, it asks that the PSY approved in 2024 be approved again. As to Oeste, it asks that the Court approve a PSY increased from 1,712 to 3,287. Golden State Water Company asks that the hearing on that portion the motion be deferred until the Watermaster more completely complies with the Court's order of 10-23-2024.

The Court declines to defer any ruling on the request for approval. In 2024, two of the five PSY calculations were approved only for the 2024-2025 water year. Deferring the request until 2026 would mean that there would no approved PSY calculations for Baja and Oeste for the 2025-2026 water year.

Instead, the Court will grant the request as to all subareas except Baja. However, those approvals shall be effective only during water year 2025-2026. The Watermaster shall renew its motion in 2026.

Throughout its motion, the Watermaster repeatedly referred to the soon-to-be-completed RMBM, predicting that the new model would materially assist the PSY calculations for all five subareas by providing more reliable estimates than those currently available. (See, e.g., motion at page 43; reply at p. 3.) Given that the PSY calculations will need to be re-done next year -- with or without that additional information -- there is little utility in arguing about the reliability of the current estimates.

The Court recognizes that the completion date for the RMBM is still unknown. Indeed, it appears to be a moving target. At one time, Mr. Wagner had committed that the new model would be completed by the end of 2024. Now, he states that the MWA is currently "finalizing" that model. (Mtn., p. 73.) In its reply, the Watermaster "hopes" that the RMBM will be completed, peer reviewed, and published by the time the Watermaster files its next annual report. (Reply, p. 3; and see the Technical Memorandum dated May 30, 2025, at p. 19.) At the hearing on the motion, Mr. Wagner cautioned that another 18-30 months could pass before the new model is completed, calibrated, and peer-reviewed.

The request to establish a new PSY for Baja is denied because the Watermaster appears to concede that the evidence to justify a new PSY is lacking. In 2024, because of its concerns regarding the analysis by which the proposed PSY for Baja had been estimated, the Court approved a PSY for Baja of 12,749 "for this year only." Thus, the Court was waiting one more year for persuasive evidence justifying an increase in PSY from the 12,189 used in 2023-2024 to the 12,749 proposed in 2024-2025 and proposed again here.

That evidence is still lacking. At page 42 of the motion, Mr. Wagner states: "At present, the PSY for Baja cannot be known with any reasonable degree of certainty." Similarly, he stated at page 43: "The elements of water supply use and disposal for the Baja Subarea are insufficiently known to make a new recommendation for PSY in Baja." Given that the Court approved 12,749 only for one year, the "new recommendation" would be something different from the 12,189 PSY of 2023-2024. If there is insufficient evidence to make a new recommendation, then the Court cannot confidently approve a PSY higher than 12,189. Exhibit 11 (page 197, et seq.), to which Mr. Wagner cites, does not persuade the Court that it is time to increase Baja's PSY. While some of the wells show improvement, water levels in others continue to decline (e.g., pp. 201, 210, 213, 215, 217, 218, 219, 220, 226).

The DF&Ws' Requests

The Court denies the DF&W's request to order the Watermaster to comply with the Judgment. The Watermaster's obligation to comply with the Judgment is self-executing. It does not require a second order. Moreover, It is not clear that the Watermaster has failed to "take into

consideration" the potential harm to public trust resources when making its annual FPA recommendations, as required by Exhibit H to the Judgment.

The Court also denies the DF&W's request to order the Watermaster "to comply with the Department's recommendations regarding the RMBM." That request is vague, because it does not identify the recommendations to which it refers. Moreover, to afford due process to the opposing party, affirmative relief should be sought by noticed motion, not by a request in a response to the opposing party's motion. Thus, the denial is without prejudice to a motion by the Department seeking specific affirmative relief.

Requests for Affirmative Relief by Golden State, Mitsubishi, and Robertson's

As with DF&W's requests for affirmative relief, the requests of Golden State, Mitsubishi, and Robertson's are properly the subject of a separate motion. They are denied without prejudice to such a motion or motions being filed.

Future motions

Hydrologic base period

The Watermaster argued that the base period should be revised to be the period of 2001-2020. However, the motion did not expressly seek approval of that change. Any future motion by the Watermaster seeking approval of that change shall address the following issues:

1. In arguing for the adoption of 2001-2020 as the hydrologic base period, Mr. Wagner states at page 32 of the motion that the proposed base period "is reasonably representative of long-term hydrologic conditions," citing to Exhibit 25 (at page 405). Is that conclusion based solely on the similarity between the average Mojave River flow during 1931-1990 (65,538 AFY) and the flow during 2001-2020 (61,635)? If not, what other factors support the conclusion that the proposed base period is reasonably representative?
2. Mr. Wagner states that in terms of the basin's water supply, both the 1931-1990 and 2001-2020 periods are representative of the long-term averages of the basin because the latter period is "only 6 percent drier" than the prior period. (Mtn., pp. 74 & 76.) Is a 6 percent difference de minimis? If so, how large would the difference need to be before it would be considered significant?

Technical Terminology

Those drafting any future motions in this case should be mindful that your audience has no technical training or expertise in hydrology. Therefore, the drafter should either avoid technical terms or take care to define technical terms that are used in a manner that allows those terms to be readily understood by laypersons.

The instant motion does not always do so. For instance, at page 67 of the motion, Mr. Wagner distinguishes between groundwater production that is "metered" and production that is measured by "flow meters." The difference between them is not clear to this layperson. Similarly, in explaining why the Wild Crossing stream gage was discontinued, the motion at page 72 quotes the USGS to the effect that both that crossing and one at Hodge were discontinued "because of unstable controls and changing stage-discharge relations . . . ." The quoted language means nothing to the Court.

Notice

The Watermaster shall serve copies of this order on all parties by mail forthwith, and shall file a proof of service with the Court within seven days of the date of mailing.

Craig G. Riemer, Retired Judge of the
Riverside Superior Court, sitting by
Assignment of the Chief Justice.

EXHIBIT 2

KBR

OCT 24 2024

SUPERIOR COURT OF CALIFORNIA, COUNTY OF RIVERSIDE

Plaintiff: CITY OF BARSTOW vs Defendant: CITY OF ADELANTO	*FOR COURT USE ONLY* FILED SUPERIOR COURT OF CALIFORNIA COUNTY OF RIVERSIDE OCT 23 2024 A. Alvarado CASE NUMBER: CIV208568

DOCUMENT COVERSHEET

Full Document Title: Order (1) Granting the Motion to Enforce Judgment (2) Establishing a Procedure for Motions to Approve Re-Calculated Production Safe Yield; (3) Posing Questions to be Answered by the Watermaster

(If the document is not officially titled, provide the description of what is being filed.)

Other File Clerk Notes: _____

SUPERIOR COURT OF THE STATE OF CALIFORNIA, COUNTY OF RIVERSIDE

CASE TITLE: City of Barstow v. City of Adelanto CASE NO.: CIV208568 DATE: October 23, 2024	Department 1	

PROCEEDING: Order (1) Granting the Motion of Golden State Water Company to Enforce the Judgment; (2) Establishing a Procedure for Motions to Approve Re-Calculated Production Safe Yield; (3) Posing Questions to Be Answered by the Watermaster in the Next Motion for Adjustments to Free Production Allowance.

MOTION TO ENFORCE JUDGMENT

Golden State Water Company ("Golden State") moved to "enforce" the judgment in this case. Newberry Springs Recreational Lakes Association ("Newberry") supported the motion. The Mojave Water Agency ("Watermaster"), the City of Hesperia, the City of Victorville and the Victorville Water District all opposed the motion.

After the issuance of a tentative decision on October 21, 2024, the matter was heard on October 22, 2024. All parties who chose to speak submitted on the tentative ruling. The matter was taken under submission to allow the Court to prepare a formal order consistent with its tentative ruling.

The Court now rules as follows:

The motion is granted. Specifically, the Watermaster is ordered as follows:

1. To re-calculate the Production Safe Yield ("PSY") for the Centro subarea and for the Alto subarea, including the Transition Zone.

2. In the process of re-evaluating PSY for those two subareas, to re-evaluate both (a) the sufficiency of any factual investigation conducted to quantify the factors to be used in those calculations, and (b) the reliability of any assumptions or estimates that the Watermaster relies upon when empirical data is not available to quantify factors.

3. Thereafter, to draft a report regarding the Watermaster's findings and to include that report in its 31st Annual Report, i.e., the report concerning Water Year 2023-2024.

4. To recommend a plan to improve the collection of hydrologic data that would be relevant to calculations of PSY in the future. In doing so, to consider the recommendations contained in Section 6.0 of the report of Anthony Brown which marked Exhibit 1 to Golden State's motion filed 9-5-24, except that paragraph 4 on page 32 (GSWC 34) is modified to read: "Based on results from the above, Watermaster should determine whether Producers in Alto have met, are currently meeting, and in the future are likely to continue to meet their obligations under the Judgment."

5. To recommend a timeline by which the recommended plan could reasonably be implemented.

6. To include both the plan and the timeline in the Watermaster's 32nd Annual Report, i.e., for Water Year 2024-2025.

Several parties filed objections, sometimes to the arguments raised by other parties, sometimes to the briefs filed by other parties, and sometimes to the evidence submitted by other parties. All those objections are overruled.

Analysis:

Curiously, the notice of motion does not identify what the Watermaster should be ordered to do to achieve the general goal of enforcing the Judgment. Instead, the notice of motion merely refers to the proposed order. The Court interpreted the motion to be seeking the relief described above. At the hearing, Golden State confirmed that the Court's interpretation was correct.

The Judgment requires the Watermaster to "rely upon and use the best available records and data to support the implementation of this Judgment. Where actual records of data are not available, Watermaster shall rely on and use sound scientific and engineering estimates." (Judgment, sec. 24(w). In substance, the motion merely sought to require the Watermaster to revisit his calculations of the Production Safe Yield ("PSY") for Alto and Centro to confirm that the Watermaster is complying with those requirements. Given the limited relief sought by Golden State's motion, the moving party's burden was not to prove that the Watermaster had failed to meet those standards, but only to present evidence sufficient to raise a substantial question as to the extent of the Watermaster's compliance. In short, it was to establish probable cause for further investigation regarding compliance. The evidence offered by Golden State and Newberry met that burden.

All objections to the evidence are overruled because the Court was not making any factual findings. Instead, the evidence was considered only to determining whether there was a substantial question regarding the sufficiency of the Watermaster's factual investigation and the reliability of the Watermaster's estimates and analysis to merit an order directing the Watermaster to revisit those topics. Therefore, the objections were not material to the Court's analysis.

Regarding Paragraph 1 of the Order.

The Upper Mojave River Basin Model is used, *inter alia*, to establish PSY. (Am. Oppo., p. 9.) That model was used to calculate the PSY for Alto subarea, or at least that portion of Alto that is outside the Transition Zone. The Watermaster has committed to revise the model by the end of this year by extending it to include the Transition Zone, the Centro subarea, and the Baja subarea. (Am. Oppo., Am. Decl. of Wagner, Ex. 1, p. 11.) The Court expects, therefore, that the Watermaster would have re-evaluated the PSY for Alto, Centro, and Baja prior to the next annual report and motion to adjust FPA even if the Court had not specifically ordered it to do so.

Regarding Paragraph 2 of the Order.

As noted above, the Watermaster is required to "rely upon and use the best available records and data to support the implementation of this Judgment. Where actual records of data are not available, Watermaster shall rely on and use sound scientific and engineering estimates." (Judgment, sec. 24(w). Accordingly, the Court expects that, whether the Watermaster is expressly ordered to do so or not, the Watermaster re-evaluates those factors as a matter of course whenever it revises PSY. Otherwise, the Court would have no basis for determining that the Watermaster's PSY recommendations were based on the best data reasonably available and the estimates that best reflect current science, as the Judgment requires.

That is not to say that the Watermaster is to engage in all possible factual data collection efforts. The Judgment must be interpreted to impose an obligation only to obtain data that is reasonably available. A determination of reasonability involves the comparison (a) of the cost to obtain those records or to generate that data (b) to the value of the data likely to be obtained or generated.

Regarding Paragraph 3 of the Order.

If potentially relevant data exists or could be generated but the Watermaster has determined that the cost of doing so is unreasonable, the report shall explain the basis for that conclusion.

Regarding Paragraph 4 of the Order.

That request is granted as to hydrologic data relevant to the PSY of Alto and Centro. The Watermaster is already "working on studying the riparian vegetation using satellite-based remote sensing tools to update consumptive use values for Phreatophytes." (Am. Oppo., Am. Decl. of Wagner, Ex. 1, p. 10.) Similarly, the Watermaster said that it will study the possibility of using remote sensing to measure surface flow and the Watermaster is not opposed to using remote sensing technologies to measure consumptive agricultural use. (*Ibid.*) At some unspecified date after February of 2022, the Watermaster installed a new stream flow gage at Hinkley Road, apparently at the urging of Golden State. (*Id.*, p. 11; Am. Oppo., p.1.) The Watermaster may be able to recommend other ways in which the hydrologic data can be enhanced at a reasonable cost. Certainly, nowhere in the Watermaster's opposition does the Watermaster contend that it is impossible to enhance the collection of relevant data at a reasonable cost. Besides, the motion seeks only that Brown's recommendations be considered by the Watermaster; it does not order the Watermaster to adopt each of those recommendations.

PROCEDURE FOR MOTIONS TO APPROVE RE-CALCULATED PSY.

1. As ordered above, the Watermaster is ordered to revise the estimated PSY for Alto (including the Transition Zone) and Centro. In the Court's order filed 7-3-24, the Court denied the Watermaster's request that the Court approve a revised PSY for Oeste. The

Court also limited its approval of the revised PSY for Baja to a single year. Thus, the Court expects a motion for approval of revised PSYs not only for Alto and Centro, but also for Oeste and Baja.

2. Any motion for approval of a revised PSY for Oeste shall address the concerns raised by the Court at pages 2-4 of its 7-3-24 order.

3. Any motion for approval of a revised PSY for Baja shall address the concerns raised by the Court at page 4 of its 7-3-24 order.

4. The motion for approval of revised PSYs shall be filed with the annual motion to adjust Free Production Allowance ("FPA"), with both types of relief being sought in a single motion. The Court waives CRC rule 3.3113(d), limiting the length of memoranda of points and authorities.

5. The memoranda and evidence filed in opposition to a motion shall be subject to the same directions regarding the Watermaster's memoranda and evidence. Thus, stated more broadly, every page of the declarations submitted by any party either in support of or in opposition to a motion, and every page of any evidence authenticated by that declaration, shall be sequentially numbered. All citations in either a memorandum of points and authorities or a declaration to any of that evidence shall include the page number on which that evidence appears.

6. All evidence upon which a party intends to rely in support of its position shall be set forth in detail in declarations or exhibits filed either by that party or some other party. That evidence shall not consist merely of conclusions or opinions. To the contrary, the evidence must be sufficient in both quantity and quality to persuade the Court to reach the same conclusion on its own analysis. To meet that standard, the evidence should be detailed. Moreover, the significance of that evidence— i.e., why that evidence, if believed, supports the party' s position— should be clearly explained. In short, the party's written arguments and evidence should be sufficient, without further evidence or explanation, to persuade the Court of the merit of the party' s contentions.

7. Any expert opinions offered either in support of or in opposition to any motion shall be limited to opinions that (a) are stated to be more likely than not true and (b) are supported by such analysis and evidence to allow a finder of fact to understand the reasons for and the weight of that opinion.

8. At the hearing, any party wishing to visually illustrate for the Court the party' s factual contentions regarding the merits of the motion and the evidence supporting those contentions may do so. That presentation shall be made by counsel, shall be illustrated through a Power Point or similar presentation, and shall be limited to the evidence previously filed in the form of declarations or exhibits. No later than five court days before the hearing, copies of the Power Point slides that a party intends to use shall be shared with every other party that has filed documents supporting or opposing the motion.

9. During the hearing, the Court may ask questions of counsel concerning the parties' respective contentions and the evidence the parties rely upon to support their contentions. If counsel is not able to adequately answer the Court' s question, counsel may call upon a witness to do so through oral testimony. Any such answer should be limited to the evidence previously filed in connection with this action. If the witness needs to refer to other evidence in order to fully answer the Court' s question, the witness shall advise the Court that the evidence goes beyond the written evidentiary record developed for the motion.

10. In the event that extra-record evidence is offered, the Court may or may not permit that evidence to be received. If extra-record evidence is received through a witness' s testimony, the Court may permit cross- examination of that witness, may permit rebuttal witnesses, or may continue the hearing, in the Court's discretion.

11. The motion and any opposition shall clearly distinguish between the FPA of parties to the judgment and the production by nonparties.

12. The Watermaster shall schedule and host an informal conference concerning the combined motions to approve PSY and adjust FPA. At the conference, the Watermaster shall preview the upcoming motion and the evidence supporting it. The purpose of the conference shall be to identify any factual or legal issues that may justify additional attention in the moving papers. The conference shall be conducted prior to the motion being filed. The Watermaster shall give notice by mail to all parties no later than 14 days before the conference. The Court shall attempt to attend, but the conference shall be conducted regardless of whether the Court is in attendance. Notice shall be given to the Court by email to Jennifer.castillo@riverside.courts.ca.gov.

QUESTIONS TO BE ADDRESSED IN THE NEXT MOTION TO ADJUST FPA.

In its next motion for adjustments to FPA, the Watermaster shall, and any other party may, address the following questions:

1. If the motion describes the production of nonparties:

   a. What is the significance of that production to the Court's consideration of proposed changes to the FPA of parties?

   b. Does "Producer" as defined in the judgment (at p. 11) include nonparty pumpers?

   c. Does "Free Production Allowance," as defined in the judgment (at p. 9), include water pumped by nonparty pumpers?

   d. Does the judgment require the Court to consider nonparty production when determining whether, and to what extent, the FPA of the parties to the judgment should be reduced? If not, does it allow the Court to do so?

2. Exhibit G, paragraph 1, refers to "average Annual and minimum Annual Subsurface Flows and/or Base Flows per Year." Does the Judgment set a minimum annual subsurface flow that must be met each year, or only establish the requisite average annual flows?

3. The Watermaster has stated that, except for consumptive uses in the TZ, all the water that flows into the TZ passes the Helendale Fault into the Centro subarea. (Am. Oppo., p. 3.)

a. Is that conclusion true for both surface and subsurface flows?

b. Are there measurements that supports that conclusion?

c. What other evidence supports that conclusion?

4. If one wanted to measure surface flow from the TZ into Centro, could that be done? If so, how? To what extent, if any, does the Watermaster currently do so?

5. The Watermaster has said that the Wild Crossing stream gage was discontinued because it was unreliable. What was the reason for that unreliability?

6. If one wanted to measure subsurface flow from the TZ into Centro, could that be done? If so, how? To what extent, if any, does the Watermaster currently do so?

7. Other than precipitation, does all inflow into Centro come from the TZ?

8. The Judgment requires PSY to be based on "a sequence of years that is representative of the long-term average." In the motion to enforce the judgment, both the Watermaster and Victorville criticized Golden State for cherry-picking a misleadingly short time frame for comparing groundwater levels. Similarly, in its 7-3-24 order, the Court criticized the Watermaster for relying on short timeframes and inconsistent timeframes. Sometimes the Watermaster has cited to the 1931-1990 average, but other times the WM has relied on 20-year or even 5-year averages.

a. Is the 1931-1990 timeframe representative of the climate in the basin today?

b. How long is "long-term?" 20 years? 30 years? 40 years? Longer?

c. Should the Court establish a different base period to be used when adjusting PSY and FPA and when questioning the accuracy of the Watermaster's model or recommendations? If so, when should that period begin and end?

<u>Issues to be addressed only if the party believes it is relevant to the motion</u>:

I. The Watermaster has stated (Am. Oppo., p. 2) that "the Alto Subarea Producers have met their Subarea Obligations . . . ." What are those obligations? In particular:

A. What obligations if any does the Alto subarea as a whole owe to Centro?

B. What obligations if any does the Transition Zone owe to Centro?

C. Is Exhibit G to the Judgment properly interpreted to mean that neither the Alto subarea as a whole nor the Transition Zone in particular have any obligation to provide to Centro a particular average annual or minimum annual subsurface flow? To provide to Centro as particular average annual Base Flow? If so, why is that the most reasonable interpretation?

D. To what extent, if any, can the magnitude of those obligations be modified? In other words, are they set by the judgment for all time, or only initially?

II. Page 7 of the Amended Opposition says that Alto owes 2,000 AFY of subsurface flow to Centro, but in the next sentence says that Alto owes that 2,000 AFY to the TZ. Which is correct?

III. The 2,000 AFY obligation was confirmed in 2006. Is it ever subject to adjustment? If so, how often should it be reevaluated?

SERVICE

Counsel for the Watermaster shall (a) serve copies of this order on all parties by mail forthwith and (b) file a proof of service within seven days of the date of mailing.

Craig G. Riemer, Retired Judge of the Riverside Superior Court, by Assignment of the Chief Justice

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EXHIBIT 3

DECLARATION OF ROBERT C. WAGNER

I, Robert C. Wagner, declare as follows:

I am a licensed Civil Engineer in the State of California and President of the firm of Wagner and Bonsignore, Consulting Civil Engineers in Sacramento, California. I serve in the capacity of Engineer for the Mojave Basin Area Watermaster in performance of its duties. I have personal knowledge of the matters set forth herein and, if called as a witness, I could and would testify competently thereto.

PART ONE

INTRODUCTION

The purpose of this analysis and information is to address the Court's Order dated April 21, 2026 instructing Watermaster to apply the existing hydrologic base period 1931-1990 when calculating the Production Safe Yield (PSY) and adjusting the Free Production Allowance (FPA).

Pursuant to the Court's Oder, Watermaster has evaluated PSY for each subarea based upon the Judgment's initial hydrologic base period (Water Years 1931-1990) and provided its FPA recommendations for Water Year 2026-27. The PSY and FPA recommendations were mailed to the Parties on June 4, 2026. On June 17, 2026, Watermaster conducted a question-and-answer workshop regarding the PSY and FPA recommendations, and on June 24, 2026, Watermaster held a public hearing to receive comments on the PSY and FPA recommendations. At the conclusion of the June 24, 2026 public hearing, the Watermaster's Board of Directors approved the PSY and FPA recommendations detailed in this Declaration and directed Watermaster staff to submit same for the Court's consideration.

Production Safe Yield definition

The Judgment defines Production Safe Yield as "The highest average Annual Amount of water that can be produced from a Subarea: (1) over a sequence of years that is representative of long-term average annual natural water supply to the Subarea net of long-term average annual natural outflow from the Subarea, (2) under given patterns of Production, applied water, return flows and Consumptive Use, and (3) without resulting in a long-term net reduction of groundwater in storage in the Subarea."

For this analysis, the 1931-1990 average annual natural water supply as measured at the Forks is considered to be the "long-term" average annual water supply. The Forks is the confluence of Deep Creek and West Fork of the Mojave River which provides the Basin's main surface water supply. The water balance presented on Table C-1 of the Judgment was based on this 60-year base period (see **Attachment A** in Exhibit 4, pp. 71-72 hereto). Table C-1 was further refined by Webb Associates (Webb 2000) based upon the same 60-year hydrologic base period.

Part (2) of the PSY definition represents the "cultural conditions" within each subarea, reasonably representative of the patterns of "Production, applied water, return flows and Consumptive Use." DWR - Bulletin 84 makes clear that "recent" cultural conditions should be used for this analysis. Accordingly, 1990 cultural conditions were utilized in Table C-1 of the 1996 Judgment; and Water Year 1997-1998 was used as the representative year for recent cultural conditions for Webb's 2000 PSY evaluation (Webb, 2000). For the Water Year 2026-2027 PSY evaluation, I determined that Water Year 2024-25 is representative of recent land uses, production and consumptive uses for the present and near future.

SUMMARY

This declaration is submitted to provide proposed PSY and FPA values for each subarea for Water Year 2026-2027, in accordance with the Court's direction.

For Water Year 2024-25, Watermaster recommended the following FPA values: 53.2 percent of BAP for Alto, 60.0 percent of BAP for Centro, 20.5 percent of BAP for Baja, 50 percent of BAP for Este, and 50 percent of BAP for Oeste. However, the Court rejected these values and set FPA as follows: 50.4 percent of BAP for Alto; 19.5 percent of BAP for Baja; 56 percent of BAP for Centro; 45 percent of BAP for Este; and 45 percent of BAP for Oeste.

In its Order dated August 5, 2025 (Exhibit 1, pp. 15-20 hereto), for Water Year 2025-2026, the Court granted Watermaster's proposal to maintain the same FPA values as follows: 50.4 percent of BAP for Alto; 19.5 percent of BAP for Baja; 56 percent of BAP for Centro; 45 percent of BAP for Este; and 45 percent of BAP for Oeste. The Court also approved for Water Year 2025-2026 only, the following PSY values: 62,005 AFY for Alto; 31,420 AFY for Centro; 6,582 AFY for Este; 3,287 AFY for Oeste; and 12,189 AFY for Baja.

The following table provides the summary of Watermaster's recommendations for Water Year 2026-2027.

Table 1. Subarea Recommendations

Subarea	PSY	2026-27 FPA Recommendation
Alto	63,442	54.5% of BAP
Baja	16,211	19.5% of BAP
Centro	28,473	55.8% of BAP
Este	6,677	40.0% of BAP
Oeste	3,685	51.9% of BAP

These values differ from those approved by the Court for Water Year 2025-2026. The reasons for the differences are: (1) the current PSY values are calculated based upon the 1931-1990 base period average water supply, *which is approximately 6% "wetter"* than the 2001-2020 base period data Watermaster used to calculate its recommended PSY values for Water Years 2024-2025 and 2025-2026; (2) the USGS groundwater model (2001, Stamos) was utilized because it captures both the entire Mojave Basin Area (MBA) and the Court ordered 1931-1990 base period; and (3) recent land uses, production and consumptive uses from Water Year 2024-25 also were utilized, as explained above.

PSY values. For Alto, Centro and Baja, the PSY values are the result of basic arithmetic calculations predicated upon the average water supply during the 1931-1990 base period, together with recent pumping and consumptive use data. Therefore, the aforesaid recommended PSY values for Alto (as noted below, Alto outflow is based on the long term average and adjusted for current consumptive use within the Transition Zone), Centro and Baja are arithmetically determined based upon the net long-term average water supply during the 1931 to 1990 base period, coupled with recent consumptive use data, and are more likely than not true.

As explained below, the recommended PSY values for Este and Oeste are determined based upon a comparison of recent pumping and changes in groundwater storage for a given period of time and, and on that basis, also are more likely than not true.

Increased FPA values for Alto and Oeste. Based upon the aforesaid PSY values, the indicated FPA values for Alto and Oeste are increased, to wit: for Alto from 50.4% to 54.5% of BAP; and for Oeste from 45% to 51.9% of BAP. For Alto, the indicated FPA is the result of dividing the PSY of 63,442 acre-feet by the Base Annual Production of 116,412 acre-feet. For Oeste, the indicated FPA is also the result of dividing the indicated PSY of 3,685 acre-feet by the

Base Annual Production of 7,095 acre-feet. In 2024, Watermaster recommended FPA for Alto of 53.3% and FPA for Oeste of 46.3%. Based upon the calculated PSY values for these subareas (for Alto, total pumping less the deficit; and for Oeste average pumping with no apparent long-term loss in storage), the indicated FPA values for Alto and Oeste are more likely than not true.

Recommendation that Baja FPA remain at 19.5% of BAP. In making its FPA recommendations, Watermaster is required to give "consideration" to the "protection of public trust resources" (Exhibit H, paragraph 2(a)). The California Department of Fish & Wildlife has submitted evidence that public trust resources in the Baja "Camp Cady" area are under particular stress because of a lack of sufficient near surface groundwater at a depth needed to support the riparian vegetation. As a result and taking into consideration the protection of public trust resources, Watermaster recommends continuing FPA for Baja at 19.5% of BAP (even though the water supply data from the 1931-1990 base period coupled with the recent pumping and consumptive use data indicate a PSY value that would otherwise warrant a higher FPA value).

FPA reduction of 5% for Este. For Este, although the data indicates a slightly higher PSY value (6,677 acre-feet), FPA continues to exceed PSY by more than 5% and, based upon paragraph 24 (o) of the Judgment, a 5% reduction of FPA for Este from 45% to 40% of BAP is recommended (i.e., FPA of 9,092 acre-feet [which is 45% of BAP] compared to PSY of 6,677 acre-feet; the difference is 2,415 acre-feet [9,092 acre-feet less 6,677 acre-feet] which, in turn, is greater than 5% of BAP [or 1,010 acre-feet]). Accordingly based upon paragraph 24(o) of the Judgment, Watermaster recommends reducing FPA for Este from 45% to 40% of BAP.

For Centro decrease in both PSY and FPA. For Centro, the data indicates a decrease in PSY (from 31,420 acre-feet to 28,473 acre-feet), and a corresponding reduction in FPA (from 56% to 55.8% of BAP). Based upon the indicated PSY value (based upon average annual water

supply to Centro and recent pumping and consumptive use data), the recommended values for PSY of 28,473 acre-feet and FPA of 55.8% for Centro are more likely than not true. The indicated PSY of 28,473 acre-feet annually is the result of Centro's total pumping (15,884 acre-feet) plus a calculated surplus (9,763 acre-feet), plus a portion of surplus corresponding to return flows percentage (28.95% of surplus is 2,826 acre-feet). The indicated FPA (55.8% of BAP) is calculated as follows: indicated PSY of 28,473 acre-feet divided by the Base Annual Production of 51,030 acre-feet. Based upon this analysis, the recommended PSY and FPA values for Centro also are more likely than not true.

Groundwater model by USGS Stamos et al. (2001). To evaluate the PSY of each subarea of the Mojave Basin Area, Watermaster used the estimates of water supply and subsurface flows between subareas from the USGS Water Resources Investigation Report 01-4002, "Simulation of Ground-Water Flow in the Mojave River Basin, California" (Stamos et al. 2001). The USGS model by Stamos et al. (2001) is the only analytical tool that captures both the entire Mojave Basin Area (MBA) and the Court ordered 1931-1990 base period. Additionally, the USGS model will allow for a model-to-model comparison of the elements of water supply, use, and disposal when MWA finalizes the Regional Mojave Basin Model. Thus, because the USGS 2001 model covers the 1931-1990 time period and the complete Mojave Basin Area, and can be compared to the Regional Mojave Basin Model (when finished), Watermaster has prepared a hydrologic inventory based thereon for each subarea in the format consistent with Table C-1. This hydrologic inventory is traditionally included in the Watermaster Annual Report and commonly referred to as Table 5-1.

Watermaster's analysis of changed conditions since 1990. Watermaster has adjusted some inputs to account for cultural changes since 1990 affecting water supply. Most of the

adjustments relate to changes in consumptive use that have occurred since 1990. The conceptual model is predicated on the net 1931-1990 average annual water supply (adjusted for current cultural conditions) as applied to the 2024-25 cultural conditions. This is the same conceptual model that was used to prepare Table C-1 of the Judgment, was later adopted by Webb (2000), and has been consistently used by Watermaster in previous PSY evaluations.

Our analysis for the Este and Oeste subareas deviates from the foregoing in that the inflow estimates by previous researchers (see Table C-1, Table 5-1) and values for inflow from the USGS 2001 model, do not represent the observed water levels for the last 30 years in Este, and the past 16 years in Oeste. For these two subareas, I interpret the actual water level data as indicating little to no change in storage over time, leading to the logical conclusion that the average pumping amount over that same period of time is the better representation, and more likely than not true as to the cultural conditions in, and the PSY values for, Este and Oeste. My recommendation to set PSY and FPA in Este and Oeste follows this logic. This is discussed in more detail hereinafter.

Changes in Water Levels as a Proxy to Change in Storage. For the PSY and FPA recommendations, Watermaster uses the extensive data of groundwater-level measurements (408 wells are actively being monitored by MWA) as the principal source of information about the hydrologic components in Baja, Este and Oeste Subareas and their effect on change in storage over time. The California Department of Water Resources (DWR) publication titled "Best Management Practices for the Sustainable Management of Groundwater Water Budget BMP" from December of 2016 states that:

The change in groundwater in storage is the total change in storage between seasonal high conditions, which typically occurs in the spring. It is recommended that the change in storage estimates be based on observed changes in groundwater levels within the basin. However,

change in groundwater storage may also be calculated as the difference between annual inflows and outflows according to the water budget equation in Section 3, where all inflows and outflows can be reliably measured or estimated.

Following DWR's recommendations, Watermaster continues to rely on the measured groundwater levels to evaluate the changes in storage for the Baja, Este and Oeste Subareas. This is so, because inflows and outflows for these subareas are subject to a high level of uncertainty and cannot be "reliably measured or estimated". However, once the Regional Mojave Basin Model is completed and calibrated, it will inform water budget components and change in storage.

Production Safe Yield. As noted above, the definition of PSY in the Judgment compares net natural long-term average supply to near term consumptive uses. In summary, Table C-1 of the Judgment provides that PSY = Total Production + Surplus / (Deficit). Stated another way, PSY = Total Production + Change in Storage.

Table 5-1 in **Attachment B** of Exhibit 4 (pp. 71-72 hereto) provides the results of the PSY calculations for each of the five subareas and, for the reasons explained herein and in Attachment B are more likely than not true; footnotes in Table 5-1 provide the source of data for each element; values shown in italics and purple are explained in the section for the respective subarea.

PRODUCTION AND CONSUMPTIVE USES

Groundwater Production and Consumptive Uses from Production. Watermaster considers the pumping and consumptive use values for Water Year 2024-25 representative for future planning purposes. For this reason, consumptive uses and production values used in the PSY calculations of Table 5-1 are based on Water Year 2024-25, with the understanding that recent cultural conditions are likely to repeat in the future. **Table 2** of Exhibit 4 (pp. 55-56 hereto) shows the total production, including production by Minimal Producers, and consumptive uses

for each subarea from Water Years 2020 to 2025. As previously noted, the period for evaluating pumping in Este and Oeste is explained under those subarea sections.

Consumptive Use by Phreatophytes. Consumptive use values by phreatophytes are being evaluated by the California Department of Fish and Wildlife. For this analysis, Watermaster reported the annual amounts of riparian water use provided by the U. S. Geological Survey Water-Resources Investigations Report 96-4241 titled "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California". The consumptive use values by phreatophytes indicated therein and based upon the USGS analysis, are more likely than not true.

PSY DETERMINATION FOR EACH SUBAREA

Este Subarea. Table 5-1 (**Attachment B** of Exhibit 4, pp. 71-72 hereto) provides the estimates of water supply, pumping, outflows and consumptive use for the Este Subarea. The water budget calculation shows a deficit of 1,439 AFY. Historical water levels are shown on the MWA Hydrograph Map for 2026 (see **Attachment D** of Exhibit 4, pp. 75-76 hereto). However, the observation of historical water levels since the mid-1990s indicates that change in storage within the Este Subarea is nearly zero. In general, the historical water levels shown on the hydrograph are relatively stable.

A review of the well hydrographs indicates that water levels throughout Lucerne Valley generally remain unchanged in recent years and, within Fifteenmile Valley, water levels are either relatively stable (see wells 04N01W09P06, 04N01W10R01), or are declining slowly (see wells 04N01W07R01, 04N01W18Q01, 04N02W09Q01). Based on these observations, net water supply and pumping are fairly closely balanced. For these reasons, Watermaster does not recommend PSY and FPA values based upon the water budget calculation (Table 5-1) which indicates a deficit.

An example of the relationship between water levels and production was evaluated by Watermaster at the Chuck Bell property in Este (Exhibit 4, p. 62 hereto). The Chuck Bell wells are indicative of the water level behavior we see in Este where the water levels have remained stable during the last 30 years.

Historical pumping in Este is shown in Exhibit 4, at p. 63 hereto. Total production in Este Subarea has been in continuous decline since about 1996. In Water Year 2024-25, total pumping was 4,334 acre-feet. The average pumping during the period of record during which water levels have remained relatively constant (1996-2025) is 6,677 AFY. As noted, PSY can be defined as total pumping plus change in storage: PSY = Pumping + Change in Storage. Because water levels have remained relatively stable for several years, it is reasonable to conclude the change in storage is near zero. Therefore, Watermaster recommends Este PSY of 6,677 acre-feet (total pumping plus change in storage).

Oeste Subarea. The PSY calculations (Table 5-1 in **Attachment B** of Exhibit 4, pp. 71-72 hereto) for Oeste Subarea show a deficit of negative 841 acre-feet. However, review of well hydrographs prepared annually by MWA (see **Attachment E** of Exhibit 4, pp. 77-78 hereto) and groundwater elevation maps prepared by USGS from 1996 to 2016 indicate that groundwater levels in the Oeste Subarea generally range widely, from about 500 to 600 feet below ground surface in the Phelan-Piñon Hills area in the more southerly part of the subarea, to about 100 to 300 feet in the vicinity of El Mirage and El Mirage Dry Lake. Water levels in the vicinity of a perched aquifer zone near Mirage Dry Lake identified by USGS are generally shallower than surrounding areas. The USGS Regional Water Table Maps spanning the period from 1996 to 2016 show a groundwater depression, likely due to pumping, at the southern margin of El Mirage Dry

Lake. However, monitoring by MWA indicates that groundwater levels are generally rising within the pumping depression.

Interpreting water-level trends in many of the wells is problematic, as levels are likely affected by pumping and can vary widely from year to year. This is the case for the wells in the Phelan-Piñon Hills area (05N07W31J03, 04N07W33J04, and 05N07W24D03). Further north in the area of El Mirage, water levels in the wells that are not influenced by pumping show generally little change or stability over time (06N07W17K01, 06N07W20D01, 06N07W26N02, and 06N06W18P03). And a few wells show increase in their water levels since around 2010 by about 70 feet (well 06N07W23C01-C03), and by about 30 feet (well 06N07W26C01). Water level changes of this magnitude are unlikely to occur without sufficient recharge to the subarea. While the actual amount of recharge may not be known with specificity, the overall water level stability over the last sixteen years indicates the change in storage is near zero.

Water levels in wells can decline for reasons other than a subarea wide, long term supply shortfall (overdraft). Groundwater levels are frequently affected by nearby production wells. A localized cone of depression may develop around pumping centers while groundwater levels elsewhere in the subarea remain stable. This is why some of the hydrographs are denoted as being possibly influenced by local pumping to inform the viewer that the variability in the water level may be due to local influence, not long term declines. Therefore, the fact that a few wells indicate water level decline does not (a) undermine the finding based on other data that relative stability has been achieved in a subarea, or (b) indicate subarea-wide loss of storage.

Table 5-1 (**Attachment B** of Exhibit 4, pp. 71-72 hereto) shows the total water supply of 2,477 AFY. Based on the general trends in water levels, and the continued decline in groundwater production, the PSY for Oeste is estimated to be approximately equal to the pumping (PSY =

Total Pumping + Change in Storage). Historical pumping in Oeste is shown on Figure 4 of Exhibit 4, p. 65 hereto. Total pumping has been in decline during recent years. The average total production for the period 2010 to 2025 is 3,685 AFY. Table 5-1 shows a deficit of negative 841 AFY, which is in conflict with the overall observed behavior of the water levels in Oeste. This is likely due to the uncertainty of the estimates of the ungaged inflows and outflows. Given the land use and pumping have changed noticeably during recent years, and the uncertainty as to the estimates of ungaged inflows and outflows, Watermaster recommends basing PSY for Oeste on the average total pumping of 3,685 acre-feet for the period 2010-2025, consistent with the observations that change in storage is near zero.

Alto Subarea. For Alto Subarea, the indicated PSY of 63,442 acre-feet annually is the result of Alto's average annual water supply of 78,986 acre-feet, less consumptive uses and outflow of 91,873 acre-feet, resulting in a projected annual deficit of negative 12,887 (Table 5-1 in **Attachment B** of Exhibit 4, pp. 71-72 hereto). Total pumping during Water Year 2024-25 was 76,329 acre-feet. PSY = Pumping + Surplus/(Deficit). Therefore, PSY for Alto is total pumping (76,329 acre-feet) less the deficit (12,887 acre-feet) resulting in PSY of 63,442 acre-feet.

Centro Subarea. For Centro Subarea, the water balance calculation shows a surplus of 9,763 acre-feet. The surplus value is the average annual water supply of 41,917 acre-feet minus consumptive uses and outflow of 32,154 acre-feet (Table 5-1 in **Attachment B** of Exhibit 4, pp. 71-72 hereto). The PSY is calculated as the sum of total pumping (15,884 acre-feet) and the indicated surplus (9,763 acre-feet), or a total of 25,647 acre-feet. However, we note that if the surplus was pumped and water use was similar to the current patterns of use, a portion of the surplus (equal to 28.9% which is the return flow percentage) increases the PSY for Centro to 28,473 acre-feet.

Baja Subarea. Table 5-1 (**Attachment B** of Exhibit 4, pp. 71-72 hereto) indicates a surplus of 4,501 AFY based on the 1931-1990 average water supply and outflow, and consumptive uses for the Water Year 2024-25 which is representative of future land uses and pumping in the Baja Subarea. Consumptive uses by riparian vegetation is consistent with the estimates by Lines and Bilhorn (1996) of 2,000 AFY as explained in the Phreatophytes section above.

The calculation of PSY for Baja is 14,982 AFY (total pumping plus surplus). If the surplus was pumped and water use was similar to the current patterns of use, a portion of the surplus (equal to 27.3% which is the return flow percentage) increases the PSY to 16,211 AFY.

Historical water production and irrigated acreages in Baja Subarea are shown in **Figure 5** of Exhibit 4, p. 67 hereto. Total pumping in Baja has been declining since before entry of Judgment (1996), decreasing from approximately 50,000 acre-feet in 1996 to 10,481 acre-feet in Water Year 2024-25 —a reduction of roughly 79%. Since 2016, pumping has decreased by approximately 65%. The total average pumping during the last five years is 12,090 AFY and during the last seven years is 14,962 AFY and during the last 10 years is 18,566 acre-feet. The average pumping during the last seven years corresponds roughly to water level inflection from declining to stabilizing and aligns with our water balance calculation of PSY of 16,122 acre-feet.

The impact of this reduction is evident in the water level hydrographs (see **Attachment F** of Exhibit 4, pp. 79-80 hereto), which depict groundwater level changes across Baja over time. For several decades, most wells have exhibited a long-term downward trend, indicating depletion of groundwater storage. However, consistent with the substantial decline in pumping over the past 10 to 12 years—and the overall reduction over the past 30 years—water levels in some wells are stabilizing, pointing to a reversal of the long-time decline.

In certain wells, water levels have begun to recover, while others continue to decline. Wells showing stabilization or recovery are generally located in areas where pumping has significantly decreased in recent years. Water level hydrographs are attached for review (see **Attachment F** of Exhibit 4, pp. 79-80 hereto).

If water levels in Baja continue to behave as they have in recent years, and pumping does not increase above recent levels, PSY for Baja is likely equal to or slightly greater than the average pumping during the recent years (14,962 AFY for the Water Years 2018-19 through 2024-25). However, based on the Table 5-1 calculation, current land uses, and the 60-year average water supply from 1931-1990, the indicated PSY is 16,211 acre-feet.

The Department of Fish and Wildlife has indicated that the riparian habitat area shown on exhibit H-1 near Camp Cady is stressed, and water levels remain depressed. Exhibit H, paragraph 2.a of the Judgment states "In considering whether to increase or decrease the Free Production Allowance in a Subarea, Watermaster shall, among other factors, take into consideration for the areas shown on Figure H-1 the Consumptive Use of water by riparian habitat, the protection of public trust resources, including the species listed in Table H-1 and the riparian habitat areas shown on Figure H-1, and whether an increase would be detrimental to the protection of public trust resources."

Following the direction in Exhibit H-1, paragraph 2a, to consider whether an increase in PSY and FPA "would be detrimental to the protection of public trust resources" and, particularly, the challenges experienced in attempting to protect public trust resources in the Camp Cady area, Watermaster recommends the Baja Subarea FPA remain unchanged (although the indicated PSY for the Baja Subarea is 16,211 acre feet).

PART TWO

PLAN FOR IMPROVING COLLECTION OF HYDROLOGIC DATA

Watermaster's plan to improve collection of hydrologic data includes the following: [a] following completion and calibration of the Regional groundwater modeling, study and utilize its resulting data and information (completion date is unknown, total expenditure expected to be approximately $2 million); [b] continuing ongoing analysis of the extensive network of monitoring wells (the Mojave Water Agency monitors 408 wells located within the Basin boundaries and 214 of those wells have transducers with continuous recorders) with the approximate cost of $800,000.00 for MWA to implement this program of regularly monitoring water levels in more than 400 wells, including the cost for support from USGS (the cost for installing a new monitoring well to enhance this extensive network ranges from $150,000.00 to $1,000,000.00 depending on the depth and complexity of the well; [c] continuing ongoing study of riparian vegetation using satellite-based remote sensing tools to update consumptive use values for phreatophytes; [d] developing and implementing by 12-31-2027 a program to identify, monitor and quantify production by Minimal Producers; and [e] identification of any data gaps, and providing a strategy to fill the remaining data gaps as described below; [f] MWA is currently investigating recharge from ephemeral streams, expected to be completed by May of 2027, at an approximate cost of $800,000.00, plus ongoing expenses as yet to be determined; and [g] geophysical investigation and collection of data for evaluation of basin hydrogeology, MWA has expended about $500,000.00 since 2023 on geophysical investigations, to be completed in June of 2028.

Data gaps such as exist for supply elements like mountain front recharge, un-gaged inflow, ephemeral stream contributions are complicated and difficult to evaluate. The USGS 2001 model

makes estimates of these elements; the RMBM will also make such estimates. MWA has investigated ephemeral stream contributions with actual measurements. Water level data monitoring is already extensive and can be expanded, although the cost of doing so is high. MWA has taken on the financial and staffing burden of providing an ongoing program of water level collection and monitoring well installation, however future efforts may be borne by the Watermaster parties. There is no immediate time frame specified by MWA or any of the parties to expand the existing program for monitoring well data collection. With respect to stream gages, particularly at Barstow, Watermaster will consider in its coming budget cycle a request that USGS investigate and recommend improvements to enhance data collection, and reliability of reported values. Direct measurements have been made weekly at Lower Narrows for approximately 30 years, and twice monthly near the Forks. These measurements are not likely to be improved; however, we can request that USGS provide a cost to review its data and measurement methodology.

Regarding GSWC's suggestion that Upstream Tech's AI modeling should also be utilized, Watermaster acknowledges that remote sensing techniques are available for estimating surface water flow in desert environments. However, there are limitations in the ability of remote sensing to accurately determine the quantity of river flows, particularly in the environment existing at the Helendale Fault, compounded with the relative infrequency of significant storm events resulting in storm flow at the HF. Remote sensing techniques still need to be field verified, and require existing data such as the USGS stream gage at Lower Narrows for calibration and the more recently installed gage downstream at Hodge. Further, there is no obligation under the judgment to measure surface flow at HF. Watermaster also notes that:

- Upstream Tech's AI product for estimating water flow through the Helendale Fault is another model – not a direct measurement—similarly, the RMBM model being developed at considerable expense by the Mojave Water Agency will produce a modeled outflow at HF.
- Watermaster considered Upstream Tech's presentation, "but was not persuaded its modeling services would be useful at this time."
- Watermaster suggests that if GSWC continues to advocate for the Upstream Tech's additional modeling and believes it would be worth the additional cost involved, GSWC should fund and conduct the modeling itself and then share the results with Watermaster. This would be consistent with the "beneficiary pays" principle of local government fees and assessments.
- Watermaster's budget funded by assessments is limited. Among other significant costs incurred by the Mojave Water Agency directly related to Watermaster's management of the Basin, Watermaster also relies on the Mojave Water Agency for the costly RMBM modeling currently being developed, which can be used to provide estimates of groundwater flow between the Transition Zone and Centro, estimates of groundwater storage over time, etc.

Watermaster believes the data and information that will be derived from the RMBM, together with other information available to and known by the Watermaster, will be adequate for Watermaster's future recommendations and reports to the Court. Watermaster also believes the additional hydrologic data and information that will be provided by the RMBM will be superior to that available through Upstream Tech's AI modeling and, therefore, at this time and under

these circumstances, the additional cost of the Upstream Tech modeling is not justified or warranted.

WHETHER ALTO SUBAREA OBLIGATION SATISFIED

The calculations shown in Table 4-3 from the Thirty-Second Annual Report of the Mojave Basin Area Watermaster demonstrate that Alto Producers have met their subarea obligation for the past ten years. Table 4-2 in each annual report has the calculation of the Makeup Obligation that is required by the Judgment for that year. The Subarea Obligation is 23,000 acre-feet annually to the Transition Zone. There is no other requirement in the Judgment for satisfying the Makeup Obligation. Consequently, based on the calculations contained in Table 4-2 and Table 4-3 of each annual report of the Watermaster, the Alto Subarea Producers have met, are currently meeting and will continue to meet their subarea obligations in the future under the Judgment (Exhibit 6, pp. 199-201 hereto).

In 2025, Watermaster conducted an analysis of the groundwater levels in the Transition Zone and in the Centro Subarea near the Helendale Fault. The average depth to water from the "pre-overdraft" conditions (1930-1950) was 15.56 feet, which is virtually the same as the average depth to water of 15.57 feet after implementation of the Judgment (1996-2024). (Exhibit 7, pp. 202-203 hereto.)

In 2025, the Mojave Water Agency also performed a Mann-Kendall (MK) statistical test to establish groundwater level trends for all wells located in the TZ and to determine whether there is a trend of water levels over time. For the shallow wells in the TZ, about 70% (during 1996-2004) to 80% (during 1990-2024) show either a rise, or no change in groundwater levels (Exhibit 8, pp. 204-206 hereto.) As indicated on Exhibit 8, of the 40 wells analyzed 33 wells had trends that were significant at the 95% confidence level (p value < 0.05). Of these, 29 showed an

upward water level trend. The number of wells in the categories Very Strong, Strong, Moderate, Weak, or Negligible were respectively 5, 5, 16, 3, 0. Only 4 wells (10%) show moderate to strong downward trend for water levels. As noted previously, a few declining wells do not invalidate the conclusion of subarea-wide stability. The MK test results confirm Watermaster's prior conclusion that the Alto producers have met, are continuing to meet, and are likely to continue to meet their Subarea Obligation to the Transition Zone.

REASONS FOR WATER LEVEL DECLINE IN GOLDEN STATE WELLS

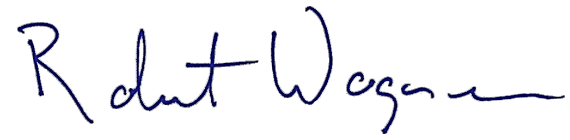
The most likely and fairly obvious reasons for the water level decline observed in the production wells operated by Golden State Water Company ("GSWC") in Centro are: (a) significantly below average water supply to the Basin during the drought conditions experienced from 2012 to 2022 (i.e., an average supply of only 27,614 AFY or about 40-percent of the 68,635 AFY long-term average supply from 1931-2025); (b) concentrated pumping in the relatively small area within Centro where GSWC's production wells are located (i.e., almost 80% of all groundwater production in Centro occurs within the area of concentrating pumping where GSWC's wells are located [between the Hodge and Barstow gages], Exhibit 5, pp. 190-194 hereto); (c) water level stability in the Transition Zone indicates no unaccounted water losses in the Transition Zone; and (d) monitoring wells in Centro located near the Helendale Fault and upstream of GSWC's well sites show relatively stable water levels (Exhibit 9, pp. 207-213 hereto).

CONSIDERATION OF MR. BROWN'S RECOMMENDATIONS

In compliance with the Court's Order to include consideration of Mr. Brown's recommendations, Watermaster has considered Mr. Brown's recommendations in Section 6.0 of his report. Watermaster's conclusions and findings regarding each of the recommendations made

in Section 6.0 and in subsequent sections of Mr. Brown's report -- including his recommendations regarding (a) Consumptive Use by Agriculture in Alto, the Transition Zone, and Centro [which are reliably determined], (b) Consumptive use by phreatophytes for Alto, the TZ, and Centro, (c) Subsurface flow between Alto and the TZ and thence to Centro, (d) Surface water flows between the TZ and Centro, and (d) Storage losses in the TZ -- and Watermaster's considerations thereof are detailed in the Thirty-Second Annual Report. They also are set forth in Exhibit 5 attached hereto, at pages 159-170, and are incorporated herein by this reference.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, and more likely than not true, and is executed in Sacramento, California on July 6, 2026.



ROBERT C. WAGNER P.E.

EXHIBIT 4

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Consulting Civil Engineers, A Corporation

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TECHNICAL MEMORANDUM

To: Mojave Basin Area Watermaster

From: Robert C. Wagner, P.E. Watermaster Engineer
A. Leonardo Urrego-Vallowe, P.E. Project Engineer

Date: June 5, 2026

Re: **Production Safe Yield Update and Recommendation for Free Production Allowance for Water Year 2026-27**

Introduction

Pursuant to the Court's Order dated April 21, 2026, Watermaster evaluated the Production Safe Yield (PSY) based upon the Judgment's initial hydrologic base period, for Water Years 1931-1990. The water balance presented on Table C-1 of Judgment, was based on this 60-year base period (see **Attachment A**); Table C-1 was further refined by Webb Associates (Webb 2000); pursuant to the requirements of the Judgment, Webb (2000) adopted the same 60-year hydrologic base period.

Updating PSY involves both evaluation of the elements of water supply that existed for the 1931-1990 period and the consumptive uses and changes that occurred after 1990, and an estimate of the near future land use conditions. As noted in Table C-1, the near future land use conditions (current cultural conditions) were represented by the conditions of 1990. For the PSY evaluation by Webb (2000), it was determined that Water Year 1997-98 was the representative year for cultural conditions. For this evaluation, Watermaster is proposing that Water Year 2024-25 is the representative land use condition for the near future. Changes in land use that occurred since 1990 were documented by Watermaster and submitted to the Court on November 12, 2025 and available via the following link:
https://www.mojavewater.org/wp-content/uploads/2025/11/20251112_WM_Engineer_Reasons_2001-2020_Base_Period.pdf

The Upper Mojave Basin Model (UMBM) is not sufficient for evaluating the PSY for the period 1931-1990, as it was developed for the period 1951-2020 and thus does not capture the full base period. Further, the UMBM did not include a complete evaluation of the Transition Zone, which is part of the Alto Subarea, and therefore is geographically incomplete. USGS Water

Resources Investigation Report 01-4002, "Simulation of Ground-Water Flow in the Mojave River Basin, California" (Stamos et al. 2001) captures both the entire Mojave Basin Area (MBA) and the Court ordered 1931-1990 base period. Stamos et al. (2001) will allow for a model-to-model comparison of the elements of water supply, use, and disposal when MWA finalizes the Regional Mojave Basin Model. Thus, because the Stamos et al. (2001) model covers the 1931-1990 time period, and the MBA entirely, and can be compared to the Regional Mojave Basin Model, when finished, we have prepared a hydrologic inventory for each subarea in the format consistent with the Table C-1 and using the Stamos et al. (2001) model. This hydrologic inventory is traditionally included in the Watermaster Annual Report and commonly referred to as Table 5-1.

Watermaster has adjusted some inputs to account for cultural changes since 1990 that have affected water supply. Most of the adjustments relate to changes in consumptive use that have occurred since 1990. The conceptual model assumes that 1931-1990 water supply conditions, apply to the 2024-25 cultural conditions as if those conditions existed over the entire 60-year hydrologic base period. This is the same conceptual model that was used to prepare Table C-1, and adopted by Webb (2000), and consistently used by Watermaster in previous PSY evaluations.

Our analysis for the Este and Oeste subareas deviates from the foregoing in that the inflow estimates by previous researchers (see Table C-1, Table 5-1) and values for inflow from the Stamos et al. (2001) model, do not represent the water level observations for the last 30 years in Este, and past 16 years in Oeste. For these two subareas, we interpret the water level data as indicating little to no change in storage over time leading to conclude that the average pumping amount over that period of time is the better representation of conditions in Este and Oeste. Our recommendation to set PSY and FPA in Este and Oeste follows this logic. This is discussed in more detail hereinafter.

This memorandum describes the methods for updating the PSY values for each of the five subareas consistent with the direction from the Court on April 20, 2026. The PSY, calculated FPA and proposed FPA for 2026-27 are provided in Table 1.

Table 1. Updated Production Safe Yield and Proposed Free Production Allowance 2026-27

	Water Year 2025-26			Water Year 2026-27			
Subarea	**Base Annual Production**	**Current PSY**	**Current FPA**	**Indicated PSY**	**Indicated FPA**	**Proposed PSY**	**Proposed FPA**
Alto	116,412	62,005	50.4%	63,442	54.5%	63,442	54.5%
Baja	66,157	12,189	19.5%	16,211	24.5%	16,211	19.5%
Centro	51,030	31,420	56%	28,473	55.8%	28,473	55.8%
Este	20,205	6,582	45%	***6,677***	***33.0%***	6,677	40%
Oeste	7,095	3,287	45%	***3,685***	***51.9%***	3,685	51.9%

Table 5-1 from the Watermaster Annual Report is included as **Attachment B** to this memorandum and provides the updated values of the PSY analysis for each subarea. In general, elements of supply such as flow between subareas, tributary inflow, mountain front recharge, deep

percolation of precipitation were obtained from the USGS model report by Stamos et al. (2001). Watermaster evaluated the production and consumptive uses during recent years and determined that Water Year 2024-25 represents current and near future cultural conditions, except for Este and Oeste, as explained in those sections. Outflows and imports were also evaluated by Watermaster and were reported based on the best available information, while considering the 1931-1990 base period constraint, and changed conditions that affect water supply, use and disposal.

Production Safe Yield

The definition of PSY in the Judgment compares long-term average supply to near term consumptive uses. Table 5-1 in **Attachment B** provides the results of the PSY calculations for each of the five subareas; footnotes in Table 5-1 provide the source of data for each element; values shown in italics and purple are explained in the section for the respective subarea.

Total Groundwater Production and Consumptive Uses

Watermaster considers the pumping and consumptive use values for Water Year 2024-25 representative for future planning. For this reason, consumptive uses and production values used in the PSY calculations of Table 5-1 are based on Water Year 2024-25, under the assumption that the water supply during the Water Years 1931 to 1990 and current cultural conditions would repeat themselves in the future. **Table 2** shows the total production, including production by Minimal Producers, and consumptive uses for each subarea from Water Years 2020 to 2025. As previously noted, the period for evaluating pumping in Este and Oeste is explained under those subarea sections.

Table 2. Historical Production and Consumptive Uses

Production

Subarea	2020	2021	2022	2023	2024	2025	Average
Alto	65,094	69,764	67,105	62,442	65,662	66,640	66,118
Transition Zone	12,618	11,809	10,351	10,039	9,872	9,689	10,730
Alto Total	77,712	81,573	77,456	72,481	75,534	76,329	76,847
Baja	20,894	15,095	12,749	11,419	10,707	10,481	13,558
Centro	18,309	19,685	16,995	16,393	16,646	15,884	17,319
Este	***5,181***	***5,258***	***5,068***	***4,501***	***4,758***	***4,334***	***4,850***
Oeste	***3,677***	***3,798***	***3,131***	***2,845***	***2,871***	***2,939***	***3,210***
Total	125,773	125,409	115,399	107,639	110,516	109,967	115,784

Note:
Production values include minimal producers.

Consumptive Use

Subarea	2020	2021	2022	2023	2024	2025	Average
Alto	33,489	37,871	33,745	31,927	35,246	35,781	34,676
Transition Zone	8,052	7,301	7,375	6,606	6,277	5,455	6,844
Alto Total	41,541	45,172	41,120	38,533	41,523	41,236	41,521
Baja	20,144	13,589	12,025	10,834	8,485	7,619	12,116
Centro	14,044	14,035	12,748	12,279	11,597	11,286	12,665
Este	***4,116***	***4,377***	***4,388***	***3,812***	***3,646***	***3,479***	***3,970***
Oeste	***2,528***	***2,574***	***2,046***	***1,869***	***2,086***	***2,279***	***2,230***
Total	82,372	79,746	72,328	67,326	67,337	65,900	72,502

Note:
Consumptive Use values include minimal producers.

Water Supply to Alto Subarea

Surface water inflow to the Basin Area is mostly from the Mojave River flow measured by the USGS gage stations at West Fork Mojave River near Hesperia, CA and Deep Creek near Hesperia, CA. The average gaged flow at the Forks during the base period 1931-1990 is 65,538 acre-feet per year (AFY). Additional elements of water supply to Alto Subarea are ungaged inflow including mountain front recharge, deep percolation of precipitation, and subsurface inflow from Oeste and Este subareas. Stamos et al. (2001) provides an estimate of mountain front recharge to the Alto Subarea; the term mountain front recharge includes ungaged surface water and deep percolation of precipitation. According to Stamos et al. (2001), the 1931-1990 average mountain front recharge to Alto is 7,763 AFY. Stamos et al. (2001) further describes tributary inflows between the Forks and Lower Narrows to be about 2,400 AFY between 1931-1994. This has been adjusted to the base period 1931-1990 to be 2,280 AFY.

Water Supply to Este and Oeste Subareas

Stamos et al. (2001) provides the following estimates for the 1931-1990 average ungaged surface flow: 1,035 AFY to Este and 1,941 AFY to Oeste. There is no measured surface water inflow or measured outflow from the Este and Oeste Subareas. As described later herein, these estimates are not supported by observations of water levels in those subareas.

Water Supply to Centro Subarea

Surface water flow from Alto to Centro is reported as the model estimated surface flow near Helendale (at Vista Road) as extracted from the USGS model by Stamos et al. (2001). The value, 32,972 AFY, represents the surface flow at Helendale Fault between 1931-1990, under the conditions that existed during that time period. Historical pumping in the Transition Zone (TZ) is provided in **Figure 1**, and shows that pumping has been in decline since at least the mid-1990's. Notably, total production and consumptive uses in the TZ have been decreasing over time.

Watermaster evaluated water levels in the TZ since 1990 and since entry of Judgment in January 1996. Our recent analysis demonstrates that water levels in the TZ are trending upwards or are stable. This evaluation can be found in the Watermaster's Technical Memorandum "Responses to Court's questions to be addressed in the next motion to adjust FPA", available via the following link:

https://www.mojavewater.org/wp-content/uploads/2025/06/TM_Addressing_Court_Questions_20250530.pdf

The evaluation demonstrated the stability of water levels supporting the conclusion that change in storage over time is nearly zero.

For the Water Year 2024-25, we estimated the consumptive use in the TZ to be 5,455 acre-feet and use this value to approximate the consumptive uses in the TZ for the near future. As the Stamos model includes consumptive uses from 1931-1990, which were on average much higher (12,367 acre-feet) than current and near future estimates (5,455 acre-feet), we can adjust the model flow at Vista Road (near Helendale) according to the change (difference) in consumptive use as estimated by Stamos et al. (2001) and as estimated by Watermaster over different time periods. Since water levels in the TZ are stable, and have been for many years, the change in flow through the TZ can be approximated by the change in the consumptive use. Thus, we can expect that future surface flow, under current land use conditions, will increase accordingly. Based on the foregoing, Watermaster's calculation shows that the surface outflow from Alto to Centro near Helendale is the average 1931-1990 modeled flow (32,972 acre-feet) plus the change in consumptive uses within the TZ (difference between 12,367 and 5,455) equals 39,884 acre-feet. The USGS model by Stamos et al. (2001) shows a storage depletion of 1,813 AFY during the period 1931-1990, thus the surface flow was adjusted to account for this change in storage. As shown on Table 5-1 (**Attachment B**), Watermaster's calculation result is 38,071 AFY.

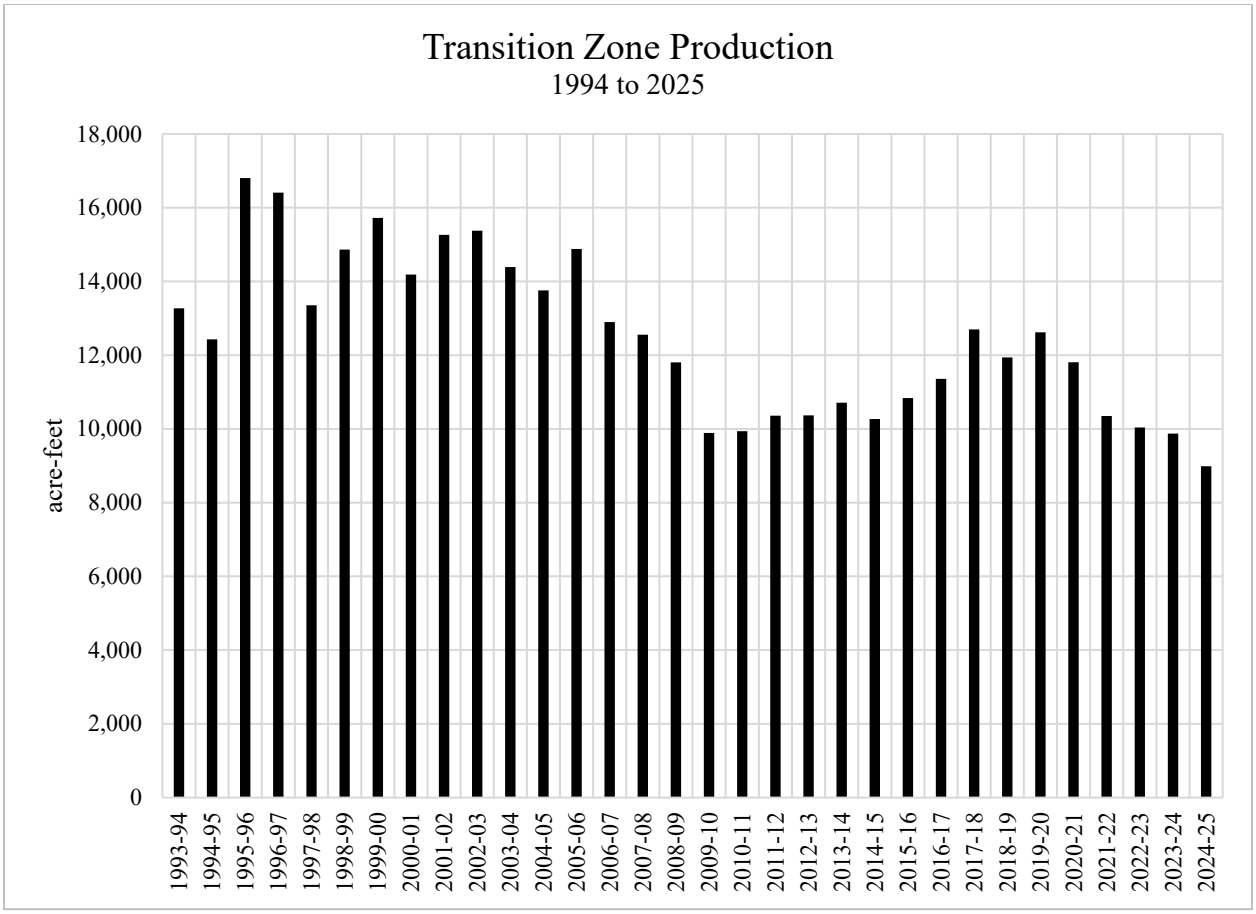


Figure 1. Historical production in the Transition Zone.

Surface Water Flow Centro to Baja

There are no gages measuring the surface flow from Centro to Baja. The Centro Subarea has a USGS gage station located in Barstow. The average gaged flow of the Mojave River at Barstow during the 1931-1990 base period is 17,097 AFY (Wagner & Bonsignore, 2012). The subarea boundary between Baja and Centro is the Waterman Fault, located several miles downstream of the Barstow gage and downstream of the Barstow Wastewater discharge. In 2012, Watermaster investigated the surface outflow from Centro to Baja at the Waterman Fault and determined this to be on average 16,406 AFY for 1931-1990. The average water flow from Centro to Baja has been studied and reported by Webb (2000) and the USGS Stamos model (2001). Table 3 is a compilation of the values reported by previous investigations.

Table 3. Estimates of surface water flow from Centro to Baja

	Source	Time Period Evaluated	Average Surface Water Flow (AFY)
Barstow	USGS Stamos (2001)	1931-1990	14,421
	USGS Streamflow Gage No. 10262500	1931-1990	17,097

	Source	Time Period Evaluated	Average Surface Water Flow (AFY)
Waterman Fault	USGS Stamos (2001)	1931-1990	10,678
	Wagner & Bonsignore (2012)	1931-1990	16,406
	Webb Associates (2000)	1931-1990	14,400
	Page C-3 of the Judgment After Trial (1996)	1931-1990	11,948 (based on the average gaged flow 17,097 at Barstow)

In addition to the Mojave River, there is ungaged inflow to Baja from tributaries and desert washes or mountain front recharge. The USGS report by Stamos et al. (2001) provides an estimated 647 acre-feet of recharge from Kane Wash and 3,705 acre-feet of tributary inflow (adjusted to 1931-1990). Watermaster has previously reported local surface inflow from Kane Wash and Boom Creek to be about 747 acre-feet (see **Attachment G**).

Estimates of subsurface inflow were determined by USGS, Stamos et al. (2001), and are assumed representative of the subsurface inflow currently, as water levels near the subarea boundary between Centro and Baja are reasonably stable over time.

Surface Water Outflow from Baja

The surface water outflow from the Baja Subarea is estimated from the USGS gage of Mojave River at Afton. However, this gage station is located about six miles downstream of the Baja Subarea boundary. Thus, we assumed that the flow at the downstream end of the Baja Subarea is the same as the flow measured at the Afton gage, assuming that ungaged tributary inflows between the boundary of the Baja Subarea and Afton are lost due to evaporation (Webb, 2000). The average gaged flow at Afton for the 1931-1990 base period is 8,732 acre-feet. Base flow of the Mojave River at Afton has changed substantially from the 1931-1990 base period (743 AFY) to the recent and current conditions (210 AFY during the years 1991-2025). To account for this change, an adjustment to the estimate of the total flow that includes the base flow representative of the current cultural conditions is needed. To achieve this, we calculated the average base flow of the Mojave River at Afton during the 1931-1990 period as follows: Storm Flow of Mojave River at Afton = Total Mojave River – Base Flow of Mojave River at Afton.

The average 1931-1990 storm flow of Mojave River at Afton is 7,989 acre-feet. The average of the 1991-2025 base flow of the Mojave River at Afton is 210 AFY. Therefore, total surface outflow from Baja that is representative of recent and present conditions is 8,199 AFY (rounded to 8,200 AFY for simplicity). The Judgment provides an estimate for long term average outflow at Afton of 8,200 AFY. This value includes an estimate for storm flow and base flow (subsurface discharge) and is based on the sixty-year hydrologic base period 1931-1990 (Wagner and Bonsignore, 2012).

The USGS model by Stamos et al. (2001) provides a subsurface outflow from Baja of 170 AFY. For purposes of the PSY calculations for Baja, Watermaster recommends using 8,030 AFY to be the surface outflow from Baja (see Table 5-1 in **Attachment B**).

Table 4. Estimates of surface water outflow from Baja

	Source	Time Period Evaluated	Average Surface Water Flow (AFY)
Afton	USGS Streamflow Gage No. 10263000	1931-1990	8,732
	USGS Streamflow Gage No. 10263000	1953-1990	6,066

	Source	Time Period Evaluated	Average Surface Water Flow (AFY)
MWA Boundary	Judgment After Trial (1996)	1931-1990	8,200
	Webb Associates (2000)	1931-1990	8,200
	Watermaster (2026)	1931-1990 (storm flow) + 1991-2025 (base flow)	8,030

Phreatophytes

Consumptive use values by phreatophytes are being evaluated by the California Department of Fish and Wildlife. For this analysis, Watermaster reported the annual amounts of riparian water use provided by the U. S. Geological Survey Water-Resources Investigations Report 96-4241 titled "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California".

PSY Determination for each Subarea

Este Subarea

Table 5-1 (**Attachment B**) provides the estimates of water supply, pumping, outflows and consumptive use for Este Subarea. The water budget calculation shows a deficit of 1,439 AFY. Historical water levels are shown on the MWA Hydrograph Map for 2026 (see **Attachment D**). However, the observation of historical water levels since the mid-1990s indicates that change in storage within Este Subarea is nearly zero. In general, the historical water levels shown on the hydrograph are relatively stable or are only changing at a small rate.

A review of the well hydrographs indicates that water levels throughout Lucerne Valley generally remain unchanged in recent years and within Fifteenmile Valley, water levels are either relatively stable (see wells 04N01W09P06, 04N01W10R01), or are declining slowly (see wells 04N01W07R01, 04N01W18Q01, 04N02W09Q01). Based on these observations, net water supply and pumping are fairly closely balanced. For these reasons, Watermaster does not recommend PSY and FPA values based upon the 1931-1990 water budget (Table 5-1) which indicates a deficit.

An example of the relationship between water levels and production was evaluated by Watermaster at the Chuck Bell property in Este (see **Figure 2**). The Chuck Bell wells are indicative of the water level behavior we see in Este where the water levels have remained stable during the last 30 years.

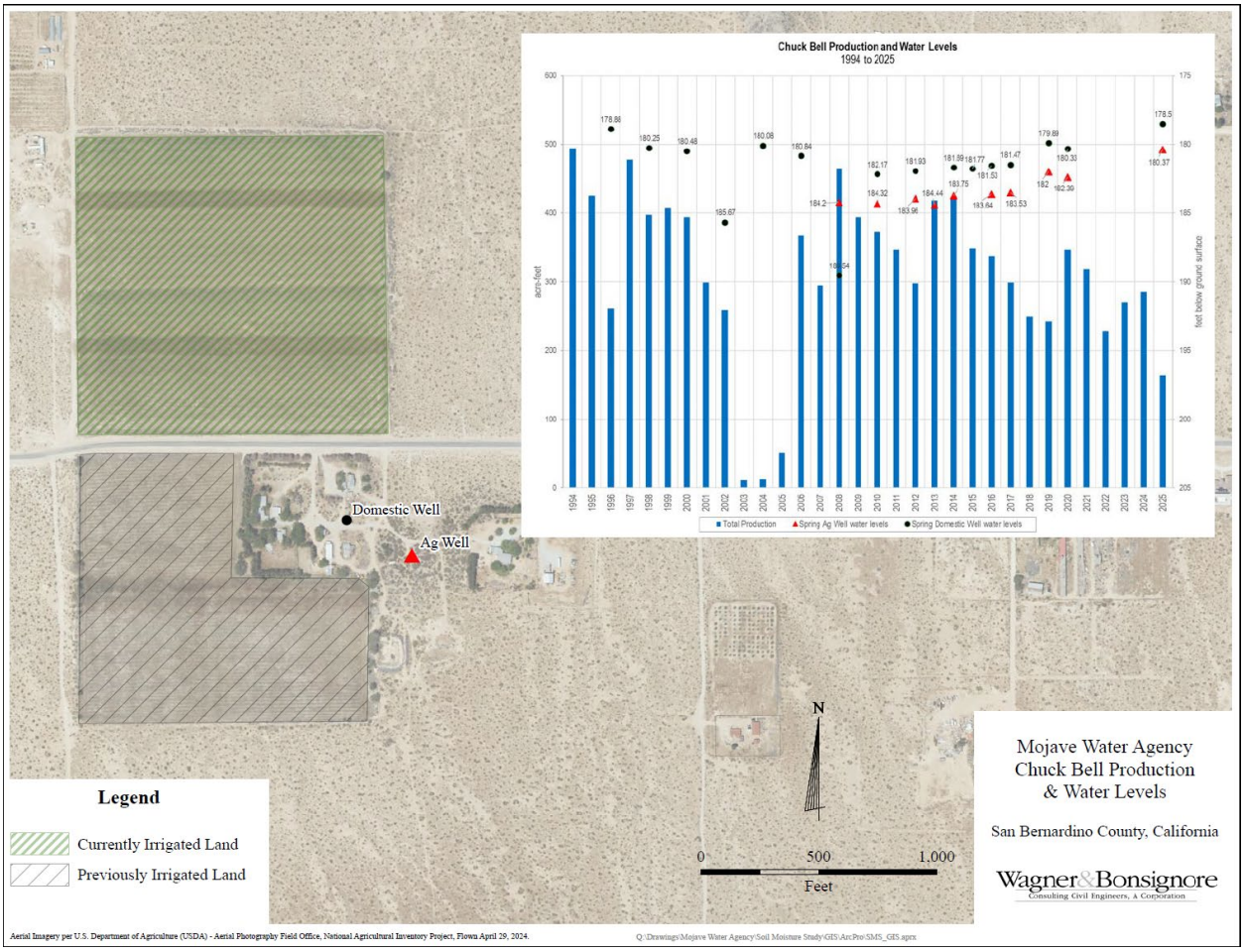


Figure 2. Chuck Bell production and water levels.

Historical pumping in Este is shown in **Figure 3**. Total production in Este Subarea has been in continuous decline since about 1996. In Water Year 2024-25, total pumping was 4,334 acre-feet. The average pumping during the period of record during which water levels have remained relatively constant (1996-2025) is 6,677 AFY.

The PSY can be defined as total pumping plus change in storage: PSY = Pumping + Change in Storage. Because water levels have remained relatively stable for several years, it is reasonable to conclude that the change in storage is near zero. Therefore, Watermaster recommends Este PSY of 6,677 acre-feet (total pumping plus change in storage).

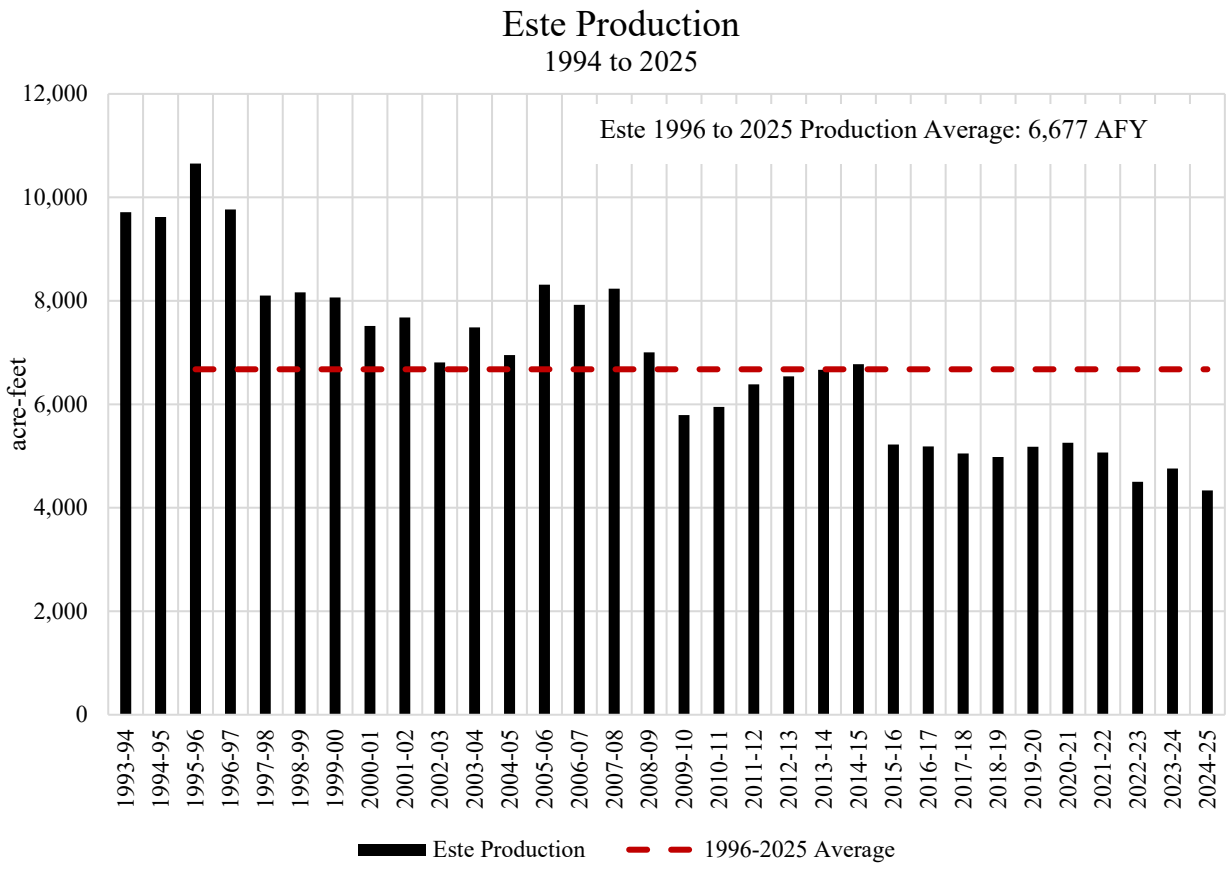


Figure 3. Historical production in Este Subarea.

Oeste Subarea

The PSY calculations (Table 5-1) for Oeste Subarea show a deficit of 841 acre-feet.

Review of well hydrographs prepared annually by MWA (see **Attachment E**) and groundwater elevation maps prepared by USGS from 1996 to 2016 indicate that groundwater levels in the Oeste subarea generally range widely, from about 500 to 600 feet below ground surface in the Phelan-Pinion Hills area in the more southerly part of the subarea, to about 100 to 300 feet in the vicinity of El Mirage and El Mirage Dry Lake. Water levels in the vicinity of a perched aquifer zone near Mirage Dry Lake identified by USGS are generally shallower than surrounding areas. The USGS Regional Water Table Maps spanning the period from 1996 to 2016 show a groundwater depression, presumably due to pumping, at the southern margin of El Mirage Dry Lake. However, monitoring by MWA indicates that groundwater levels are generally rising within the pumping depression.

Interpreting water-level trends in many of the wells is problematic, as levels are likely affected by pumping and can vary widely from year to year. This is the case for the wells in the Phelan-Pinion Hills area (05N07W31J03, 04N07W33J04, and 05N07W24D03). Further north in the area of El Mirage, water levels in the wells that are not influenced by pumping show generally little change or stability over time (06N07W17K01, 06N07W20D01, 06N07W26N02, and 06N06W18P03). And a few wells show increase in their water levels since around 2010 by about 70 feet (well 06N07W23C01-C03), and by about 30 feet (well 06N07W26C01). Because of the overall water level stability over time, it is reasonable to conclude that the change in storage is near zero during this time.

Table 5-1 (**Attachment B**) shows the total water supply of 2,477 AFY. Table 2Based on the general trends in water levels, and the continued decline in groundwater production, the PSY for Oeste is estimated to be approximately equal to the pumping (PSY = Total Pumping + Change in Storage). Historical pumping in Oeste is shown on **Figure 4**. Total pumping has been in decline during recent years. The average total production for the period 2010 to 2025 is 3,685 AFY. Table 5-1 shows a deficit of -841 AFY, which is in conflict with the overall behavior of the water levels. This is likely due to the uncertainty of the estimates of the ungaged inflows and outflows. Given the land use and pumping have changed noticeably during the recent years, Watermaster recommends basing the PSY on the average total pumping of 3,685 acre-feet for the period 2010-2025.

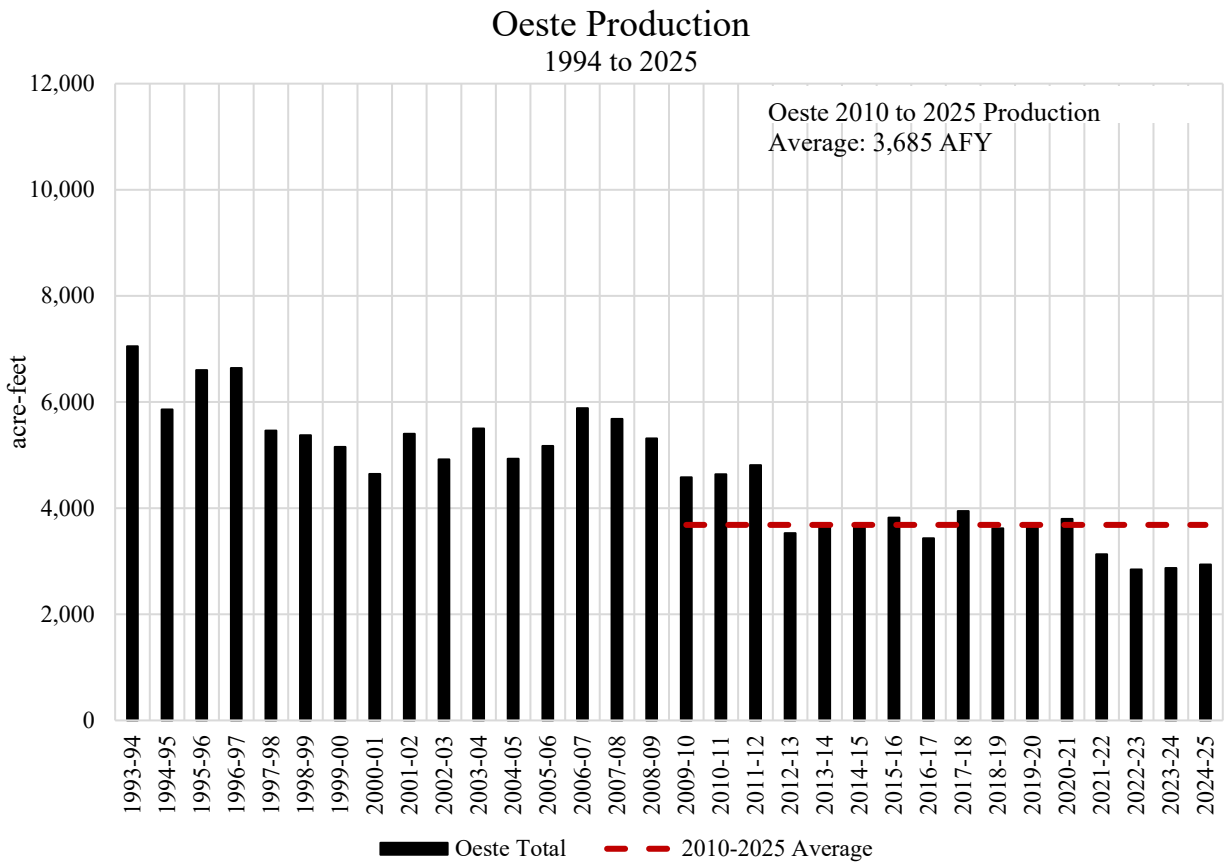


Figure 4. Historical production in Oeste Subarea.

Alto Subarea

For Alto Subarea, the PSY calculation indicates a total deficit of 12,887 acre-feet. Total pumping during Water Year 2024-25 was 76,329 acre-feet. PSY = Pumping + Surplus/(Deficit). Therefore, PSY for Alto is 63,442 acre-feet.

Centro Subarea

For the Centro Subarea, the water balance calculation shows a surplus of 9,763 acre-feet (Table 5-1 in **Attachment B**). The PSY is calculated as the sum of total pumping (15,884) and the indicated surplus (9,763). Initial calculation of the PSY is 25,647 acre-feet. However, we note that if the surplus were to be pumped and water use was similar to the current patterns of use, a portion of the surplus (equal to 28.9% which is the return flow percentage) increases the PSY to 28,473 acre-feet.

Baja Subarea

Table 5-1 (**Attachment B**) indicates a surplus of 4,501 AFY based on the 1931-1990 average water supply and outflow, and consumptive uses for the Water Year 2024-25 which is representative of future land uses and pumping in Baja Subarea. Consumptive uses by riparian vegetation is consistent with the estimates by Lines and Bilhorn (1996) of 2,000 AFY as explained in the *Phreatophytes* section above.

The calculation of PSY for Baja is 14,982 AFY (total pumping plus surplus). If the surplus were to be pumped and water use was similar to the current patterns of use, a portion of the surplus (equal to 27.3% which is the return flow percentage) increases the PSY to 16,211 AFY.

Historical water production and irrigated acreages in Baja Subarea are shown in **Figure 5**. Total pumping in Baja has been declining since before entry of Judgment (1996), decreasing from approximately 50,000 acre-feet in 1996 to 10,481 acre-feet in Water Year 2024-25 —a reduction of roughly 79%. Since 2016, pumping has been steadily decreasing by approximately 65%. The total average pumping during the last five years is 12,090 AFY.

The impact of this reduction is evident in the water level hydrographs (see **Attachment F**), which depict groundwater level changes across Baja over time. For several decades, most wells have exhibited a long-term downward trend, indicating depletion of groundwater storage. However, consistent with the substantial decline in pumping over the past 10 to 12 years—and the overall reduction over the past 30 years—water levels in some wells appear to be stabilizing, suggesting they may have reached, or are approaching, a low point.

In certain wells, water levels have begun to recover, while others continue to decline. Wells showing stabilization or recovery are generally located in areas where pumping has significantly decreased in recent years. Water level hydrographs are attached for review.

Assuming the water levels will continue to behave as shown for the recent years, and assuming that future pumping does not increase, the PSY for Baja is likely equal to or slightly greater than the average pumping during recent years (12,090 AFY for the Water Years 2020-21 through 2024-25). However, based on the Table 5-1 calculation, current land uses, and the 60-year average water supply, PSY would be 16,211 acre feet.

The Department of Fish and Wildlife has indicated that the riparian habitat area shown on exhibit H-1 near Camp Cady is stressed, and water levels remain depressed. Exhibit H, paragraph 2.a of the Judgment states *"In considering whether to increase or decrease the Free Production Allowance in a Subarea, Watermaster shall, among other factors, take into consideration for the areas shown on Figure H-1 the Consumptive Use of water by riparian habitat, the protection of public trust resources, including the species listed in Table H-1 and the riparian habitat areas shown on Figure H-1, and whether an increase would be detrimental to the protection of public trust resources."*

Following the direction in Exhibit H-1, paragraph 2a, to consider whether an increase in PSY and FPA "would be detrimental to the protection of public trust resources" and, particularly, the challenges experienced in attempting to protect public trust resources in the Camp Cady area, Watermaster recommends the Baja Subarea PSY remain unchanged (although the indicated PSY for the Baja Subarea is 16,211 acre feet).

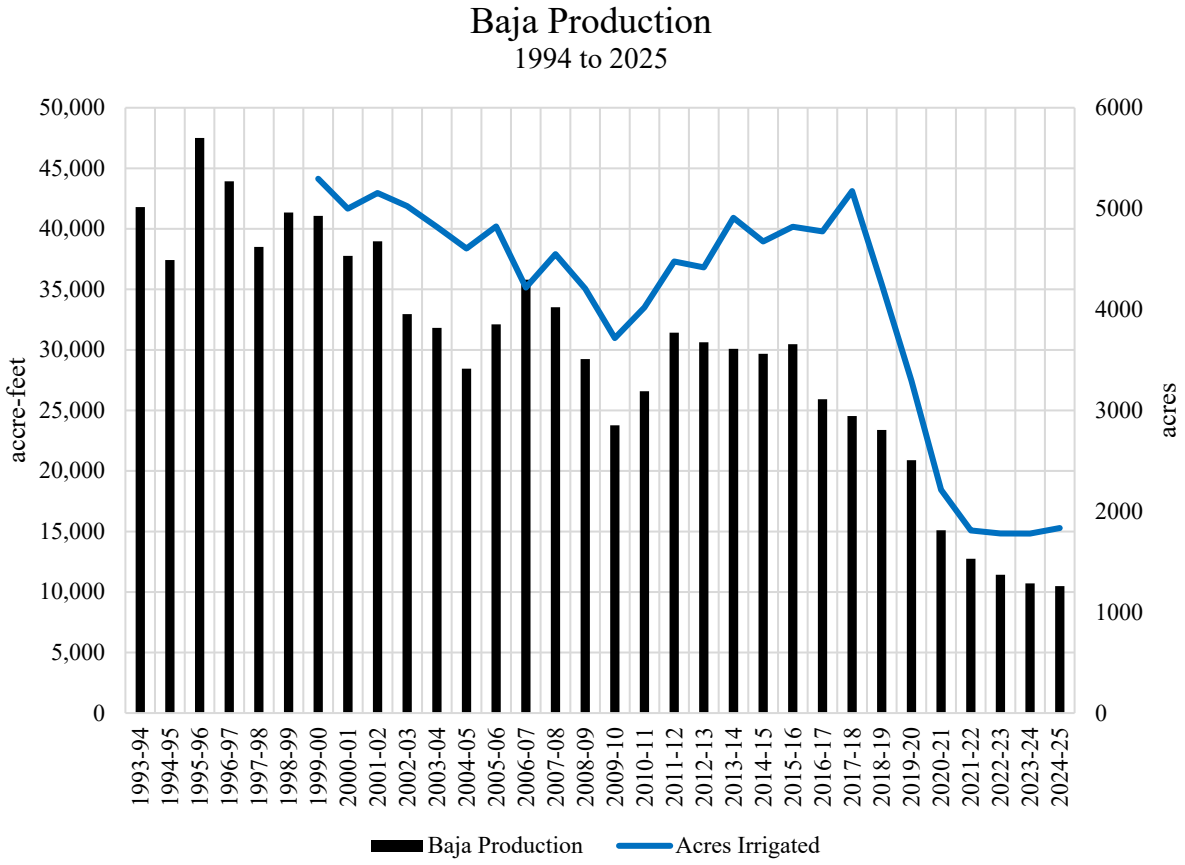


Figure 5. Historical production in Baja Subarea.

Imports

Elements of supply included in PSY include certain imports that have been long-term reliable supplies but could be interrupted. Wastewater effluent discharged to the MBA in Alto by Lake Arrowhead Community Services District (LACSD), and wastewater effluent discharged to Este by Big Bear Area Wastewater Reclamation Authority (BBAWRA), is included in the PSY calculation for those subareas. The amounts of discharge are reported in the Watermaster Annual Report (page 23) and considered representative for future planning. Changes that occur in the annual amount discharged by these entities are evaluated annually and reported in the Annual

Reports. Makeup Water Obligations are not included in the PSY calculations given that those started around 1993, and therefore not part of the water supply during the period 1931 to 1990.

Enclosures:

Attachment A Table C-1 of Judgment

Attachment B Table 5-1 Production Safe Yield Update

Attachment C Alto Subarea Transition Zone Hydrographs 2026

Attachment D Este Subarea Hydrographs 2026

Attachment E Oeste Subarea Hydrographs 2026

Attachment F Baja Subarea Hydrographs 2026

Attachment G Analysis of Baja Water Supply and Outflow by Wagner and Bonsignore dated February 22, 2012

Attachment A

TABLE C-1
Mojave Basin Area Adjudication
Subarea Hydrological Inventory Based On
Long-Term Average Natural Water Supply and Outflow
and Current Year Imports and Consumptive Use
(All Amounts in Acre-Feet)

	Este	Oeste	Alto	Centro	Baja	Basin Totals
WATER SUPPLY						
Surface Water Inflow						
Gaged	0	0	65,000	0 [1]	0 [2]	65,000 [3]
Ungaged	1,700	1,500	3,000	37,300 [1]	14,300 [2]	6,500 [4]
Subsurface Inflow	0	0	1,000	2,000	1,200	0
Deep Percolation of Precipitation	0	0	3,500	0	100	3,600
Imports						
Lake Arrowhead CSD	0	0	1,500	0	0	1,500
Big Bear ARWWA	2,000	0	0	0	0	2,000
TOTAL	3,700	1,500	74,000	39,300	15,600	78,600
CONSUMPTIVE USE AND OUTFLOW						
Surface Water Outflow						
Gaged	0	0	0 [1]	0 [5]	8,200	8,200
Ungaged	0	0	37,300 [1]	14,000 [5]	0	0
Subsurface Outflow	200	800	2,000	1,200	0	0
Consumptive Use						
Agriculture	6,800	2,900	16,300	20,300	30,200	76,500
Urban	1,900	1,200	36,300	9,500	9,700	58,600
Phreatophytes	0	0	5,100	900	1,500	7,500 [6]
Exports	0	0	0	0	0	0
TOTAL	8,900	4,900	97,000	45,900	49,600	150,800
Surplus / (Deficit)	(5,200)	(3,400)	(23,000)	(6,600)	(34,000)	(72,200)
Total Estimated Production (Current Year) [7]	15,700	7,600	98,900	46,500	54,300	223,000
PRODUCTION SAFE YIELD (Current Year) [7]	10,500	4,200	75,900	39,900	20,300	150,800

SAMPLE CALCULATIONS

[1] Estimated from reported flows at USGS gaging station, Mojave River at Victorville Narrows.

[2] Includes 14,000 acre-feet of Mojave River surface flow across the Waterman Fault estimated from reported flows at USGS gaging station, Mojave River at Barstow, and 300 acre-feet of local surface inflow from Kane Wash.

[3] Represents the sum of Este (1,700 af), Oeste (1,500 af), Alto (3,000 af) and Baja (300 af from Kane Wash).

[4] Inter subarea subsurface flows do not accrue to the total basin water supply.

[5] Estimated from reported flows at USGS gaging station, Mojave River at Barstow.

[6] Estimated by Bookman-Edmonston.

[7] For purposes of this Table, the current year is 1990.

Attachment B

TABLE 5-1
Production Safe Yield Update
Based on 1931-1990 Average Natural Water Supply and Outflow, Average Imports, and Consumptive Use, and Production for 2024-25, except as noted

(all amounts in acre-feet)

	Este	Oeste	Alto	Centro	Baja	Basin Totals
WATER SUPPLY						
Surface Water Inflow						
Gaged	0	0	65,538 [2]	0	0	65,538
Ungaged	1,035 [1]	1,941 [1]	7,763 [1]	38,071 [3]	17,153 [5]	10,739 [7]
Tributary Inflow[4]	0	0	2,280	2,280	3,705	2,280 [7]
Subsurface Inflow	0 [9]	536 [8]	2,034 [9]	1,566 [9]	1,462 [9]	0 [10]
Imports						
Lake Arrowhead CSD	0	0	1,371 [11]	0	0	1,371
Big Bear ARWWA	2,000 [6]	0	0	0	0	2,000
TOTAL	**3,035**	**2,477**	**78,986**	**41,917**	**22,320**	**81,928**
CONSUMPTIVE USE AND OUTFLOW						
Surface Water Outflow	0	0	38,071 [3]	16,406 [12]	8,030 [13]	8,030
Subsurface Outflow	995 [9]	1,039 [9]	1,566 [9]	1,462 [9]	170 [9]	0 [6]
Consumptive use						
Agriculture[14]	1,660	13	800	5,786	4,592	12,851
Urban[14,15]	1,819	2,266	40,436	5,500	3,027	53,048
Phreatophytes[16]	0	0	11,000	3,000	2,000	16,000
TOTAL	**4,474**	**3,318**	**91,873**	**32,154**	**17,819**	**89,929**
Surplus / (Deficit)	~~*(1,439)*~~	~~*(841)*~~	(12,887)	9,763	4,501	(8,001)
Total Estimated Production[17]	6,677	3,685	76,329	15,884	10,481	113,056
PRODUCTION SAFE YIELD[18]	**6,677** [19]	**3,685** [19]	**63,442**	**28,473** [20]	**16,211** [20]	**105,055**
INDICATED FREE PRODUCTION ALLOWANCE	***33.0%***	***51.9%***	***54.5%***	***55.8%***	***24.5%***	

[1] Mountain-front recharge values from Table 10 of Stamos et al (2001), simulated hydrologic budgets for the average 1931-1990. Mountain-front recharge includes ungaged surface water and deep percolation of precipitation.

[2] Average discharge of Mojave River at The Forks, 1931-1990 (The Forks is the addition of reported values from USGS stations at West Fork Mojave River Near Hesperia, CA (10261000) and Deep Creek Near Hesperia, CA (10260500).

[3] Average 1931-1990 surface flow near the Helendale Fault from the USGS model by Stamos et al (2001), adjusted by decreases in the consumptive use from production within the Transition Zone from model period 1931-1990 to the Water Year 2024-25.

[4] Tributary inflow from page 15 of Stamos et al (2001) averaged about 2,400 AFY to Alto (above the Lower Narrows), about 2,400 AFY to both the Transition Zone and Centro, and about 3,900 AFY to Baja for 1931-1994. Reported values are adjusted for the base period 1931-1990.

[5] Includes 16,406 af of Mojave River surface flow across the Waterman Fault estimated by "Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault", and 747 af of local surface inflow from Kane Wash and Boom Creek (Wagner & Bonsignore, 2012).

[6] Judgment After Trial, 1996, Table C-1.

[7] Represents the sum of Este, Oeste, and Alto.

[8] Additional subsurface flow from Sheep Creek of 536 af.

[9] Average 1931-1990 subsurface flows per Figure 34 of Stamos et al, 2001 (USGS).

[10] Inter subarea subsurface flows do not accrue to the total basin water supply.

[11] Lake Arrowhead CSD average Water Year 1996 to 2025

[12] Estimated by "Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault", Wagner & Bonsignore, 2012.

[13] Watermaster calculation based on average 1931-1990 storm flow and 1991-2025 base flow of the USGS gage Mojave River at Afton, CA (10263000), minus subsurface flow from Baja of 170 AFY.

[14] Consumptive Use Analysis by Watermaster for Water Year 2024-25.

[15] Includes consumptive use of "Minimals Pool" (estimated Minimal's production is 7,077 af).

[16] From USGS Water-Resources Investigation Report 96-4241 "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" by Lines and Bilhorn (1996).

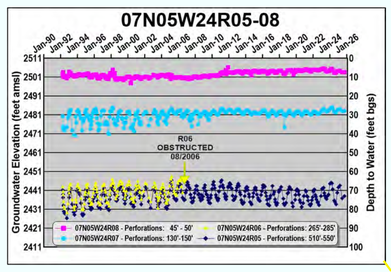
[17] Production data for Alto, Centro and Baja for Water Year 2024-25. Production for Este is the 1996-2025 average, and for Oeste is the 2010-2025 average. Included in the production values are the estimated minimal producer's water use by Subarea.

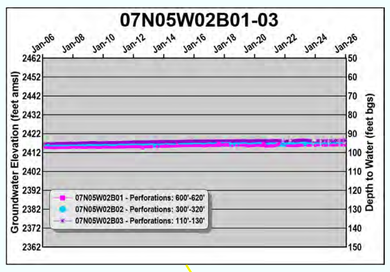
[18] Imported State Water Project water purchased by MWA is not reflected in the above table.

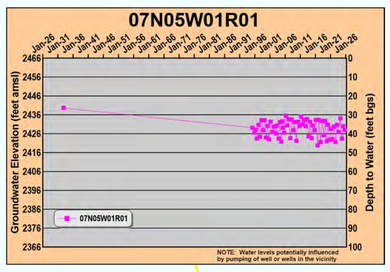
[19] For Este and Oeste Subareas, the Production Safe Yield is assumed equal to the average production during the period of time when change in storage is approximately zero (see pages 9 through 12 of Watermaster's Technical Memorandum).

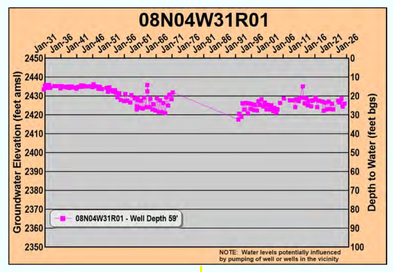
[20] For Centro and Baja Subareas, calculated PSY includes a portion of the surplus corresponding to return flow percentage during Water Year 2024-25 as follows: 28.9% for Centro and 27.3% for Baja.

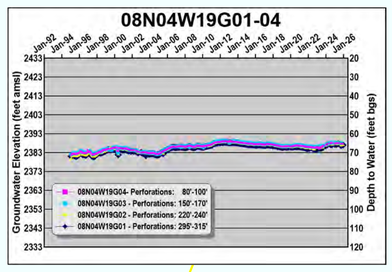
Attachment C

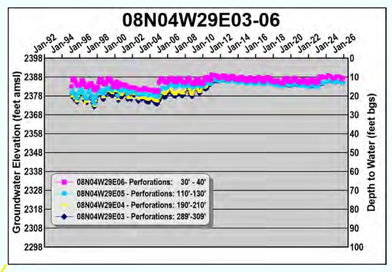


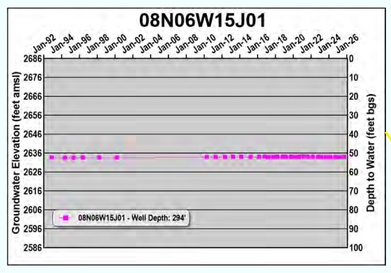


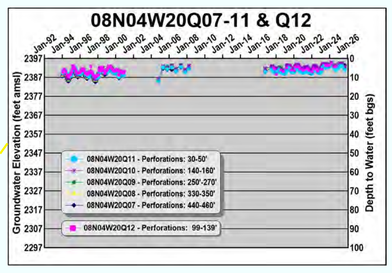


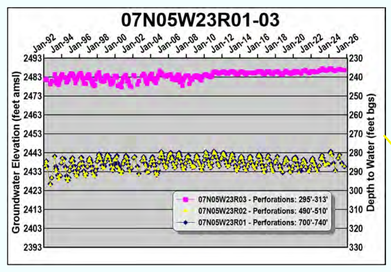


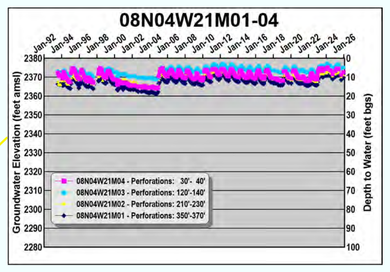


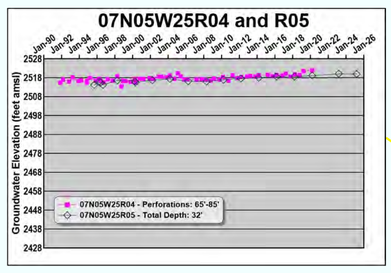


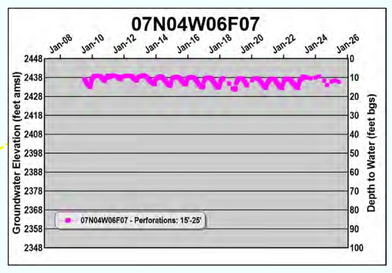


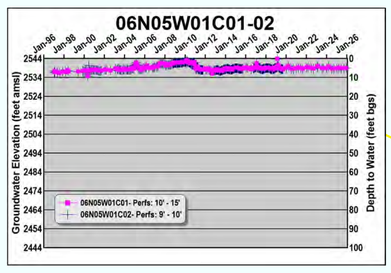


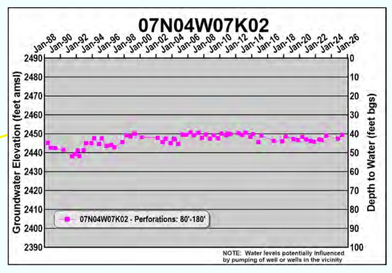


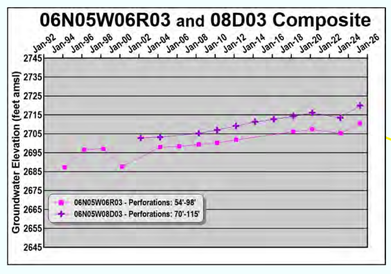


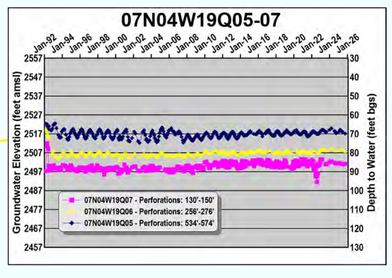


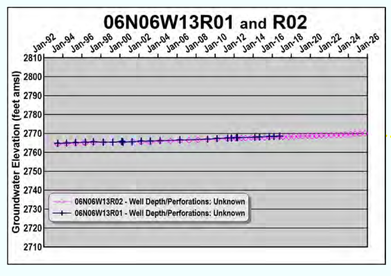


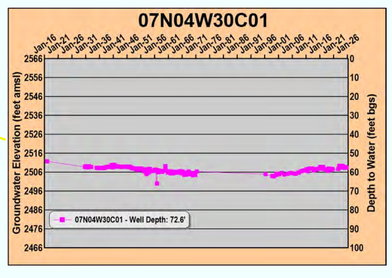


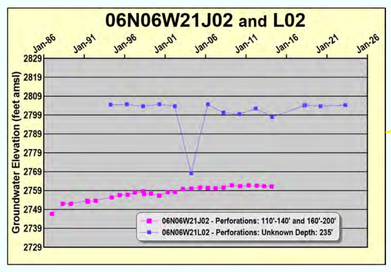


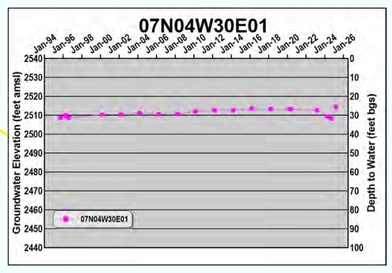


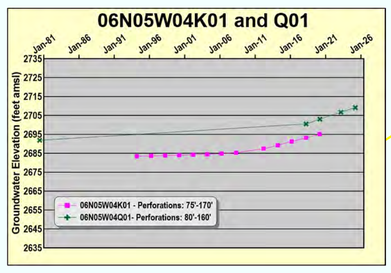


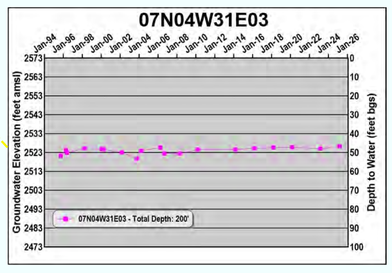


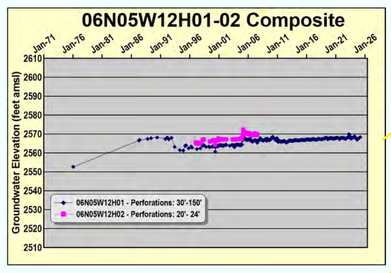


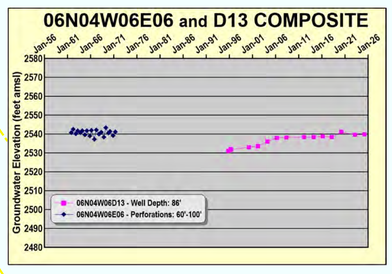


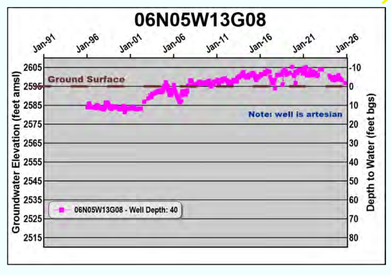


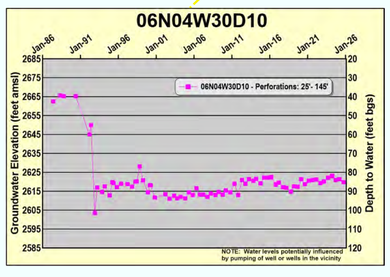


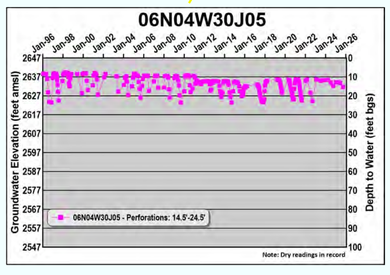


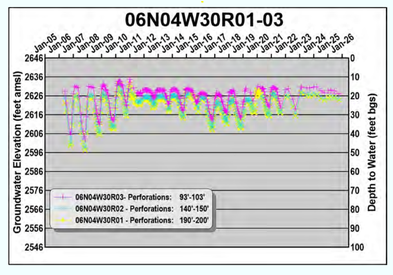


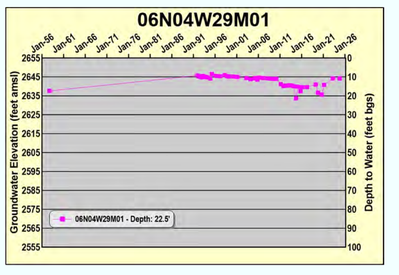


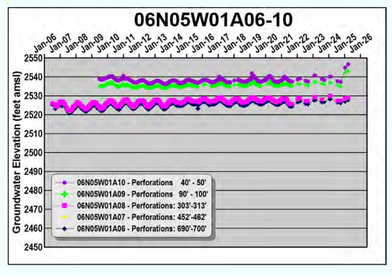


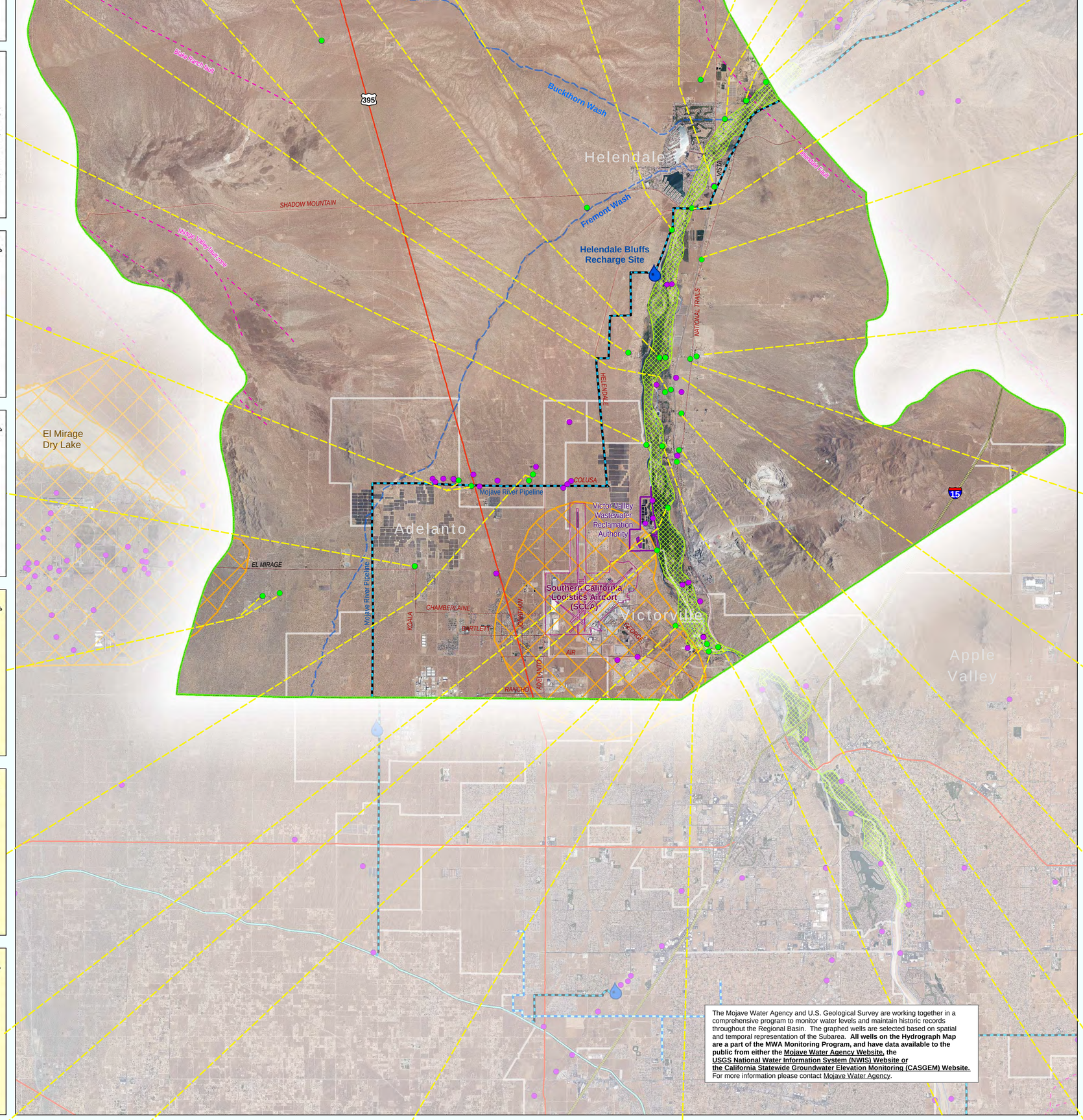












The Mojave Water Agency and U.S. Geological Survey are working together in a comprehensive program to monitor water levels and maintain historic records throughout the Regional Basin. The graphed wells are selected based on spatial and temporal representation of the Subarea. **All wells on the Hydrograph Map are a part of the MWA Monitoring Program, and have data available to the public from either the Mojave Water Agency Website, the USGS National Water Information System (NWIS) Website or the California Statewide Groundwater Elevation Monitoring (CASGEM) Website.** For more information please contact Mojave Water Agency.

Mojave Water Agency

Data Sources:
MWA, US Census
USGS/NWIS,
DWR Bulletin 84 1967
Date: January 2024
Mojave Water Agency
Water Resources Department

- Graphed Wells
- MWA Monitoring Program Wells
- MWA Potable Pipeline
- MWA Recharge Pipeline
- CA Geologic Faults (CGS, USGS)
- USGS Perched Water Table

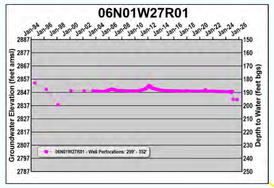
Alto Subarea Transition Zone Hydrographs 2026

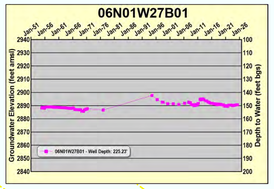
- Recent record
- Long-term record (begins ~1950 to ~ 1980)
- Very long-term record (begins ~1920)

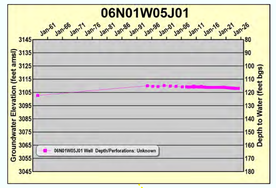
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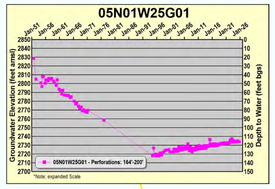
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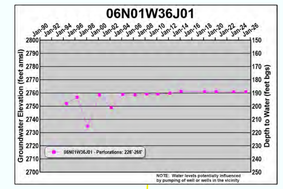
Attachment D

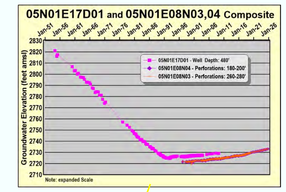


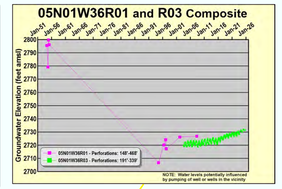


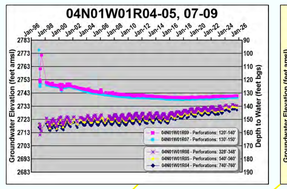


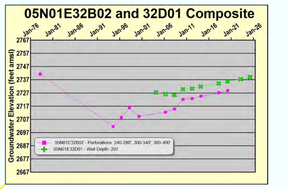


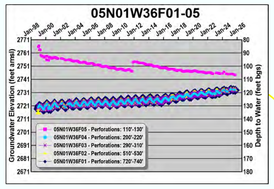


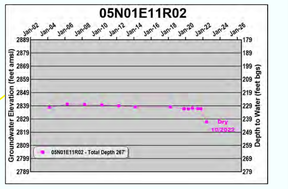


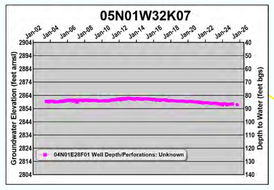


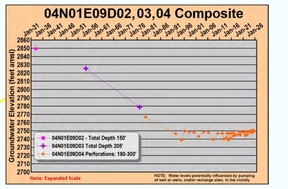


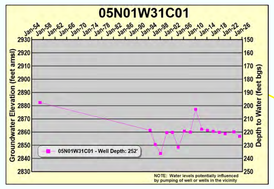


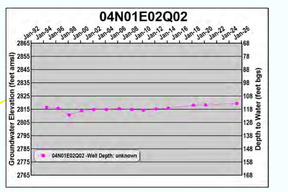


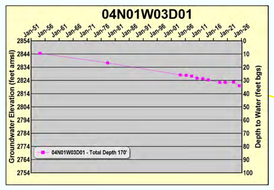


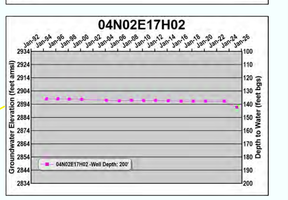


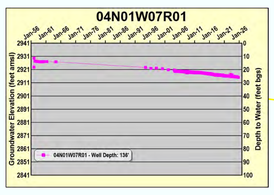


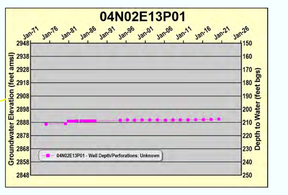


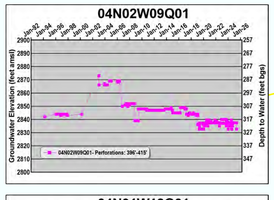


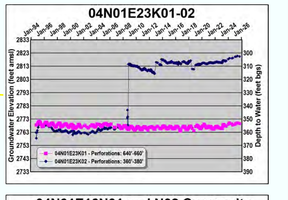


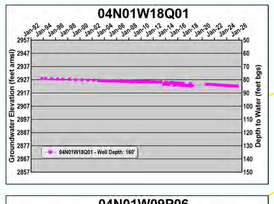


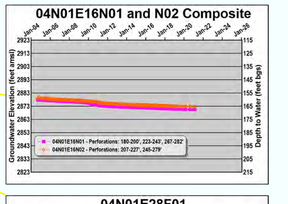


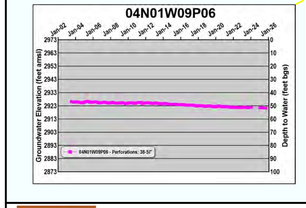


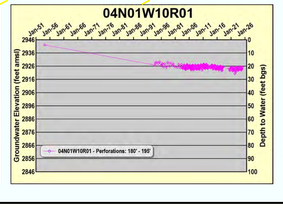


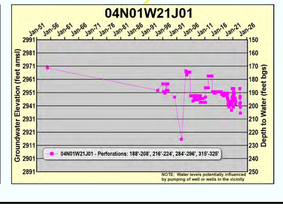


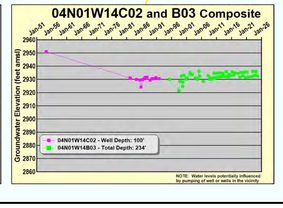


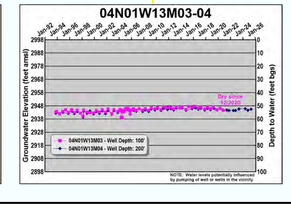


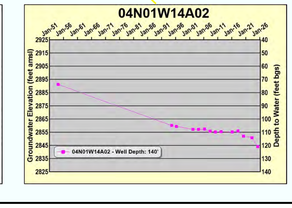


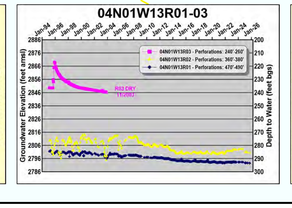


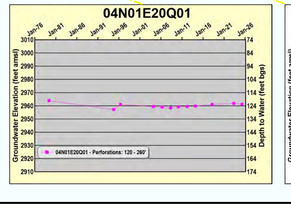


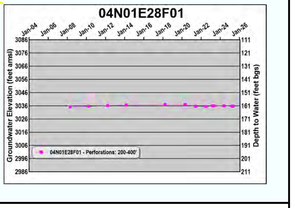


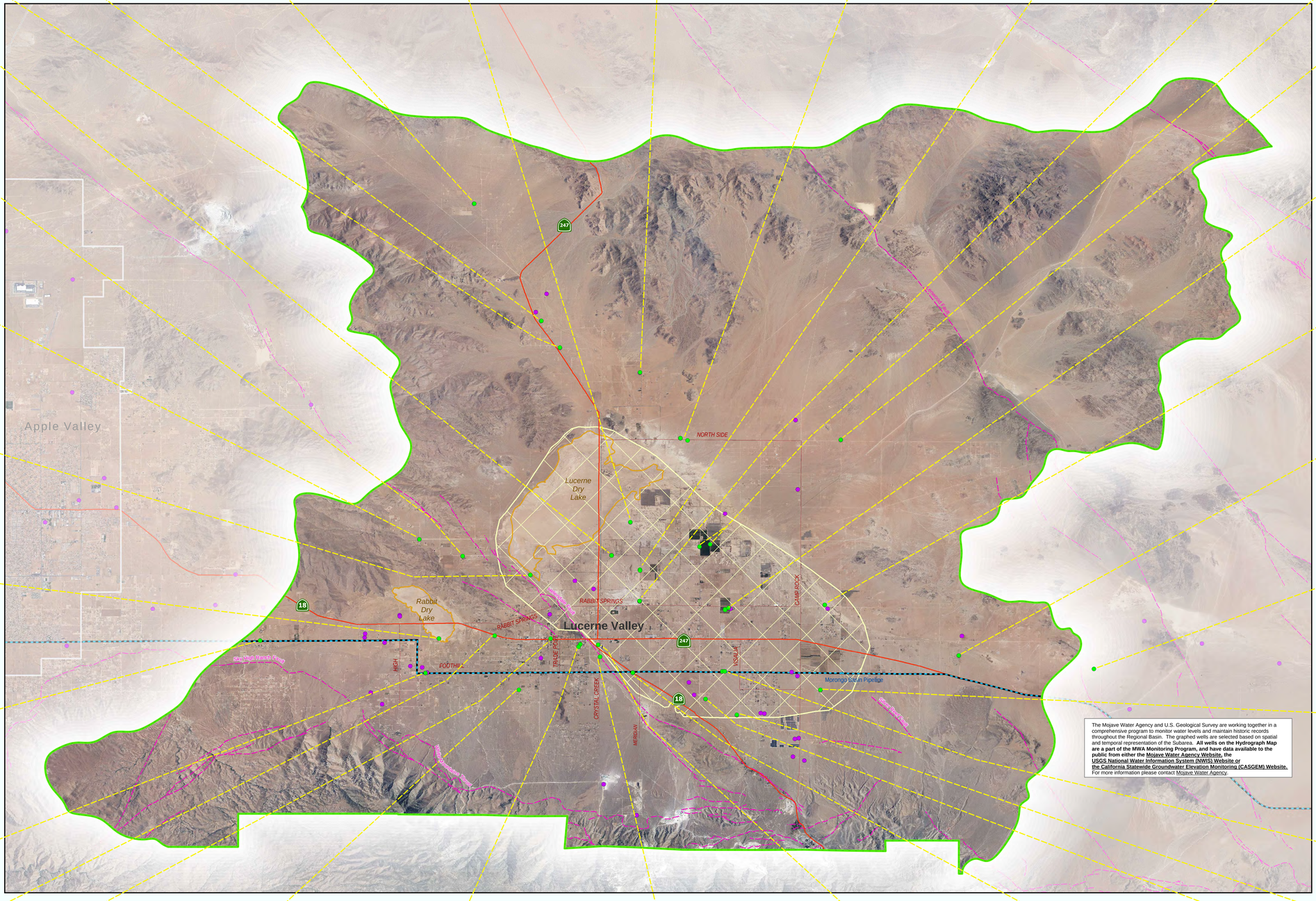












The Mojave Water Agency and U.S. Geological Survey are working together in a comprehensive program to monitor water levels and maintain historic records throughout the Regional Basin. The graphed wells are selected based on spatial and temporal representation of the Subarea. **All wells on the Hydrograph Map are a part of the MWA Monitoring Program, and have data available to the public from either the Mojave Water Agency Website, the USGS National Water Information System (NWIS) Website or the California Statewide Groundwater Elevation Monitoring (CASGEM) Website.** For more information please contact Mojave Water Agency.

Mojave Water Agency

Data Sources:
MWA, US Census, USGS/NWIS, DWR Bulletin 84 1967
Date: 02/2026
Mojave Water Agency
Water Resources Department

- Graphed Wells
- MWA Monitoring Program Wells
- MWA Recharge Pipeline
- CA Geologic Faults (CGS, USGS)
- USGS Perched Water Table

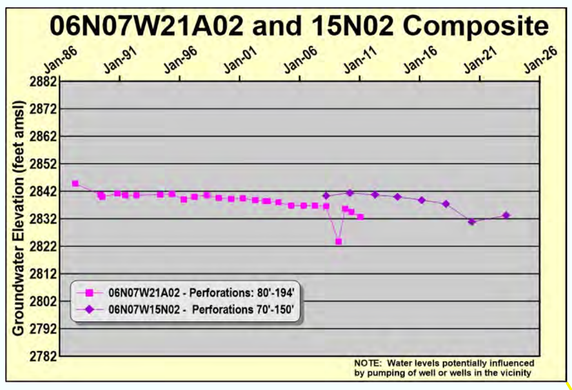
Este Subarea Hydrographs 2026

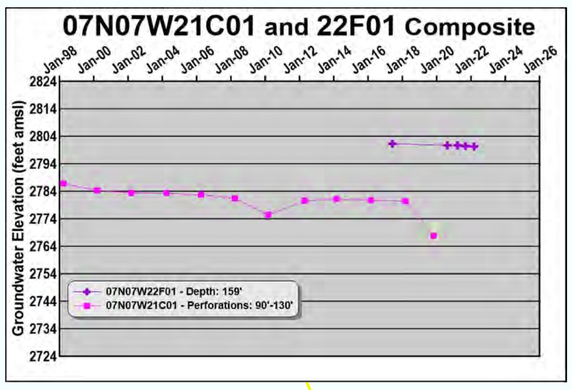
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- Long-term record (begins ~1950 to ~1980)
- Very long-term record (begins ~1920)

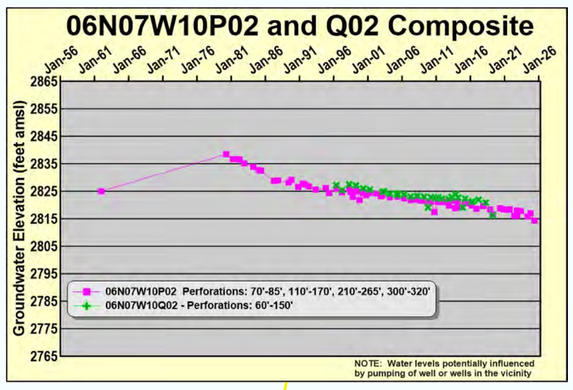
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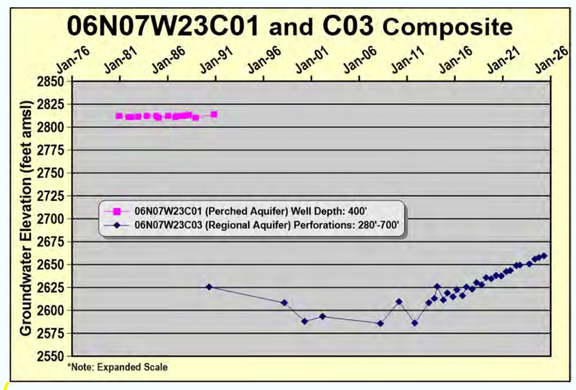
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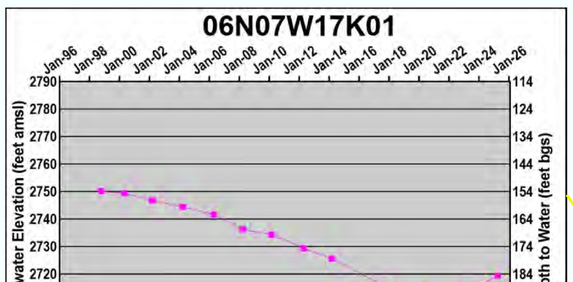
Attachment E



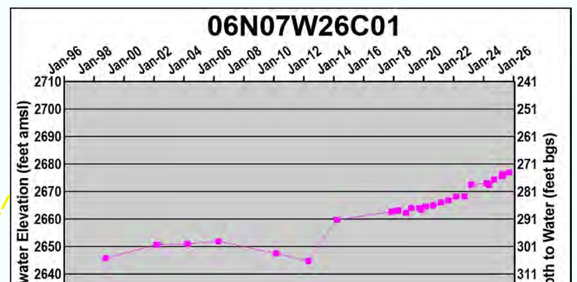


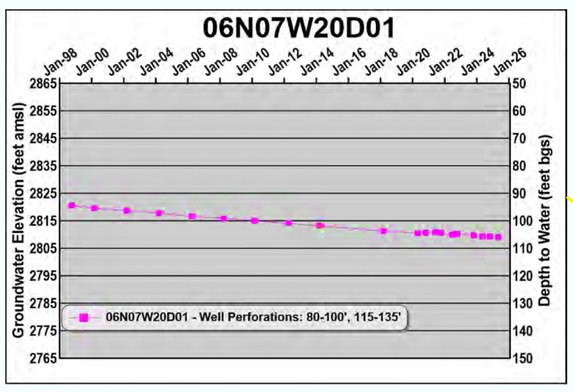


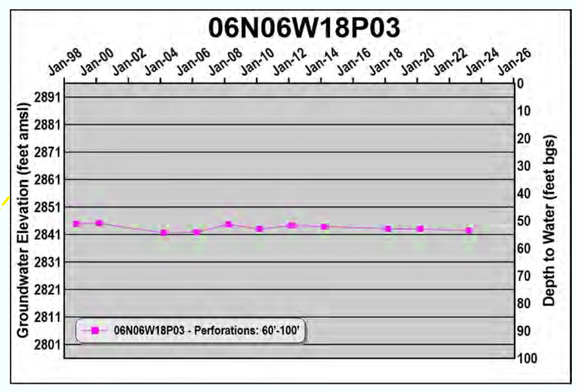


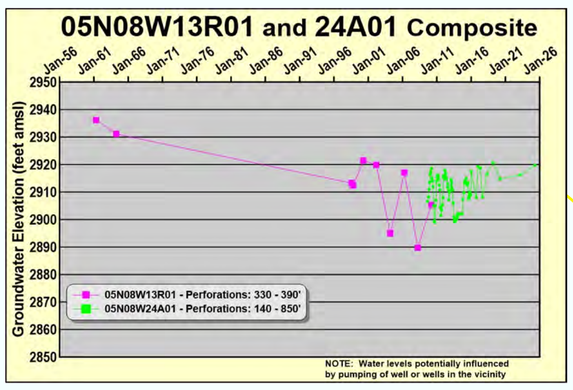


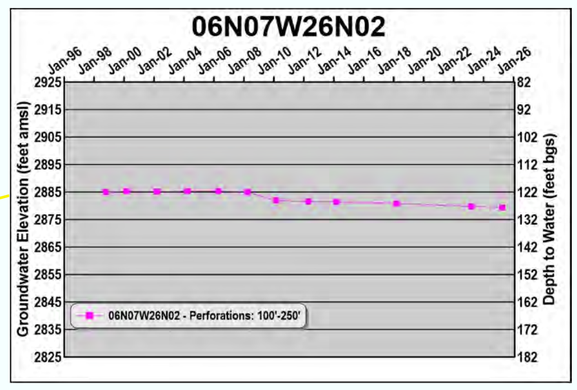


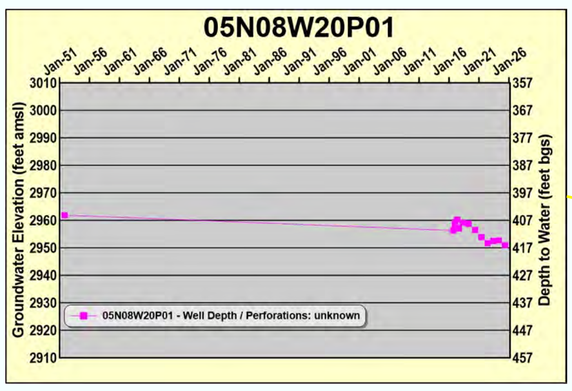


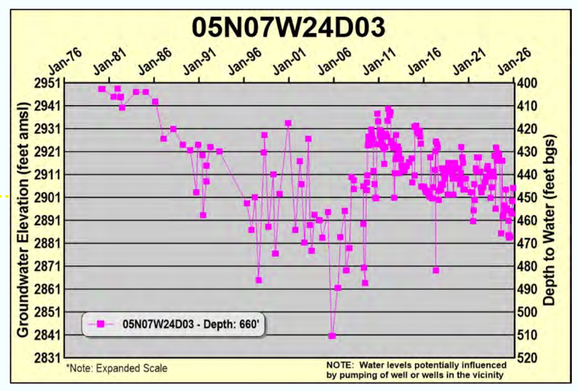


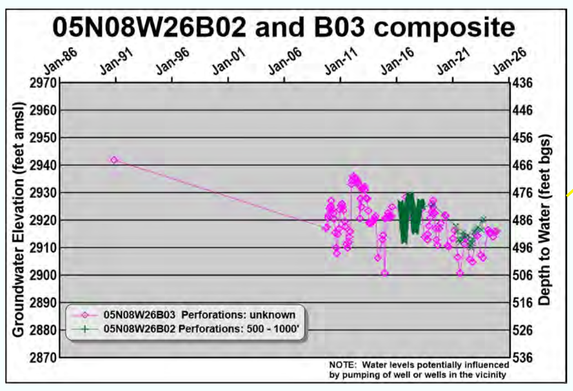


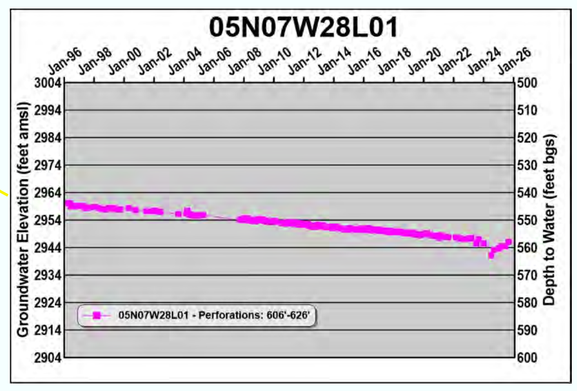


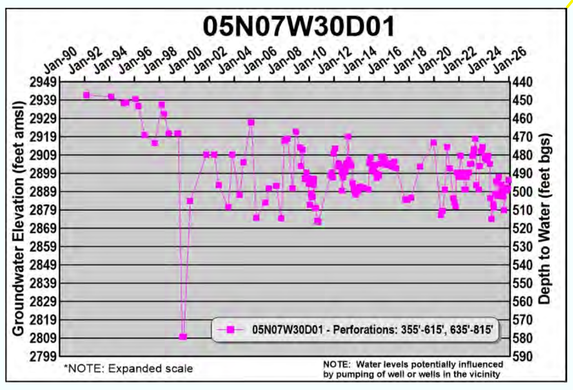


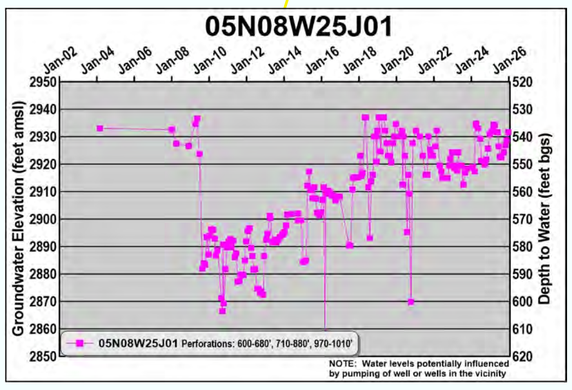


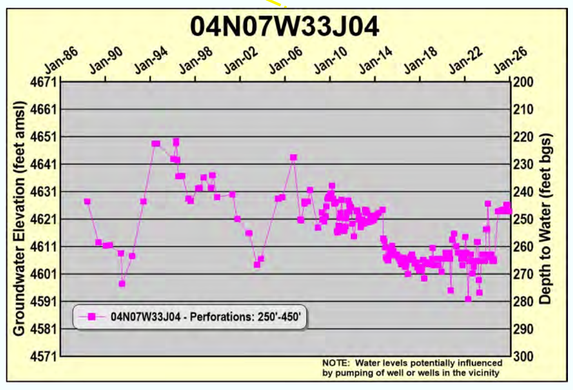


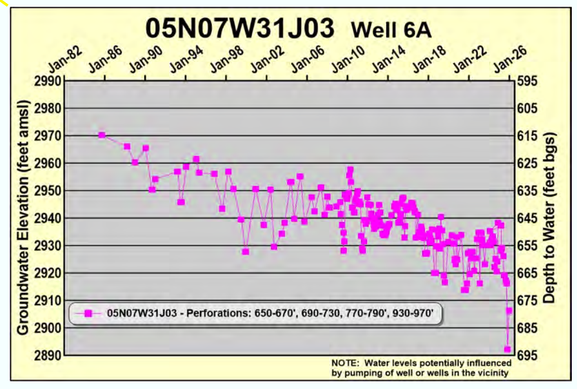












Mojave Water Agency

Data Sources:
MWA, US Census, USGS/NWIS,
Date: 02/2026
Mojave Water Agency
Water Resources Department

Graphed Wells
- Perched
- Water Table
- Water Table and Perched

- MWA Monitoring Program Wells
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Oeste Subarea Hydrographs 2026

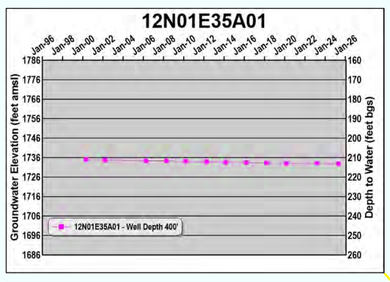
- Recent record
- Long-term record (begins ~1950 to ~1980)
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0 0.5 1 2 Miles

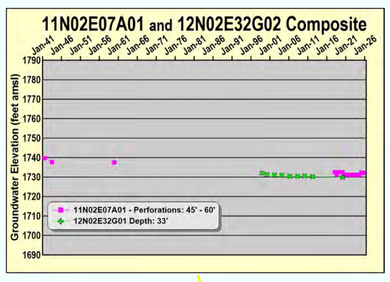
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Attachment F

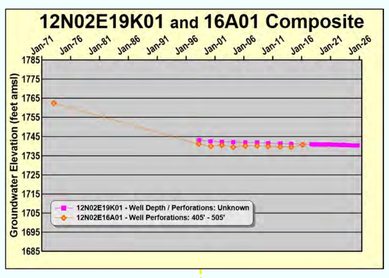
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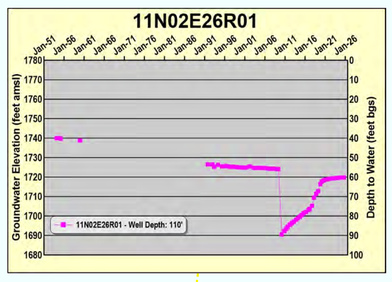
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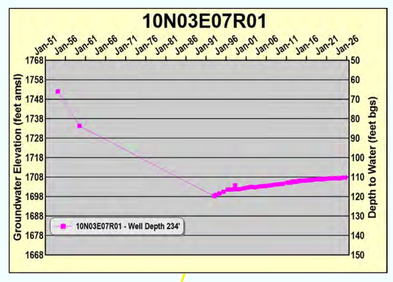
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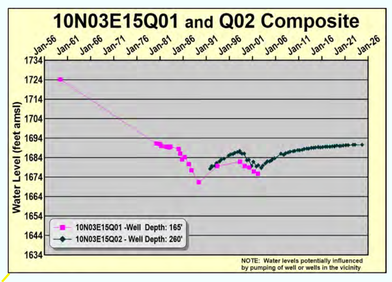
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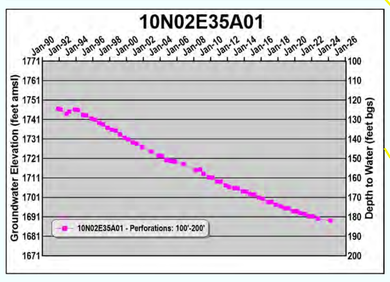
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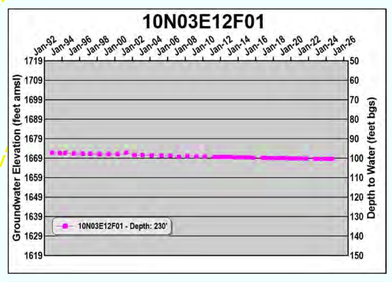
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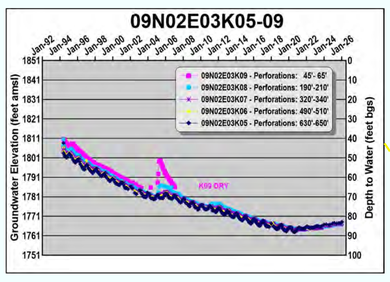
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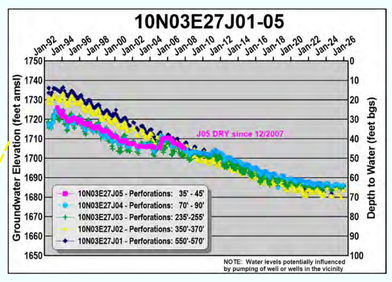
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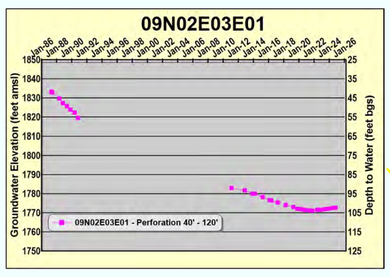
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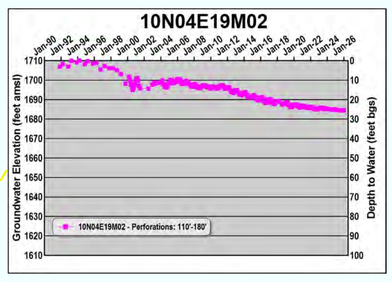
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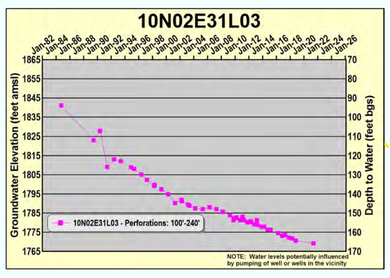
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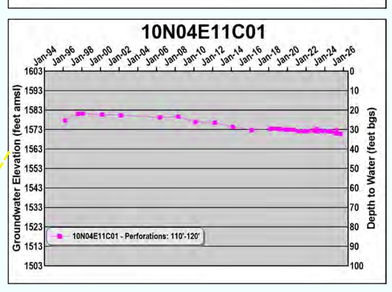
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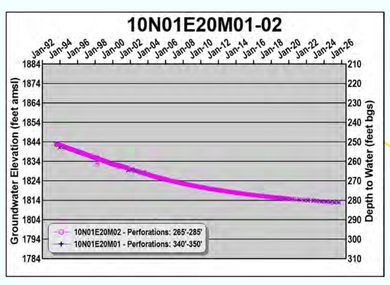
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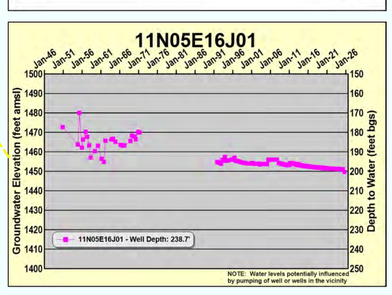
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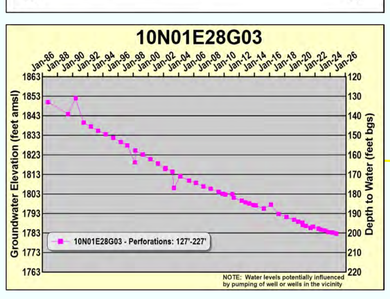
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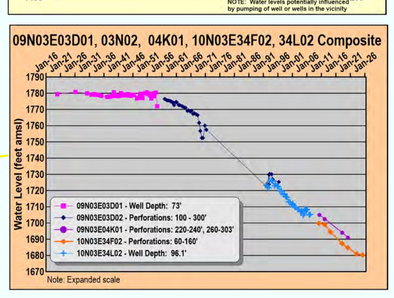
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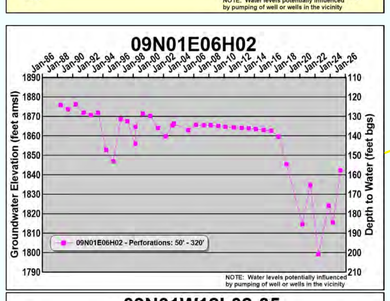
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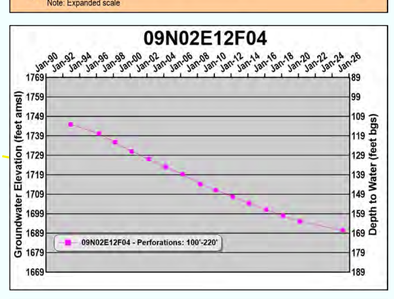
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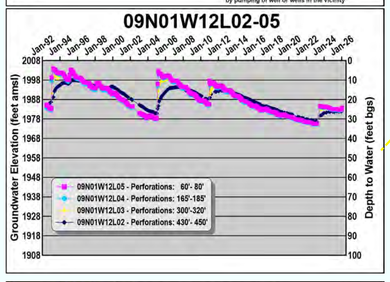
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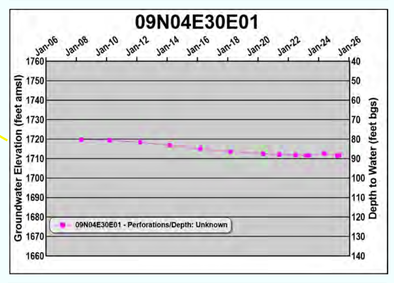
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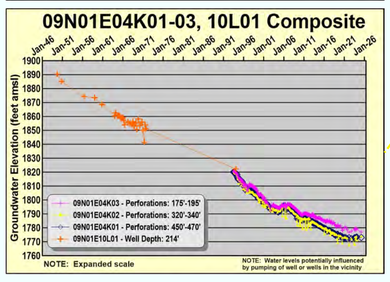
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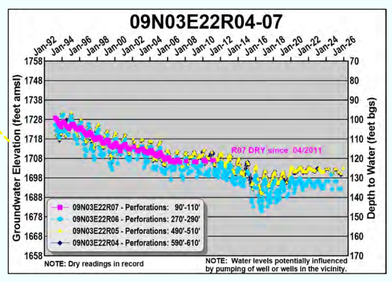
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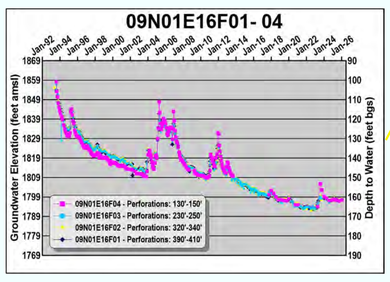
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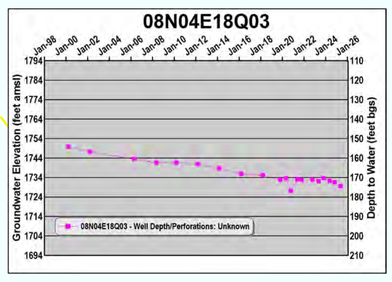
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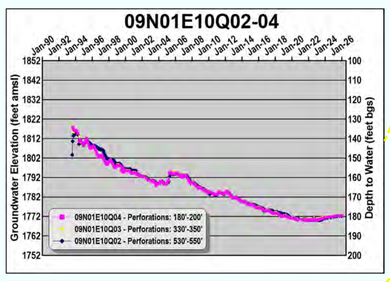
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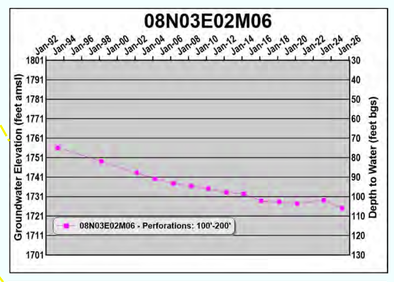
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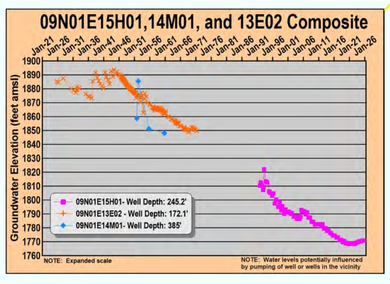


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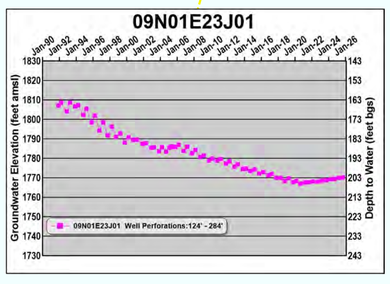


The Mojave Water Agency and U.S. Geological Survey are working together in a comprehensive program to monitor water levels and maintain historic records throughout the Regional Basin. The graphed wells are selected based on spatial and temporal representation of the Subarea. **All wells on the Hydrograph Map are a part of the MWA Monitoring Program, and have data available to the public from either the Mojave Water Agency Website, the USGS National Water Information System or the California Statewide Groundwater Elevation Monitoring (CASGEM) Website.**
For more information please contact Mojave Water Agency.

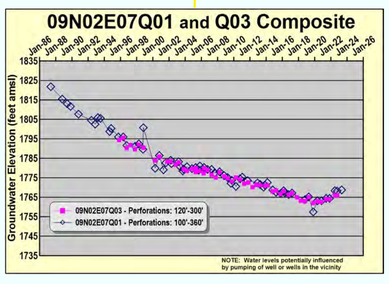
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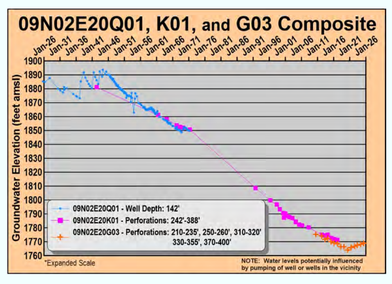
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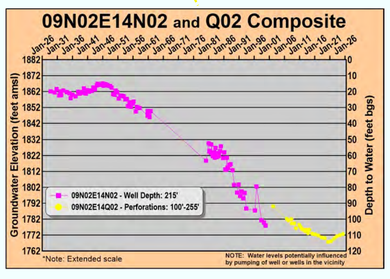
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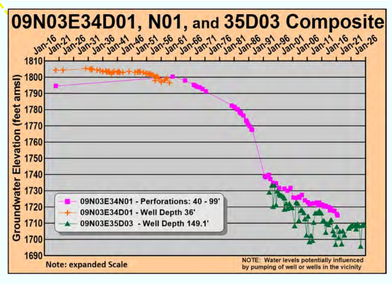
09N02E20Q01, K01, and G03 Composite



09N02E14N02 and Q02 Composite



09N03E34D01, N01, and 35D03 Composite



Mojave Water Agency

Data Sources:
MWA, US Census,
USGS/ NWIS,
DWR Bulletin 84 1967
Date: 02/2026
Mojave Water Agency
Water Resources Department

- Graphed Wells
- MWA Monitoring Program Wells
- Exhibit H Riparian Habitat Area
- CA Geologic Faults (CGS, USGS)
- MWA Recharge Pipeline
- MWA Recharge Site

Baja Subarea Hydrographs 2026

- Recent record
- Long-term record (begins ~1950 to ~1980)
- Very long-term record (begins ~1920)

0 2 4 Miles

N

Attachment G

Mojave Water Basin Area Watermaster

ANALYSIS OF BAJA WATER SUPPLY AND OUTFLOW

February 22, 2012

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Wagner&Bonsignore
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ANALYSIS OF BAJA WATER SUPPLY AND OUTFLOW

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APPENDICES

Appendix A - Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault

Appendix B - Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

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Appendix D - Explanation of computed potential evapotranspiration and actual evapotranspiration for Harter project

INTRODUCTION

The following report provides the basis for adjusting on a short term basis elements of water supply, use, and disposal as shown on Table 5-2 of the Watermaster's Annual Report to the Court. Additionally, Watermaster requested guidance for a recommendation on adjusting Free Production Allowance for the Baja Subarea in the short term and for the future. During a series of workshops and meetings with Watermaster and the Baja Subarea Advisory Committee (BSAC) over the past several years, we provided data and analysis to support the recommendations contained herein.

The following items are discussed in this report:

1) Long term average Inflow at Waterman Fault
2) Long term average outflow at Afton
3) Phreatophyte Usage in Baja Subarea
4) Supply Contribution from Desert Washes
5) Recommendation for Future Rampdown

LONG TERM AVERAGE ANNUAL INFLOW AT WATERMAN FAULT

The boundary between the Centro and Baja subareas is generally located near the Waterman Fault. Discharge is measured by the USGS stream gage at Barstow about 5 miles upstream from the boundary. Consequently surface flow into Baja carried by the Mojave River is un-gauged. The Judgment After Trial, January 10, 1996 (Judgment) sets forth the average annual inflow to Baja as 14,000 acre-feet per year (Judgment appendix C). Paragraph 2, page C-3 of the Judgment presents a schedule to be used to estimate the surface flow at the Waterman Fault based on measured flow at Barstow. The long term average annual flow as measured at Barstow during the sixty year hydrologic base period of the Judgment is 17,097 acre-feet (USGS stream gage records).

The schedule shown on page C-3 of the Judgment indicates that the first 2,000 acre-feet of flow at Barstow is completely consumed as recharge or consumptive use and produces zero surface flow at Waterman Fault. According to the schedule, when 100,000 acre-feet is measured at Barstow, there will be surface flow at Waterman Fault of 85,400 acre-feet, or that 14,600 acre-feet will be lost to recharge between the gage at Barstow and the boundary at Waterman. To ascertain the validity of the assumption inherent in the schedule and determine the volume of recharge that could be stored annually, we evaluated the area located roughly between the gage at Bartow and the Waterman Fault. The results of our investigation are provided in the accompanying Technical Memorandum (Appendix A), and the findings were presented to Watermaster in September of 2011.

An important part of the analysis involves the determination of available storage space in a finite period of time. The results, presented in Table 6 of Appendix A, indicate that the average annual discharge across the Waterman Fault for the sixty year hydrologic base period, 1931 to 1990 would be 16,406 acre-feet. We recommend that the inflow to Baja be changed to 16,406 acre-feet from 14,000 acre-feet for two reasons:

1. Losses between the Barstow gage and Waterman Fault are a function of channel conditions, pumping and return flow, consumptive use of native vegetation, discharges by the City of Barstow wastewater treatment plant and are represented in the aggregate by the change in water levels shown on Figure 7 of Attachment A.
2. The analysis resulting in the recommendation of 16,406 acre-feet is based on a data set that is more complete than the assumptions that were made for the Judgment. Primarily, substantially more water level data and water use data are available since 1992 than prior to 1992.

The assumptions set forth in the Judgment for this particular inflow element were based on information developed for prior years. Consequently, we are better able to relate stream flow and losses to estimates of change in storage quantifiable by reasonable estimates of hydrologic conditions and measured water level changes.

LONG TERM AVERAGE ANNUAL OUTFLOW AT AFTON

The Judgment includes an estimate for long term average annual outflow at Afton of 8,200 acre-feet. This value includes an estimate for storm flow and base flow (subsurface discharge), and is based on the sixty year hydrologic base period 1931-1990. Since surface flow at Waterman Fault is inflow to Baja and outflow at Afton represents surface discharge from Baja, the estimated average annual surface water recharge to Baja is represented by the difference. From

the foregoing discussion, 16,406 acre-feet of inflow at Waterman Fault, less 8,200 acre-feet of outflow at Afton, would result in 8,206 of average annual recharge to Baja.

USGS Water Resources Investigation Report 01-4002, "Simulation of Ground-Water Flow in the Mojave River Basin, California" (Stamos et al 2001) provides an estimate for stream leakage in the amount of 12,013 acre-feet from the Mojave River to the Baja subarea during the hydrologic base period, (Stamos et al, page 83). Previous work regarding stream leakage is reprinted below:

Estimates of Annual Discharge from
the Mojave River Groundwater Basin

Study	Net stream leakage *(acre-feet)*
1930 (Hardt 1971)	10,050
1963 (Hardt 1971)	11,650
1937-61 (DWR 1967)	12,642
1931-90 (MBAW Judgment Table C-1)	7,400
1931-90 (USGS)	12,013

Although these values cover different time periods and different conditions, they are consistent, with the exception of the value included in the Judgment. If we use an inflow value of 17,153 acre-feet (16,406 plus 647 acre-feet from Kane wash and 100 acre-feet of precipitation) the stream leakage number would be 8,953 acre-feet (17,153-8,200 acre-feet), which is still less than reported by the others. However, there is no reason to prefer any one of the values listed in the table as closer to a true value than another. Each is based on a set of assumptions that is true for the given circumstances and supportable by the data available at the time.

To evaluate the long term water supply conditions in Baja, it is necessary to understand the long term average annual discharge at Afton reported in the Judgment, which includes a period of twenty three years of incomplete records from 1932-1952, and 1979 and 1980. An estimate for the incomplete record from the 1932 to 1952 was made by USGS (Hardt, 1971 page 16) and independently by Hanson Engineers (February 1993), prior to trial. The estimated average annual discharge at Afton based on Hardt, was 8,549 acre-feet and 8,247 acre-feet based on Hanson's estimate.

Despite the agreement in the estimates, it is possible that both values are overstated. It is also possible that the USGS reported discharge value at Barstow on which the estimate for Waterman fault and the incomplete data at Afton are based, is too low. Further, it is possible that the USGS reported value for stream leakage as determined by Stamos by modeling is not representative of the actual conditions that result in recharge. It would be very difficult to establish with certainty the true value of average annual discharge at Barstow, Waterman and Afton, as it occurred in the past. Accordingly, we propose using the USGS record at Afton from 1953 -1990 with minor modification to represent outflow at Afton Canyon. The results are shown on the proposed Table 5-2, which estimates stream leakage as surface inflow less outflow, or 17,153-5,611 =11,542 acre-feet. This value is more consistent with the previous work.

The period of missing record at Afton occurred during a period of time preceding the date that overdraft is generally considered to have commenced (around 1950), and the condition of the groundwater system and river channel in Baja that relate to recharge prior to 1950 no longer exist. The actual period of complete record for the USGS gage at Afton, includes 1931, 1953-1978, 1981-2010.

We recommend using the average discharge at Afton, represented by the actual record, but including data synthesized for 1979 and 1980, as this period spans the period of overdraft condition in Baja. The average discharge at Afton for this period is 5,611 acre-feet including storm flow of 5,475 and base flow of 137 acre-feet, as shown on table below:

Mojave Basin Area Watermaster
Estimated Future Average Discharge of the Mojave River at Afton, CA
Based on Estimated Potential Base Flow
(all values in acre-feet)

Water Year	Reported/Estimated[1]			Adjusted for Potential Base Flow[2]	
	Total Flow	Storm Flow	Base Flow	Base Flow	Total Flow
1931	1,268	143	1,125	137	280
1932	18,850	17,864	986	137	18,001
1933	1,000	0	1,000	137	137
1934	1,000	0	1,000	137	137
1935	1,000	0	1,000	137	137
1936	1,000	0	1,000	137	137
1937	54,070	53,070	1,000	137	53,207
1938	72,200	71,200	1,000	137	71,337
1939	1,000	0	1,000	137	137
1940	1,000	0	1,000	137	137
1941	49,900	48,900	1,000	137	49,037
1942	1,000	0	1,000	137	137
1943	47,200	46,200	1,000	137	46,337
1944	18,200	17,200	1,000	137	17,337
1945	10,800	9,800	1,000	137	9,937
1946	6,720	5,720	1,000	137	5,857
1947	1,000	0	1,000	137	137
1948	1,000	0	1,000	137	137
1949	1,000	0	1,000	137	137
1950	1,000	0	1,000	137	137
1951	1,000	0	1,000	137	137
1952	2,190	1,190	1,000	137	1,327
1953	990	7	983	137	144
1954	952	0	952	137	137
1955	912	34	878	137	171
1956	902	49	853	137	186
1957	753	0	753	137	137
1958	2,784	2,112	672	137	2,249
1959	597	18	579	137	155
1960	684	5	679	137	142
1961	668	22	646	137	159
1962	563	10	553	137	147
1963	751	178	573	137	315
1964	539	8	531	137	145
1965	566	54	512	137	191
1966	4,781	4,349	432	137	4,486
1967	1,466	1,168	298	137	1,305
1968	358	65	293	137	202
1969	72,725	72,282	443	137	72,419

Mojave Basin Area Watermaster
Estimated Future Average Discharge of the Mojave River at Afton, CA
Based on Estimated Potential Base Flow
(all values in acre-feet)

Water Year	Reported/Estimated[1]			Adjusted for Potential Base Flow[2]	
	Total Flow	Storm Flow	Base Flow	Base Flow	Total Flow
1970	542	0	542	137	137
1971	360	0	360	137	137
1972	598	0	598	137	137
1973	311	0	311	137	137
1974	435	0	435	137	137
1975	160	0	160	137	137
1976	297	0	297	137	137
1977	897	580	317	137	717
1978	46,749	46,271	478	137	46,408
1979	1,200	657	543	137	793
1980	66,700	66,157	543	137	66,293
1981	1,381	89	1,292	137	226
1982	1,052	100	952	137	237
1983	13,312	12,482	830	137	12,619
1984	1,820	1,106	714	137	1,243
1985	684	0	684	137	137
1986	550	0	550	137	137
1987	562	0	562	137	137
1988	915	234	681	137	371
1989	434	0	434	137	137
1990	546	0	546	137	137
1991	744	224	520	137	361
1992	628	307	321	137	444
1993	66,590	65,900	690	137	66,037
1994	483	0	483	137	137
1995	391	24	367	137	161
1996	633	280	353	137	417
1997	646	241	405	137	378
1998	1,287	935	352	137	1,072
1999	578	234	344	137	371
2000	283	7	275	137	144
2001	350	110	240	137	247
2002	239	0	239	137	137
2003	249	0	249	137	137
2004	394	113	281	137	250
2005	44,638	44,434	204	137	44,571
2006	186	14	172	137	151
2007	150	0	150	137	137
2008	166	36	130	137	173

Mojave Basin Area Watermaster
Estimated Future Average Discharge of the Mojave River at Afton, CA
Based on Estimated Potential Base Flow
(all values in acre-feet)

Water Year	Reported/Estimated[1]			Adjusted for Potential Base Flow[2]	
	Total Flow	Storm Flow	Base Flow	Base Flow	Total Flow
2009	112	7	105	137	144
2010	190	63	127	137	200
Average (all)	**8,035**	**7,403**	**632**	**137**	**7,540**
Average (measured)	**4,961**	**4,461**	**500**	**137**	**4,598**
Average (1953-1990 all)	**6,066**	**5,475**	**591**	**137**	**5,611**
Average (1953-1990 measured)	**4,517**	**3,923**	**594**	**137**	**4,060**
Average (1953-2010 all)	**6,025**	**5,534**	**491**	**137**	**5,671**
Average (1953-2010 measured)	**5,027**	**4,538**	**489**	**137**	**4,675**

Notes:
[1] Discharge of Mojave River at Afton, CA from water years 1932 through 1952 by William Hardt and published by USGS in Open - File Report, "Hydrologic Analysis of Mojave River Basin California using Electric Analog Model" dated August 18, 1971. Water Years 1979 and 1980 estimated by Mojave Basin Area Watermaster All other water year discharge values as reported by USGS station Mojave River at Afton, CA (10263000)..
[2] Potential future base flow estimated as the five-year average base flow from 2006 through 2010.

No Measured Data at Afton
Used to Estimate Future Base Flow

A fundamental premise of the Judgment is that arresting overdraft by purchasing supplemental water will result in stabilizing water levels in the upstream basins. Further, it is assumed that the sixty year base period hydrology that produced the average annual water supply will be repeated. Conditions in Alto have resulted in water level stability in the near river aquifer, Free Production Allowance is 60% of the Base Annual Production, and supplemental water has been purchased to offset the deficit. In Centro, there is a slight surplus in supply based on current pumping conditions and long term water supply. Also, total water production in Centro is about 60% less than it was during the Judgment's base period. As conditions is Alto and Centro are significantly different today than they were 20 years ago (at the end of the hydrologic base period), we should expect long term supply conditions at Barstow in the future to be similar to the past.

However, it is unlikely that a similar conclusion can be made about Baja. Water levels have fallen significantly downstream from the Waterman Fault and upstream and downstream of the Calico Newberry Fault (at Minneola Road). The reduction in pumping in the past several years will at best stabilize water levels, but without purchase and recharge of imported water, water levels are unlikely to rise. Consequently the hydrologic conditions that exist currently are likely to remain in future.

The Judgment's water supply conditions are based on a hydrologic base period, 1931-1990 with the assumption that the future water supply will mimic the past. Under the assumption that the water supply will be repeated, the Alto and Centro subareas will remain balanced in the future, imported water will continue to be purchased and recharged. Therefore we expect the water supply conditions at least to the Waterman Fault, to be consistent with history.

PHREATOPHYTES

As part of this evaluation of the Baja water supply conditions, and consistent with the information provided to Watermaster in September 2011, we are not recommending any change to the value assigned to phreatophyte use which is currently 2,000 acre-feet. We have discussed with Mr. Thomas Bilhorn, consultant to DFG, the process for re-evaluating this number. The Department is considering its position relative to the current health of the riparian habitat at Camp Cady, and in the Baja subarea in general. We have previously said that the conditions under which phreatophyte use was estimated to be 2,000 acre-feet per year have changed. Further, declines in water levels resulting from over pumping in Baja are not likely to recover sufficiently to support riparian plants to a past condition. At best, water levels under either current pumping conditions, or reduced pumping, will stabilize at or near the current levels. If this assumption is true, it is unlikely that a healthy riparian habitat will return in Baja beyond the limits of Camp Cady.

According to Mr. Bilhorn the Department is most concerned about two things

1. Preserving and restoring Camp Cady.
2. Potentially restoring habitat elsewhere in Baja.

Consequently, the Department's goal may depend in part on using the 2,000 acre-feet assumed to be used by riparian plants in a different manner. Until the Department and Watermaster staff understand the relationship between the current 2,000 acre-foot estimate for phreatophyte use and the longer term goals of the Department, we are unprepared to make a recommendation on the fate of the water identified as phreatophyte use in the Judgment (Table 5-1 of the Watermaster Annual Report).

SUPPLY CONTRIBUTION FROM DESERT WASHES

For purposes of this report, we have included an estimated 647 acre-feet of recharge from Kane Wash as determined by USGS (Stamos, 2001). Also, we estimate that desert washes contribute to the water supply, although estimates of inflow volume vary. In work previously submitted to Watermaster, the desert wash contribution was conservatively estimated to be 205 acre-feet.

PROPOSED
TABLE 5-2

BAJA SUBAREA HYDROLOGICAL INVENTORY BASED ON LONG TERM AVERAGE NATURAL WATER SUPPLY AND OUTFLOW AND 2009-10 IMPORTS AND CONSUMPTIVE USE

(ALL AMOUNTS IN ACRE-FEET)

WATER SUPPLY	**Table 5-1**	**Table 5-2**	**Table 5-2 Proposed**
Surface Water Inflow			
Gaged	0	0	0
Ungaged	14,400	14,400	**17,153** [1]
Other Ungaged	0	0	**205** [2]
Subsurface Inflow	1,200	1,200	**1,581** [3]
Deep Percolation of Precipitation	100	100	100
Imports			
Replacement Water Deliveries	0	0	0
Water Storage Accounts [4]	0	0	0
Lake Arrowhead CSD	0	0	0
Big Bear Area RWA	0	0	0
TOTAL	**15,700**	**15,700**	**19,039**
CONSUMPTIVE USE AND OUTFLOW			
Surface Water Outflow			
Gaged	8,200	8,200	**5,611** [5]
Ungaged	0	0	0
Subsurface Outflow	0	0	0
Consumptive use			
Agriculture	20,800	10,400	10,400
Urban [6]	7,900	5,300	5,300
Phreatophytes [7]	2,000	2,000	2,000
Exports	0	0	0
TOTAL	**38,900**	**25,900**	**23,311**
Surplus / (Deficit)	(23,200)	(10,200)	**(4,272)**
Total Estimated Production (Current Year) [8]	43,879	23,767	23,400
PRODUCTION SAFE YIELD (Current Year)	**20,679**	**13,567**	**19,128**

[1] Estimated from reported flows at USGS gaging station, Mojave River at Barstow. Includes 16,406 acre-feet of Mojave River surface flow across the Waterman Fault estimated by "Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault", Wagner & Bonsignore, 2012 (see Appendix A, Table 6), and 747 acre-feet of local surface inflow from Kane Wash and Boom Creek.

[2] Estimated contribution from washes (Wagner, 2011).

[3] USGS Stamos modeling results 2001, pg. 87 Figure 34

[4] Water that was pre-purchased under the MWA Claim Program.

[5] Based on stormflow at Afton for water years 1931, 1953-78, 1981-1990 (from USGS) 1979-1980 estimated by Hanson Engineering 1992 plus base flow of 137 acre-feet (Watermaster 2010)

[6] Includes consumptive use of "Minimals Pool".

[7] From USGS Water-Resurces Investigation Report 96-4241 "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" 1996.

[8] Based on Water Production Data for the 2009-10 Water Year.
Included in the production values are the estimated minimal producer's water use by Subarea.

RECOMMENDATION FOR FUTURE RAMPDOWN

Based on the foregoing, there is a deficit in Baja of 4,272 acre-feet. The annual deficit in Baja has averaged about 15,000 acre-feet per year since about 1950. If the current hydrologic conditions are consistent with the assumptions made herein, we might expect water level decline to slow, or possibly begin to stabilize. However, given the episodic nature of recharge to Baja, it may be several years before we know. Consequently we recommend reducing the Free Production allowance by 2.5% per year for two more years (2012-2013 and 2013-2014) consistent with the existing court order. At that time, we would evaluate the water supply conditions and changes in water levels since entry of Judgment.

The full extent of the Rampdown required in Baja to reach a balance is dependent of three conditions:

1. The amount of natural water supply.
2. The type of use.
3. The extent and distribution of pumping.

Assuming that the current pattern of land use remains the same, pumping would be sustainable, in the aggregate at around 20,000 acre-feet per year, with a lower consumptive use. A pattern of land use representing a lower consumptive use (meaning less agriculture and more domestic use) would allow for additional pumping. Assuming that water levels stabilize over a reasonable period of time (spanning the past 20 years and the next 5 years) Rampdown could be stopped (at 50% of BAP) at least for a few years to evaluate conditions.

We note that none of the proposed revisions discussed herein actually provide additional water. Rather, the revisions provide a framework to evaluate Free Production Allowance under different assumptions. Water level changes in Baja will ultimately provide the best measure of health in the groundwater system.

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2. Hydrologic Analysis of Mojave River Basin California Using Electric Analog Model, Open File Report. U.S. Department of the Interior Geological Survey, Water Resources Division by William Hardt. Prepared in cooperation with The Mojave Water Agency, US. Marine Corps Supply Center, Barstow and George Air Force Base, Menlo Park, California, August 18, 1971

3. Simulation of Ground-Water Flow in the Mojave River Basin, California, Water-Resources Investigations Report 01-4002. U.S. Department of the Interior, U.S. Geological Survey. By C. L. Stamos, P. Martin, T. Nishikawa, and B. Cox. Prepared in Cooperation with Mojave Water Agency. Sacramento, California, 2001

4. Analysis of the Flow of the Mojave River at the Lower Narrows, Near Victorville San Bernardino County, California, J. C. Hanson, Consulting Civil Engineer, Sacramento, California. August 1992

5. Mojave Basin Area Watermaster Annual Reports

6. Stream gage data for the Mojave River, U.S. Geological Survey, 2012

APPENDICES

Appendix A - Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault

Appendix B - Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

Appendix C - Analysis of Baja Subarea Desert Wash Discharge

Appendix D - Explanation of computed potential evapotranspiration and actual evapotranspiration for Harter project

APPENDIX A

Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault

TECHNICAL MEMORANDUM

TO: Mojave Basin Area Watermaster

FROM: Robert C. Wagner, P.E, Watermaster Engineer,
David M. Houston, P.E.

DATE: January 24, 2012

RE: Evaluations of Potential Mojave River Recharge Losses between Barstow and Waterman Fault

Information contained herein is intended to summarize the results of evaluations of potential groundwater recharge along the Mojave River between the USGS stream gage near Barstow, CA and Waterman Fault (see location map, Figure 1).

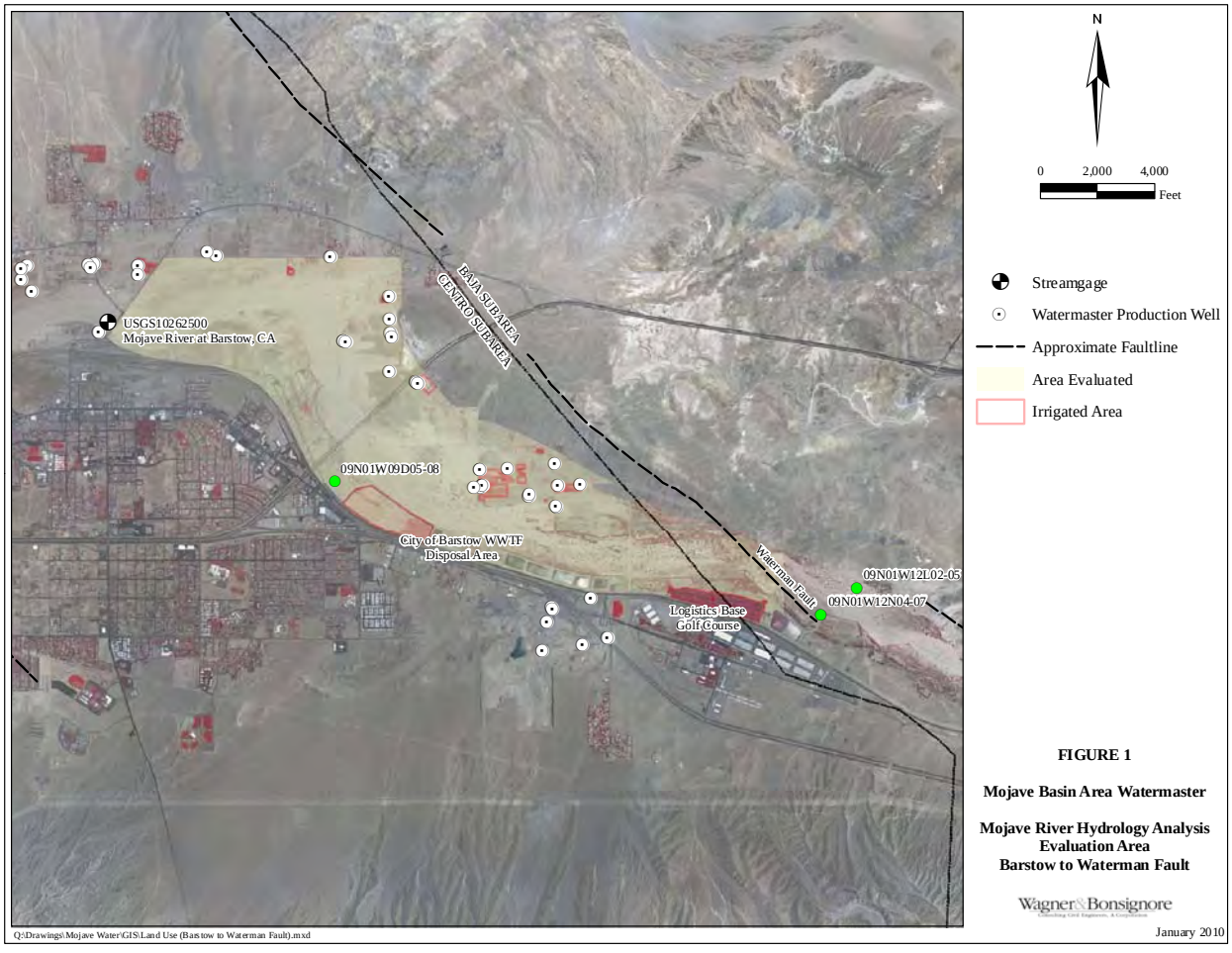


FIGURE 1

Mojave Basin Area Watermaster

Mojave River Hydrology Analysis Evaluation Area Barstow to Waterman Fault

Wagner & Bonsignore

Evaluations were conducted as a free body mass-balance and an evaluation of Centro recharge potential based on an analysis conducted by Mojave Water Agency (MWA) in which surface water losses were calculated based on potential change in groundwater levels indicating recharge in the study area.

1.0 MASS-BALANCE EVALUATION

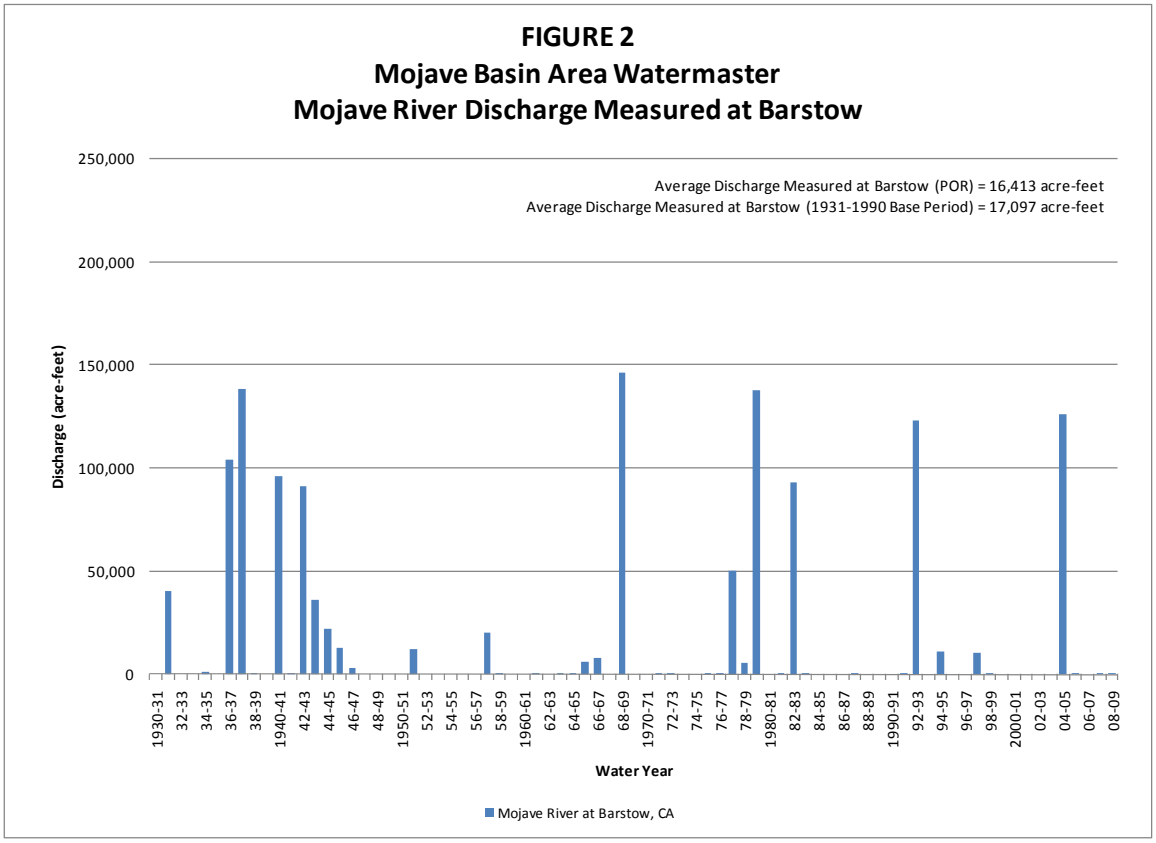
The 2,452 acre evaluated area is an approximated boundary of alluvial soils along the Mojave River, between the USGS streamgage 10262500 at Barstow, CA and the Waterman Fault, which potentially recharges to the groundwater aquifer below. The evaluated area was treated as a free body and an estimation of total supply and demand for the area was quantified. Based on an analysis of historic groundwater level measurements, we began our evaluation with the assumption that the area was nearly in balance. Groundwater levels decline slightly in dry years and rise following storm events. Water balances for three periods were evaluated; water year 2008, 15-year period from water year 1994 through 2008, and the last balance utilized various maximum periods of record available for each parameter. Results of our analysis, as shown in Tables 1 through 3, support our original hypothesis.

Measureable elements of supply to the area consist of discharge of the Mojave River, precipitation, and City of Barstow Wastewater Treatment Facility (WWTF) effluent. Measureable elements of demand on the area consist of verified pumping production and acreages of land likely consumptively using water. Other elements of supply or demand were estimated in order to complete a water mass balance for the evaluated area. Measured and estimated elements of supply and demand are described in sections below.

1.1 Supply

<u>USGS 10262500 Mojave River at Barstow, CA</u>

Discharge of the Mojave River is measured by the USGS near the North 1st Avenue bridge. Discharge is reported in the Annual Reports (Annual Reports) of the Mojave Basin Area Watermaster (MBAW). As shown on the location map, the streamgage is the westernmost edge of the evaluated area. See chart, Figure 2, for measured values of Mojave River discharge at Barstow. Measurements at the gage show the area is characterized by long periods of negligible surface flow interrupted by infrequent storm events producing large spikes of discharge, as shown on the hydrograph in Figure 2.



Surface Runoff

A small percentage of precipitation results in surface runoff and a smaller percentage of surface runoff will contribute to groundwater recharge. The majority of precipitation will be lost to evaporation, used by vegetation, or simply not percolate past the top layer of soil. For the evaluated area, the surface runoff is assumed to be negligible.

Subsurface Inflow

Subsurface inflow entering Centro Subarea is reported as an estimated 2,000 acre-feet. According to the Regional Water Table (2008) in the Mojave River and Morongo Groundwater Basins, Southwestern Mojave Desert, California, the groundwater elevation changes about 400 feet from 2,350 feet to about 1,950 feet in roughly 25 miles along the Mojave River from the western boundary to the eastern boundary of Centro. However, in the roughly 10 miles upstream of the evaluation area, the water table only changes 100 feet. Due to limited availability of more detailed data regarding subsurface inflow, based on the small change in water table elevation upstream of the evaluation area, to simplify the evaluation, we assumed subsurface inflow to the evaluated area was minimal. This is a limitation of the evaluation.

Precipitation

As described in the Surface Runoff section, the majority of precipitation is assumed to be consumptively used between Barstow and Waterman fault. The amount of precipitation falling on the evaluated area was estimated using measurements reported for the California Irrigation Management Information System (CIMIS) station Barstow NE. Data from this station was available from water years 1998 through 2009.

Deep Percolation of Precipitation

Deep Percolation of Precipitation is assumed to be negligible.

City of Barstow WWTF Effluent

City of Barstow Wastewater Treatment Facility effluent was approximated at by influent data provided by City of Barstow. Data was available from 2006 through 2009.

Irrigation Return Flow

Irrigation return flow is roughly estimated as 30% of agricultural pumping and 70% of domestic pumping based on previous studies reported in "Simulation of Ground-Water Flow in the Mojave River Basin, California" USGS WRIR 01-4002. Municipal return flow was estimated as 46% of pumping based on independent studies in the Alto subarea by MBAWM.

1.2 Demand

Mojave River Estimated Outflow

Groundwater levels monitored using wells in the evaluated area, with perforation depths varying from 60 to 640 feet below ground surface, appear to indicate that the supply and demand for the evaluated area is nearly balanced (see charts below, Figures 3 and 4).

FIGURE 3
Mojave Basin Area Watermaster
09N01W12N04-07

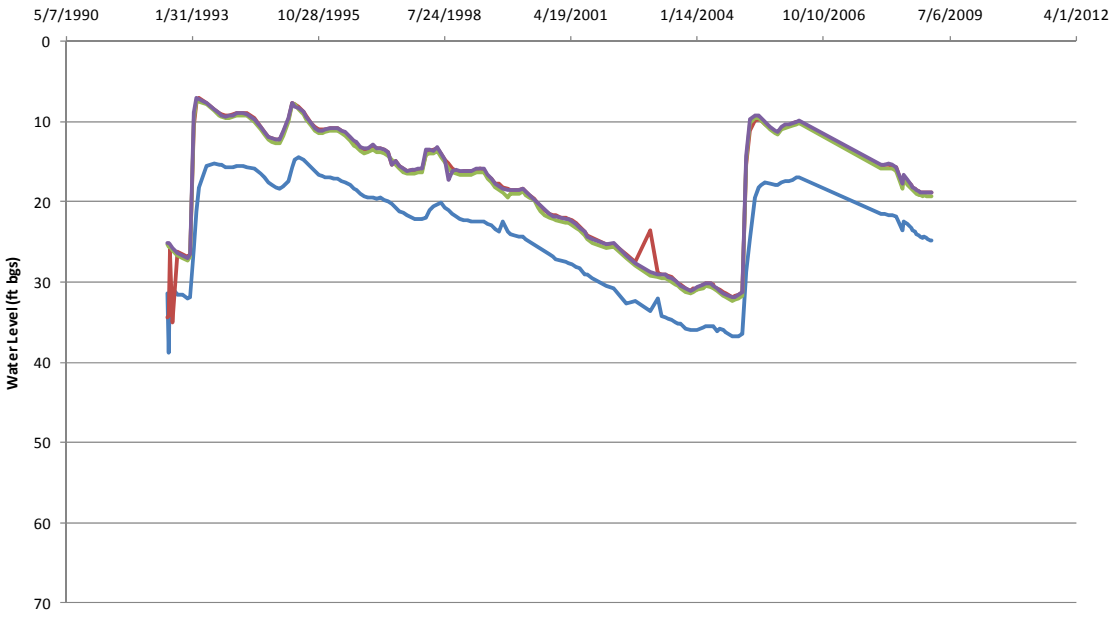
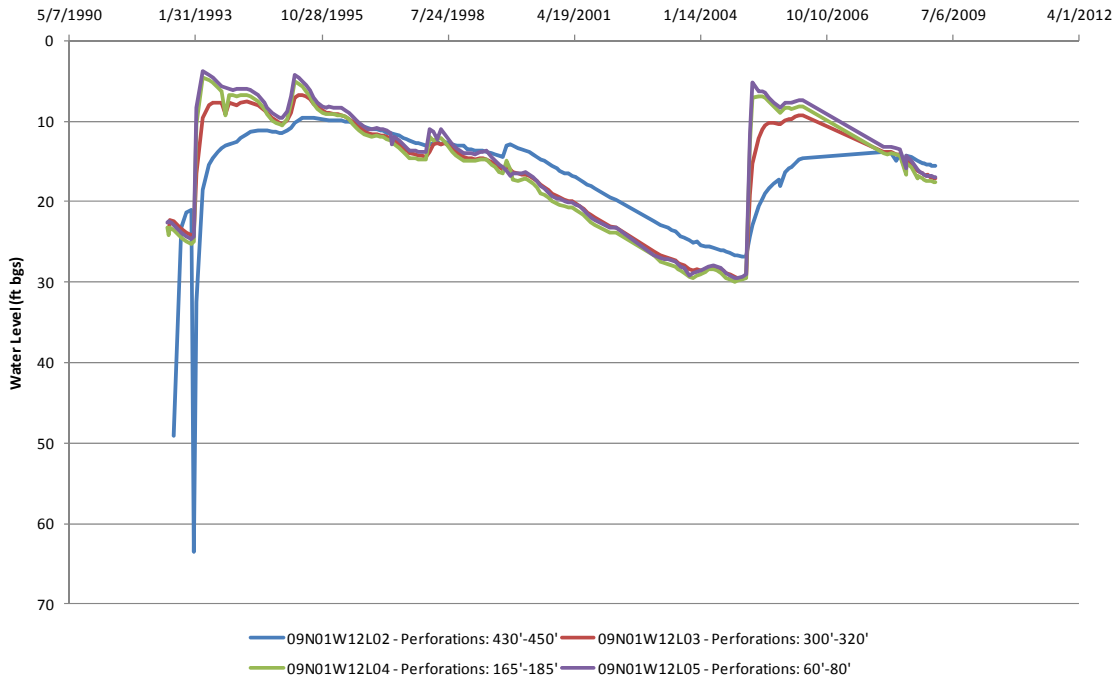


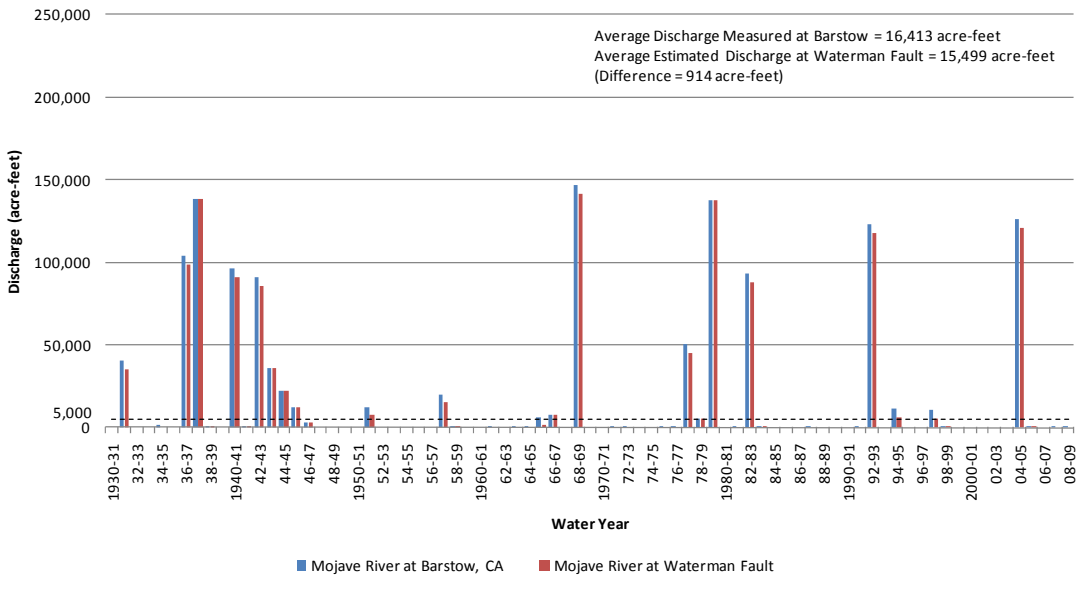
FIGURE 4
Mojave Basin Area Watermaster
09N01W12L02-05



Over the course of the 12 year dry period from water years 1993 through 2004 water levels declined about 20 to 25 feet. A large storm at the beginning of water year 2005 raised the water levels about 20 feet. Based on the available water level data, we estimated outflow at the Waterman Fault assuming that the groundwater recharge for the evaluated area has a maximum value. We estimated this maximum value based on an estimated soil available water capacity of about 10 percent. Based on an estimated maximum depth between 20 and 25 feet, an effective porosity of 10 percent, and an evaluated area of about 2,500 acres, the maximum groundwater recharge value is about 5,000 acre-feet.

We created a historic discharge hydrograph for Waterman Fault (Figure 5) based on the assumption that a maximum of 5,000 acre-feet could recharge between the Barstow streamgage and Waterman Fault. Mojave River discharge at Waterman Fault was assumed to be 5,000 acre-feet per year less than discharge measured at Barstow. We also assumed that the soil would be saturated in any year following a year with greater than 5,000 acre-feet of discharge and accordingly would not recharge. In such a year the streamflow losses between Barstow and Waterman Fault were assumed to be negligible.

FIGURE 5
Mojave Basin Area Watermaster
Mojave River Discharge Measured at Barstow and Estimated at Waterman Fault



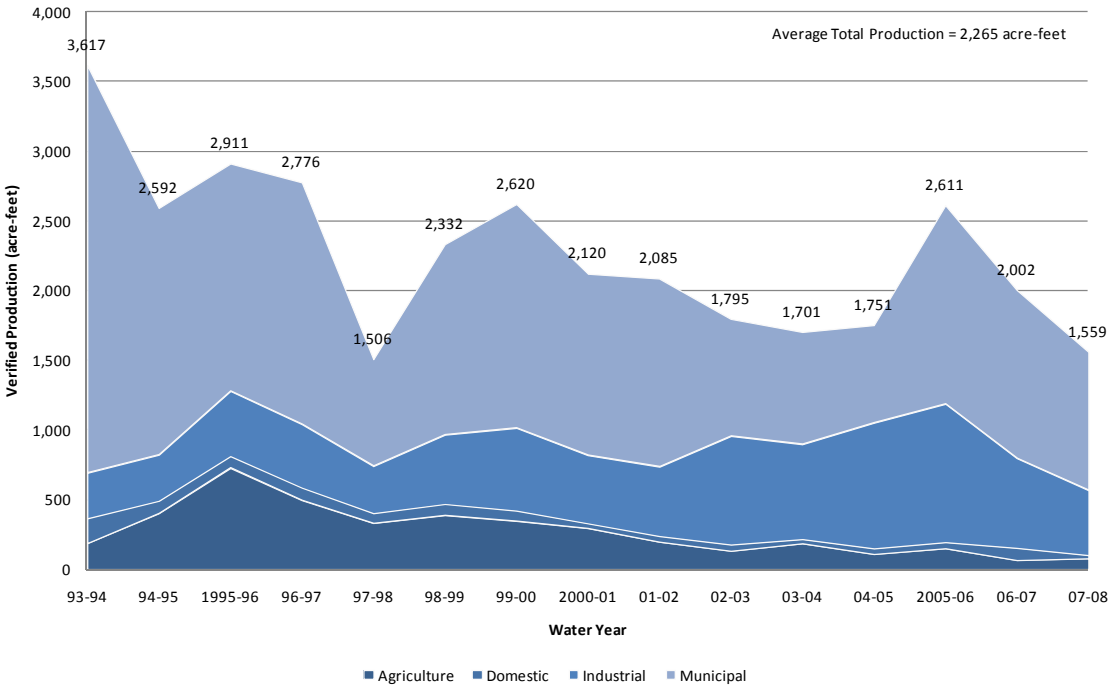
Subsurface Outflow

Subsurface outflow from Centro Subarea is reported in the Annual Reports to be about 1,200 acre-feet per year. Waterman Fault nearly coincides with the boundary of Centro Subarea, accordingly this value is used for the subsurface outflow of the evaluated area.

Water Production (Pumping)

Verified production for the evaluated area was provided by Watermaster for water years 1994 through 2008. The production uses are identified as Agricultural, Domestic, Industrial, and Municipal. Industrial uses in the evaluated area are represented solely by Service Rock Products Corporation. Municipal uses are only by Golden State Water Company. Verified production is shown on Figure 6.

FIGURE 6
Mojave Basin Area Watermaster
Verified Production Between Barstow and Waterman Fault



Consumptive Use

Irrigation

The majority of lands irrigated in water year 2007 were delineated by Watermaster and provided in GIS files. We identified additional lands receiving water by reviewing

infrared aerial imagery of the area. Lands identified by Watermaster indicated the crop type being irrigated. We used a Consumptive Use estimation program, called CUP-Plus, that was developed by California Department of Water Resources (DWR) and UC Davis. The program estimates Crop Evapotranspiration (ET_C) for an irrigated crop in an identified area based on input daily climate data specific for the area. Daily climate data measured at CIMIS station Barstow NE was used to estimated ET_C values. ET_C values were then used to estimate the consumptive use of each crop. Irrigated areas identified based on review of infrared aerial imagery were assumed to have the same consumptive use as improved pasture areas.

Urban Areas

Urban areas within the evaluated area were identified using infrared aerial imagery. A percentage of irrigated area was estimated and a consumptive use similar to turfgrass was assumed for urban outdoor use.

Phreatophytes

Native vegetation areas were identified using infrared aerial imagery. A percentage of the identified areas consumptively using water was estimated and the use of the riparian plants was calculated based on information for the Centro Subarea in "Riparian Vegetation and its Water Use During 1995 Along the Mojave River, Southern California" by G. Lines and T. Bilhorn, USGS WRIR 96-4241.

Surface Water Evaporation

Ponds and Lakes were identified by Watermaster and through review of aerial imagery. Evaporation from the surface of the water bodies was estimated based on surface area and the average reference evapotranspiration (ET_O) for the CIMIS Barstow NE station.

1.3 Results

Water year 2008 was a dry year; very little flow was measured in the Mojave River at the Barstow gage. Accordingly, it was assumed that flow at Waterman Fault was negligible and a water balance concluded that the area was slightly in deficit, as expected (see Table 1).

TABLE 1
Water Balance - Water Year 2007-08
(all measurements in acre-feet)

Component	Barstow to Waterman Fault
Supply	
Mojave River Measured Inflow (Barstow)[1]	10
Surface Runoff[2]	0
Subsurface Inflow	0
Precipitation[3]	375
Deep Percolation of Precipitation	0
City of Barstow WWTF Effluent[4]	2,810
Subtotal	**3,196**
Return Flow[5]	497
Total Available Supply	**3,692**
Demand	
Mojave River Estimated Outflow (Waterman Fault)	0
Subsurface Outflow (from Judgement After Trial)	1,200
Production[6]	
Agricultural	78
Domestic	26
Industrial	466
Municipal	989
Consumptive Use of Irrigation (Water Year 2007 Acreage)[7]	
Logistics Base Golf Course	189
City of Barstow WWTF Disposal Area	406
All Other Irrigated Areas	176
Urban Area Consumptive Use[8]	47
Phreatophytes Consumptive Use[9]	490
Surface Water Evaporation[10]	113
Total Demand	**4,180**
Surplus/(Deficit)	**(488)**

Notes:
(1) From Annual Reports of Mojave Basin Area Watermaster (MBAW).
(2) Surface runoff is assumed to be negligible.
(3) Precipitation reported by Barstow NE CIMIS station, falling on evaluated area.
(4) Approximate, based on influent data provided by City of Barstow.
(5) Return flow is estimated as 30% of agricultural pumping, 70% domestic and 46% municipal.
(6) 2007-08 verified production from MBAW.
(7) Irrigated acreage provided by MBAW. Additional acreage was estimated using infrared aerial imagery and assuming an ET_C value from CA DWR CUP plus Program.
(8) Urban areas estimated using infrared aerial imagery and assuming an ET_C value from CA DWR CUP plus Program.
(9) Consumptive use of riparian plants calculated based on information for Centro Subarea in "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" by G. Lines and T. Bilhorn, USGS WRIR 96-4241.
(10) Evaporation is calculated based on water surface areas estimated using aerial imagery and CIMIS average ET_O for Barstow NE station (68.04 in.).

The second water balance was evaluated from water year 1994 through 2008, see Table 2. Verified water production from 1994 through 2008 was readily available and precipitation was near average for this period. As shown on Figures 3 and 4, storms in 1993 and 2005 appear to recharge the groundwater basin while dry periods between storms correspond to a slight decline in storage. This phenomenon was used to estimate potential flows at Waterman Fault based on flows measured at Barstow (as shown in Figure 5). For the 1994-2008 water balance, Mojave River average outflow at Waterman Fault was estimated in such a manner and the balance yielded a surplus of about 711 acre-feet.

TABLE 2
Water Balance - Water Years 1993-94 Through 2007-08
(all measurements in acre-feet)

Component	Barstow to Waterman Fault
Supply	
Mojave River Measured Inflow (Barstow)[1]	9,865
Surface Runoff[2]	0
Subsurface Inflow	0
Precipitation[3]	1,010
Deep Percolation of Precipitation	0
City of Barstow WWTF Effluent[4]	2,818
Subtotal	**13,694**
Return Flow[5]	756
Total Available Supply	**14,450**
Demand	
Mojave River Estimated Outflow (Waterman Fault)[6]	8,853
Subsurface Outflow (from Judgement After Trial)	1,200
Production[7]	
Agricultural	273
Domestic	70
Industrial	564
Municipal	1,358
Consumptive Use of Irrigation (Water Year 2007 Acreage)[8]	
Logistics Base Golf Course	189
City of Barstow WWTF Disposal Area	406
All Other Irrigated Areas	176
Urban Area Consumptive Use[9]	47
Phreatophytes Consumptive Use[10]	490
Surface Water Evaporation[11]	113
Total Demand	**13,739**
Surplus/(Deficit)	**711**

Notes:
(1) From Annual Reports of Mojave Basin Area Watermaster (MBAW).
(2) Surface runoff is assumed to be negligible.
(3) 1998-2009 precipitation reported by Barstow NE CIMIS station, falling on evaluated area.
(4) Approximate, based on influent data provided by City of Barstow.
(5) Return flow is estimated as 30% of agricultural pumping, 70% domestic and 46% municipal.
(6) Estimated average flow at Waterman Fault from based on an analysis of estimated losses between the fault and the USGS gage at Barstow, CA, as shown in Figure 5.
(7) 1993-94 through 2007-08 verified production from MBAW.
(8) Irrigated acreage provided by MBAW. Additional acreage was estimated using infrared aerial imagery and assuming an ET_C value from CA DWR CUP plus Program.
(9) Urban areas estimated using infrared aerial imagery and assuming an ET_C value from CA DWR CUP plus Program.
(10) Consumptive use of riparian plants calculated based on information for Centro Subarea in "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" by G. Lines and T. Bilhorn, USGS WRIR 96-4241.
(11) Evaporation is calculated based on water surface areas estimated using aerial imagery and CIMIS average ET_O for Barstow NE station (68.04 in.).

The third evaluation assumes the area is in balance with the goal of estimating long term average outflow at Waterman Fault, see Table 3. Available long term periods of record were used for various elements of supply and demand in the water balance. Water year 2007 land uses were used to estimate consumptive use demands. Subtracting elements of demand from elements of supply results in a calculated long term average outflow at Waterman Fault of about 16,795 acre-feet, about 300 acre-feet less than the long term average inflow at Barstow.

Results of the three water balance evaluations, though all elements cannot be known at this time, support the assumption that the evaluated area is nearly in hydrologic balance. Accordingly, Mojave River flow measured at Barstow can be used to in a similar manner to estimate flow at Waterman Fault, thence inflow to the Baja Subarea.

TABLE 3

Water Balance - Using Data from Historical Periods of Record
(all measurements in acre-feet)

Component	Barstow to Waterman Fault
Supply	
Mojave River Inflow (Barstow)[1]	17,097
Surface Runoff[2]	0
Subsurface Inflow	0
Precipitation[3]	1,010
Deep Percolation of Precipitation	0
City of Barstow WWTF Effluent[4]	2,818
Subtotal	**20,925**
Return Flow[5]	756
Total Available Supply	**21,681**
Demand	
Subsurface Outflow (from Judgement After Trial)	1,200
Production[6]	
Agricultural	273
Domestic	70
Industrial	564
Municipal	1,358
Consumptive Use of Irrigation (Water Year 2007 Acreage)[7]	
Logistics Base Golf Course	189
City of Barstow WWTF Disposal Area	406
All Other Irrigated Areas	176
Urban Area Consumptive Use[8]	47
Phreatophytes Consumptive Use[9]	490
Surface Water Evaporation[10]	113
Total Demand	**4,886**
Mojave River Outflow (Waterman Fault)	**16,795**

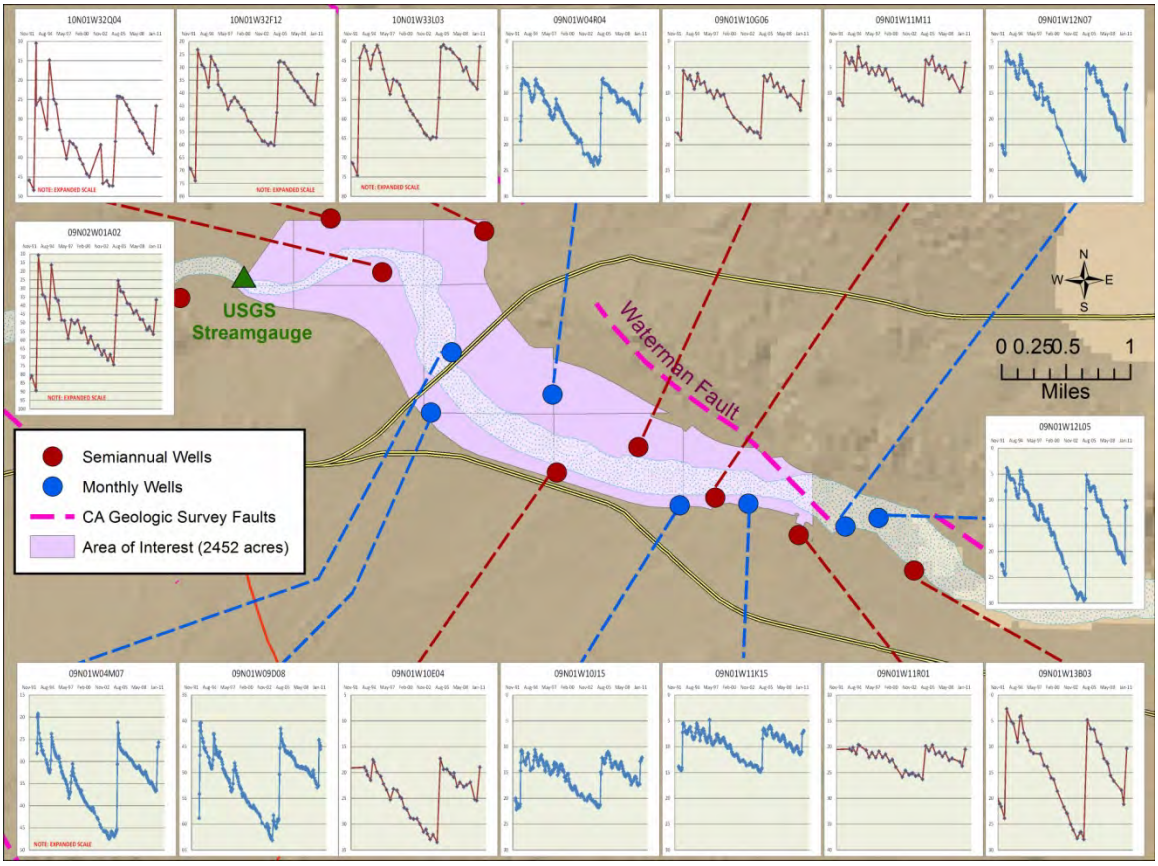
Notes:
[1] 1931-1990 average, from USGS.
[2] Surface runoff is assumed to be negligible.
[3] 1998-2009 precipitation reported by Barstow NE CIMIS station, falling on evaluated area.
[4] Approximate, based on influent data provided by City of Barstow.
[5] Return flow is estimated as 30% of agricultural pumping, 70% domestic and 46% municipal.
[6] 1993-94 through 2007-08 verified production from MBAW.
[7] Irrigated acreage provided by MBAW. Additional acreage was estimated using infrared aerial imagery and assuming an ET_C value from CA DWR CUP plus Program.
[8] Urban areas estimated using infrared aerial imagery and assuming an ET_C value from CA DWR CUP plus Program.
[9] Consumptive use of riparian plants calculated based on information for Centro Subarea in "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" by G. Lines and T. Bilhorn, USGS WRIR 96-4241.
[10] Evaporation is calculated based on water surface areas estimated using aerial imagery and CIMIS average ET_O for Barstow NE station (68.04 in.).

2.0 RECHARGE POTENTIAL EVALUATION

Groundwater Monitoring

The evaluated area along the Mojave River, between the USGS streamgage 10262500 at Barstow, CA and the Waterman Fault, is monitored by MWA at 16 locations (see Figure 7 below). Groundwater levels gradually fall during dry periods and recover during each storm as discussed in Section 1.0 and shown on the hydrographs dating from water years 1992 through 2011.

FIGURE 7



Aquifer Change in Storage

MWA analyzed the porosity of samples taken from the Centro area and compared their findings with the reported findings of similar analyses. Samples were evaluated for total porosity (the space between soil grains) and effective porosity (the volume of pore space that will drain under the influence of gravity). Findings of porosity are shown on Table 4 below.

TABLE 4
Total and Effective Porosity in Centro Subarea

Type	Porosity	Source
Total Porosity	19.5 & 33.7%	Analog Model (Hardt, 1971)
	20 & 20%	Numeric Model (Stamos, 2001)
	24 & 26%	MR-1 & MR-2 Advanced elogs (Schlumberger, 2009)
	30, 15, 25, 24 & 24%	MWA Samples (MWA, 2011)
Average	**~24%**	
Effective Porosity	9 & 10%	MR-1 & MR-2 Advanced elogs (Schlumberger, 2009)
	8, 2, 1, 4, & 8%	MWA Samples (MWA, 2011)
Average	**~9%**	

MWA analyzed water level recovery resulting from each storm, and based on an estimated effective porosity of the soils in the evaluated area of 9% (Winkel, Tony MWA, See Attachment A), approximated a volume of water recharging to the aquifer for each storm. A maximum estimated change in groundwater storage of 6,196 acre-feet resulted from the storm in water year 1993. The reported discharge of the Mojave River at Barstow in 1993 was about 122,800 acre-feet; the resulting discharge at Waterman Fault would be 116,604 acre-feet (See Table 5).

TABLE 5
Estimated Change in Groundwater Storage and
Resulting Discharge of the Mojave River at Waterman Fault

Water Year	Reported Discharge at Barstow	Estimated Change in Groundwater Storage	Resulting Discharge at Waterman Fault	Waterman Percentage of Barstow	Years Between Storms	Average Annual Change in Storage
1993	122,800	6,196	116,604	95%	10	628
1995	11,110	1,869	9,241	83%	2	935
1998	10,512	985	9,527	91%	3	328
2005	126,168	4,365	121,803	97%	7	624
2011	NA	2,034	NA	NA	6	433
Average	67,648	3,090	64,294	91%	6	589

The storm occurring in water year 1993 was preceded by a dry period lasting about 10 years. Accordingly, the recharge volume of 6,196 acre-feet was assumed to be about the capacity of the groundwater aquifer. The resulting average annual change in storage for the 10-year period between 1983 and 1993 was about -628 acre-feet per year, accounting for small intermittent storms. For the purposes of this analysis, it was assumed that the groundwater aquifer increased in available storage by 628 acre-feet per year and accumulated each year during a dry period. Each storm was assumed to recharge the aquifer to a maximum of 6,196 acre-feet. Resulting surface water loss rates between Barstow and Waterman Fault were estimated to be equivalent to the available aquifer storage.

As shown in Table 6 below, the resulting average annual loss between Barstow and Waterman Fault is estimated to be about 697 acre-feet from 1931 through 2010 (690 acre-feet from 1931-1990). The resulting average annual estimated discharge at Waterman Fault was 15,516 acre-feet per year from 1931 through 2010 (16,406 acre-feet from 1931-1990).

TABLE 6
Estimated Annual Surface Water Losses from the Mojave River Between Barstow and Waterman Fault

Water Year	Reported Discharge at Barstow	Estimated Available Aquifer Storage	Estimated Surface Water Losses	Estimated Discharge at Waterman Fault
1931	0	6,196	0	0
1932	40,305	0	6,196	34,109
1933	0	628	0	0
1934	0	1,255	0	0
1935	1,180	1,883	1,180	0
1936	0	2,510	0	0
1937	103,879	0	3,138	100,741
1938	138,094	0	628	137,466
1939	550	78	550	0
1940	0	705	0	0
1941	96,003	0	1,333	94,670
1942	101	527	101	0
1943	90,974	0	1,154	89,820
1944	36,254	0	628	35,626
1945	22,087	0	628	21,459
1946	12,577	0	628	11,949
1947	2,877	628	628	2,249
1948	0	1,255	0	0
1949	0	1,883	0	0
1950	0	2,510	0	0
1951	0	3,138	0	0
1952	12,548	0	3,766	8,782
1953	0	628	0	0
1954	0	1,255	0	0
1955	0	1,883	0	0
1956	0	2,510	0	0
1957	0	3,138	0	0
1958	20,063	0	3,766	16,297
1959	4	624	4	0
1960	0	1,251	0	0
1961	0	1,879	0	0
1962	735	2,506	735	0
1963	0	3,134	0	0
1964	1	3,761	1	0
1965	6	4,382	6	0

Water Year	Reported Discharge at Barstow	Estimated Available Aquifer Storage	Estimated Surface Water Losses	Estimated Discharge at Waterman Fault
1966	6,350	0	5,010	1,340
1967	7,691	0	628	7,063
1968	0	628	0	0
1969	146,601	0	1,255	145,346
1970	0	628	0	0
1971	0	1,255	0	0
1972	44	1,839	44	0
1973	151	2,315	151	0
1974	0	2,943	0	0
1975	0	3,571	0	0
1976	1	4,197	1	0
1977	2	4,823	2	0
1978	50,463	0	5,450	45,013
1979	5,560	628	628	4,932
1980	137,654	0	1,255	136,399
1981	0	628	0	0
1982	1	1,254	1	0
1983	92,995	0	1,882	91,113
1984	42	586	42	0
1985	0	1,213	0	0
1986	0	1,841	0	0
1987	0	2,468	0	0
1988	8	3,088	8	0
1989	0	3,716	0	0
1990	0	4,343	0	0
1991	0	4,971	0	0
1992	30	5,568	30	0
1993	122,800	0	6,196	116,604
1994	0	628	0	0
1995	11,110	0	1,255	9,855
1996	0	628	0	0
1997	0	1,255	0	0
1998	10,512	0	1,883	8,629
1999	0	627	0	0
2000	0	1,255	0	0
2001	0	1,882	0	0
2002	0	2,510	0	0
2003	0	3,138	0	0
2004	0	3,765	0	0
2005	126,168	0	4,393	121,775
2006	182	446	182	0
2007	0	1,073	0	0
2008	10	1,691	10	0
2009	0	2,318	0	0
2010	374	2,572	374	0

Water Year	Reported Discharge at Barstow	Estimated Available Aquifer Storage	Estimated Surface Water Losses	Estimated Discharge at Waterman Fault
1931-2010 Avg	**16,212**	**1,580**	**697**	**15,516**
1931-1990 Avg	**17,097**	**1,535**	**690**	**16,406**

3.0 CONCLUSIONS

Estimated discharge of the Mojave River at Waterman Fault based on these two evaluations seems to be in agreement. Results of the three water balance evaluations in Section 1.0, though all elements cannot be known at this time, support the assumption that the evaluated area is nearly in hydrologic balance. Similarly, the evaluation of recharge potential in Section 2.0 suggests an average surface water loss of 690 acre-feet, for water years 1931 through 1990, resulting in an estimated discharge of 16,406 acre-feet at Waterman Fault, which is about a difference of 2% from the 16,795 estimated in Section 1.0. Accordingly, Mojave River flow measured at Barstow can be used to in a similar manner to estimate flow at Waterman Fault, thence inflow to the Baja Subarea.

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APPENDIX B

Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

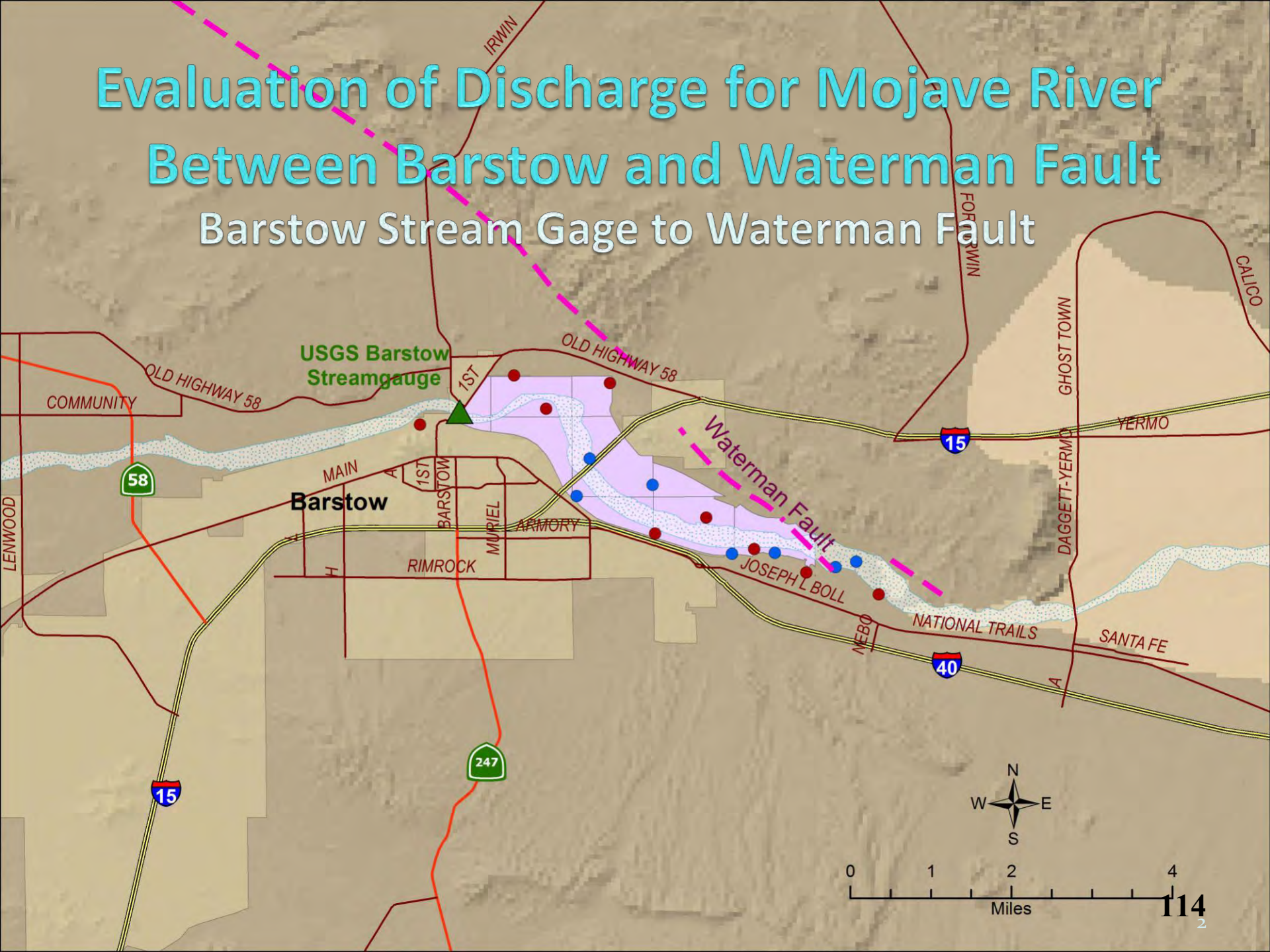
APPENDIX B

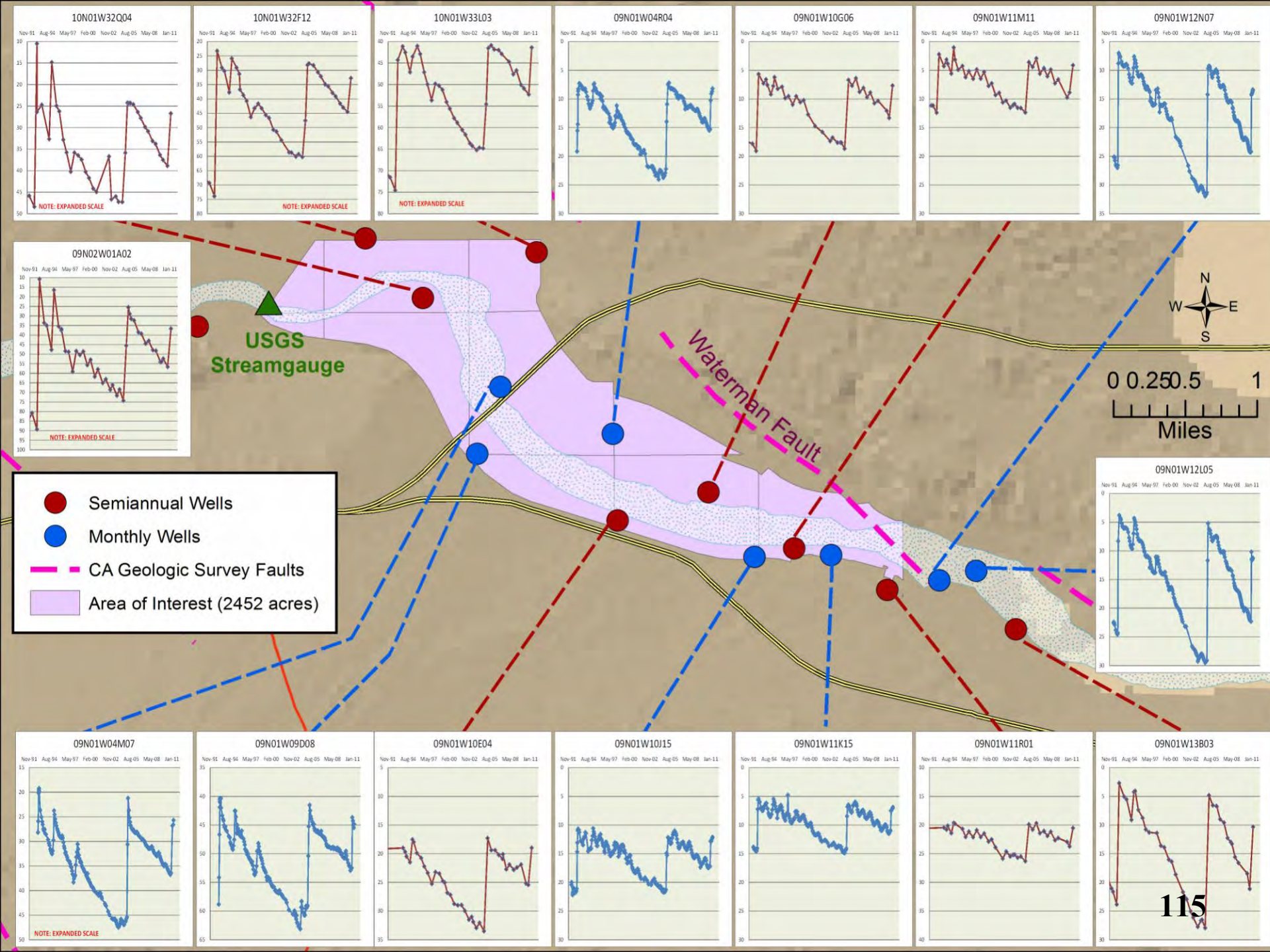
Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

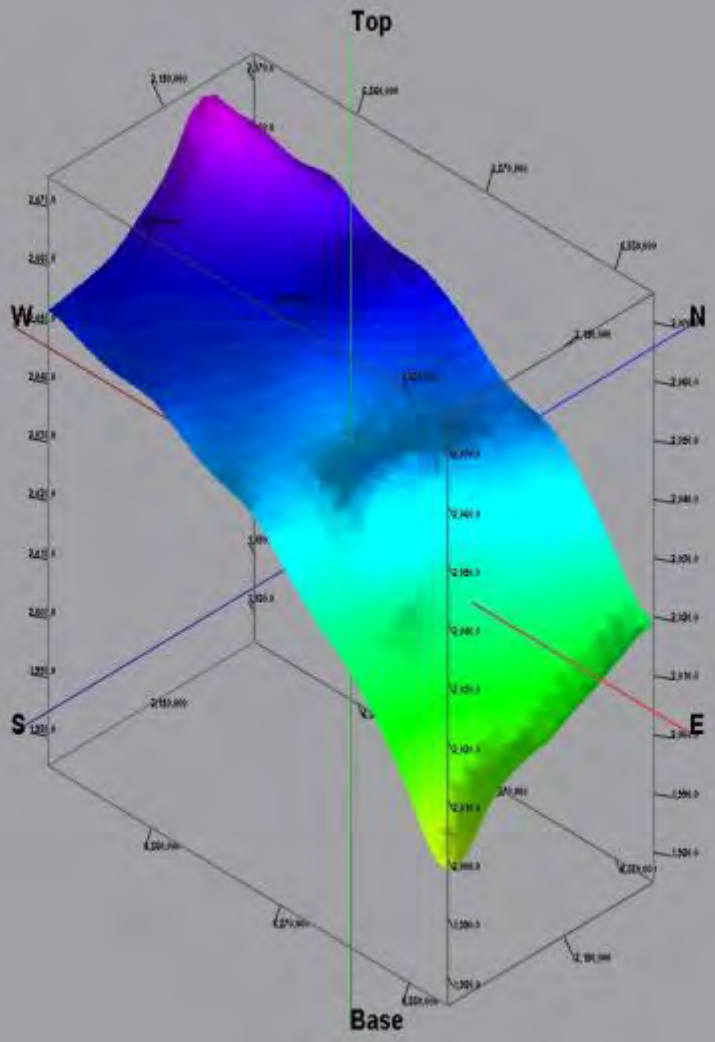
Robert C. Wagner, P. E. Watermaster Engineer
Tony Winkel, P. E. Mojave Water Agency

Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

Barstow Stream Gage to Waterman Fault



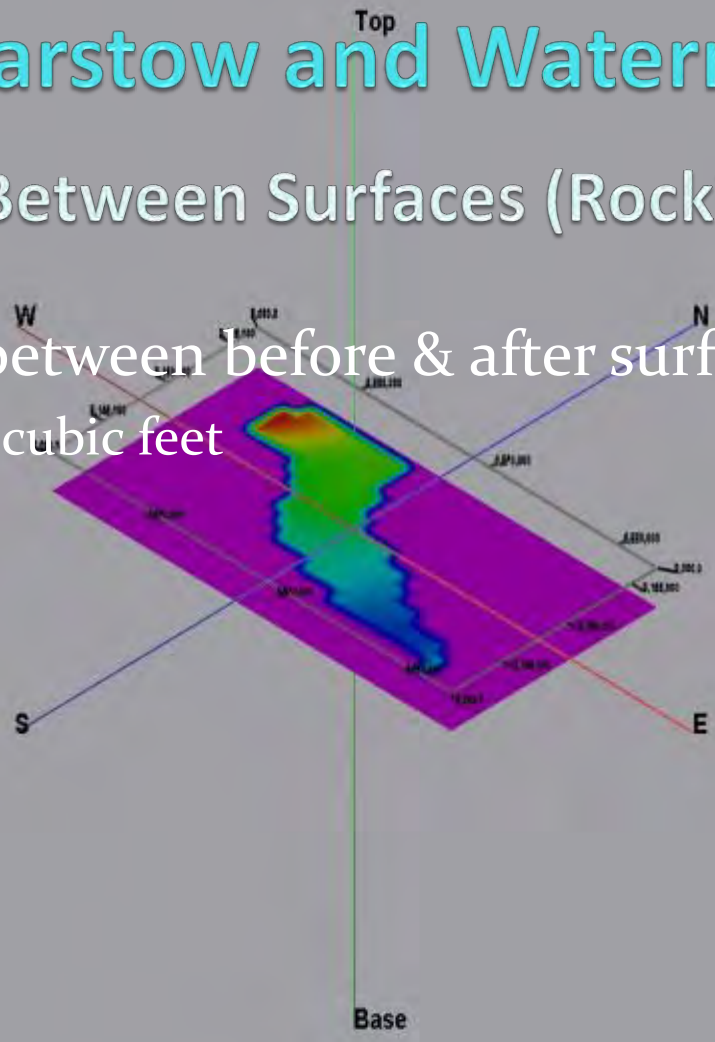

10N01W32Q04
10N01W32F12
10N01W33L03
09N01W04R04
09N01W10G06
09N01W11M11
09N01W12N07
09N02W01A02
NOTE: EXPANDED SCALE
USGS Streamgauge
Waterman Fault
N
W
E
S
0 0.250.5 1
Miles
09N01W12L05
Semiannual Wells
Monthly Wells
CA Geologic Survey Faults
Area of Interest (2452 acres)
09N01W04M07
09N01W09D08
09N01W10E04
09N01W10J15
09N01W11K15
09N01W11R01
09N01W13B03


Top
W
N
S
E
Base

Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

Volume Between Surfaces (RockWorks)

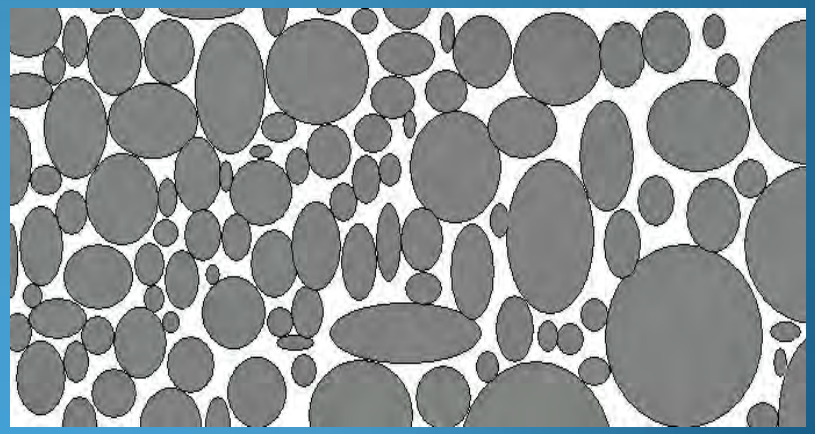
- Total volume between before & after surfaces
  - 2,112,876,826 cubic feet



Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

Porosity

- Total Porosity
  - The space between the grains
- Effective porosity
  - The volume of pore space that will drain under the influence of gravity.



Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

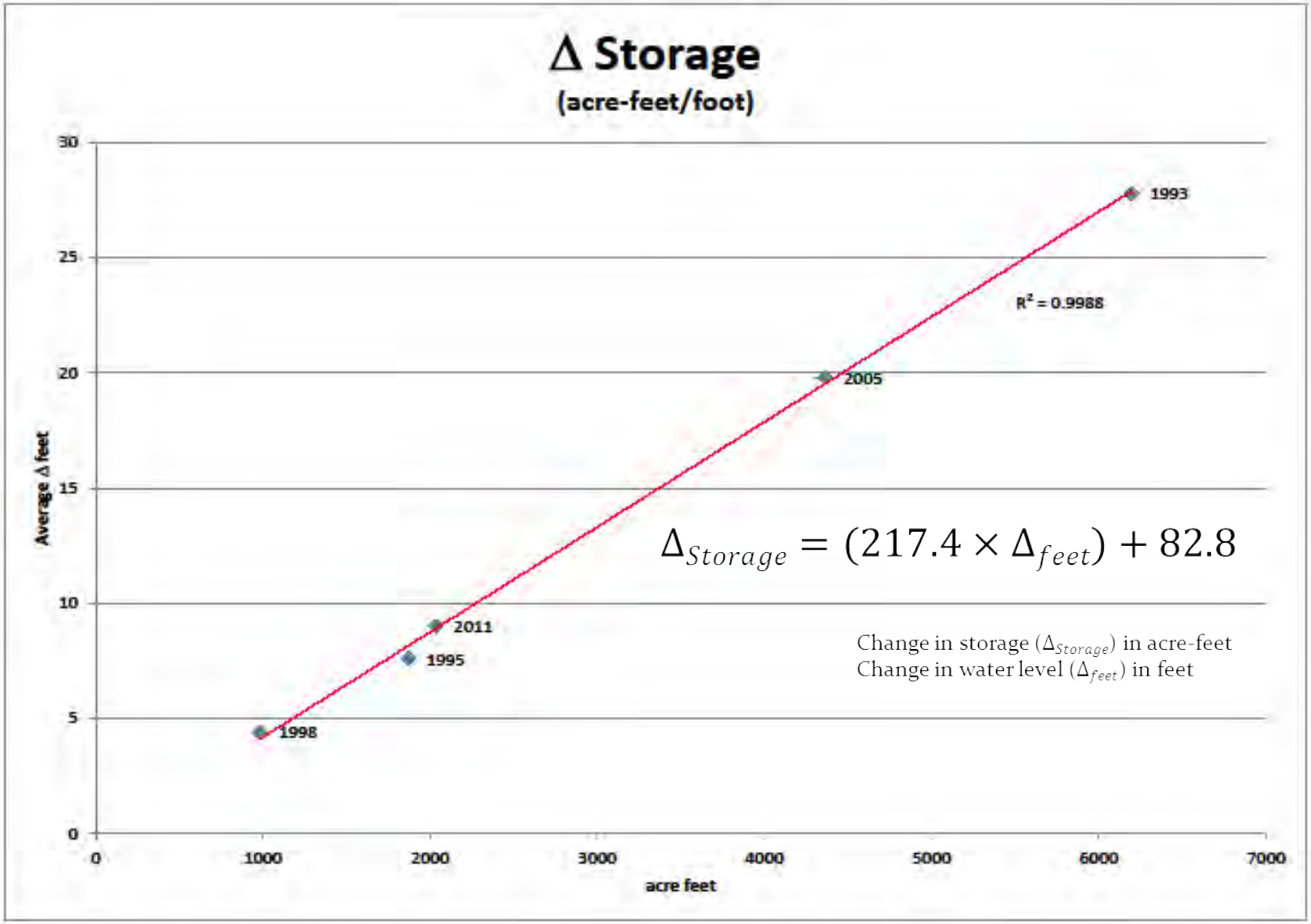
Total vs. Effective Porosity

- Total Porosity ~24%
  - 19.5 & 33.7%
    - Analog Model (Hardt, 1971)
  - 20-20%
    - Numeric Model (Stamos, 2001)
  - 24 & 26%
    - MR-1 & MR-2 Advanced elogs (Schlumberger, 2009)
  - 30, 15, 25, 24, & 24%
    - MWA samples (MWA, 2011)
- Effective Porosity ~9%
  - 9 & 10%
    - MR-1 & MR-2 Advanced elogs (Schlumberger, 2009)
  - 8, 2, 1, 4, & 8%
    - MWA samples (MWA, 2011)

Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

Storm Recharge

- Change in Storage at 9% Porosity
  - 1993 - 6,196 acft
  - 1995 - 1,869 acft
  - 1998 - 985 acft
  - 2005 - 4,365 acft
  - 2011 - 2,034 acft


Δ Storage
(acre-feet/foot)
Average Δ feet
30
25
20
15
10
5
0
0
1000
2000
3000
4000
5000
6000
7000
acre feet
1993
2005
2011
1995
1998
R² = 0.9988
$\Delta_{Storage} = (217.4 \times \Delta_{feet}) + 82.8$
Change in storage ($\Delta_{Storage}$) in acre-feet
Change in water level (Δ_{feet}) in feet

Evaluation of Discharge for Mojave River Between Barstow and Waterman Fault

Summary

- Change in storage can be calculated
  - $\Delta_{Storage}=217.4\times\Delta_{feet}+82.8$

APPENDIX C

Analysis of Baja Subarea Desert Wash Discharge

May 4, 2011

Robert C. Wagner, P.E., Watermaster Engineer

ANALYSIS OF BAJA SUBAREA DESERT WASH DISCHARGE

INTRODUCTION

The following report was prepared as part of the ongoing discussions between Watermaster staff and the Baja Subarea Advisory Committee regarding the evaluation of water supply to Baja, and to advance the general understanding of ungaged inflow to the Mojave River.

The Mojave River originates at the confluence of Deep Creek and West Fork Mojave River, near Hesperia at the Mojave River Dam. The Dam is a flood control facility that does not store water. The river flows in a general north north-easterly direction toward Barstow, and eventually exits the Mojave Basin Area a few miles upstream from Afton. Continuous surface flow in the river primarily occurs only when winter storms produce runoff from the mountains. Flow occurs along the entire reach of the river only during episodes of floodflow (USGS, Stamos et al 2001). Flow in the river measured at the Barstow gauging station and the supply to Baja is primarily the result of runoff from precipitation in the San Bernardino Mountains.

U. S. Geological Survey Water-Resources Investigation Report 95-4189 (WRIR 95-4189) authored by Gregory Lines (1996) presents an estimate of ungaged tributary inflow to the Mojave River by adopting a methodology published in USGS Water-Supply Paper 1999-E, "Mean Annual Runoff as Related to Channel Geometry of Selected Streams in California (E.R. Hedman 1970)." The Baja Subarea Advisory Committee has asked that Watermaster consider the estimated annual discharge of 3900 acre-feet from ungaged tributaries presented in WRIR 95-4189 (Lines, 1996), and whether the estimate should be included in the supply to the Baja Subarea.

BACKGROUND

Rain resulting in groundwater recharge occurs either as direct deposition onto the landscape infiltrating the soil surface and percolating past the root zone, or rainfall in excess of infiltration as runoff accumulating in channels percolating through the channel bed to recharge the groundwater.

Recharge from precipitation on the desert valley floor is considered to be minimal in the Mojave area and adjacent Antelope Valley. Fundamental to this understanding is the basic mechanics of rainfall, soil storage capacity, and evapotranspiration. For example, if the typical rooting depth is approximately 6 feet and the soil water field capacity (water held in pore space) is 12 percent by volume, then the total water held within the rooting depth is approximately 8.5 inches. Therefore, for these conditions, the rainfall amount sufficient to produce water percolating past the root zone would be greater than 8.5 inches and the water held within the root zone becomes evapotranspiration. Several studies conducted in the greater Mojave Desert or comparable regions have concluded similar results as follows:

- California Department of Water Resources, Bulletin No. 84 (DWR 1967) found "for this study, all precipitation less than 8 inches annually was considered to be used in satisfying the growth and transpiration requirements of the [sic] native vegetation and, therefore, was not considered an item of water supply or consumption."
- USGS (Hardt, 1971) found "recharge to the aquifers from direct precipitation on the desert floor probably is negligible."

- USGS (Nishikawa et. al., 2001) found "it was assumed that areal recharge from periods of precipitation and runoff was insignificant because of the infrequent occurrence of these periods and the low precipitation and high pan evaporation rates in the study area. This assumption is supported by other studies in the Mojave Desert [for example, Izbicki et. al. (1998)]."
- USGS (Stamos et. al., 2001) found "recharge to the aquifer system from direct precipitation is considered to be minimal because precipitation or runoff do not adequately meet evapotranspiration and soil-moisture requirements."
- USGS (Durbin, 1978) found "because the average annual precipitation on the valley floor is less than 10 in. (250 mm) (Rantz, 1969), very little runoff is generated on the valley floor, and probably very little precipitation penetrates below the root zone.
- In an environment somewhat similar to that of Antelope Valley, Blaney, Taylor, and Young (1930) and Young and Blaney (1942) found that precipitation does not penetrate below the root zone if the annual precipitation is less than about 12 in. (300 mm). Therefore, precipitation on the valley floor was not considered to be an important source of ground-water recharge."
- USGS (Leighton, 2003) found "precipitation over the valley floor generally is less than 10 in./yr (Rantz, 1969) and evapotranspiration rates [pan evaporation rate is about 114 in./yr (Bloyd, 1967)] and soil moisture requirements are high; therefore, recharge from direct infiltration of precipitation is negligible (Snyder, 1955; Durbin, 1978)."
- USGS (Mendez, 1997) found "recharge to the ground-water system from direct infiltration (areal recharge) of precipitation is minimal."

The other pathway rain recharges groundwater is by percolation through the channel bed during flow events. Flow events occurring in watersheds tributary to the Mojave River are typically sporadic and likely occur on timescales comparable to the rain event. The bed material and soil moisture are likely identical to the surrounding landscape. Therefore, the percolation mechanics are likely governed by the same circumstances and the probability for recharge is negligible. Consequently, recharge from precipitation on the valley floor is considered insignificant.

Lines (1996) estimated the ungaged tributary inflow to the Mojave River from desert washes by adopting a methodology published in USGS Water-Supply Paper 1999-E, "Mean Annual Runoff as Related to Channel Geometry of Selected Streams in California (E.R. Hedman 1970)." Hedman employed a methodology that related channel forms to mean annual discharge by carefully measuring the channel geometry of various streams in California, where the mean annual runoff was known. Hedman related depth and width of 48 stream channels throughout California and developed a statistical relationship between channel geometry and mean annual discharge from his measurements and USGS stream gage records. It is important to note that Lines (1996) did not estimate recharge occurring in the washes.

Lines (1996) made measurements at 29 sites over a wide geographical and hydrological area of Southern California near active stream gages and at sites where streamflow measurements had been taken previously. Lines (1996) was unable to develop a statistically significant relationship using channel depth. However, Lines (1996) did report that a relationship developed using channel width was statistically significant. Figure 17, page 20 of Lines (1996) shows the relationship graphically (Figure 1 of this report). An inspection of Figure 1 shows the wide range of discharge that is indicated by the statistical relationship. For example the data is well scattered for channel widths less than 5 feet. At a width of about 4 feet, the discharge is within a range of

about 20 acre-feet annually to about 2,000 acre-feet annually. For a channel width of about 2 feet to about 3 feet, the discharge is between 10 acre-feet and 4,000 acre-feet.

We do not conclude from the foregoing that the methodology employed by Hedman and then adopted by Lines (1996) to relate channel forms to known discharge is flawed. Rather, the methodology is not easily adopted for desert washes, as used by Lines (1996), and the methodology itself is difficult to apply. The stream systems studied by Hedman relate two variables to discharge, depth and width. Lines (1996) was unable to find a relationship with depth and relied only on width. As pointed out in the foregoing discussion, for channel widths less than 5 feet, the methodology and data collected in this study is a poor predictor of discharge.

Lines (1996) estimates the average annual ungaged tributary inflow of 3900 acre-feet contributes to the Mojave River lower main stem (Baja subarea) based on a weighted average of watershed area. To arrive at this value, Lines (1996) uses a ratio of area draining to the lower main stem (432 square miles, and the area of the Baja washes 180 square miles; 432/180 = 2.4) multiplied by the estimated discharge from the Baja washes (1630 acre-feet). If the estimate of discharge from Baja washes is overstated by the statistical relationship, then the estimate of ungaged tributary inflow is also overstated.

Lines (1996) assumed that tributary inflow to the Mojave River from ephemeral streams (desert washes) occurred at the same relative magnitude as ephemeral runoff in the Mojave River at Barstow. There is little basis to support this assumption. As noted by USGS (Stamos, et al 2001), runoff at Barstow is a function of precipitation events in the San Bernardino Mountains to the south. Runoff in the desert washes is a function of local precipitation. There is nothing cited in Lines (1996) indicating that precipitation events in the San Bernardino mountains produce runoff to the tributary areas of the desert washes in Baja of a similar pattern as discharge at Barstow. Notably, about 60% of precipitation as measured at Daggett (east of Barstow) occurs during periods of the year when there is little or no flow at Barstow (see Figure 2).

We believe that the estimate presented in Lines (1996) is overstated by a factor of 10 and that the amount of ungaged supply to Baja is already accounted for on Table 5-1 of the Watermaster Annual Reports.

ALTERNATE APPROACH

Boom Creek, Daggett Wash, Calico Wash, Manix Wash, Wilhelm Wash, and Unnamed Wash are ungaged desert washes tributary to the Mojave River, and are located within the Baja Subarea of the Mojave Basin. In order to determine the amount of discharge contributing to the Mojave River from these desert washes, reference streams measured by USGS in the surrounding area were utilized. These reference gaged streams are Cushenbury Creek, Pipes Creek, Cache Creek, Cottonwood Creek, Spencer Canyon Creek, Goler Gulch, and Beacon Creek (Plate 1). Based on mean annual precipitation, mean annual discharge, and approximate drainage area, a unit-discharge figure was produced for each gaged watershed, seven in total. Each unit-discharge was then applied to each desert wash, incorporating its own watershed size, ranging from about 1,000 acres to more than 65,000 acres, and mean annual precipitation, ranging from 3.5 to 4.5 inches in an average year. The results range from 11 acre-feet to a maximum of 205 acre-feet of discharge in an average year for the desert washes tributary to the Mojave River.

Utilizing ArcGIS, watershed boundaries for the desert washes and reference gaged streams were delineated using 7.5 minute USGS quadrangles to determine drainage area. Once completed, a GIS database composed of isohyetal lines of equal rainfall (Rantz, 1972) was overlaid to determine the approximate mean annual precipitation for each watershed (Plate 1). Rantz (1972) provides a simple and reliable estimation of mean annual precipitation over very

large areas. Although dated, the Rantz data is reasonably consistent with long-term mean annual precipitation for reference gages. For example, mean annual precipitation is 4.5 inches at the Barstow station (period of record is 1913 through 1980) and 3.8 inches at the Daggett F.A.A. station (period of record is 1949 through 2010), while Rantz estimates that both stations receive approximately 4.5 inches of average annual precipitation. Also shown on Table 1, for the channels studied by Lines (1996), is the mean annual precipitation, reported discharge, and corresponding mean annual precipitation for those watersheds as a percentage of the mean annual precipitation for the area surrounding the Baja washes.

The reference gaged streams are at higher elevation and are located in the San Bernardino Mountains to the south of the Baja washes, and to the west in the Tehachapi and San Gabriel Mountains. These watersheds receive much higher average annual rainfall, and vary in drainage area but are comparable in size to the desert washes. Total drainage area is about 132,000 for the reference gaged streams, and about 116,000 acres for the desert washes. Average annual rainfall for the reference gaged streams is approximately 12 inches, whereas the desert washes receive 4.25 inches on average.

Using the USGS methodology (Lines, 1996) for estimating discharge (Figure 1), the reference gaged streams would produce a total of 1,573 acre-feet of discharge during an average year. However, according to USGS streamgage records, the average annual discharge for these streams is a combined 159 acre-feet, about 10% of what was predicted by Lines (1996) (see Table 2).

Estimated average annual discharge was calculated for each Baja wash using the reference gaged streams (Table 3). This analysis was performed by using the ratio of average annual discharge to the total amount of water from precipitation within the reference gaged streams watershed, and applying the resulting unit-discharge to the total amount of water from precipitation within the watersheds of each Baja wash. The results provide a range of values due to the wide array of different characteristics in each reference gaged watershed, including, but not limited to, slope, aspect, canopy cover, evapotranspiration, and elevation. The seven values are intended to provide a range of average annual discharge estimates for comparison to the discharge estimates of the USGS (Lines, 1996).

To further understand the desert stream system, closer analysis of Cushenbury Creek and Pipes Creek was conducted. It was found that rainfall of up to 2 inches in a day did not result in any flow at the Cushenbury Creek streamgage, and only storm events in excess of 2 inches created any consistent response in recorded flow (Figure 3). Furthermore, discharge was only recorded when annual precipitation was greater than 9 inches, with the exception of water year 1962, when rainfall was 9.3 inches and produced no discharge at the Cushenbury Creek streamgage (Figure 4). The situation is similar for Pipes Creek; less than 3 inches of rainfall per day did not produce a response in measured flow (Figure 5). Moreover, recorded annual discharge required in excess of 10 inches of precipitation annually, with the exception of 1970 when annual rainfall totaled 1.4 inches and yielded 4 acre-feet of discharge (Figure 6).

We also evaluated the discharge from the Oak Creek watershed situated between Cottonwood Creek and Cache Creek watersheds (see Plate 1). These three watersheds discharge to the Antelope Valley from the east slope of the mountains near Tehachapi. A comparison of the discharge records during the period of overlapping record (Figure 7) shows that Oak Creek produces more discharge than the two adjacent watershed despite all three having about the same weighted mean annual precipitation. Figure 8 indicates that Oak Creek has at times, an extended recession hydrograph and base discharge, not apparent in the other two. Oak Creek also exhibits a runoff pattern similar to snow melt driven watersheds. During the winter of 1969, Oak Creek discharge was limited, and rapidly increased in early spring and rapidly decreased into late spring.

The discharge was limited but constant through summer and fall and the pattern repeats each season. The Baja washes do not exhibit this behavior nor do the watersheds adjacent to Oak Creek. Oak Creek is not considered to be representative of the expected discharge patterns experienced in the desert washes and was not included in this analysis.

CONCLUSION

From the results of the Cushenbury and Pipes Creek analysis we can conclude that at least of 9 inches of rainfall per year is needed in order to produce any measurable amount of discharge. The Baja washes are located at a much lower elevation, and receive about 3.5 to 4.5 inches of rainfall per year. If Cushenbury and Pipes Creeks are indicators of what is required in order to see discharge from a desert wash, the Baja washes cannot be expected to produce significant discharge. We estimate for the Baja washes the total average annual contribution to the Mojave River is less than 205 acre-feet. The average based on the seven referenced gages is 105 acre-feet per year and the median is 74 acre-feet per year. The Judgment After Trial, January 10, 1996, estimated the contribution from ungaged inflow to be 300 acre-feet, all of which was attributed toKane Wash, and 100 acre feet of deep percolation of precipitation for a total of 400 acre feet. Lines (1996) does not include contributions from Kane Wash, because Kane does not discharge to the river.

RECOMMENDATION

Based on the foregoing, we do not recommend a change to the estimated amount of ungaged tributary inflow to Baja adopted by the court in the Judgment After Trial, January 10, 1996.

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TABLE 1
Mojave Watermaster
Weighted Mean Annual Precipitation of Baja Washes and Streamgages used in USGS Report[1]

Baja Washes	Approximate Drainage Area[2] (ac)	Weighted Mean Annual Precipitation[3] (in)
Boom Creek	1,032	4.5
Daggett Wash	15,468	3.5
Calico Wash	65,163	4.5
Manix Wash	28,399	4.5
Wilhelm Wash	4,826	4.25
Unnamed	1,012	4.25
Average		**4.25**

Streamgages used in USGS Analysis[1]	Approximate Drainage Area[2] (ac)	Mean Annual Discharge[4] (af)	Weighted Mean Annual Precipitation[3] (in)	Percent of Baja Wash Mean Annual Precipitation
USGS 10252550 Caruthers Creek Near Ivanpah, CA	525	94	11	259%
USGS 10255700 San Felipe Creek Near Julian, CA	63,084	710	16.8	395%
USGS 10255805 Coyote Creek Bl Box Canyon Near Borrego Springs, CA	99,467	1,930	9.7	228%
USGS 10255810 Borrego Palm Creek Near Borrego Springs, CA	13,960	750	12.5	294%
USGS 10256000 Whitewater River at White Water, CA	36,805	12,600	26	612%
USGS 10257720 Chino Canyon Creek Bl Tramway Near Palm Springs, CA	3,015	658	15.8	372%
USGS 10258000 Tahquitz Creek Near Palm Springs, CA	10,785	3,880	22.2	522%
USGS 10258500 Palm Canyon Creek Near Palm Springs, CA	11,576	3,960	12.9	304%
USGS 10259000 Andreas Creek Near Palm Springs, CA	5,532	2,220	15.4	362%
USGS 10260200 Pipes Creek Near Yucca Valley, CA[5]	9,603	20	18.1	426%
USGS 10260400 Cushenbury Creek Near Lucerne Valley, CA	4,071	46	14	329%
USGS 10260500 Deep Creek Near Hesperia, CA	85,974	52,700	25	588%
USGS 10260620 Houston Creek Above Lake Gregory at Crestline, CA	244	518	44.8	1054%
USGS 10260630 Abondigas Creek Above Lake Gregory at Crestline, CA	756	878	45	1059%
USGS 10260950 West Fork Mojave River Above Mojave River Forks Res Near Hesperia, CA	44,771	33,140	28.3	666%
USGS 10261100 Mojave River Bl Forks Res Near Hesperia, CA	134,057	45,920	26	612%
USGS 10261500 Mojave River at Lower Narrows Near Victorville, CA	334,772	56,700	15.8	372%
USGS 10261800 Beacon Creek at Helendale, CA	473	0.7	4.5	106%
USGS 10262500 Mojave River at Barstow, CA	873,361	18,190	9.4	221%
USGS 10263000 Mojave River at Afton, CA	1,369,506	5,730	7.6	179%
USGS 10263500 Big Rock Creek Near Valyermo, CA	14,660	13,040	30.7	722%
USGS 10264560 Spencer Canyon Creek Near Fairmont, CA	2,267	38	12.1	285%
USGS 10264590 Cottonwood Creek Near Rosamond, CA	21,765	10	19	447%
USGS 10264600 Oak Creek Near Mojave, CA	10,135	920	19	447%
USGS 10264710 Goler Gulch Near Randsburg, CA	26,560	14	3.5	82%
USGS 10264740 Cache Creek Near Mojave, CA	67,273	87	13.6	320%
USGS 10264750 Pine Tree Creek Near Mojave, CA	21,451	188	12.4	292%
USGS 10264770 Cottonwood Creek Near Cantil, CA	104,508	46	13.2	311%
USGS 10264878 Ninemile Creek Near Brown, CA	6,680	500	10.5	247%
USGS 11031500 Agua Caliente Creek Near Warner Springs, CA	12,184	1,960	17.1	402%
Average			**17.7**	**417%**

Notes:

[1] Ground-Water and Surface-Water Relations along the Mojave River, Southern California, G.C. Lines, U.S. Geological Survey, 1996.

[2] Measured based on USGS 7.5 Minute Quadrangles.

[3] Based on GIS data from California Department of Forestry and Fire Protection, 2010, digitized from Mean Annual Precipitation in the California Region, S.E. Rantz, 1972.

[4] As reported in Ground-Water and Surface-Water Relations along the Mojave River, Southern California, G.C. Lines, U.S. Geological Survey, 1996.

[5] Not included in USGS Analysis; however, included in this calculation due to it's geographic location.

TABLE 2
Mojave Basin Area Watermaster
Predicted and Measured Average Annual Discharge for USGS Streamgages of Interest

Watershed	Approximate Drainage Area[1] (acres)	Weighted Mean Annual Precipitation[2] (inches)	Average Annual Discharge Predicted by USGS Methodology[3] (acre-feet)	Average Annual Discharge Measured by USGS[4] (acre-feet)
Cushenbury Creek[5]	4,071	14	564.5	23.1
Pipes Creek[6]	9,603	18.1	-	20.1
Cache Creek[7]	67,273	13.6	722.8	83.7
Cottonwood Creek[8]	21,765	19	111.1	8.7
Spencer Canyon Creek[9]	2,267	12.1	111.1	9.0
Goler Gulch[10]	26,560	3.5	35.0	13.6
Beacon Creek[11]	473	4.5	28.0	0.7
Total			**1,573**	**159**

Notes:

[1] Measured based on USGS 7.5 Minute Quadrangles.

[2] Based on GIS data from California Department of Forestry and Fire Protection, 2010, digitized from Mean Annual Precipitation in the California Region, S.E. Rantz, 1972.

[3] Ground-Water and Surface-Water Relations along the Mojave River, Southern California, G.C. Lines, U.S. Geological Survey, 1996.

[4] USGS National Water Information System (NWIS) application (http://waterdata.usgs.gov/ca/nwis/), accessed February 2011.

[5] USGS 10260400 Cushenbury Creek Near Lucerne, CA water years 1958 through 1971.

[6] USGS 10260200 Pipes Creek Near Yucca Valley, CA water years 1959 through 1971. Channel width of Pipes Creek is not known, therefore discharge could not be predicted using Lines' methodology.

[7] USGS 10264740 Cache Creek Near Mojave, CA water years 1965 through 1972.

[8] USGS 10264590 Cottonwood Creek Near Rosamond, CA water years 1964 through 1972.

[9] USGS 10264560 Spencer Canyon Creek Near Fairmont, CA water years 1964 through 1973.

[10] USGS 10264710 Goler Gulch Near Randsburg, CA water years 1967 through 1972.

[11] USGS 10261800 Beacon Creek at Helendale, CA water years 1961 through 1967.

TABLE 3
Mojave Basin Area Watermaster
Estimated Unit Discharge and Mean Annual Precipitation for Gaged Watersheds and Estimated Average Annual Discharge for Baja Washes Tributary to Mojave River

Gaged Watershed	Approximate Drainage Area[1] (acres)	Weighted Mean Annual Precipitation[2] (inches)	Average Annual Discharge Measured by USGS[3] (acre-feet)	Unit Discharge[4]	Referenced Precipitation Station	Mean Annual Precipitation for Period of Record (inches)	Mean Annual Precipitation During Streamgage Period of Record (inches)	Percent of Period of Record Mean Annual Precipitation During Streamgage Period of Record
Cushenbury Creek[5]	4,071	14	23.1	0.0049	Cushenbury Springs[12]	8.3	8.0	96%
Pipes Creek[6]	9,603	18.1	20.1	0.0014	Kee Ranch[13]	8.6	7.2	84%
Cache Creek[7]	67,273	13.6	83.7	0.0011	Tehachapi[14]	11.2	11.1	99%
Cottonwood Creek[8]	21,765	19	8.7	0.0003	Tehachapi[14]	11.2	10.5	93%
Spencer Canyon Creek[9]	2,267	12.1	9.0	0.0039	Fairmont[15]	15.6	16.4	105%
Goler Gulch[10]	26,560	3.5	13.6	0.0018	Randsburg[16]	5.7	5.1	89%
Beacon Creek[11]	473	4.5	0.7	0.0042	Barstow[17]	4.5	3.3	73%

Baja Washes	Approximate Drainage Area[1] (acres)	Weighted Mean Annual Precipitation[2] (inches)	Estimated Average Annual Discharge Based on Cushenbury Creek Unit Discharge (acre-feet)	Estimated Average Annual Discharge Based on Pipes Creek Unit Discharge (acre-feet)	Estimated Average Annual Discharge Based on Cache Creek Unit Discharge (acre-feet)	Estimated Average Annual Discharge Based on Cottonwood Creek Unit Discharge (acre-feet)	Estimated Average Annual Discharge Based on Spencer Canyon Creek Unit Discharge (acre-feet)	Estimated Average Annual Discharge Based on Goler Gulch Unit Discharge (acre-feet)	Estimated Average Annual Discharge Based on Beacon Creek Unit Discharge (acre-feet)	Estimated by Lines, 1996 (acre-feet)
Boom Creek	1,032	4.5	1.9	0.5	0.4	0.1	1.5	0.7	1.6	100
Daggett Wash	15,468	3.5	22.0	6.3	5.0	1.1	17.8	7.9	18.7	400
Calico Wash	65,163	4.5	119.0	33.9	26.8	6.2	96.3	43.0	101.5	400
Manix Wash	28,399	4.5	51.8	14.8	11.7	2.7	42.0	18.8	44.2	500
Wilhelm Wash	4,826	4.25	8.3	2.4	1.9	0.4	6.7	3.0	7.1	200
Unnamed	1,012	4.25	1.7	0.5	0.4	0.1	1.4	0.6	1.5	30
Total			**205**	**58**	**46**	**11**	**166**	**74**	**175**	**1,630**

Notes:
[1] Measured based on USGS 7.5 Minute Quadrangles.
[2] Based on GIS data from California Department of Forestry and Fire Protection, 2010, digitized from Mean Annual Precipitation in the California Region, S.E. Rantz, 1972.
[3] USGS National Water Information System (NWIS) application (http://waterdata.usgs.gov/ca/nwis/), accessed February 2011.
[4] Unit discharge is the ratio of average annual discharge to the total amount of water from precipitation within the watershed.
[5] USGS 10260400 Cushenbury Creek Near Lucerne, CA water years 1958 through 1971.
[6] USGS 10260200 Pipes Creek Near Yucca Valley, CA water years 1959 through 1971.
[6] USGS 10264740 Cache Creek Near Mojave, CA water years 1965 through 1972.
[8] USGS 10264590 Cottonwood Creek Near Rosamond, CA water years 1964 through 1972.
[9] USGS 10264560 Spencer Canyon Creek Near Fairmont, CA water years 1964 through 1973.
[10] USGS 10264710 Goler Gulch Near Randsburg, CA water years 1967 through 1972.
[11] USGS 10261800 Beacon Creek at Helendale, CA water years 1961 through 1967.
[12] Period of record is water years 1961 through 2001. Data from County of San Bernardino, Flood Control District (http://www.sbcounty.gov/dpw/floodcontrol/default.asp).
[13] Period of record is water years 1951 through 1984. Data from County of San Bernardino, Flood Control District (http://www.sbcounty.gov/dpw/floodcontrol/default.asp).
[14] Period of record is water years 1927 through 1996. Data from Western Regional Climate Center Webpage, NOAA (http://www.wrcc.dri.edu/index.html).
[15] Period of record is water years 1927 through 2007. Data from Western Regional Climate Center Webpage, NOAA (http://www.wrcc.dri.edu/index.html).
[16] Period of record is water years 1937 through 1990. Data from County of San Bernardino, Flood Control District (http://www.sbcounty.gov/dpw/floodcontrol/default.asp).
[17] Period of record is water years 1913 through 1980. Data from Western Regional Climate Center Webpage, NOAA (http://www.wrcc.dri.edu/index.html).

FIGURE 1
Analysis of USGS Methodology for Estimating Discharge from Desert Washes (Lines 1996)

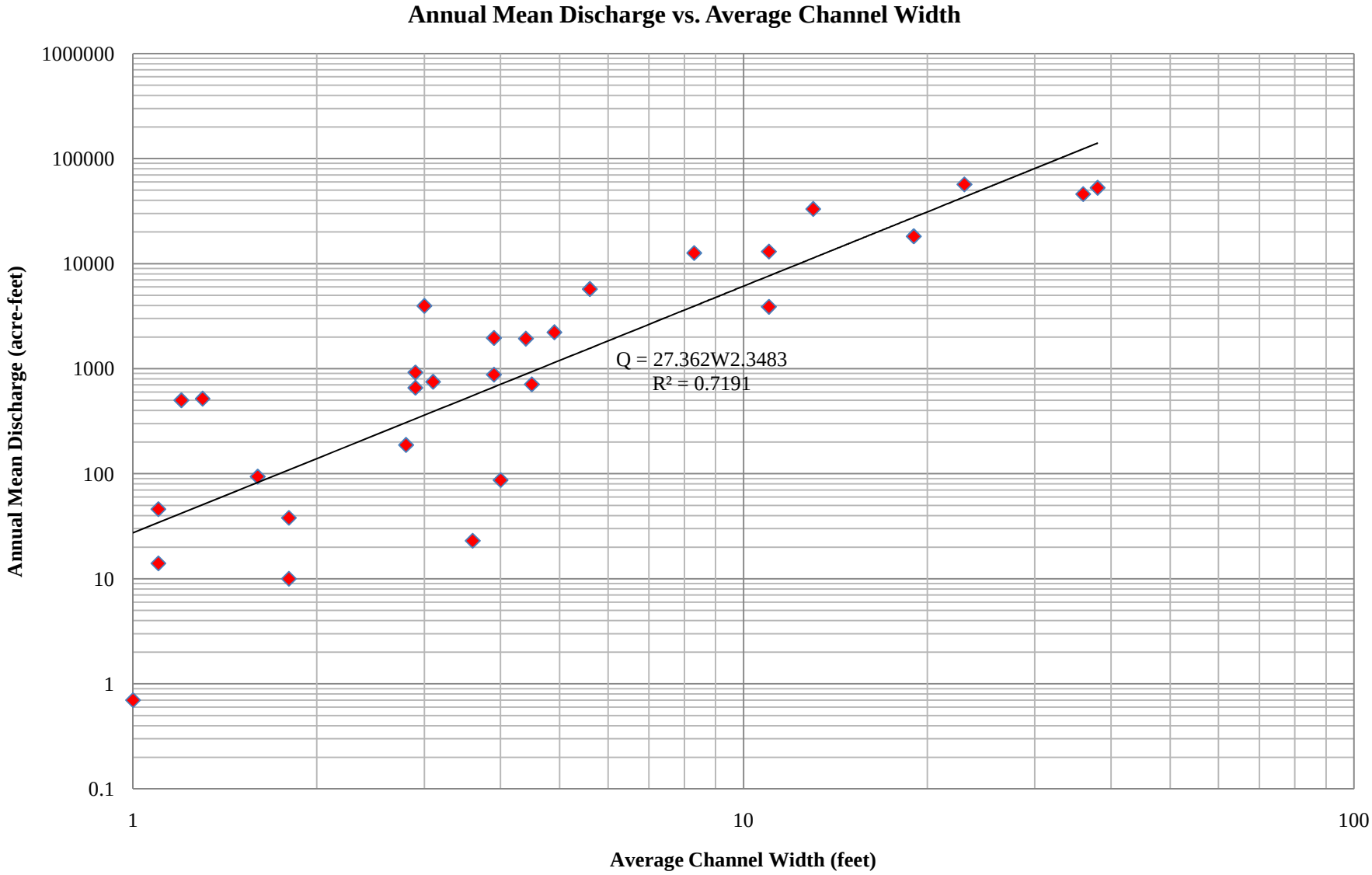


FIGURE 2
Average Monthly Discharge for Mojave at Barstow and Average Monthly Precipitation at Daggett

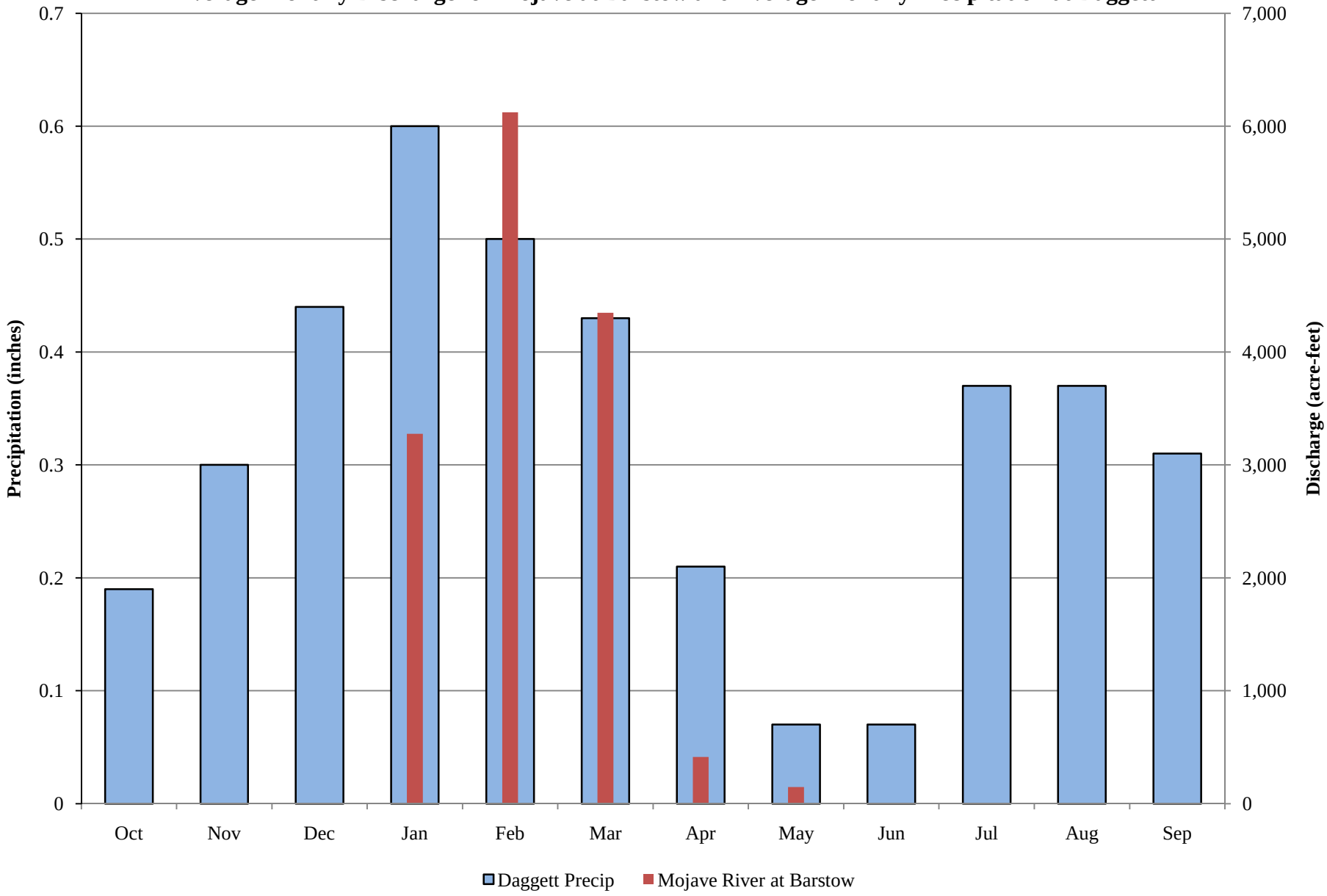


FIGURE 3
Comparison of Daily Precipitation and Cushenbury Creek Daily Flow
Water Years 1961 through 1971

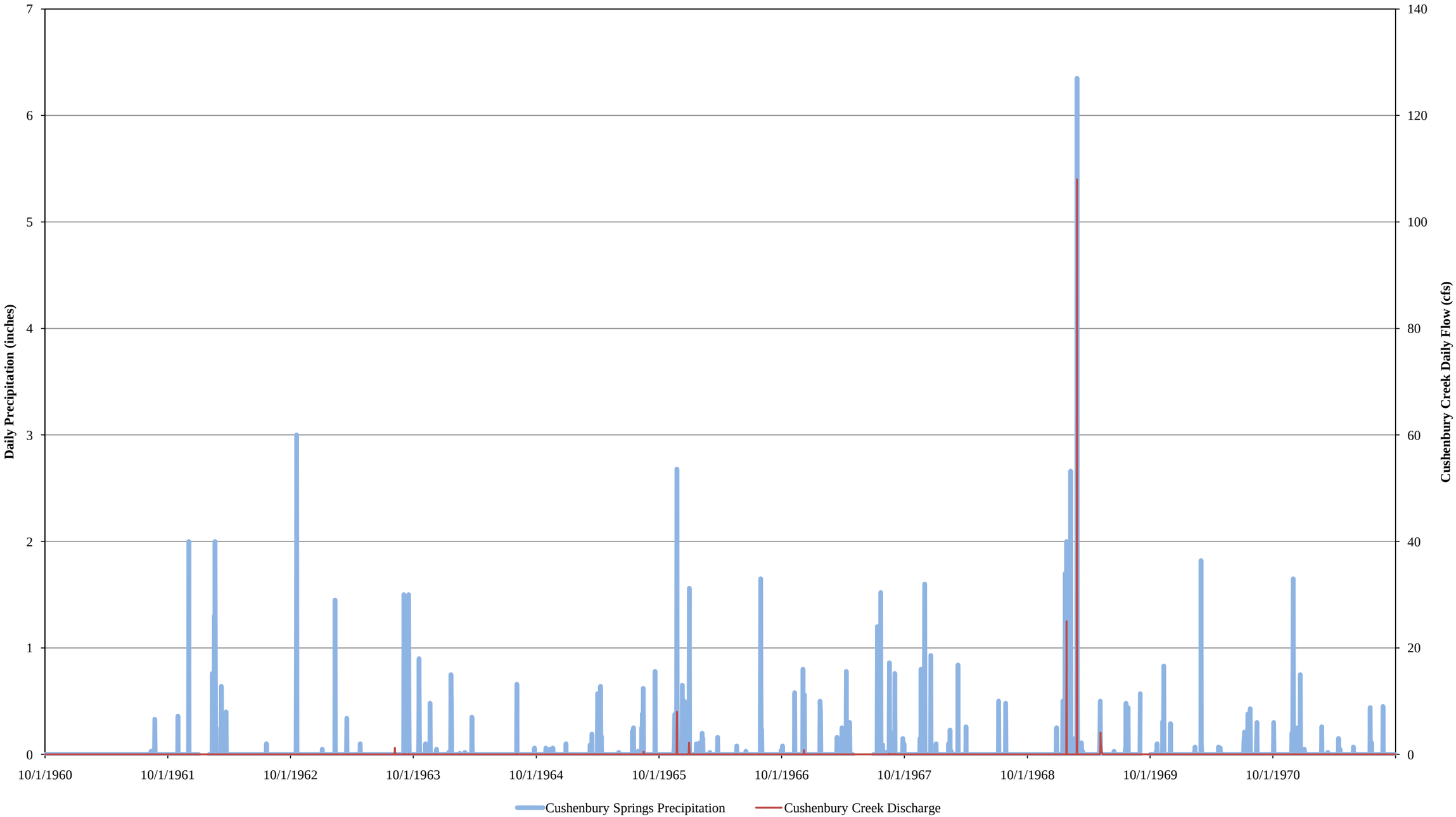
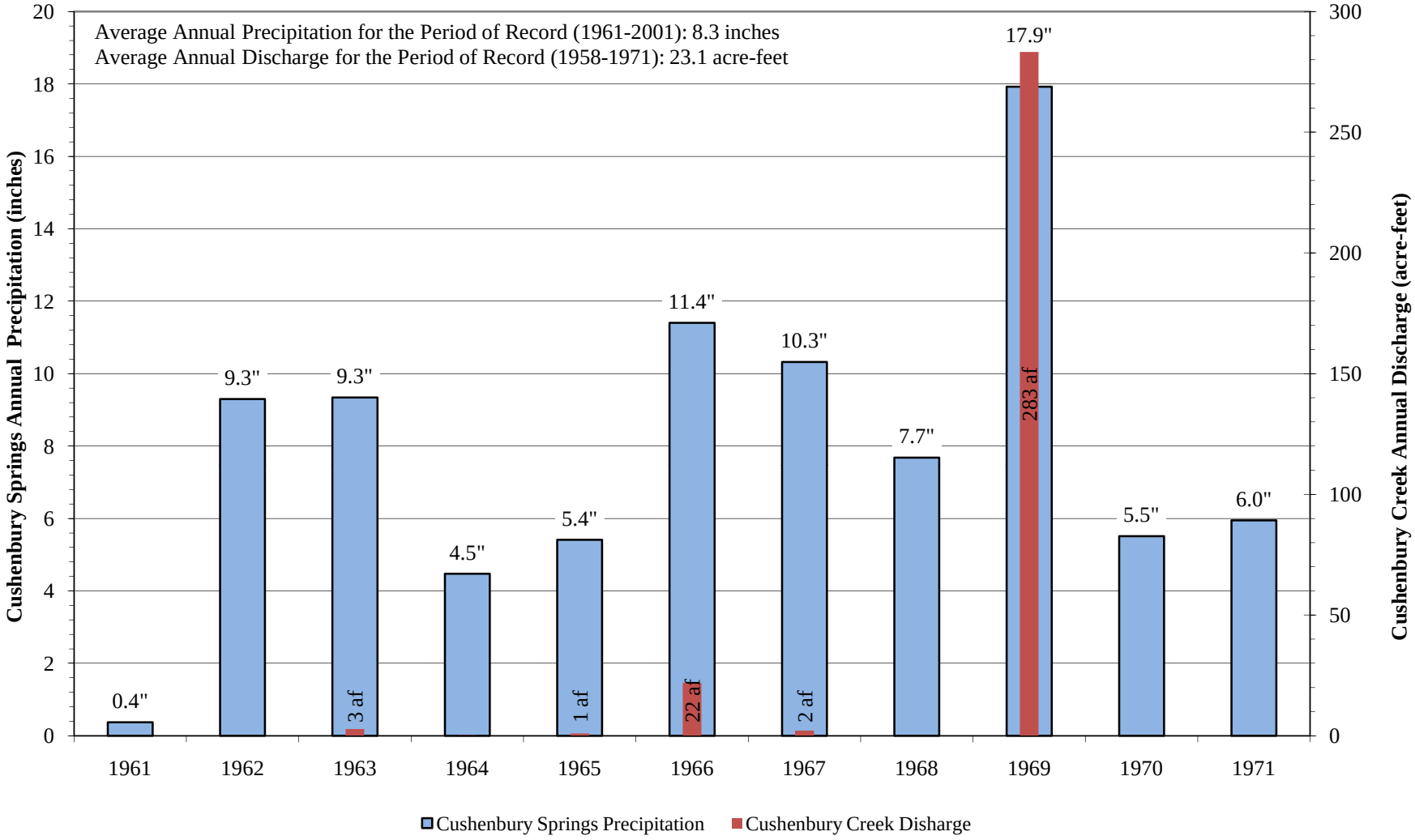


FIGURE 4
Comparison of Cushenbury Creek Annual Discharge and Cushenbury Springs Annual Precipitation
Water Years 1961-1971



G:\MOJAVE ADJUDICATION\Analysis\3020-001x-mojox048 & 050 Este Historic Precipitation Analysis.xlsx, FIGURE 4

FIGURE 5
Comparison of Daily Precipitation at Kee Ranch and Pipes Creek Daily Flow
Water Years 1959 through 1971

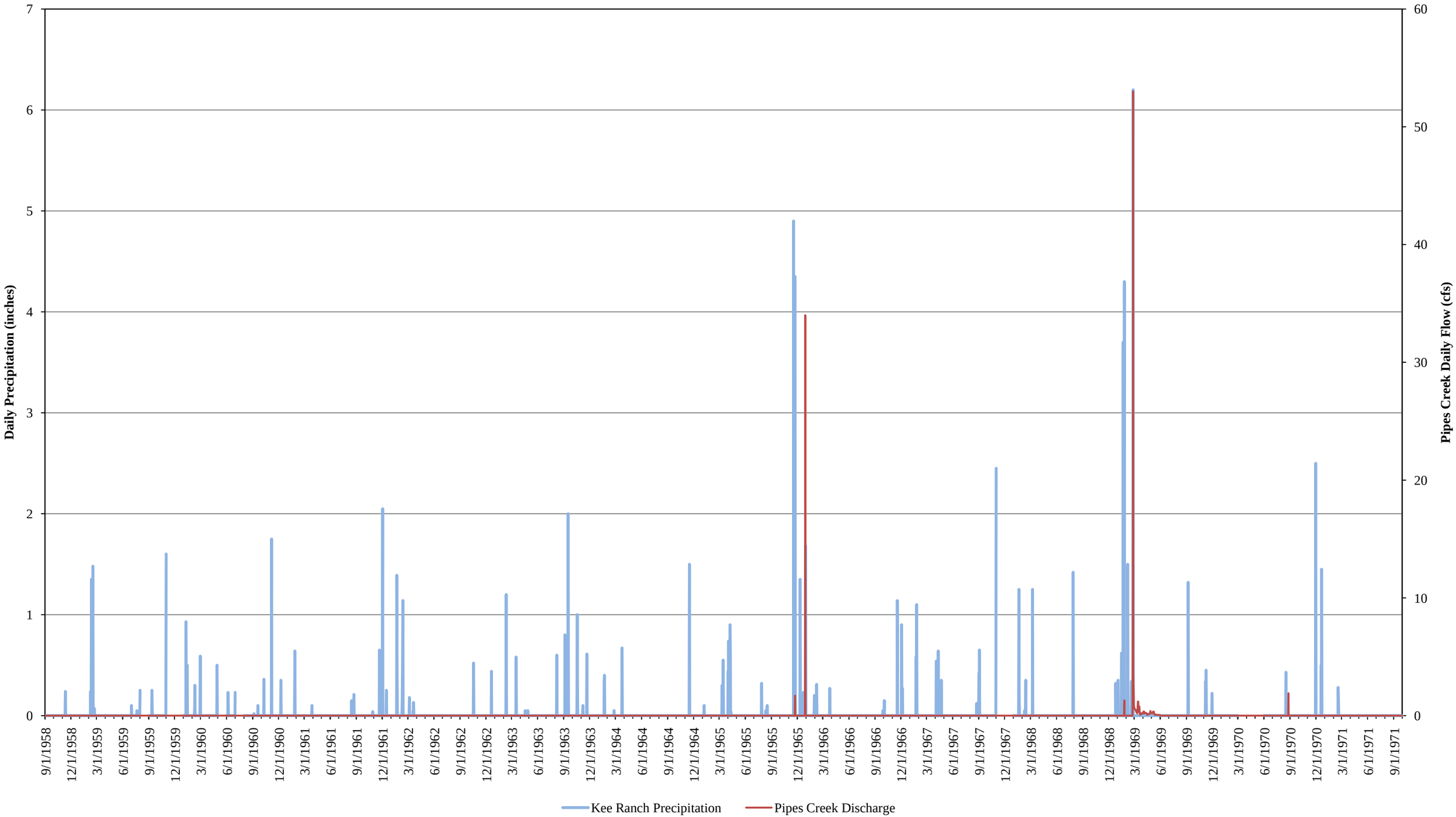
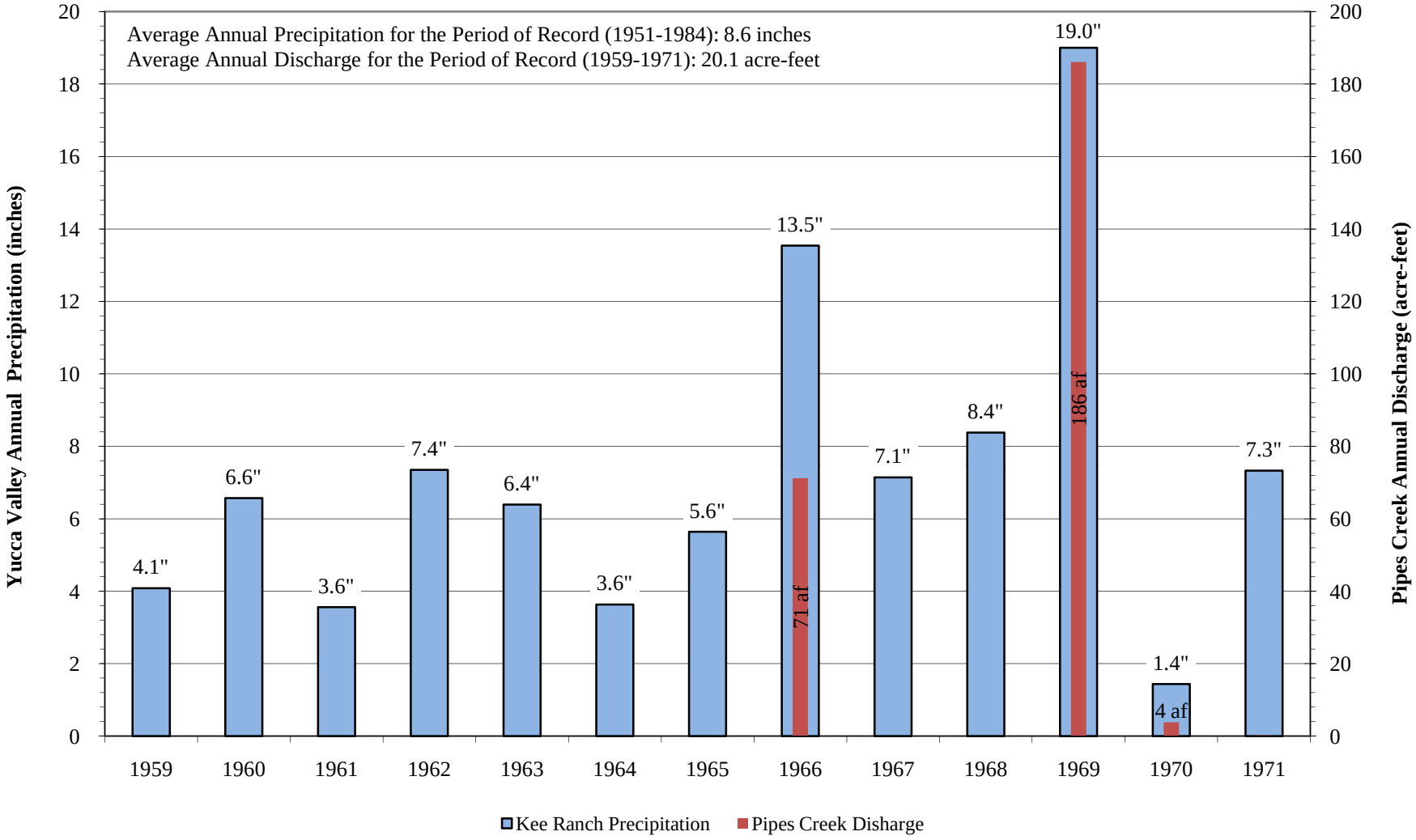


FIGURE 6
Comparison of Pipes Creek Annual Discharge and Kee Ranch Annual Precipitation
Water Years 1959-1971



G:\MOJAVE ADJUDICATION\Analysis\3020-001x-mojox048 & 050 Este Historic Precipitation Analysis.xlsx, FIGURE 6

FIGURE 7
Daily Flow for Oak Creek, Cache Creek, and Cottonwood Creek
During the Period of Overlapping Record, Water Years 1966 through 1972

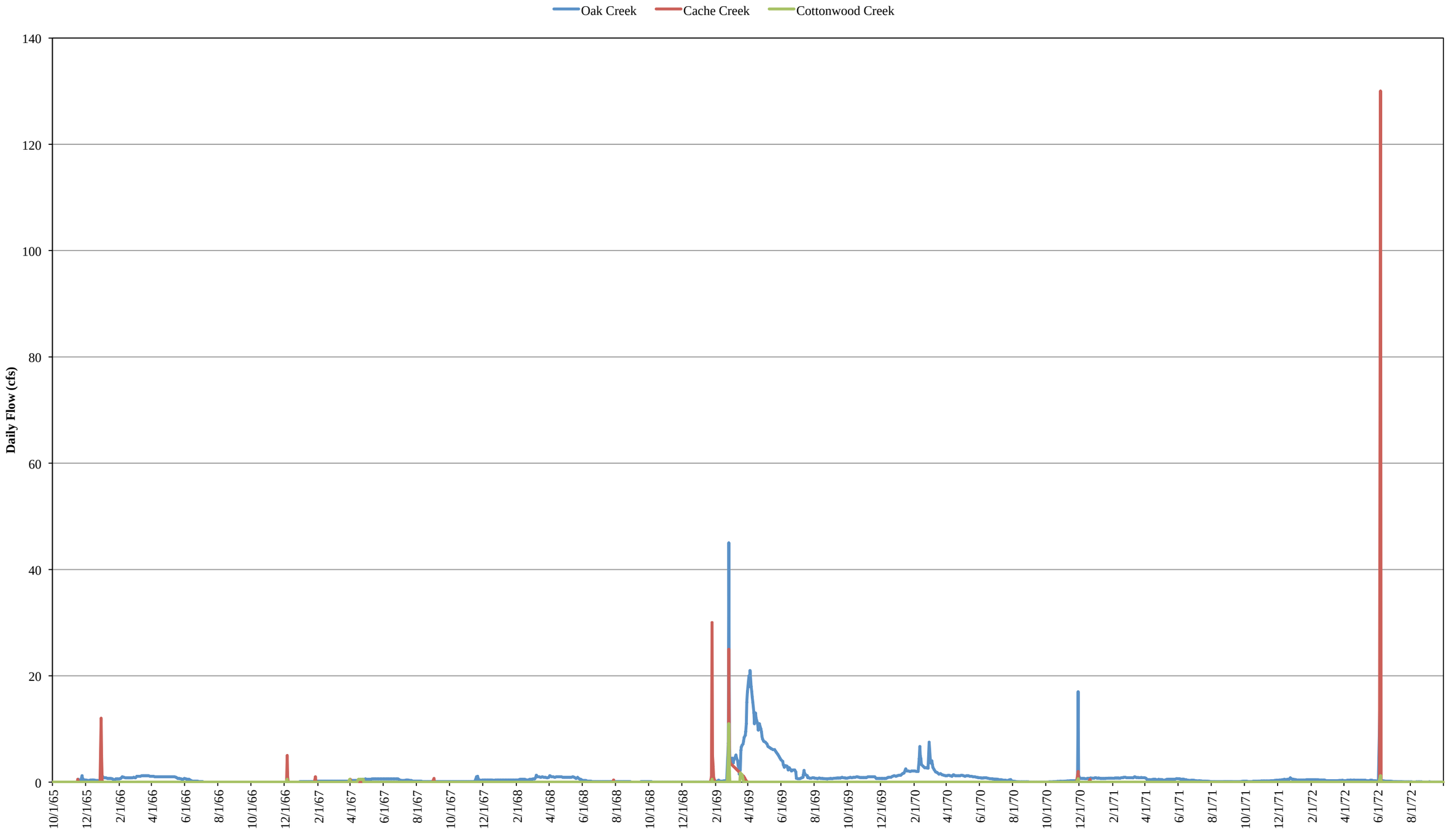
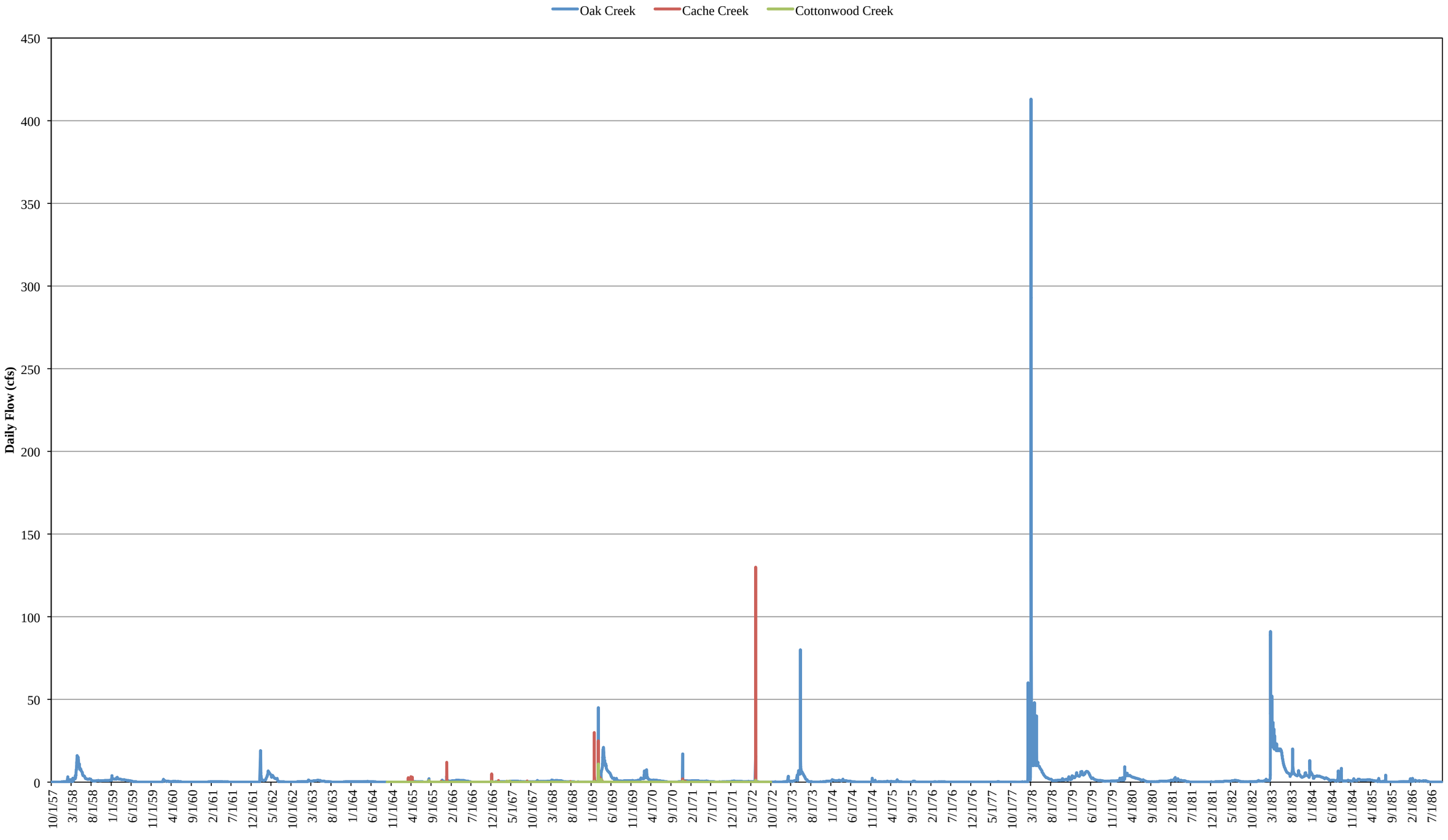
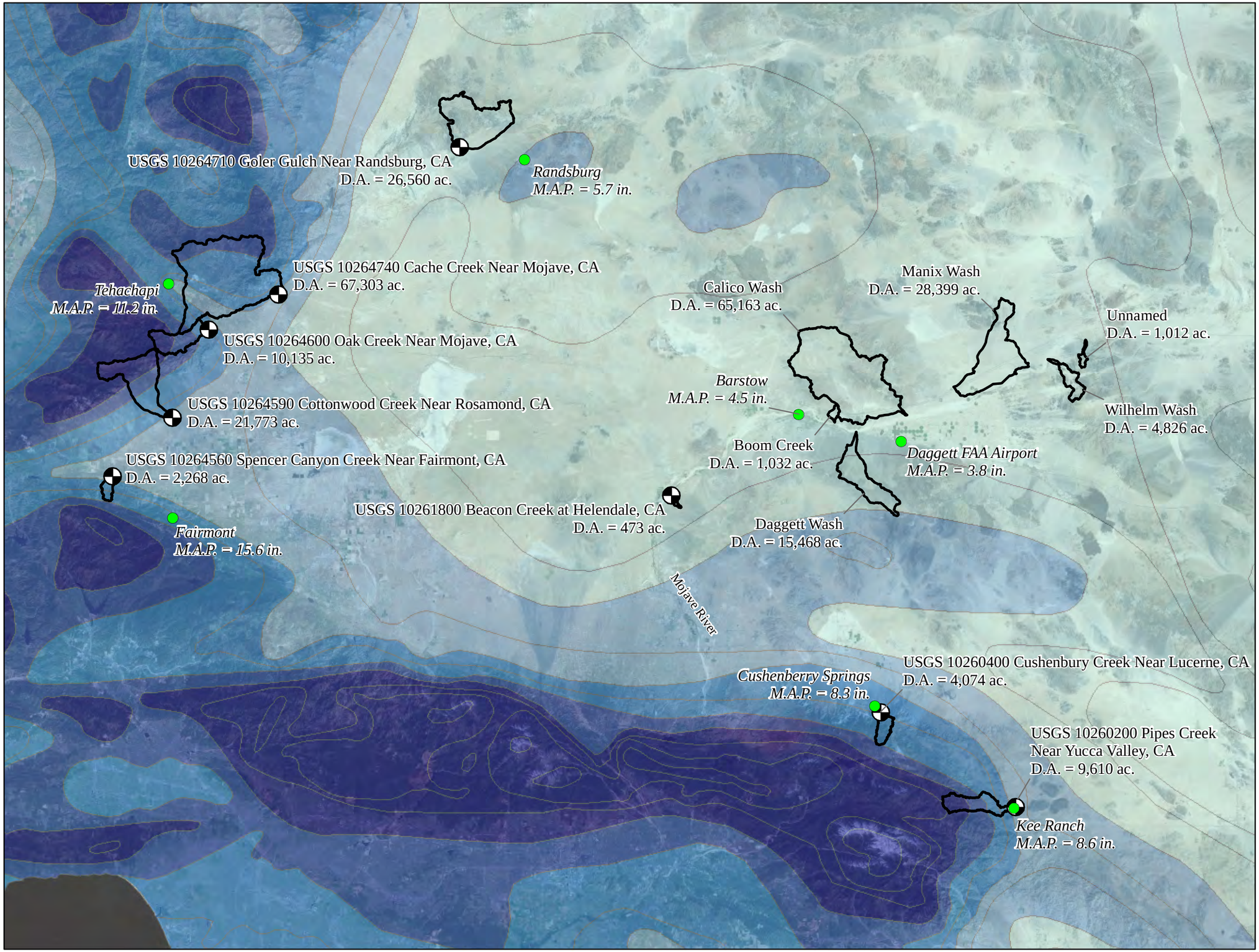


FIGURE 8
Daily Flow for Oak Creek, Cache Creek, and Cottonwood Creek
Water Years 1958 through 1986





N

0 6 12 24

Miles

Precipitation Station

USGS Streamgage

Watershed Boundary

Areas of Equal Mean Annual Precipitation (inches)

- 0 - 5.0
- 5.1 - 10.0
- 10.1 - 15.0
- 15.1 - 20.0
- 20.1 - 45.0

Notes:
M.A.P. = Mean Annual Precipitation
D.A. = Drainage Area

PLATE 1

Mojave Basin Area Watermaster

Watersheds Investigated
for
Estimated Mean Annual Discharge
Within the
Mojave River Basin

Wagner & Bonsignore
Consulting Civil Engineers, A Corporation

Mean Annual Precipitation per California Department of Forestry and Fire Protection, 2010 and were digitized from *Mean Annual Precipitation in the California Region*, Compiled by S.E. Rantz, 1972.
Aerial photograph per Microsoft Corporation and its data suppliers, 2010.

May 2011

Q:\Drawings\Mojave Water\GIS\PLATE 1 - Overview Map of Watersheds and MAP.mxd

APPENDIX D

Explanation of Computed Potential Evapotranspiration and Actual Evapotranspiration for Harter Project

TECHNICAL MEMORANDUM

TO: Watermaster, MWA

FROM: Bob Wagner, Wagner & Bonsignore, CCE

RE: Explanation of computed potential evapotranspiration and actual evapotranspiration for Harter project

DATE: December 09, 2010

No averages of data were used in computing return flow from the Harter project.

Potential evapotranspiration (PET) represents the atmospheric capacity to hold water. The factors that determine the magnitude of PET are solar radiation, relative humidity, air temperature, and wind speed. Actual evapotranspiration (AET) is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). For a specific crop type, AET is related to PET.

The California Irrigation Management Information System (CIMIS) is a program in the Office of Water Use Efficiency (OWUE), California Department of Water Resources (DWR) that manages a network of over 120 automated weather stations in the state of California. The data measured at the weather station include solar radiation, relative humidity, air temperature, and wind speed. CIMIS data is compiled on an hourly time-step and represents the amount of AET from a well water homogenous surface of turf, and is reported as the reference crop evapotranspiration, ET_0. The reference crop evapotranspiration is related to AET from any crop by a crop coefficient, K_c, which is empirically determined for a wide variety of crops and for a range of crop growth stages. The formalization of this relationship is PET * K_c = AET.

In this analysis, CIMIS data was summed to a monthly value and an estimate of AET for alfalfa was computed from a monthly value of K_c for alfalfa. The CIMIS station is located in Barstow, CA, approximately 12 miles west of the study area.

TABLE 1

Aggregated Yearly Summary Utilizing Varying Monthly K_c Values based on 6 Alfalfa Cuttings per Year[1] for

09N02E07Q01 Well #01, 09N02E15Q01 Well #03, 09N02E15R03 Well #04, 09N02E21H03 Well #01A, 09N02E21J01 Well #02, and 09N02E22E02 Well #04 + E05 Well #04a

Water Year	Crop Acreage	Calculated Production (af)	Production per Acre (af/ac)	Rainfall (af)	Total Applied Water (af)	Total Applied Water per Acre (af/ac)	Consumptive Use[2] (af)	Consumptive Use per Acre (af/ac)	Estimated Return Flow (af)	Estimated Return Flow per Acre (af/ac)	Return Flow as a Percentage of Calculated Production
1998	160	1,161	7.3	81	1,242	7.8	810	5.1	432	2.7	37%
1999	160	1,118	7.0	37	1,154	7.2	913	5.7	241	1.5	22%
2000	160	1,286	8.0	18	1,304	8.2	948	5.9	356	2.2	28%
2001	288	2,006	7.0	115	2,121	7.4	1,680	5.8	441	1.5	22%
2002	456	3,403	7.5	316	3,719	8.2	2,681	5.9	1,038	2.3	31%
2003	456	2,911	6.4	158	3,069	6.7	2,540	5.6	528	1.2	18%
2004	344	2,406	7.0	175	2,581	7.5	1,968	5.7	613	1.8	25%
2005	476	3,210	6.7	657	3,867	8.1	2,440	5.1	1,427	3.0	44%
2006	607	3,910	6.4	127	4,038	6.7	3,288	5.4	749	1.2	19%
2007	498	3,544	7.1	24	3,568	7.2	2,740	5.5	828	1.7	23%
2008	534	3,775	7.1	80	3,855	7.2	3,080	5.8	775	1.5	21%
2009	534	3,631	6.8	138	3,770	7.1	2,991	5.6	779	1.5	21%
										Average:	26%

[1] Cutting periods per *High Desert Research Results, Alfalfa and Other Forages* , 1989.

TABLE 2

Aggregated Yearly Summary Utilizing Varying Monthly K_c Values based on 6 Alfalfa Cuttings per Year[1] Assuming All Crops Irrigated Were Alfalfa[2] for 09N02E07Q01 Well #01, 09N02E15Q01 Well #03, 09N02E15R03 Well #04, 09N02E21H03 Well #01A, 09N02E21J01 Well #02, and 09N02E22E02 Well #04 + E05 Well #04a

Water Year	Crop Acreage	Calculated Production (af)	Production per Acre (af/ac)	Rainfall (af)	Total Applied Water (af)	Total Applied Water per Acre (af/ac)	Consumptive Use (af)	Consumptive Use per Acre (af/ac)	Estimated Return Flow (af)	Consumptive Use as a Percentage of Total Applied Water
1998	160	1,160.8	7.3	81.1	1,241.8	7.8	810.0	5.1	431.8	65.23%
1999	160	1,117.6	7.0	36.5	1,154.2	7.2	912.9	5.7	241.3	79.09%
2000	160	1,285.6	8.0	18.4	1,304.0	8.2	948.2	5.9	355.8	72.71%
2001	382	2,331.9	6.1	152.0	2,484.0	6.5	2,226.1	5.8	257.9	89.62%
2002	592	3,909.9	6.6	316.7	4,226.6	7.1	3,481.0	5.9	745.5	82.36%
2003	532	3,278.1	6.2	158.1	3,436.2	6.5	2,963.9	5.6	472.3	86.26%
2004	592	3,244.5	5.5	174.9	3,419.4	5.8	3,386.2	5.7	33.2	99.03%
2005	600	3,652.6	6.1	657.3	4,309.9	7.2	3,075.1	5.1	1,234.8	71.35%
2006	607	3,910.2	6.4	127.5	4,037.6	6.7	3,288.5	5.4	749.1	81.45%
2007	610	3,939.5	6.5	29.0	3,968.5	6.5	3,356.2	5.5	612.3	84.57%
2008	610	3,962.4	6.5	80.1	4,042.5	6.6	3,518.3	5.8	524.2	87.03%
2009	610	3,750.9	6.1	138.4	3,889.3	6.4	3,416.5	5.6	472.8	87.84%
										82.21%

[1] Cutting periods per *High Desert Research Results, Alfalfa and Other Forages* , 1989.

[2] Assumes crops identified as grain or unidentified crops irrigated as Alfalfa.

TABLE 3

Yearly Summary Utilizing Varying Monthly K_c Values based on 6 Alfalfa Cuttings per Year[1]

Water Year	Crop Acreage	Calculated Production (in)	Rainfall (in)	Total Applied Water (in)	Actual Evapotranspiration (in)	Estimated Return Flow (in)	Return Flow as a Percentage of Calculated Production
1998	160	87	6	93	61	32	37%
1999	160	84	3	87	68	18	22%
2000	160	96	1	98	71	27	28%
2001	288	84	5	88	70	18	22%
2002	456	90	8	98	71	27	31%
2003	456	77	4	81	67	14	18%
2004	344	84	6	90	69	21	25%
2005	476	81	17	97	62	36	44%
2006	607	77	3	80	65	15	19%
2007	498	85	1	86	66	20	23%
2008	534	85	2	87	69	17	21%
2009	534	82	3	85	67	18	21%
Average	**-**	**84**	**5**	**89**	**67**	**22**	**26%**

[1] Cutting periods per *High Desert Research Results, Alfalfa and Other Forages* , 1989.

TABLE 4

Aggregated Monthly Summary of Calculated Production, Consumptive Use, ET, and Total Applied Water

Calculated Production (af)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	49.0	39.9	0.0	7.6	0.0	60.5	103.1	141.6	189.8	114.0	224.0	231.2	**1,160.8**
1999	46.5	0.0	18.1	54.5	31.6	130.5	210.2	139.1	208.3	148.0	47.1	83.6	**1,117.6**
2000	38.0	58.1	28.7	19.0	53.6	72.4	126.2	172.2	190.3	177.8	139.5	209.8	**1,285.6**
2001	39.5	68.3	5.6	21.1	15.8	63.5	204.2	291.9	317.6	320.3	267.1	391.0	**2,005.9**
2002	128.3	102.3	14.9	47.0	46.6	229.3	357.8	403.3	443.5	542.3	466.8	621.1	**3,403.1**
2003	160.8	157.6	8.8	3.3	92.4	194.0	274.1	395.1	463.1	391.2	340.1	430.1	**2,910.8**
2004	100.4	94.4	17.6	3.4	47.5	141.9	152.9	322.2	433.5	326.2	322.7	443.6	**2,406.2**
2005	146.4	35.0	16.9	0.1	25.4	69.9	349.3	530.8	500.8	475.3	491.6	568.0	**3,209.6**
2006	218.6	96.6	11.3	47.3	133.9	200.7	587.0	444.7	670.3	471.2	460.9	567.8	**3,910.2**
2007	204.9	80.8	37.1	45.6	89.4	268.4	281.7	472.0	500.8	559.0	399.3	605.4	**3,544.5**
2008	243.9	164.4	36.5	2.1	70.6	294.4	346.2	503.8	504.3	470.2	457.6	681.1	**3,775.1**
2009	200.2	100.3	41.6	2.3	44.3	300.9	331.2	469.5	461.0	484.6	565.5	629.8	**3,631.3**
Total	**1,576.6**	**997.5**	**237.0**	**253.4**	**651.2**	**2,026.2**	**3,324.0**	**4,286.2**	**4,883.6**	**4,480.1**	**4,182.4**	**5,462.5**	**32,360.7**

Consumptive Use (af)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	65.3	26.3	17.0	22.0	34.6	72.3	80.1	93.0	111.3	111.0	104.7	72.4	**810.0**
1999	61.8	31.2	20.5	29.2	48.3	85.9	93.4	116.1	121.3	115.8	107.9	81.5	**912.9**
2000	68.0	32.5	21.7	27.0	43.5	85.3	116.9	126.7	122.6	130.9	93.9	79.2	**948.2**
2001	109.2	55.5	34.0	35.5	66.1	149.5	185.6	221.7	239.2	223.4	202.8	157.2	**1,679.7**
2002	184.2	83.9	44.9	67.5	149.2	248.1	309.3	329.2	357.8	341.0	333.6	232.6	**2,681.3**
2003	169.5	91.0	37.0	76.0	113.2	246.2	288.4	304.8	337.6	335.3	288.7	252.7	**2,540.5**
2004	152.3	52.1	34.8	52.1	86.7	192.6	227.0	258.4	250.9	259.0	219.5	182.2	**1,967.7**
2005	164.3	76.9	44.6	51.4	93.1	223.7	290.6	320.8	339.8	320.2	273.0	241.1	**2,439.6**
2006	221.3	117.4	65.2	101.6	183.8	269.5	336.1	420.8	421.3	413.3	414.6	323.7	**3,288.5**
2007	186.3	102.4	56.4	86.7	149.4	287.3	316.4	274.4	370.6	348.9	314.5	246.6	**2,740.0**
2008	214.5	104.4	58.5	72.3	164.7	322.0	386.7	361.9	417.5	362.4	346.3	268.8	**3,079.9**
2009	222.2	101.1	51.2	84.0	132.6	290.0	357.3	392.1	326.5	396.9	353.7	283.2	**2,990.8**
Total	**1,818.9**	**874.7**	**485.9**	**705.2**	**1,265.3**	**2,472.5**	**2,987.8**	**3,220.0**	**3,416.3**	**3,358.0**	**3,053.1**	**2,421.3**	**26,079.1**

Actual ET (ET_c) (in)

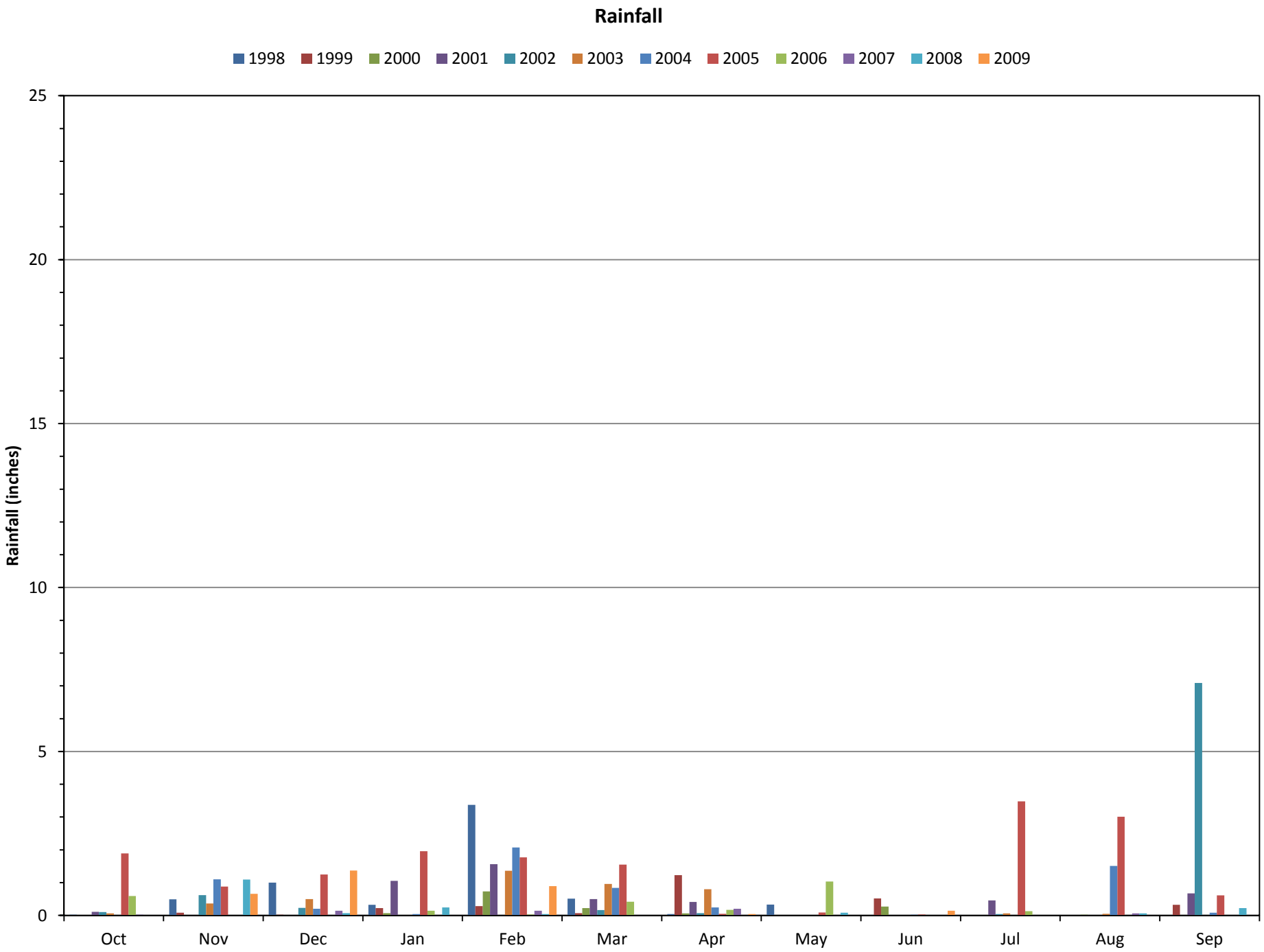
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	4.9	2.0	1.3	1.6	2.6	5.4	6.0	7.0	8.3	8.3	7.9	5.4	**60.8**
1999	4.6	2.3	1.5	2.2	3.6	6.4	7.0	8.7	9.1	8.7	8.1	6.1	**68.5**
2000	5.1	2.4	1.6	2.0	3.3	6.4	8.8	9.5	9.2	9.8	7.0	5.9	**71.1**
2001	4.5	2.3	1.4	1.5	2.8	6.2	7.7	9.2	10.0	9.3	8.5	6.6	**70.0**
2002	4.8	2.2	1.2	1.8	3.9	6.5	8.1	8.7	9.4	9.0	8.8	6.1	**70.6**
2003	4.5	2.4	1.0	2.0	3.0	6.5	7.6	8.0	8.9	8.8	7.6	6.6	**66.9**
2004	5.3	1.8	1.2	1.8	3.0	6.7	7.9	9.0	8.8	9.0	7.7	6.4	**68.6**
2005	4.1	1.9	1.1	1.3	2.3	5.6	7.3	8.1	8.6	8.1	6.9	6.1	**61.5**
2006	4.4	2.3	1.3	2.0	3.6	5.3	6.6	8.3	8.3	8.2	8.2	6.4	**65.0**
2007	4.5	2.5	1.4	2.1	3.6	6.9	7.6	6.6	8.9	8.4	7.6	5.9	**66.0**
2008	4.8	2.3	1.3	1.6	3.7	7.2	8.7	8.1	9.4	8.1	7.8	6.0	**69.2**
2009	5.0	2.3	1.2	1.9	3.0	6.5	8.0	8.8	7.3	8.9	7.9	6.4	**67.2**
Total	**56.6**	**26.8**	**15.5**	**21.8**	**38.4**	**75.9**	**91.5**	**100.1**	**106.2**	**104.7**	**93.9**	**74.0**	**805.3**

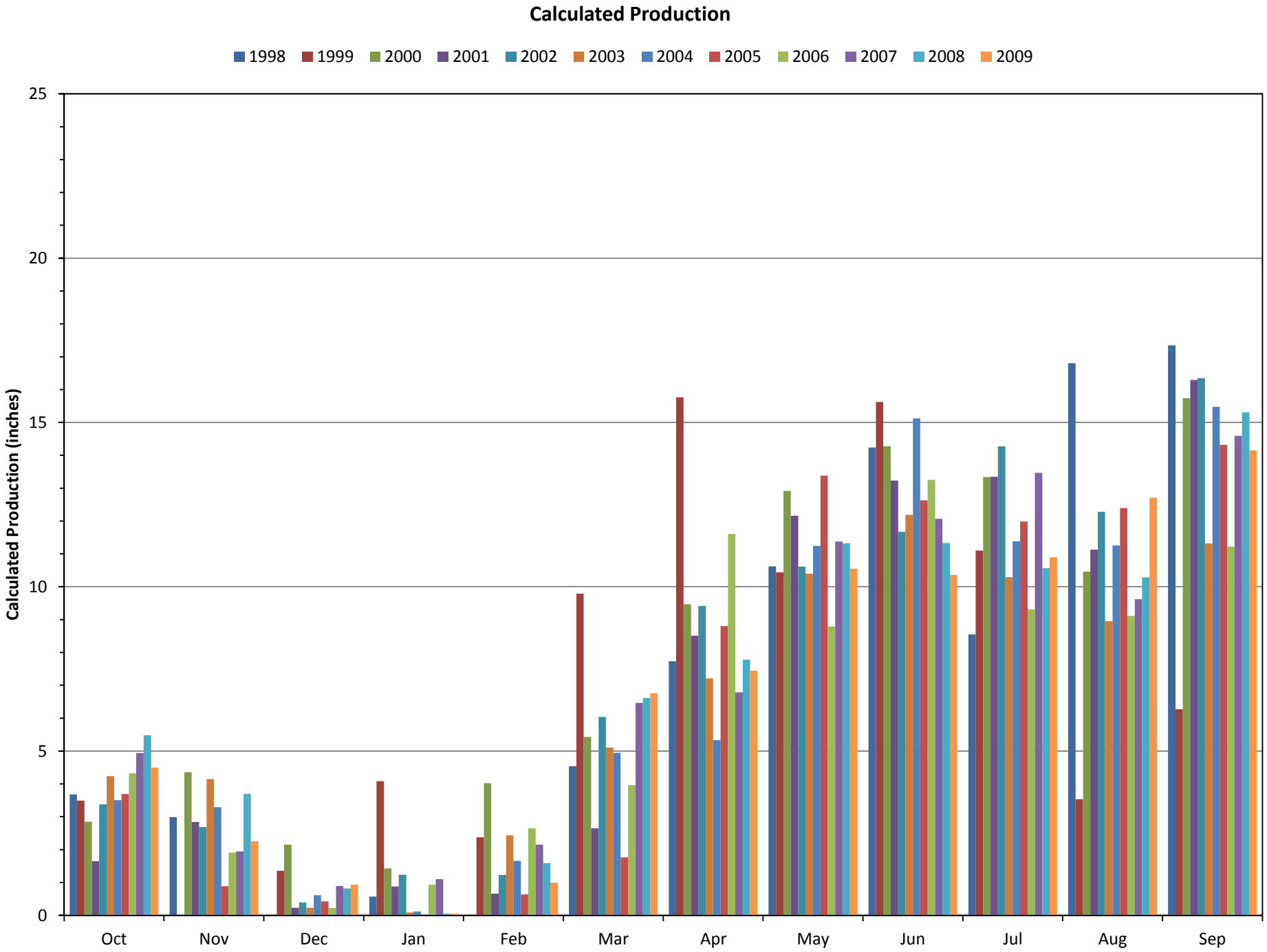
Potential ET (ET_o) (in)

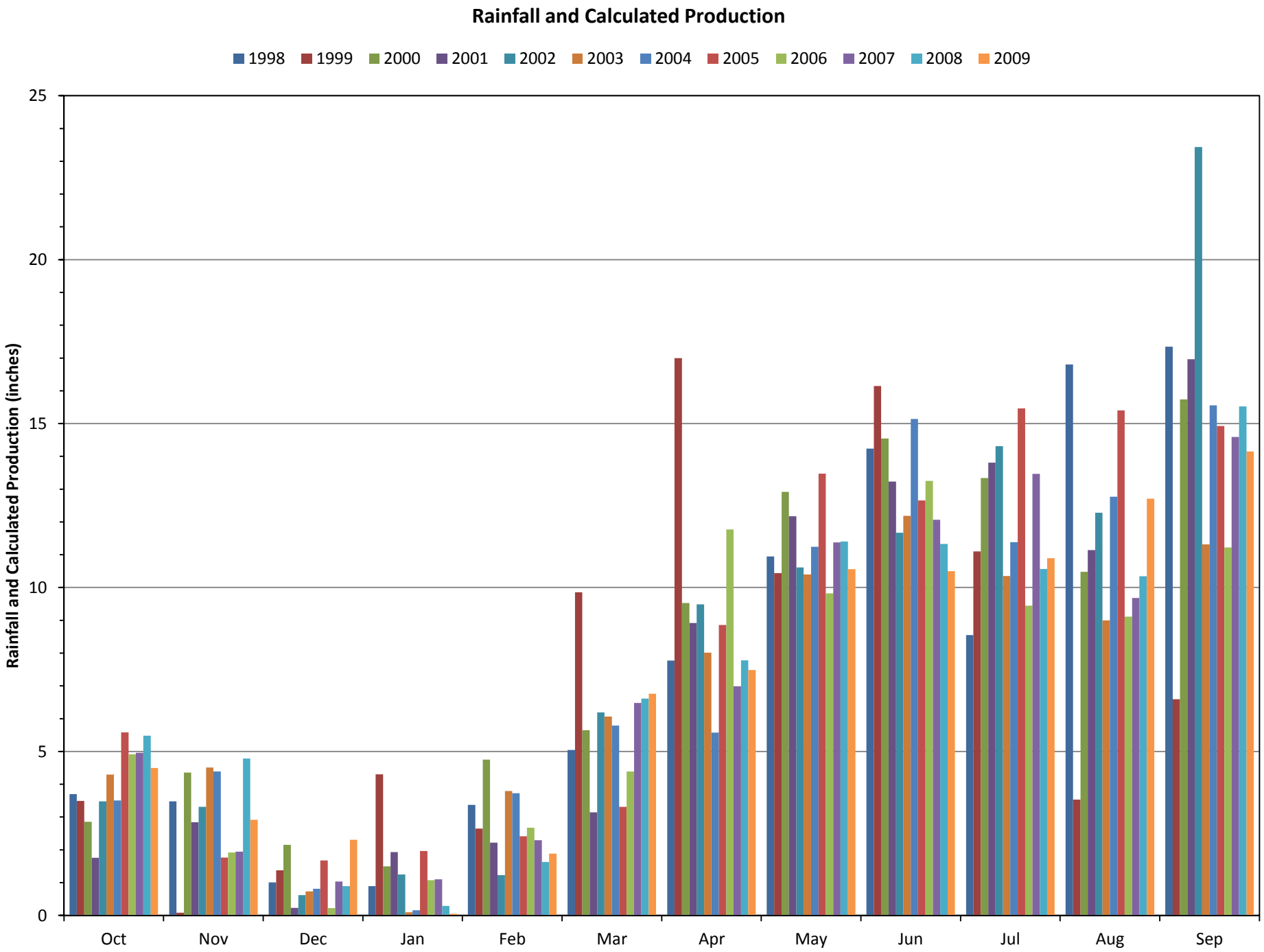
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	5.1	2.4	2.0	2.1	2.3	4.5	5.5	7.5	9.4	9.4	8.9	6.1	**65.2**
1999	4.8	2.9	2.4	2.7	3.2	5.4	6.4	9.4	10.3	9.8	9.2	6.8	**73.3**
2000	5.3	3.0	2.6	2.5	2.9	5.3	8.0	10.3	10.4	11.1	8.0	6.6	**76.0**
2001	4.7	2.9	2.2	1.9	2.4	5.2	7.0	10.0	11.3	10.6	9.6	7.3	**75.0**
2002	5.0	2.7	1.9	2.2	3.5	5.4	7.4	9.3	10.6	10.2	10.0	6.8	**75.1**
2003	4.6	3.0	1.5	2.5	2.6	5.4	6.9	8.7	10.0	10.0	8.6	7.4	**71.3**
2004	5.5	2.2	1.9	2.3	2.7	5.6	7.2	9.7	9.9	10.2	8.7	7.1	**73.0**
2005	4.3	2.4	1.8	1.6	2.1	4.7	6.7	8.7	9.7	9.2	7.8	6.8	**65.7**
2006	4.5	2.9	2.0	2.5	3.2	4.4	6.0	9.0	9.4	9.3	9.3	7.2	**69.7**
2007	4.6	3.0	2.2	2.6	3.2	5.8	6.9	7.1	10.1	9.5	8.6	6.6	**70.3**
2008	5.0	2.9	2.1	2.0	3.3	6.0	7.9	8.8	10.6	9.2	8.8	6.8	**73.4**
2009	5.2	2.8	1.8	2.4	2.6	5.4	7.3	9.5	8.3	10.1	9.0	7.1	**71.5**
Total	**58.5**	**33.1**	**24.5**	**27.3**	**34.1**	**63.2**	**83.2**	**107.9**	**120.0**	**118.7**	**106.4**	**82.7**	**859.4**

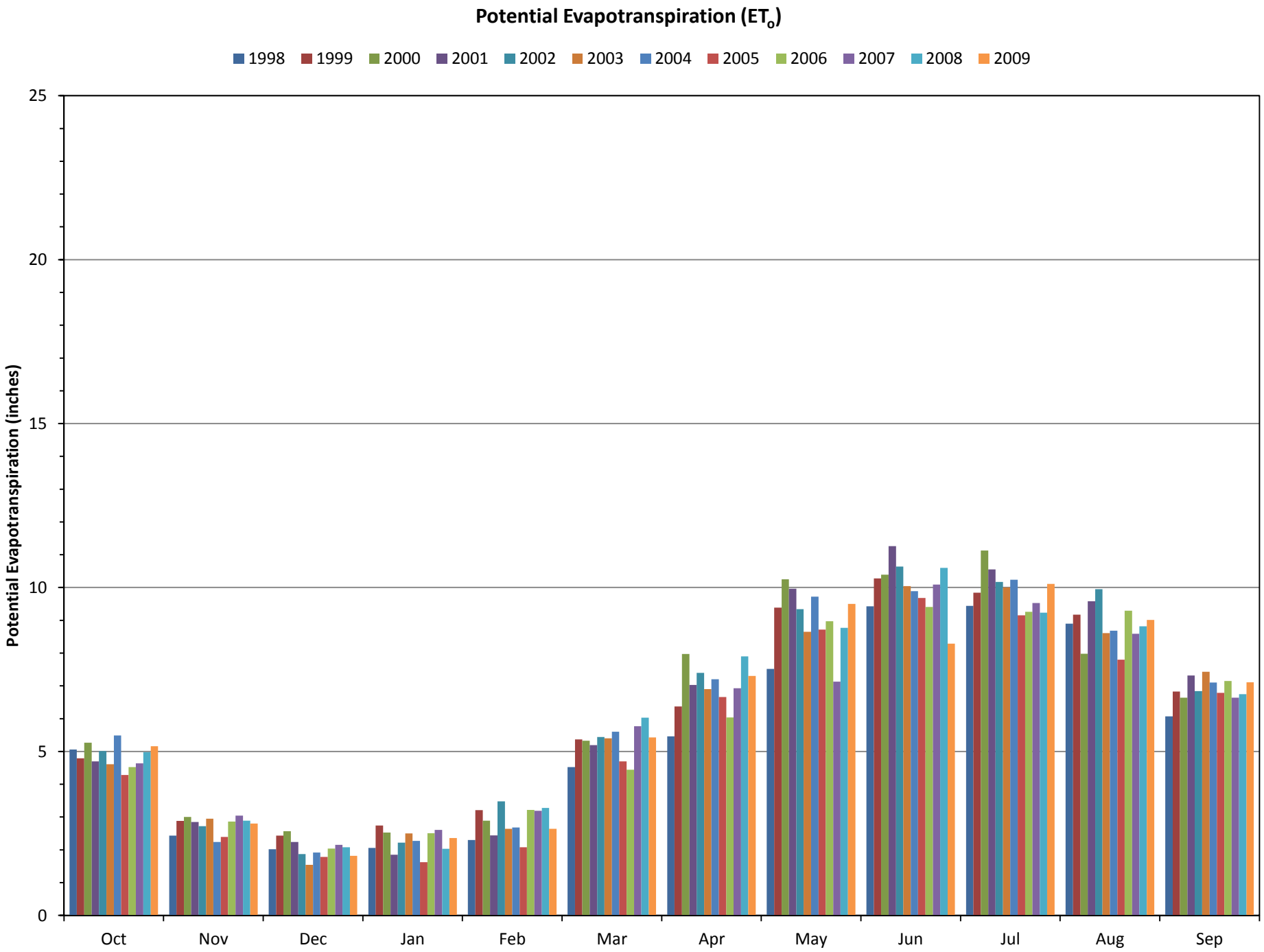
Total Applied Water (af)

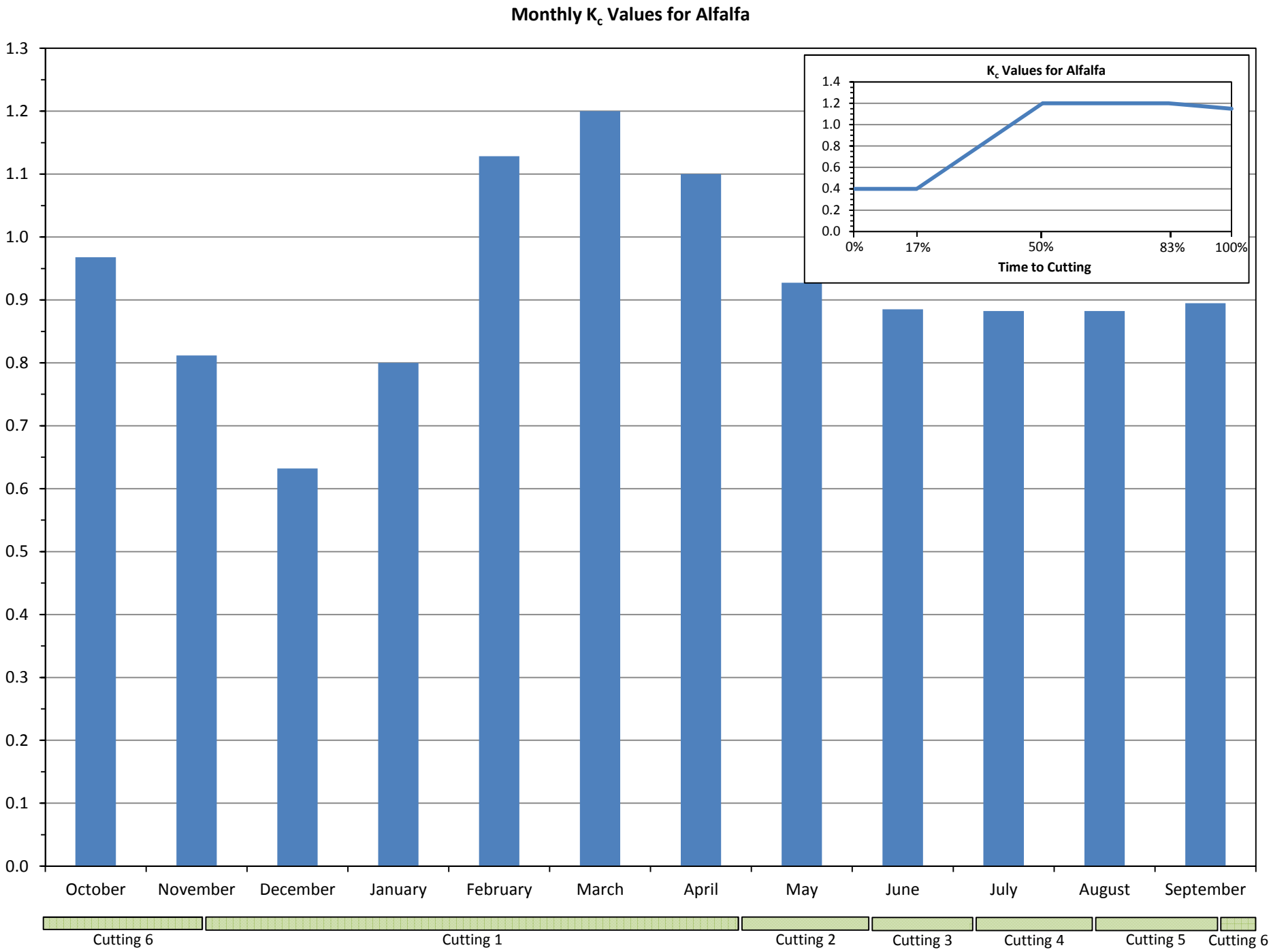
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	49.0	39.9	0.0	7.6	0.0	60.5	103.1	141.6	189.8	114.0	224.0	231.2	**1,160.8**
1999	46.5	0.0	18.1	54.5	31.6	130.5	210.2	139.1	208.3	148.0	47.1	83.6	**1,117.6**
2000	38.0	58.1	28.7	19.0	53.6	72.4	126.2	172.2	190.3	177.8	139.5	209.8	**1,285.6**
2001	39.5	68.3	5.6	21.1	15.8	63.5	204.2	291.9	317.6	320.3	267.1	391.0	**2,005.9**
2002	128.3	102.3	14.9	47.0	46.6	229.3	357.8	403.3	443.5	542.3	466.8	621.1	**3,403.1**
2003	160.8	157.6	8.8	3.3	92.4	194.0	274.1	395.1	463.1	391.2	340.1	430.1	**2,910.8**
2004	100.4	94.4	17.6	3.4	47.5	141.9	152.9	322.2	433.5	326.2	322.7	443.6	**2,406.2**
2005	146.4	35.0	16.9	0.1	25.4	69.9	349.3	530.8	500.8	475.3	491.6	568.0	**3,209.6**
2006	218.6	96.6	11.3	47.3	133.9	200.7	587.0	444.7	670.3	471.2	460.9	567.8	**3,910.2**
2007	204.9	80.8	37.1	45.6	89.4	268.4	281.7	472.0	500.8	559.0	399.3	605.4	**3,544.5**
2008	243.9	164.4	36.5	2.1	70.6	294.4	346.2	503.8	504.3	470.2	457.6	681.1	**3,775.1**
2009	200.2	100.3	41.6	2.3	44.3	300.9	331.2	469.5	461.0	484.6	565.5	629.8	**3,631.3**
Total	**1,576.6**	**997.5**	**237.0**	**253.4**	**651.2**	**2,026.2**	**3,324.0**	**4,286.2**	**4,883.6**	**4,480.1**	**4,182.4**	**5,462.5**	**32,360.7**

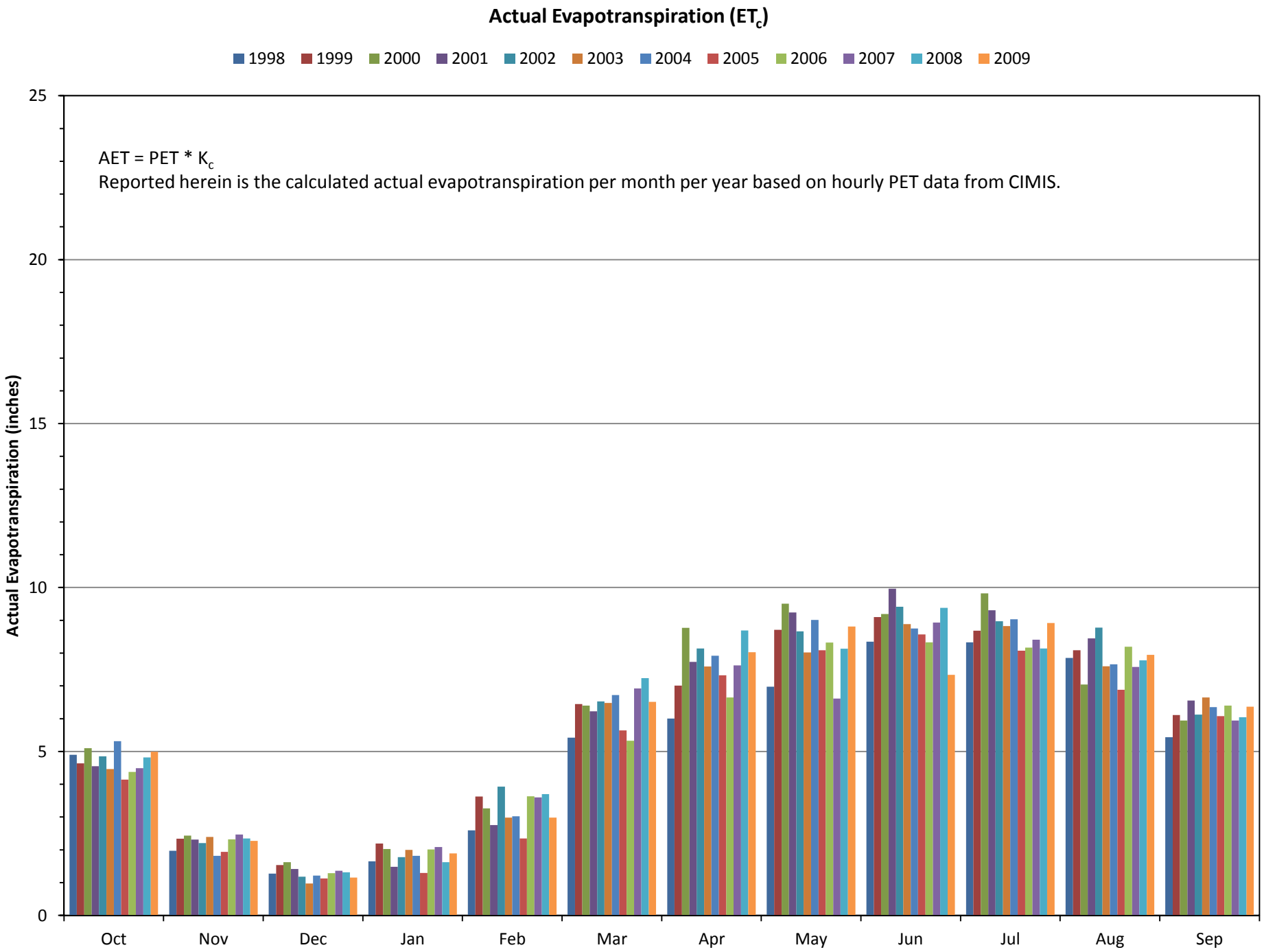

Rainfall
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Rainfall (inches)
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Calculated Production
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Calculated Production (inches)
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Rainfall and Calculated Production
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Rainfall and Calculated Production (inches)
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Potential Evapotranspiration (ET_o)
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Potential Evapotranspiration (inches)
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

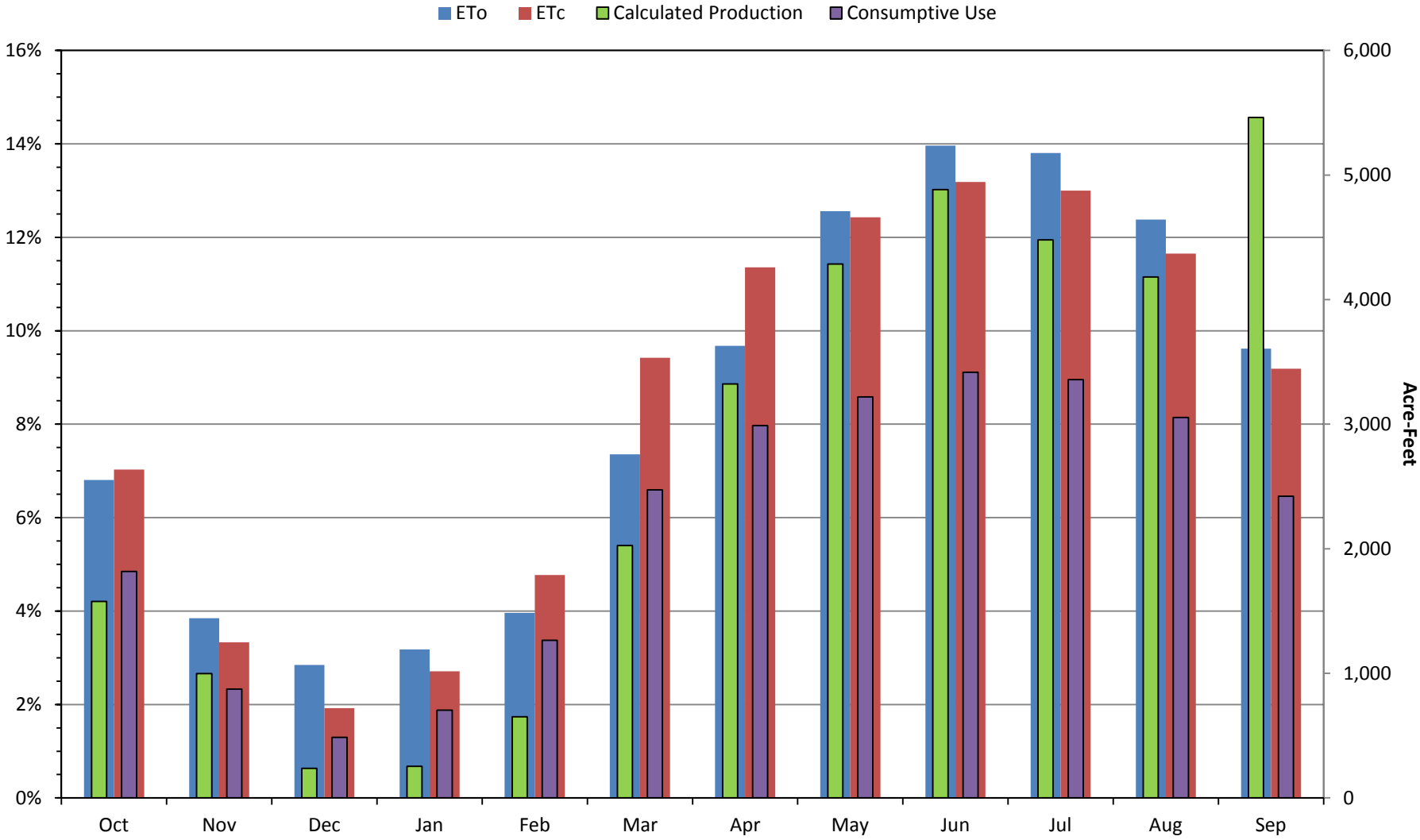

Monthly K_c Values for Alfalfa
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
October
November
December
January
February
March
April
May
June
July
August
September
K_c Values for Alfalfa
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0%
17%
50%
83%
100%
Time to Cutting
Cutting 6
Cutting 1
Cutting 2
Cutting 3
Cutting 4
Cutting 5
Cutting 6


Actual Evapotranspiration (ET_c)
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
AET = PET * K_c
Reported herein is the calculated actual evapotranspiration per month per year based on hourly PET data from CIMIS.
Actual Evapotranspiration (inches)
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Retuen Flow - Total Water compared to Actual Evapotranspiration
Total Water
Actual Evapotranspiration
Average Annual Return Flow (1998-2009)
Estimated Return Flow: 22.0"
Percent of Calculated Production: 26.0%
Inches
120
100
80
60
40
20
0
32"
37%
18"
22%
27"
28%
18"
22%
27"
31%
14"
18%
21"
25%
36"
44%
15"
19%
20"
23%
17"
21%
18"
21%
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

Monthly ET_o and Potential ET_c for Alfalfa[1] as a Percentage of Total and Aggregated Calculated Production and Consumptive Use[2]

Water Years 1998 through 2009



[1] Assumes 6 cuttings per year.

[2] Includes only production and consumptive use for fields irrigating Alfalfa.

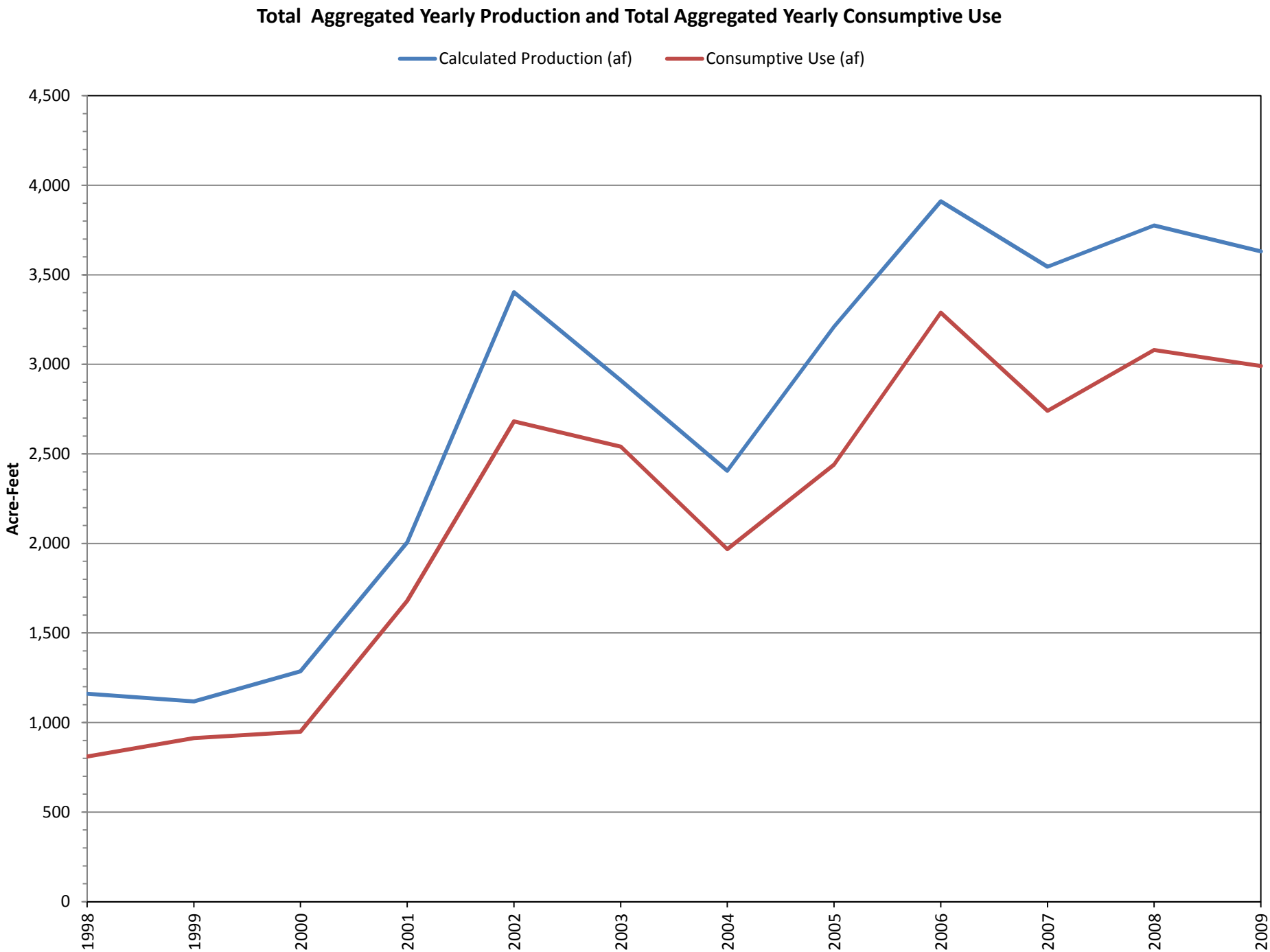

Total Aggregated Yearly Production and Total Aggregated Yearly Consumptive Use
Calculated Production (af)
Consumptive Use (af)
Acre-Feet
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

EXHIBIT 5

Wagner&Bonsignore
Consulting Civil Engineers, A Corporation

Nicholas F. Bonsignore, P.E.
Robert C. Wagner, P.E.
Paula J. Whealen

Martin Berber, P.E.
Patrick W. Ervin, P.E.
David P. Lounsbury, P.E.
Vincent Maples, P.E.
Leah Orloff, Ph.D, P.E.
David H. Peterson, C.E.G., C.H.G.
Ryan E. Stolfus

TECHNICAL MEMORANDUM

To: Mojave Basin Area Watermaster

From: Robert C. Wagner, P.E. Watermaster Engineer
A. Leonardo Urrego-Vallowe, P.E. Project Engineer

Date: June 22, 2026

Re: **Plan to improve collection of hydrologic data and consideration of Golden State Water Company's recommendations**

This memorandum addresses the Court's Order dated October 23, 2024, for Watermaster:

To recommend a plan to improve the collection of hydrologic data that would be relevant to calculations of PSY in the future. In doing so, to consider the recommendations contained in Section 6.0 of the report of Anthony Brown which marked Exhibit 1 to Golden State's motion filed 9-5-24, except that paragraph 4 on page 32 (GSWC 34) is modified to read: "Based on results from the above, Watermaster should determine whether Producers in Alto have met, are currently meeting, and in the future are likely to continue to meet their obligations under the Judgment."

Recommended Plan to Improve the Collection of Hydrologic Data

Watermaster through the Mojave Water Agency (MWA) has been and continues to improve the collection of hydrologic data with the implementation of the following items:

1. **Installation and monitoring of new stream flow gages.** MWA has installed new stream flow gages at the Mojave River System and tributary streams. These new gages are continuously monitored by the MWA's monitoring program.
    - Mojave River at Daggett CA (USGS gage 10262700): Records Mojave River flows at Daggett in the Baja Subarea, downstream of the Waterman Fault. Installed in approximately August 2022, based on the start of available record.
    - Sheep Creek Wash (MWA gage) captures mountain front recharge from Sheep Creek Wash in Oeste Subarea. Total of 3 stations for surface flow and climate monitoring. Installed in February of 2024.

- Arrastre Canyon Spring (MWA gage): measures inflow at Arrastre Canyon in the Fifteen-Mile Valley in Este Subarea. There are two Arrastre Canyon gages. Arrastre Canyon, AC01, was installed on September 30, 2025, to replace one that burned down in the 2025 Ranch Fire. The other one, Arrastre Canyon, AC02, was installed on December 3, 2024.
- Kane Wash (MWA gage) records the flow from the Newberry Mountains and Rodman mountains in Baja Subarea. Kane Wash has three gages. KW01 was installed on February 10, 2024. KW02 and KW03 were installed on December 5, 2024.

Additionally, two USGS gages have been re-activated:

- Cushenbury Canyon C NR Lucerne Valley CA (USGS gage 10260400): Measures stream flow at the Cushenbury Wash in Este Subarea. Re-activated in approximately August 2023, based on the start of available record. Previous period of record was 1957 – 1971.
- Mojave River near Hodge CA (USGS gage 10262000): This USGS gage records stream flow at the Mojave River near the Hodge in Centro Subarea. Re-activated in approximately October 2022. Previous period of record was 1930 – 1932, and 1970-1993.

The location of these new gages is shown on **Attachment A**. The newly collected data will support improved understanding and quantification of water budgets for individual groundwater basins within the Mojave Basin Area (MBA). Current evaluations of existing datasets and groundwater models indicate a substantial uncertainty regarding the role of ungaged inflow and mountain front recharge in contributing to groundwater supplies across the MBA. However, the newly collected data will help generate high-quality estimates of potential additional recharge, supporting proactive, science-based decision-making for sustainable groundwater basin management.

2. **Installation of weather stations.** A total of eleven weather stations have been installed by MWA. These weather stations provide continuous time series of climatological parameters including but not limited to air temperature, wind speed, solar radiation, precipitation, relative humidity, and reference evapotranspiration. The data collected is being used and analyzed to improve the understanding of hydrogeologic features of the MBA in connection with the surface and groundwater processes. Real time access to this data is provided via the Western Weather Group at the website: https://mojave.westernweathergroup.com/.

   In addition, the MWA website provides real time data (15-minute interval) showing precipitation and stream flow relationships at critical locations in the MBA: Deep Creek, West Fork, Lower Narrows, Hodge, Barstow, Daggett, and Afton Canyon. Access to the real time data is provided via MWA website at https://www.mojavewater.org/real-time-data/.

3. **Continuing monitoring of the water levels.** MWA continues its monitoring program of water levels with an extensive and robust network of monitoring wells throughout the MBA.

As noted above, Watermaster is already collecting hydrologic data relating to the MBA. Watermaster's plan to improve collection of hydrologic data includes: (a) study and utilization of the Regional Mojave Basin Model when completed and calibrated; (b) further analysis of the network of monitoring wells; (c) identification of any data gaps, and providing a strategy to fill the data gaps; (d) studying riparian vegetation using satellite-based remote sensing tools to update consumptive use values for phreatophytes; and (e) developing and implementing a program to identify, monitor and quantify production by Minimal Producers. Watermaster's plan is being implemented in the current Water Year 2025-26 and will continue to be implemented throughout the following years.

Watermaster's Consideration of Recommendations from Section 6.0 of Expert Report of Anthony Brown

Per the October 23, 2024, Court's Order, Watermaster considered the recommendations contained in Section 6.0 of the Expert Report of Anthony Brown, Exhibit 1 to Golden State Water Company's motion filed on September 5, 2024. This section describes Watermaster's consideration of each of the recommendations in Section 6.0 of Mr. Brown's report.

Recommendation 1. *Watermaster should re-evaluate the water budgets for Alto, the TZ, and Centro. This should include improved quantification of the following:*

- *Consumptive Use by agriculture and phreatophytes*
- *Storage losses in the TZ*
- *Subsurface flow between Alto and the TZ and thence to Centro*
- *Surface water flows between the TZ and Centro*

In April of 2026, the Court ordered Watermaster to re-evaluate the Production Safe Yield calculation for each subarea using the initial hydrologic base period of the Judgment (1931-1990). Pursuant to the direction of the Court, Watermaster prepared recommendations for PSY and FPA for Water Year 2026-27 using the long-term water supply, as directed by the Court, from the initial base period 1931-1990. Estimates of water supply and subsurface flows between subareas derive from the USGS Water Resources Investigation Report 01-4002, "Simulation of Ground-Water Flow in the Mojave River Basin, California" (Stamos et al. 2001). The USGS model by Stamos et al. (2001) was used by Watermaster in the PSY determination because:

1. It captures the base period 1931-1990. By comparison, the Upper Mojave Basin Model (UMBM) was developed for the modeling period 1951-2020 and thus, it does not capture the full base period.

2. The USGS model by Stamos et al. (2001) captures the five subareas of the MBA. By comparison, the UMBM only covers the Alto Subarea above the Lower Narrows, portions of the Este and portions of the Oeste subareas.
3. The USGS model by Stamos et al. (2001) can be used for model-to-model comparison. The Stamos et al. (2001) model will allow for comparison with the elements of water supply, use and disposal when MWA finalizes the Regional Mojave Basin Model.

Pursuant to the Court's Order dated April 21, 2026, Watermaster updated the water budgets for Alto (including the TZ), Centro, Baja, Este and Oeste based on the hydrologic base period of 1931-1990 and recent Consumptive Uses, Imports and Outflows. Watermaster presented this analysis in the Technical Memorandum titled *Production Safe Yield Update and Recommendation for Free Production Allowance for Water Year 2026-27*, available via the following link https://www.mojavewater.org/20260605_psy_fpa_2026-2027/

Consumptive Use by Agriculture in Alto, the Transition Zone, and Centro. Recent pumping data compiled by Watermaster is based on flow meter records, or other Watermaster approved methods for measuring and reporting. Watermaster's Technical Memorandum *Production Safe Yield re-calculation per Court's Order* dated May 30, 2025 (available via the link https://www.mojavewater.org/tm_psy_reevaluation_20250530/), provides the different methods and percentages for measuring pumping in each subarea. Overall, about 99% of water pumped is metered/measured since at least 2012. Thus, the amount of production is reliably verified. Consumptive use by an agricultural crop is determined using the evapotranspiration rates of applied water and the irrigated acreages. The difference between the potential consumptive use and the applied water (pumping) corresponds to return flow to the system. The estimates of consumptive use by agriculture and return flows utilize accepted methodologies that are aligned with the scientific recommendations.

Consumptive use by phreatophytes for Alto, the TZ, and Centro. In 2024, Watermaster re-evaluated riparian habitat water use in Alto, the TZ and Centro. Watermaster analysis using remote sensing techniques indicates an average consumptive use of 3,776 AFY in Alto upstream of the Lower Narrows, 6,178 AFY in the TZ, and 2,146 acre-feet in Centro. The USGS report by Lines and Bilhorn (1996) indicated that the long-term consumptive uses by riparian vegetation of 5,000 AFY in Alto upstream of the Lower Narrows, 6,000 AFY in the TZ, and 3,000 AFY in Centro. The values reported by Lines and Bilhorn represent the average riparian vegetation use during the 1931-1990 period. The California Department of Fish and Wildlife (CDFW) is currently investigating the consumptive uses by the riparian habitat. The results of this study will be used to provide more recent and updated values of the consumptive uses by riparian habitat. Our recommendation is to continue to use the Lines and Bilhorn (1996) values until CDFW has completed its riparian habitat study and the results can be evaluated and if appropriate, incorporated into the water budget calculations and the RMBM (when complete).

Subsurface flow between Alto and the TZ and thence to Centro. Watermaster estimates of subsurface flows were established by the parties to the Judgment. Watermaster considered and

adopted a recommendation, presented to the Court in April 2006, to establish subsurface flow obligation for Alto to Centro of 2,000 acre-feet per year.

The USGS model by Stamos et al. (2001) provides estimates of subsurface flows from Alto to the TZ of 3,501 AFY and from the TZ into Centro of 1,566 AFY during the 1931-1990 base period.

In April of 2025, Watermaster prepared updated estimates of the subsurface flows near the Helendale Fault to update a 2006 study of flow across the TZ to Centro boundary (see **Attachment B**). MWA well hydrographs for water levels measured after 2016 indicate that levels in wells upstream of the fault (Alto TZ) have remained relatively constant. This update indicates that the estimated subsurface flow ranges from 2,300 to 3,400 AFY based on water levels for nine years between 2006 and 2024. Based upon this more recent analysis, the Judgment's assumption of 2,000 acre-feet Subsurface Flow through the TZ appears to be conservative and, accordingly, Centro actually is receiving more than 2,000 acre-feet per year of subsurface flow.

Surface water flows between the TZ and Centro. In 2025, Watermaster prepared a Technical Memorandum titled *Responses to Court's questions to be addressed in the next motion to adjust FPA* available via the following link:
https://www.mojavewater.org/tm_addressing_court_questions_20250530/

This Technical Memorandum provided an analysis of monitoring wells in the TZ showing stable long-term water levels. Watermaster carefully reviews water levels within the TZ to confirm that the long-term average storage losses in the TZ are nearly zero. The network of monitoring wells in the TZ supports this conclusion. The TZ monitoring wells show stable long-term water levels throughout the TZ, including the area near and downgradient (within Centro) of the Helendale Fault.

Storage losses in the TZ. Because water levels and pumping are the best available data at this time, Watermaster continues to rely on these parameters to evaluate changes in storage and to re-evaluate PSY recommendations. Based on the water levels in the TZ, Watermaster concluded that the long-term average change in storage within the TZ is nearly zero. Once complete, the Regional Mojave Basin Model will provide more information about the storage changes and outflow in the TZ.

Recommendation 2. *Watermaster should update the current UMRB model to include the entire adjudicated area subject to the Judgment, and then use the updated (and calibrated) model to reevaluate water budgets.*

MWA is in the process of finalizing the Regional Groundwater Model which will include the Alto (Transition Zone), Centro, Baja, Oeste and the Fifteen-Mile Valley in Este Subarea initially, and ultimately the Lucerne Valley portion. The USGS model by Stamos et al. (2001) includes the entire Este Subarea, which is the basis for the current PSY determination. Once the RMBM is complete and calibrated, the model will be used to evaluate water budgets.

Recommendation 3. *Watermaster should perform statistical analyses to correlate groundwater levels in Alto, the TZ, and Centro (three areas) with: (i) time; (ii) with combined surface and subsurface inflows; and with (iii) groundwater production (three variables). These analyses should consider the following three periods of time: (i) prior to the Judgment (pre-1994); (ii) during the period of production ramp-down (1994-2004); and (iii) the period after the ramp-downs (2005-2024).*

In 2025, Watermaster conducted an analysis of the groundwater levels in the Transition Zone and in the Centro Subarea near the Helendale Fault. Watermaster analyzed hydrographs showing the relationship between depth to water at different wells and total historical production in the Transition Zone. The hydrographs and results of this analysis were presented in the Technical Memorandum titled *Responses to Court's questions to be addressed in the next motion to adjust FPA* dated March 30, 2025.

As described in this Technical Memorandum, "the average depth to water from the pre-development conditions (1930 - 1950) was 15.56 feet, which is the same as the average depth to water with and after the implementation of the Judgment (1996-2024) of 15.57 feet."

In addition, Mr. Brown recommended a Mann-Kendall (MK) statistical test to establish groundwater level trends for all wells located in the Transition Zone to determine whether there is a trend of water levels over time. Based upon Mr. Brown's recommendation, MWA performed an MK statistical test in 2025, and determined therefrom that about 70% (during 1996-2024) to 80% (during 1990-2024) of the shallow wells in the Transition Zone show either a rise, or no change in groundwater levels. These results *do not indicate* that 20%-30% of the wells show a declining water level. The results *do indicate* the following: For the period 1996 to 2024 (since entry of Judgment) 33 of 40 wells analyzed (82.5%) had trends that were significant at the 95% confidence level (p-value < 0.05). Of these 33, 29 (88%) wells showed an upward water level trend. 7 of the wells showed no significant trend. The number of wells in the categories Very Strong, Strong, Moderate, Weak, or Negligible were respectively 5, 5, 16, 3, 0. Only 4 wells of 40 analyzed show moderate to strong downward trend for water levels.

We conclude from this analysis that there is water level stability within the TZ as was envisioned by Section F. 2 of the 1996 Amended Statement of Decision.

The results of this analysis are provided in **Attachment C**.

Recommendation 4. *Based on results from the above, Watermaster should determine whether Producers in Alto have met, are currently meeting, and in the future are likely to continue to meet their obligations under the Judgment.*

Exhibit G of the Judgment defines the Alto Subarea obligation as "an average Annual combined Subsurface Flow and Base Flow of 23,000 acre-feet per Year to the Transition Zone." The subsurface flow component was deemed to be 2,000 acre-feet per year.

The results of Watermaster's analysis indicated that the Alto producers have met their subarea obligation, are continuing to meet and are likely to continue to meet their obligation in the future. This was demonstrated through the analysis of the hydrographs presented in Watermaster's Technical Memorandum *Responses to Court's questions to be addressed in the next motion to adjust FPA*, as well as the calculation of subsurface flows between Alto and the Centro Subarea (see **Attachment B**).

As noted, in April of 2025, Watermaster developed updated estimates of subsurface flows near the Helendale Fault to revise the 2006 analysis of flow across the Transition Zone–Centro boundary. The updated analysis, based on groundwater levels from nine years between 2006 and 2024, estimates subsurface flow to range between approximately 2,300 and 3,400 acre-feet per year (see **Attachment B**). Based on this analysis, Watermaster indicates that the Judgment's assumed subsurface flow of 2,000 acre-feet per year through the TZ is conservative.

The Makeup Obligation from Alto to Centro is determined by the base flow at Lower Narrows, subsurface flow deemed by the Judgment, and the treated wastewater discharge from Victor Valley Wastewater Reclamation Authority (VVWRA) in the TZ. Table 4-3 from the Thirty-Second Annual Report of the Mojave Basin Area Watermaster shows the yearly Makeup Obligations from Alto to Centro during the Water Years 2015-16 through 2024-25. It demonstrates that the producers in Alto have met their subarea obligation. Each year Watermaster reports the preceding ten (10) years; however, the compilation is available in the Annual Reports since Water Year 1993-1994. It is important to note that there are only two inputs to determining the Makeup Obligation: (1) base flow and the assumed subsurface flow at Lower Narrows; and (2) VVWRA discharges.

Recommendation 5. *If Watermaster determines the obligation has not been, is not being, and will not be met, Watermaster should develop a plan to ensure they are met in the future and then implement such a plan, and develop an approach to address past shortfalls in water delivery.*

As mentioned above, Alto producers have met and continue to meet their subarea obligation. Importantly, the Makeup Obligation calculation is designed to ensure that the obligation of 21,000 acre-feet of surface water flow and 2,000 acre-feet of subsurface flow to the TZ is always met per the Judgment. Therefore, no additional action is needed at this time.

Recommendation 6. *If Watermaster determines the obligation has been, is being, and will be met, Watermaster should recommend and implement additional analyses that would evaluate why chronic water levels declines are being observed at Golden State's production wells in Centro.*

As mentioned above, the Alto producers have been and will continue to meet their Subarea obligations to Centro. The most likely reason for the water level decline observed at Golden State's production wells in Centro is the below average water supply to the MBA experienced from 2012 to 2022, coupled with Golden State's pumping in a concentrated small area in Centro. **Attachment D** provides graphics showing total and cumulative production by sublocation in Centro Subarea for the 1993-2025 period. About 79% of total groundwater production occurs

within the area of concentrated pumping in which the Golden State wells are located (between Hodge and Barstow gage). **Attachment E** is the aerial imagery showing the spatial distribution of groundwater pumping within Centro Subarea, the location of production wells by Golden State and other producers between Hinkley and Barstow (Focus Area), as well as the average groundwater production between Water Years 2016-17 and 2022-23.

Watermaster has previously explained and demonstrated the reason for the groundwater level declines near Golden State's wells, and that the Alto Producers have met their Subarea Obligation, and that there are no unaccounted water losses in the TZ. The *Watermaster's Amended Opposition to Golden State Water Company's Motion to Enforce Judgment* dated October 9, 2024 provides the reasons for and analysis of this issue, and is summarized herein as follows:

The historical dry period 2012-2022 was about 40-percent of long-term average supply 1931-2025. **Attachment F** is the hydrograph showing the historical dry periods at the Forks. According to the flow at the Forks, the average water supply to the Basin Area during the period 2012-2022 was 27,614 AFY, which is 60-percent drier than the 95-year (1931-2025) long-term average of 68,635 AFY. In other words, the inflow to the MBA, including the Centro Subarea, received only a small portion of the long-term average potential recharge. Therefore, the issues at Golden State wells are related to the drought conditions and the lack of storm flow during the 2012 to 2022 period, and the concentrated pumping that occurs within the relatively small area in which Golden State wells are located. This conclusion is further confirmed by the fact that the monitoring wells located upstream of the "Focus Area" (between the TZ and Hodge) show relatively stable water levels. See Centro Subarea hydrographs in **Attachment G**. For example, monitoring well 08N04W12Q01 located upstream of Hodge has a long period of record and indicates that water level measurements around 1931 were at elevation 2,322 feet msl, and the most recent water level in 2026 was also at 2,322 feet msl.

The foregoing constitutes a complete consideration of the recommendations contained in Section 6.0 of the Expert Report by Anthony Brown. However, in subsequent paragraphs of Mr. Brown's report he suggests certain other methodologies for data collection, which we also discuss briefly below.

Section 6.1 Additional Statistical Analyses

See response to **Recommendation 3** above.

Section 6.2 Improved Measurement of Surface Water Flow into Centro

Watermaster has stated previously that the Alto Subarea obligation to Centro is "an average Annual combined Subsurface Flow and Base Flow of 23,000 acre-feet per year to the Transition Zone" (paragraph 1.e of Exhibit G to the Judgment). Per the 1996 Amended Statement of Decisions, the surface water requirement from Alto to Centro is 21,000 acre-feet average annually and is measured at the Lower Narrows, not at Helendale Fault (HF).

Watermaster acknowledges remote sensing techniques are available for estimation of surface water flow in desert environments. However, the ability of remote sensing to accurately quantify river flows is limited under the environmental conditions existing at the HF, compounded by the relative infrequency of significant storm events that produce detectable storm flows at the HF.

Implementing remote sensing, as proposed by Golden State Water Company (GSWC) is not a requirement under the Judgment. Nonetheless, Watermaster has considered the recommendation of using remote sensing to determine surface water flow into Centro. In the *Watermaster's Reply Brief in response to Motion to Adjust Free Production Allowance for Water Year 2025-2026*, dated July 28, 2025, Watermaster observed that:

- GSWC proposes using Upstream Tech's AI modeling to estimate water flow through the Helendale Fault, but Watermaster views it as another model—not a direct measurement—similar to the RMBM being developed by MWA.
- Watermaster considered Upstream Tech's presentation, "but was not persuaded its modeling services would be useful at this time."
- Watermaster suggests that if GSWC strongly supports Upstream Tech, GSWC should fund and conduct the modeling itself and share the results with Watermaster.
- Watermaster budget is limited and relies on MWA for the costly modeling work being performed, including the RMBM.

Watermaster's Technical Memorandum titled *Responses to Court's questions to be addressed in the next motion to adjust FPA* dated May 30, 2025, included hydrographs of the Mojave River surface flows measured by the USGS at the Lower Narrows (USGS gage #10261500) and near Hodge (USGS gage #10262000). The hydrographs include Sentinel-2 NDWI imagery near HF during two different times. As noted on the imageries, "the normalized difference water index is most appropriate for water body mapping". The two images show the location of surface water along the Mojave River from the TZ into Centro during the times when Hodge gage was recording Mojave River discharge values. This demonstrates how Watermaster has incorporated remote sensing techniques as a visual check for storm flows passing into the Centro Subarea. However, Watermaster continues to use recorded surface flow measurements from the USGS gages, measurements of discharges from VVWRA, measured groundwater pumping and groundwater levels in the TZ, measurement of precipitation and estimates of consumptive uses within the TZ to calculate the surface and subsurface flows from the TZ into Centro at the HF. These measurements are considered the best available data at this time.

Section 6.3 Remote Sensing of Riparian and Agricultural Evapotranspiration

Consumptive uses of water by riparian habitat are adopted by Watermaster from the U.S. Geological Survey Water-Resources Investigations Report 96-4241 titled "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" by Lines and Bilhorn. For Alto, including the Transition Zone, Lines and Bilhorn (1996) indicated an average

water use of 11,000 acre-feet per year. This number was previously adopted as part of the Alto/Transition Zone water budget and PSY calculation.

Watermaster is not opposed to use of remote sensing technologies to improve and/or update estimates of consumptive use by agriculture and phreatophytes. In fact, Watermaster has worked on studying the riparian vegetation using satellite-based remote sensing tools to update consumptive use values for phreatophytes.

The total consumptive use for an agricultural crop is determined using the evapotranspiration rates of applied water and the irrigated acreages. Current estimates of agricultural evapotranspiration rates are calculated by Watermaster as the evapotranspiration of applied water (ETaw) from CUP+. CUP+ is a tool developed by DWR and the University of California, Davis to estimate ETaw values specific for each crop type. The CUP+ program incorporates climatological conditions, obtained from the CIMIS (California Irrigation Management Information System) stations, and which are specific for each subarea and vary from year to year. The CUP+ program also incorporates the crop coefficients, which are specific for each type of ag cultivation. Therefore, this methodology has been widely used and considered acceptable for calculation of ETaw (FAO 56).

In 2024, Watermaster presented an analysis of the riparian water use using remote sensing techniques. Watermaster analysis indicates an average annual consumptive use of 3,776 acre-feet per year for Alto upstream from the Lower Narrows, and 6,178 acre-feet per year for the Transition Zone, totaling 9,954 acre-feet per year. The table below summarizes and compares the estimates of riparian habitat water use.

	Lines and Bilhorn (1996)		OpenET eeMETRIC analysis		
Subarea	Total Area, including hydrophytes	Estimated CU of groundwater and surface water by riparian vegetation	Total Area, including hydrophytes	Total Average ET from 2008-2023	Difference
	(acres)	(acre-feet)	(acres)	(acre-feet)	
Alto upstream from the Lower Narrows	1,399	5,000	1,430	3,776	-24%
Alto Transition Zone	2,605	6,000	2,882	6,178	3%
Centro	2,828	3,000	3,179	2,146	-28%
Baja	2,790	2,000	4,319	1,581	-21%

CDFW has commissioned a multi-year study to update the estimates by Lines and Bilhorn (1996) and will be updated in Watermaster records when completed.

6.4 Transition Zone Water Budget

Watermaster has previously demonstrated that the Transition Zone Water balance provides an adequate calculation of the surface and subsurface flows entering the TZ at the Lower Narrows. This represents the total flow entering Centro at or near the Helendale Fault. In the Watermaster's

Technical Memorandum *Responses to Court's questions to be addressed in the next motion to adjust FPA*, Watermaster presented a complete hydrologic inventory for the TZ for the Water Years 2023 and 2024 (i.e., the complete years when we have full record of flows at the Hodge gage). Watermaster also demonstrated the relationship between the total surface flows at the Lower Narrows and the total flows near Hodge.

Watermaster analysis concluded that "this demonstrates that the Transition Zone generally allows for surface, subsurface and storm flows to pass into the Centro subarea."

Watermaster concurs that a groundwater model could provide an improved water budget calculation, and the Regional Groundwater Model that is being developed by MWA will provide estimates of groundwater flow rates between the Transition Zone and Centro, estimates of change of groundwater storage over time, etc.

Enclosures:

Attachment A – Map showing location of stream flow gages in MBA

Attachment B – Subsurface Flow at the Alto-Centro Subarea Boundary

Attachment C – MWA Statistical analysis memorandum

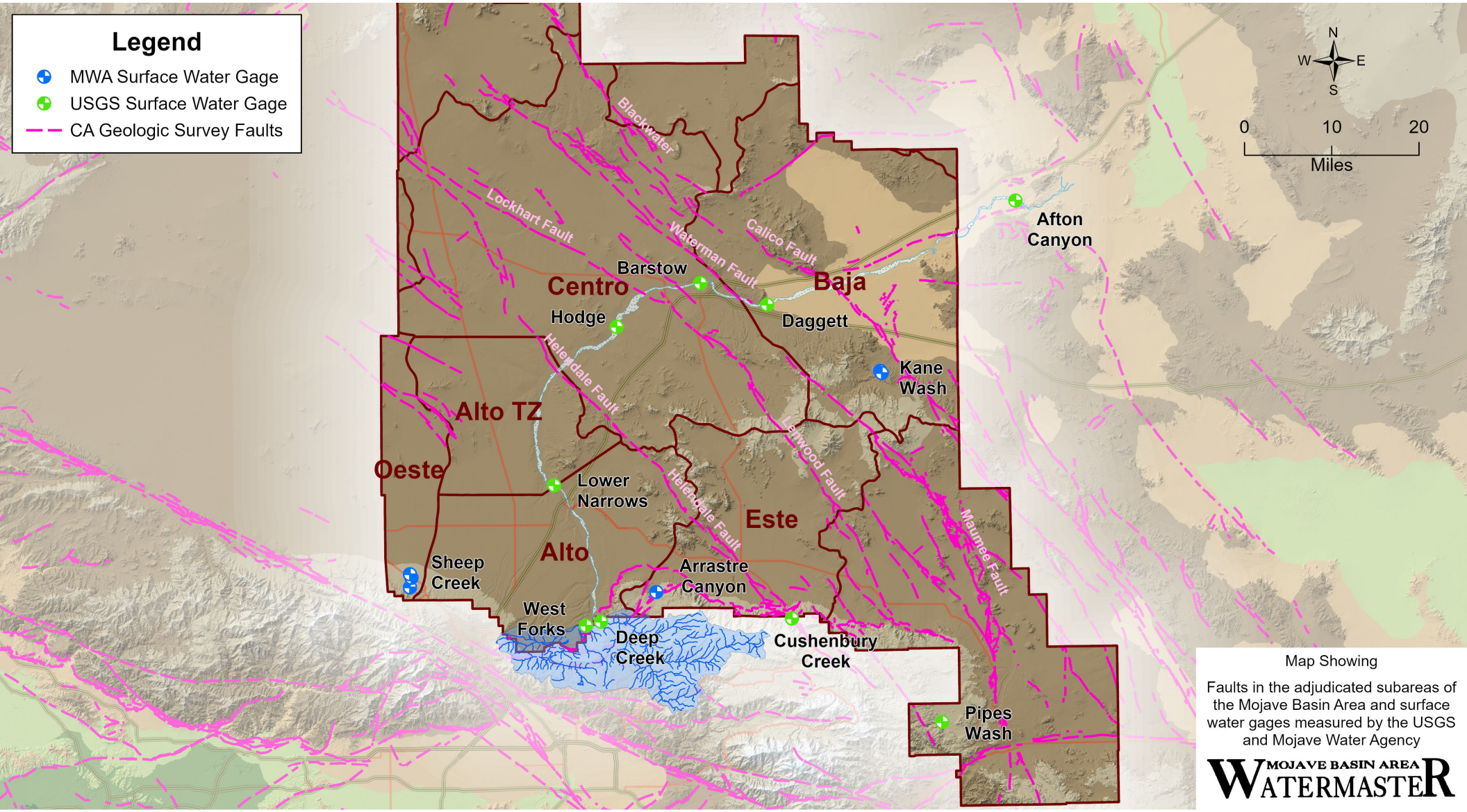
Attachment D – Centro Production by Sub Location

Attachment E – Map showing Average Production in Centro Subarea

Attachment F – Historical dry periods at the Forks

Attachment G – Centro Subarea Hydrographs 2026

Attachment A



Map Showing

Faults in the adjudicated subareas of the Mojave Basin Area and surface water gages measured by the USGS and Mojave Water Agency

MOJAVE BASIN AREA WATERMASTER

W:\GIS\SurfaceWaterGagesWithFaults\SurfaceWaterGagesWithFaults.aprx

July 2025

Attachment B

Wagner&Bonsignore
Consulting Civil Engineers, A Corporation

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MEMORANDUM

To: Mojave Basin Area Watermaster

From: Robert C. Wagner, P.E. and David H. Peterson, C.Hg

Date: April 16, 2025

Re: **Review of Subsurface Flow at the Alto-Centro Subarea Boundary Mojave Basin Area**

This memorandum presents a review of previous studies performed to estimate the annual subsurface flow across the Alto-Centro Subarea boundary. In addition, groundwater data reviewed were used to calculate the annual flow across the Helendale fault, which generally defines the subarea boundary. This review relied on existing maps and data; field investigation or well testing were not performed. The sources reviewed are listed in the References.

Hydrogeologic Setting of the Alto Transition Zone - Centro Boundary (Helendale Fault)

The setting of the area reviewed is shown on the attached geologic map from a study of the Helendale fault by the U.S. Geological Survey (USGS; Stamos and others, 2003, Figure 2). Groundwater flow through the shallow (Floodplain) and deeper alluvial (Regional) aquifers has been evaluated at the Alto Transition Zone (TZ) - Centro Subarea boundary in several prior studies. These prior studies have generally concluded that the Helendale fault, which generally defines the Alto-Centro subarea boundary, does not impede groundwater flow in the shallow Floodplain aquifer. In California Department of Water Resources Bulletin 84 (DWR; 1967), analysis of groundwater levels concluded that the Helendale fault impedes groundwater flow in the deeper, older alluvium (i.e., Regional aquifer), but not within the recent channel deposits of the Mojave River. The study also noted that upstream of the fault, rising water (i.e., an upward gradient) contributes to the Mojave River, while downstream, this condition is reversed.

A 1971 study by Hardt (USGS) also noted that water levels in wells adjacent to the Mojave River near the Helendale fault indicated that the fault impeded flow in the deeper, older alluvium (Regional aquifer), but not within the overlying Mojave River deposits (Floodplain aquifer). Since most pumping and development is from the shallow river deposits of the Floodplain aquifer, Hardt concluded that ground-water movement was little affected by the Helendale fault. Hardt also noted that the fault acts as a barrier in the older alluvium (Regional aquifer) and causes water to move upward to the land surface on the south (upstream) side of the fault, which in part accounts for the abundance of phreatophytes upstream of the fault.

Review of well hydrographs prepared by Mojave Water Agency and U.S. Geological Survey for various years generally indicate that water levels in most wells through the Alto TZ remained stable or rose slightly since the early 1990s, indicating that groundwater storage within the Transition Zone has remained relatively stable or has increased slightly. Hydrographs show a period from about 2000 to 2005 when water levels in wells upstream and south of the fault steadily declined up to about seven feet, but rebounded after a large storm event in 2005. Overall, gradients have remained relatively constant.

In the electric analog model of the Mojave basin, Hardt (1971) developed values for transmissivity (the flow through a vertical strip through the aquifer one foot wide) of the Floodplain aquifer, based on an empirical relationship between specific capacity of a well (the pumping yield per foot of drawdown) and transmissivity. This was obtained mainly by estimating transmissivity of the materials from information on well drillers reports. Hardt notes that the values of transmissivity developed by this method are approximate, and dependent on factors such as the accuracy of the drillers descriptions and estimates of well yield, in addition to construction (efficiency) of the well. Transmissivity developed by this method was about 100,000 gallons per day (gpd) per foot in the channel deposits (i.e., Floodplain aquifer), and much lower, about 5,000 to 25,000 gpd per foot in the adjacent and underlying older alluvium (Regional aquifer). The transmissivity estimates developed by Hardt (1971) have subsequently been used or cited in subsequent studies by USGS and by private consultants.

In 2003, the USGS released a report of the geohydrologic study of the Helendale fault (Stamos and others, 2003). In that study, multi-point wells (piezometers) were installed in four locations near the fault. The USGS performed a well pumping test in one of the wells (8N/4W-20Q12) and monitored the response in the piezometers. The USGS also performed single well (slug) tests to estimate aquifer transmissivity. The pumping test yielded a calculated transmissivity 1,346 gpd per foot for the Floodplain aquifer, much lower than the transmissivities estimated by Hardt (1971) or Stamos and others (2001). However, the USGS concluded that the tested well may have been located in less permeable materials that were not representative of the overall Floodplain aquifer. The single well (slug) test data also did not agree well with prior studies or well test and so were used only as a relative comparison between the wells for the study.

In a 2013 study of the Centro and Baja subareas, Todd Engineers also used the relationship between specific capacity and transmissivity to estimate transmissivities from well logs. They assumed unconfined aquifer conditions and used a conversion factor of 1,500 to estimate a range of 50,000 to 100,000 gpd/ft for the Floodplain aquifer. The estimates assumed an aquifer thickness of 150 feet, similar to the conditions at the subarea boundary.

Prior Estimates of Subsurface Flow Across the Alto-Centro Subarea Boundary

Early investigations of the Mojave River Groundwater Basin by Department of Water Resources, (DWR; Weber, 1967) estimated groundwater flow from the upper Mojave Basin (Alto, Este, Oeste) to the middle Mojave at 2,000 acre-feet per year (AFY). The subsurface flows across

the subarea boundary were calculated using a form of Darcy's equation. In this equation, the flow across the boundary in gallons per day Q = TIW; where W is the width of aquifer at the basin boundary in feet; T (transmissivity) is the hydraulic conductivity of the aquifer material times the saturated thickness of the aquifer, expressed in gallons per day per foot of aquifer width; and I is the slope of the groundwater surface (i.e., the gradient).

In a 2001 groundwater model by USGS (Stamos and others), Hardt's 1971 transmissivity data were used as initial input to the model and subsequently adjusted during model calibration. From the 2001 USGS groundwater model simulation, flow across the Helendale fault was calculated to range from 2,444 AFY in 1930 to 720 AFY in 1994, with an average of 1,566 AFY over that period. However, the same report cites an estimate by Gregory Mendez of the USGS that as much as 5,000 to 6,000 AFY of groundwater may actually flow through the Floodplain aquifer across the fault, with an additional 1,200 AFY in the deeper Regional Aquifer.

In a 2003 study of the Transition Zone hydrogeology by URS Corporation, the prior estimates of flow by Weber (1987) at 2,000 AFY and USGS (2001) of 1,556 AFY were presented, as well as an independent calculation of flow across the Helendale fault, using previously developed transmissivity values. In their study, URS estimated that average flow across the Helendale fault, using 1998 water levels, was about 3,358 AFY in the Floodplain Aquifer and about 1,220 in the deeper Regional Aquifer across the Helendale fault.

Updated Estimate of Flow Across Alto TZ-Centro Boundary

As part of the current review, we also performed an estimate of groundwater flow across the Helendale fault. Our analysis used water levels and gradients calculated from USGS regional water table maps and MWA hydrographs (see attached 2025 hydrograph map) for the period from 2006 to 2016, and the cross-sectional area of the Floodplain aquifer measured from Cross Section A-A' (see attached) in the 2003 USGS Helendale fault study (Stamos and others, 2003). In addition, we used MWA monitoring data from 2024 to evaluate recent conditions. We compared Floodplain aquifer thickness shown on the USGS cross section (denoted by symbols Qra and Qya) to unpublished cross sections we prepared (Wagner & Bonsignore, 2024) as part of MWA's groundwater model update and found good agreement. Additionally, a transmissivity of 100,000 gpd per foot was used, based on information presented in Hardt (1971) and was divided by an aquifer thickness of 150 feet to obtain a hydraulic conductivity (k) of 666 gallons/day or equivalently, 89 ft/day.

Gradients were estimated from measurements taken from relatively small-scale USGS regional water table maps and so are considered approximate. From the period of 2006 to 2016, water levels near the cross section varied from about 2,391 to 2,396 feet and gradients in the vicinity of the USGS cross section generally ranged from about 0.0024 to 0.0043. The results of our analysis are shown in the following table:

Subsurface Flows at USGS Cross Section A-A' (Stamos and others, 2003; see attachments)

Year	Groundwater Elevation Near Fault (Well Number)	Measurement Date	Average Gradient	Wells and Elevations Used for Gradient Calculation/Distance	Flow through Section, AFY
2006	2,395 (20Q11)	4/21/2006	0.0043	6N1(2,463) – 29E6(2,401) 2.69 mi.	3,411
2010	2,394 (19G4)	3/29/2010	0.0041	6N1(2,459) - 29E6 (2,401)/ 2.69 mi.	3,253
2012	2,396 (19G4)	3/13/2012	0.0029	6N1(2,444) - 29E6 (2,402)/ 2.69 mi.	2,301
2014	2,392 (20Q13)	3/3/2014	0.0030	6F7 (2,438) – 29E6 (2,402)/ 2.27 mi.	2,380
2016	2,391 (20Q13)	3/8/2016	0.0031	6F7 (2,438)- 29E6 (2,401)/ 2.27 mi.	2,459
2018	2,390 (20Q11)	Annual Averages	0.0041	6F7 (2,434) - 29E6 (2,385) / 2.27 mi.	3,253
2020	2,391 (20Q11)		0.0042	6F7 (2,436)- 29E6 (2,386) / 2.27 mi.	3,332
2022	2,390 (20Q11)		0.0042	6F7(2,436) - 29E6 (2,386) / 2.27 mi.	3,332
2024	2,392 (20Q11)		0.0041	6F7 (2,437) - 29E6 (2,388)/ 2.27 mi.	3,253
Averages	2,393		0.0038		2,997

Note: Water level data from 2006 – 2016 from USGS; data from 2018 – 2024 are from MWA. Gradient calculations for 2018 to 2024 were based on average water levels for the year.

The subsurface flow analysis performed above indicates that flow through the Helendale fault has exceeded 2,000 AFY for the period reviewed. While our analysis relied primarily on water-table maps by USGS published through 2016 and MWA well monitoring data from 2018 to 2024, water levels in wells south and upstream of the fault (Alto TZ) have only changed slightly over time. Since water levels and gradients have been small over time, changes in flow through the subarea boundary are also expected to be small.

Discussion and Conclusions

As previously discussed, calculation of flow using Darcy's Law requires three inputs; cross sectional area, gradient, and permeability/transmissivity. Of these, cross sectional area and gradient can be determined or calculated from well data and water levels. In the analysis, we calculated the area of the saturated Floodplain aquifer using the USGS cross section and an average groundwater elevation of about 2,393 feet. This was the approximate average water level during the period analyzed, although variations in water levels might introduce a few percent of error into the calculations.

Somewhat more difficult to measure is transmissivity, which was obtained from the references reviewed and was based on the approximate relationship between the pumping yield and drawdown observed in newly completed wells, often during initial development. Ideally, transmissivity data would be obtained by controlled, constant-rate pumping tests in several locations, in wells that fully penetrate the aquifer (i.e., at least 150 feet deep in this area). However, without these types of tests, the use of specific capacity data to estimate transmissivity is a broadly accepted method in hydrogeologic studies and is a typical method used in development of groundwater models.

As shown above, the calculated subsurface flow has averaged about 2,997 acre feet per year at Helendale Fault and has been as high as 3,411 acre feet and as low as 2,301 acre feet. The average is at nearly 3,000 acre feet per year, which is about 50% higher than the 2,000 acre feet per year assumed for the Judgement. Additionally, MWA monitoring data for well 08N04W20Q11, located just upstream of the Helendale fault indicates that water levels are little changed since 2018.

Attachments

Geologic Map and Explanation Sheet from Stamos and others, USGS, 2003 (Figure 2)
Cross Section A-A' from Stamos and others, USGS, 2003 (Figure 3)
Alto Subarea Transition Zone Hydrographs 2025 – MWA

References

Albert A. Webb Associates, 2000, Consumptive Water Use Study and Update of Production Safe Yield Calculations for the Mojave Basin Area: Unpublished report to the Mojave Basin Area Watermaster, dated February 16, 2000, 234p.

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Stamos, C.L., Cox, B.F., Izbicki, J.A., and Mendez, G.O., 2003, Geologic Setting, Geohydrology and Ground-Water Quality near the Helendale Fault in the Mojave River Basin, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations Report 03-4069, 53p.

Todd Engineers with Kennedy/Jenks Consultants, 2013, Final Report, Conceptual Hydrogeological Model and Assessment of Water Supply and Demand for the Centro and Baja Management Subareas, Mojave River Groundwater Basin: Unpublished report to the Mojave Water Agency, dated July 2013, 291p. with Appendices.

URS Corporation, 2003, Mojave River Transition Zone Recharge Project, Phase I Report, Transition Zone Hydrogeology: Unpublished report to the Mojave Water Agency, dated March 13, 2003, 112 p., with tables and illustrations.

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Weber, E.M. (Supervising Geologist), 1967, Mojave River Groundwater Basins Investigation: California Department of Water Resources, Bulletin 84, 196p, with figures and tables.

Figures from Stamos and others, 2003, USGS Water-Resources Investigations Report 03-4069

Geologic Setting, Geohydrology, and Ground-Water Quality near the Helendale Fault in the Mojave River Basin, San Bernardino County, California

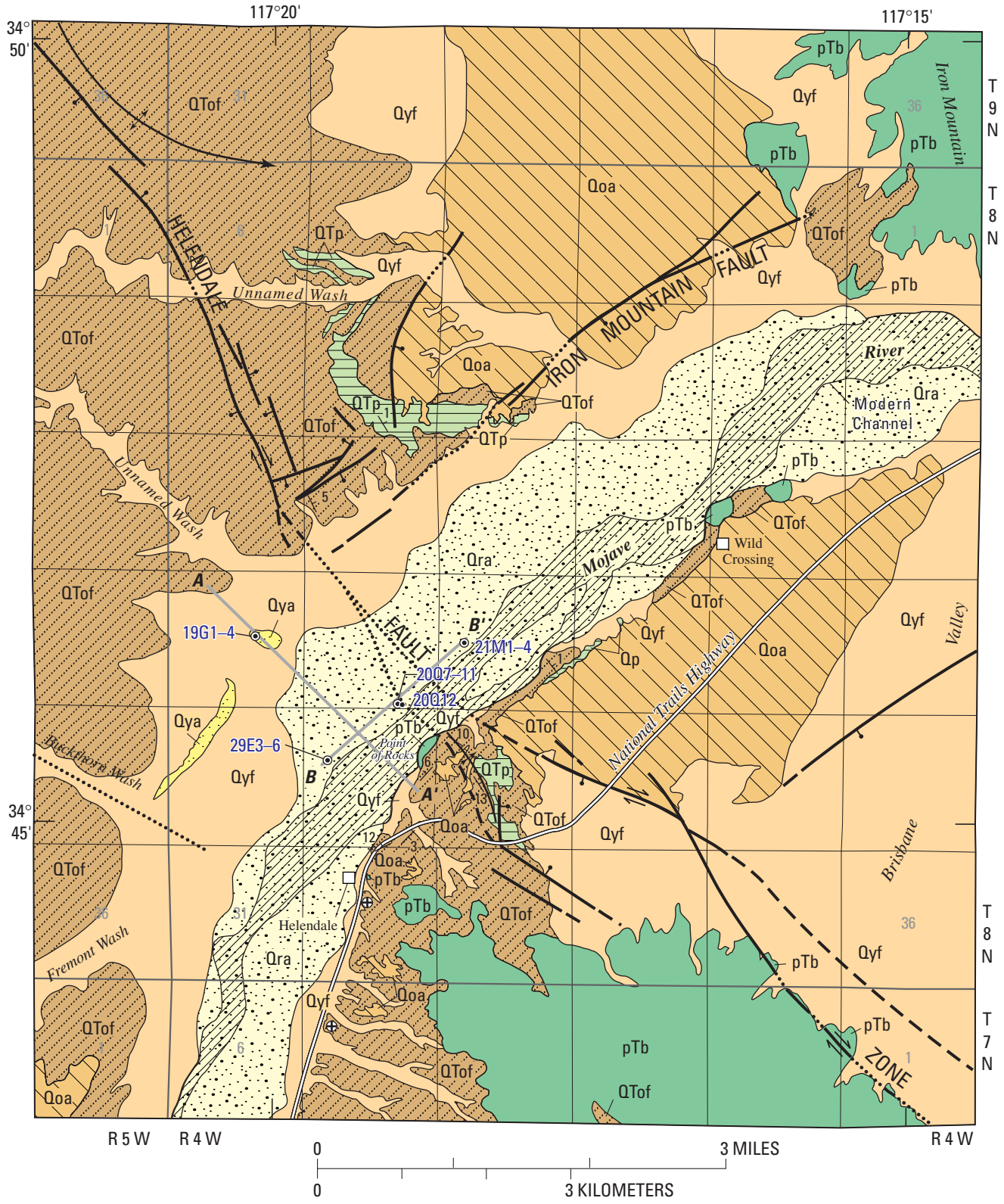


Figure 2. Surface geology, line of cross sections *A–A'* and *B–B'*, and location of the multiple-well monitoring sites near Helendale, San Bernardino County, California.

Reference: Stamos and others, USGS, 2003

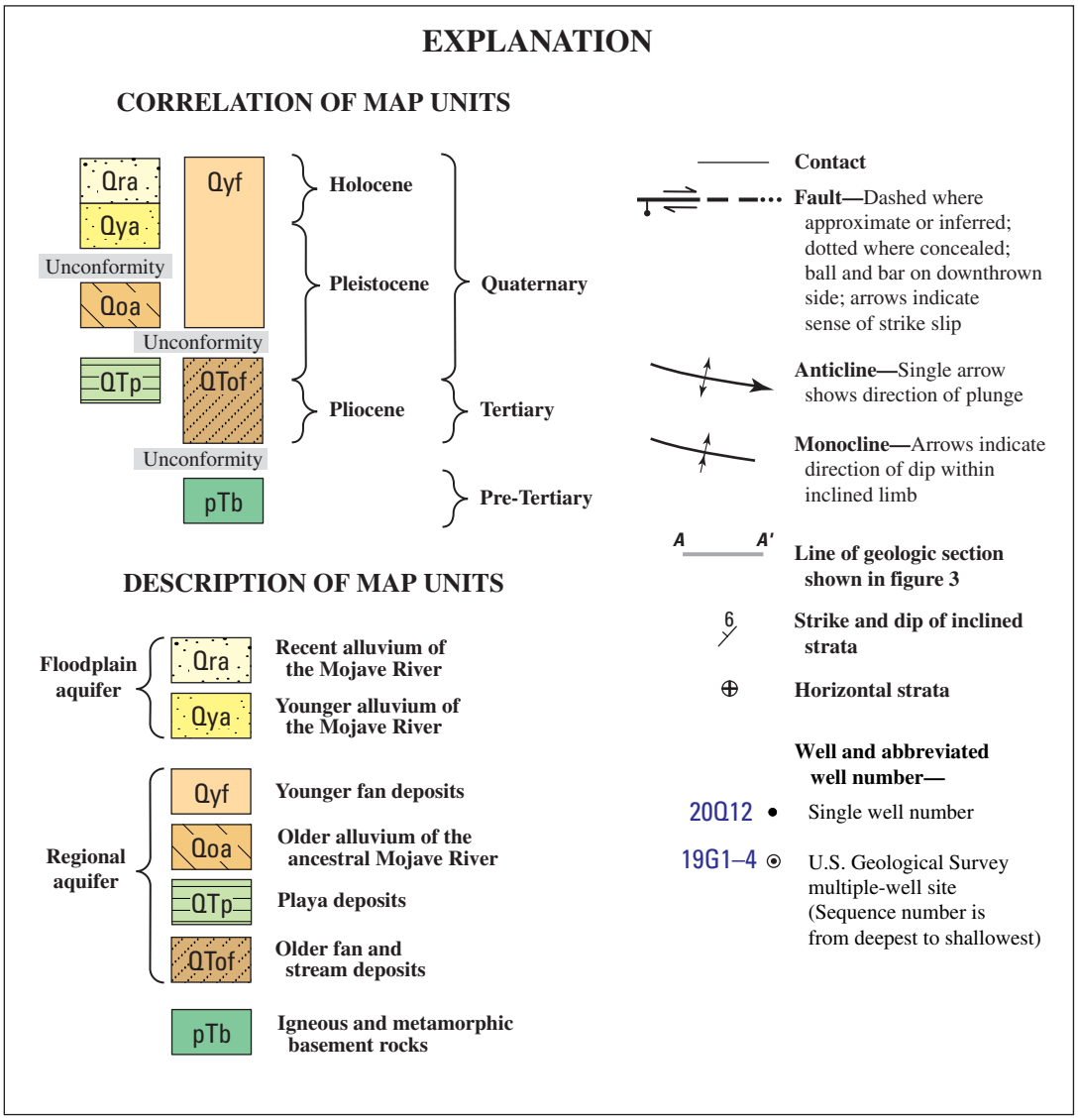


Figure 2.—Continued.

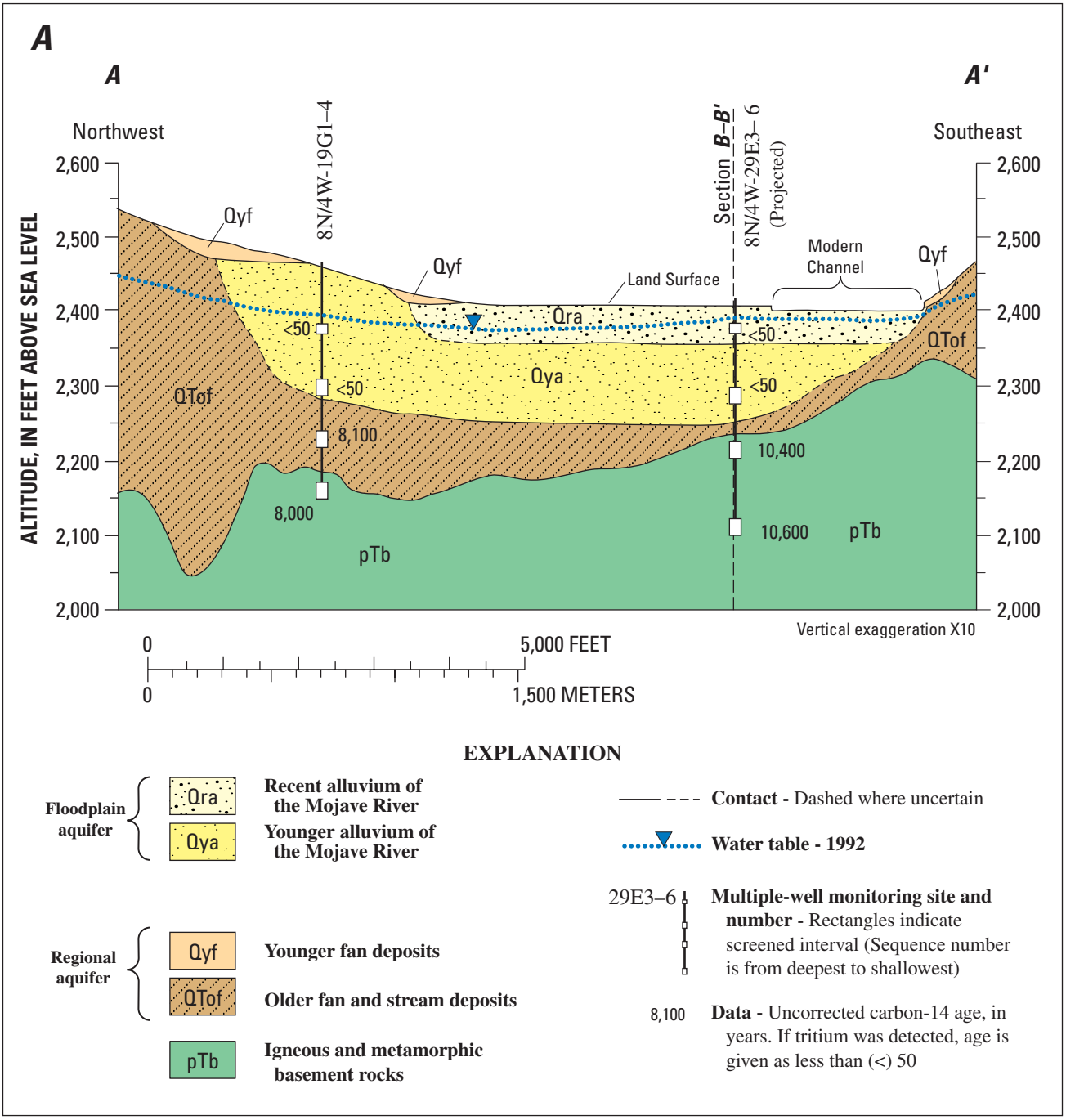
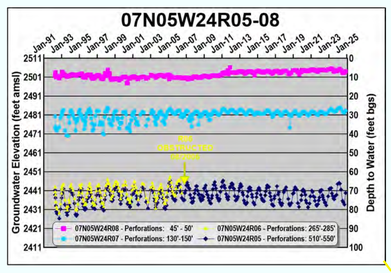
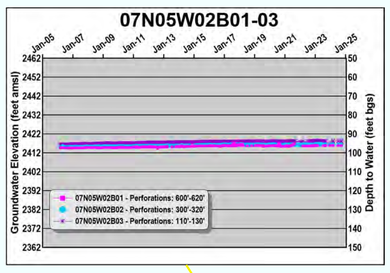


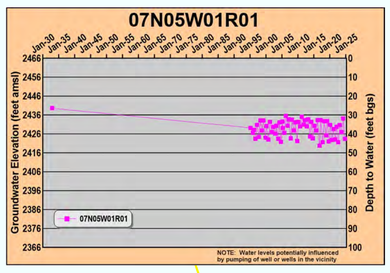
Figure 3. Geologic cross sections near Helendale, San Bernardino County, California, (*A*) cross section *A–A'*, and (*B*) cross section *B–B'*.

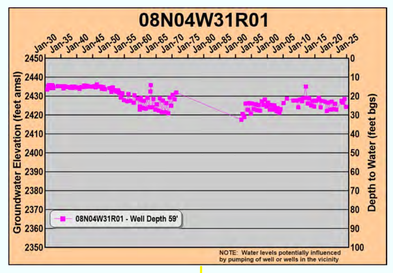
Mojave Water Agency, 2025

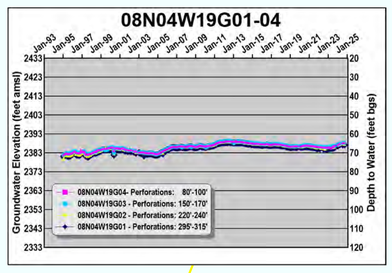
Alto Subarea Transition Zone Hydrographs 2025

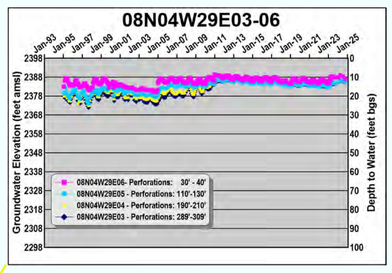


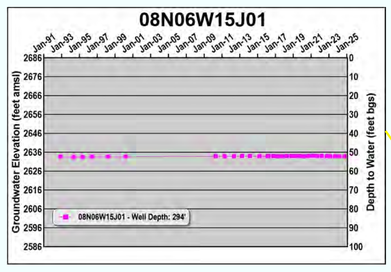


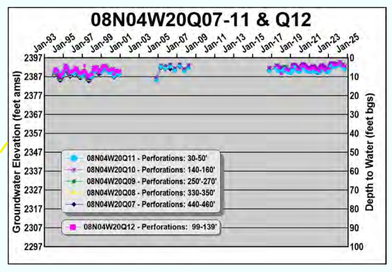


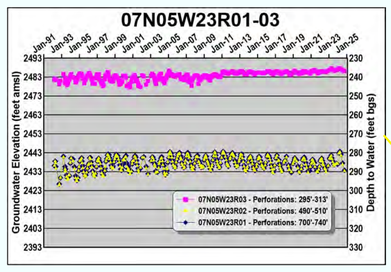


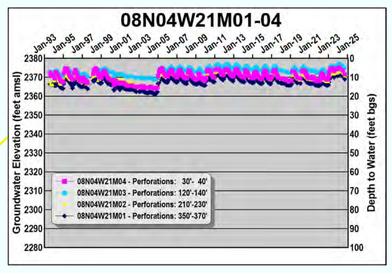


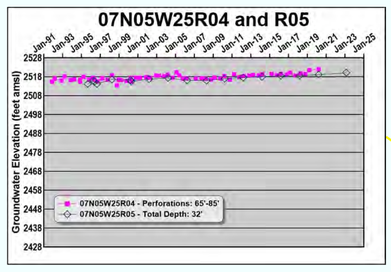


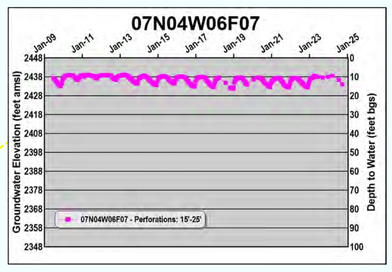


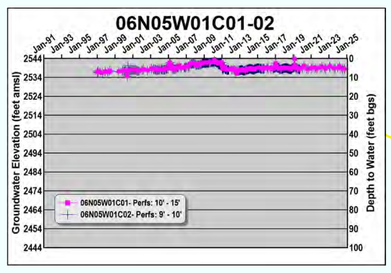


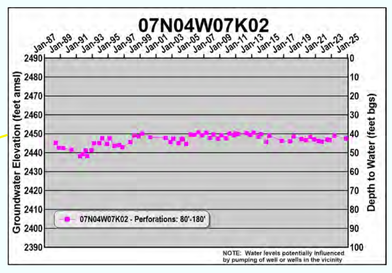


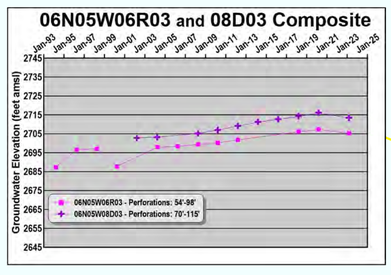


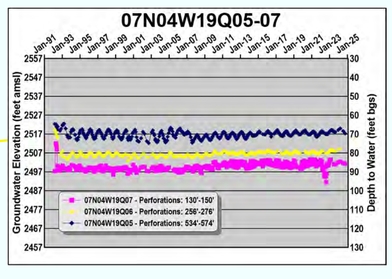


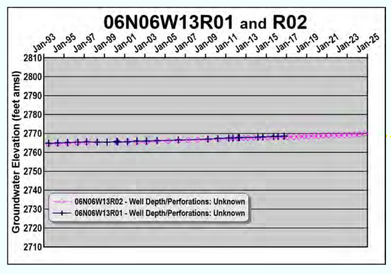


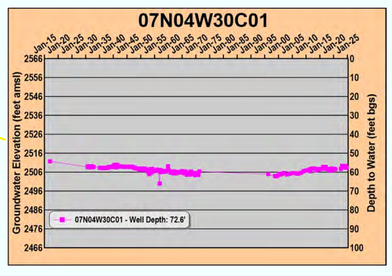


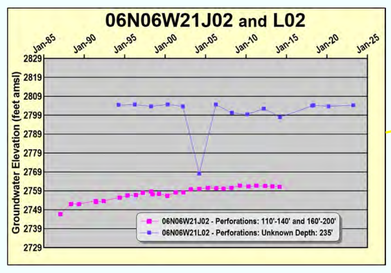


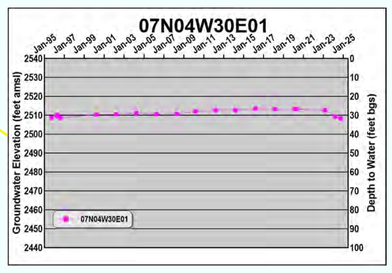


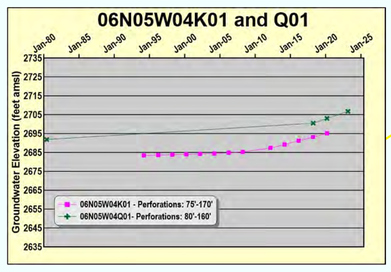


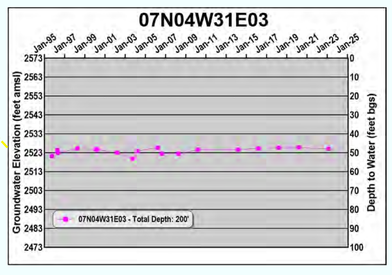


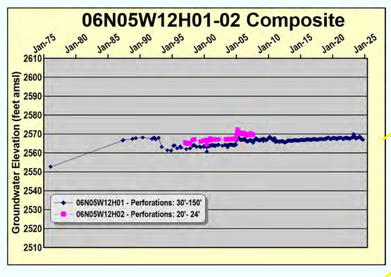


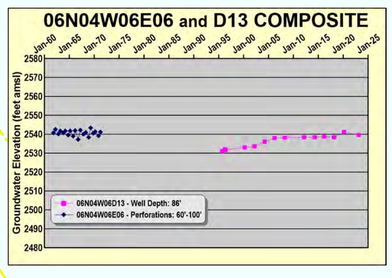


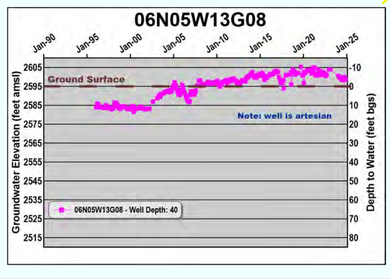


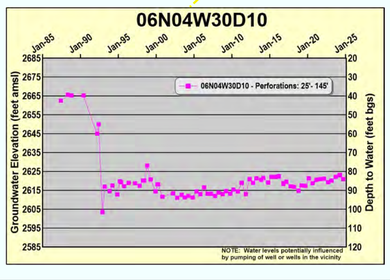


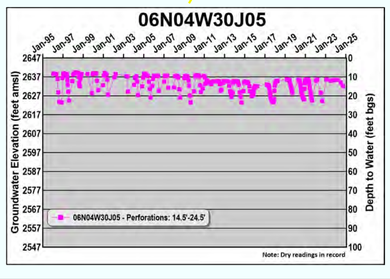


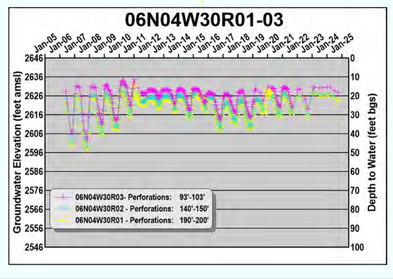


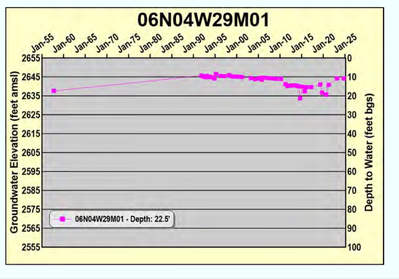


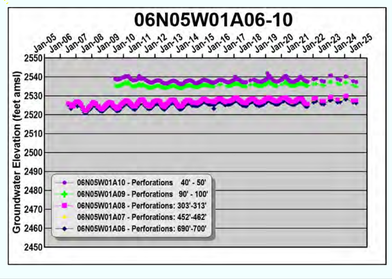












The Mojave Water Agency and U.S. Geological Survey are working together in a comprehensive program to monitor water levels and maintain historic records throughout the Regional Basin. The graphed wells are selected based on spatial and temporal representation of the Subarea. **All wells on the Hydrograph Map are a part of the MWA Monitoring Program, and have data available to the public from either the Mojave Water Agency Website, the USGS National Water Information System (NWIS) Website or the California Statewide Groundwater Elevation Monitoring (CASGEM) Website.** For more information please contact Mojave Water Agency.

Mojave Water Agency

Data Sources:
MWA, US Census
USGS/NWIS,
DWR Bulletin 84 1967
Date: January 2024
Mojave Water Agency
Water Resources Department

- Graphed Wells
- MWA Monitoring Program Wells
- MWA Potable Pipeline
- MWA Recharge Pipeline
- CA Geologic Faults (CGS, USGS)
- USGS Perched Water Table

Alto Subarea Transition Zone Hydrographs 2025

- Recent record
- Long-term record (begins ~1950 to ~ 1980)
- Very long-term record (begins ~1920)

0 0.5 1 2 Miles

N

Attachment C

TECHNICAL MEMORANDUM

To: Mojave Basin Area Watermaster

From: Kapo Coulibaly, PhD, P.G

Date: May 30, 2025

Re: **Statistical Analysis of Groundwater Levels in The Transition Zone**

In October 2024, the Superior Court of California, County of Riverside ordered the Watermaster to provide a statistical analysis of the groundwater levels in the Transition Zone. The goal being to establish the trends in groundwater level changes.

1. Approach

The Mann-Kendall (MK) statistical test was used to establish groundwater level trends. This approach was chosen for two reasons:

- The purpose of the MK test is to statistically assess if there is a monotonic upward or downward trend of the variable of interest over time.
- Unlike linear regression it does not require that the data or the residual be normally distributed

The MK test was applied to the depth to water of 39 shallow wells from 1990 to 2024, 40 wells from 1996 to 2024 and 7 wells from 1931 to 1990.

2. Results

a. Period from 1990 to 2024

Of the 39 wells analyzed 34 wells had trends that were significant at the 95% confidence level (pvalue < 0.05). Of these wells 31 (80%) exhibit a negative correlation with time, meaning the depth to water got smaller over time, in other words the groundwater levels have been rising between 1990 and 2024.
The correlation derived from the MK test can be classified as Very Strong, Strong, Moderate, Weak, or Negligible. The number of wells in each category was respectively: 5, 8, 13, 5, and 0 for the rising water level trend.

b. Period from 1996 to 2024

Of the 40 wells analyzed 33 wells had trends that were significant at the 95% confidence level (pvalue < 0.05). Of these, 29 showed an upward water level trend.
The number of wells in the categories Very Strong, Strong, Moderate, Weak, or Negligible were respectively 5, 5, 16, 3,0. Only 4 wells show moderate to strong downward trend for water levels.

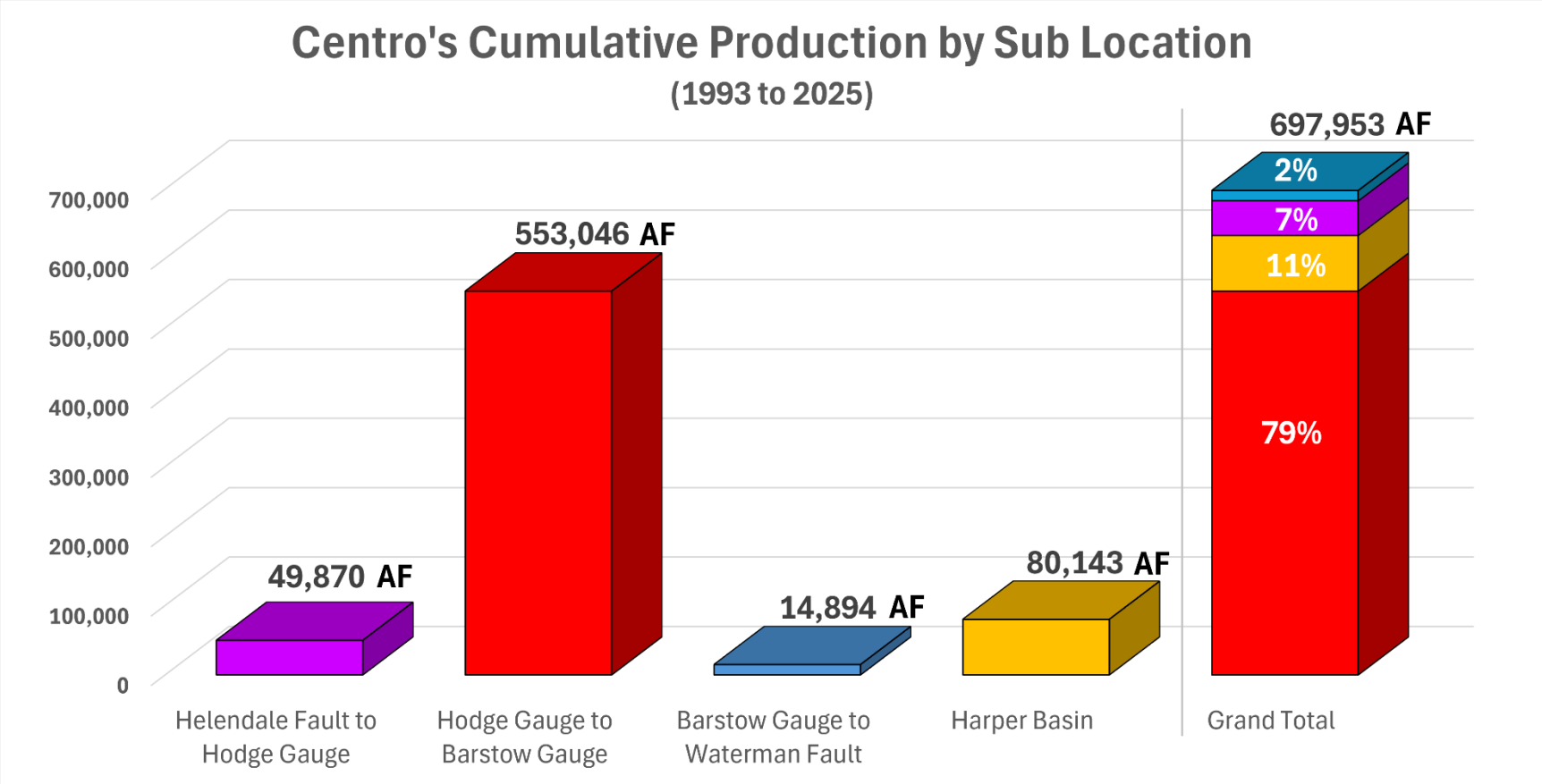
c. Period from 1931 to 1990

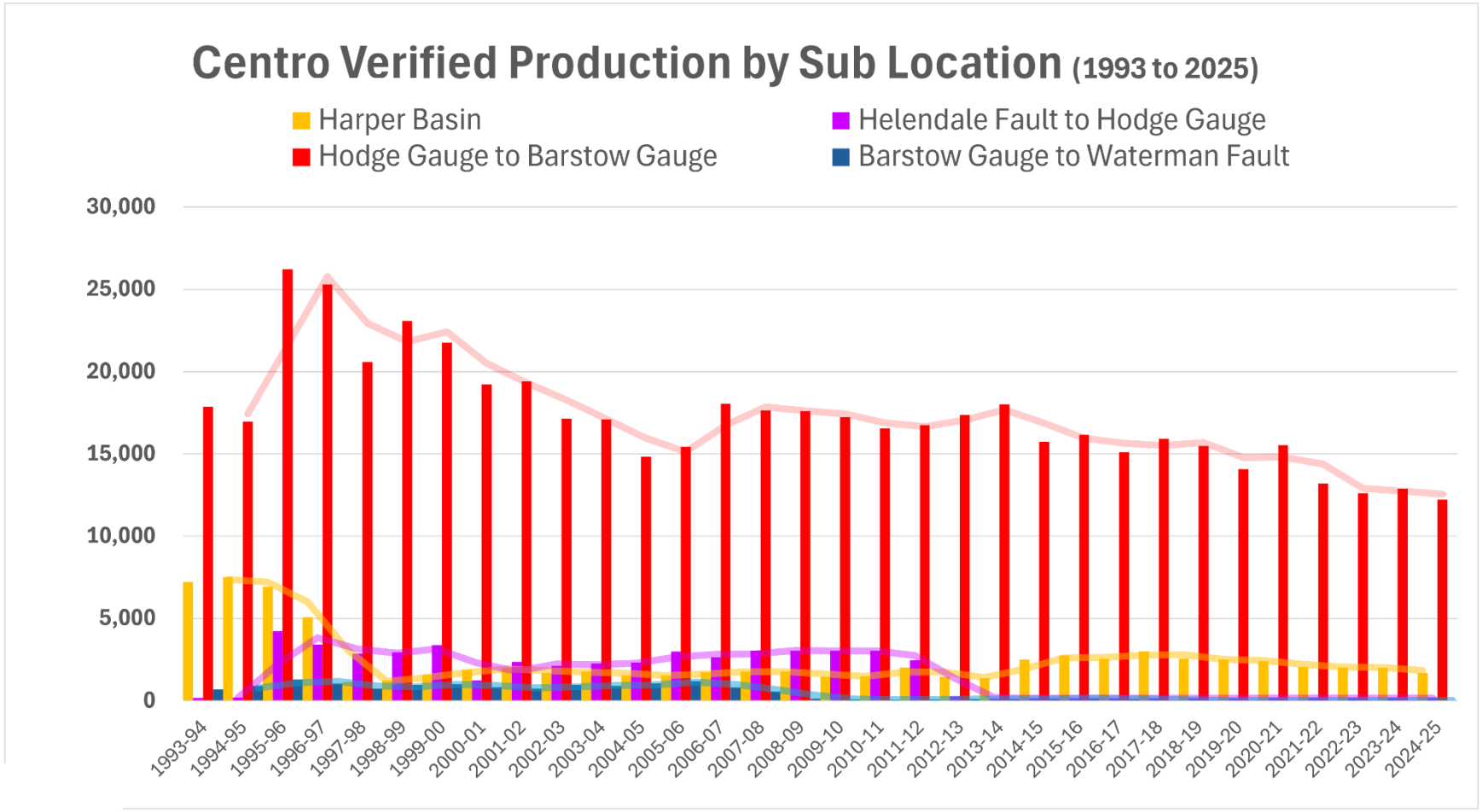
Only 7 wells had data for this period and 4 of them have a lot of missing data making the results of the MK test unreliable. Of the remaining 3 only one showed a significant trend at the 95% confidence level, which was a groundwater level downward trend.

3. Conclusion

The MK test analysis shows that approximately 70% (1996-2024) to 80% (1990-2024) of the shallow wells in the Transition Zone show either a rise of groundwater levels (Moderate to very strong upward trend) or no change (weak to negligible trend) for the periods from 1996 to 2024 and 1990 to 2024.

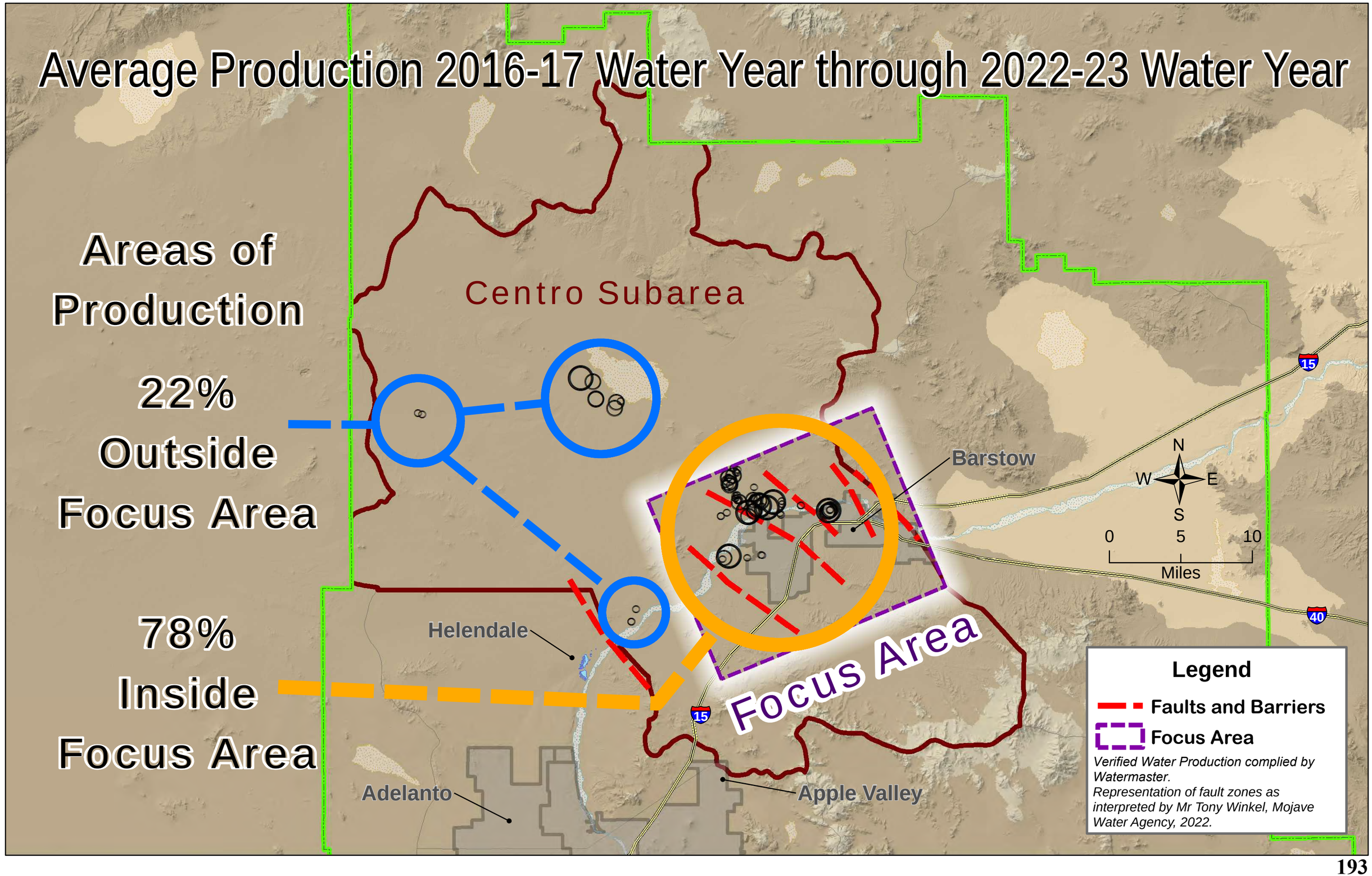
Attachment D

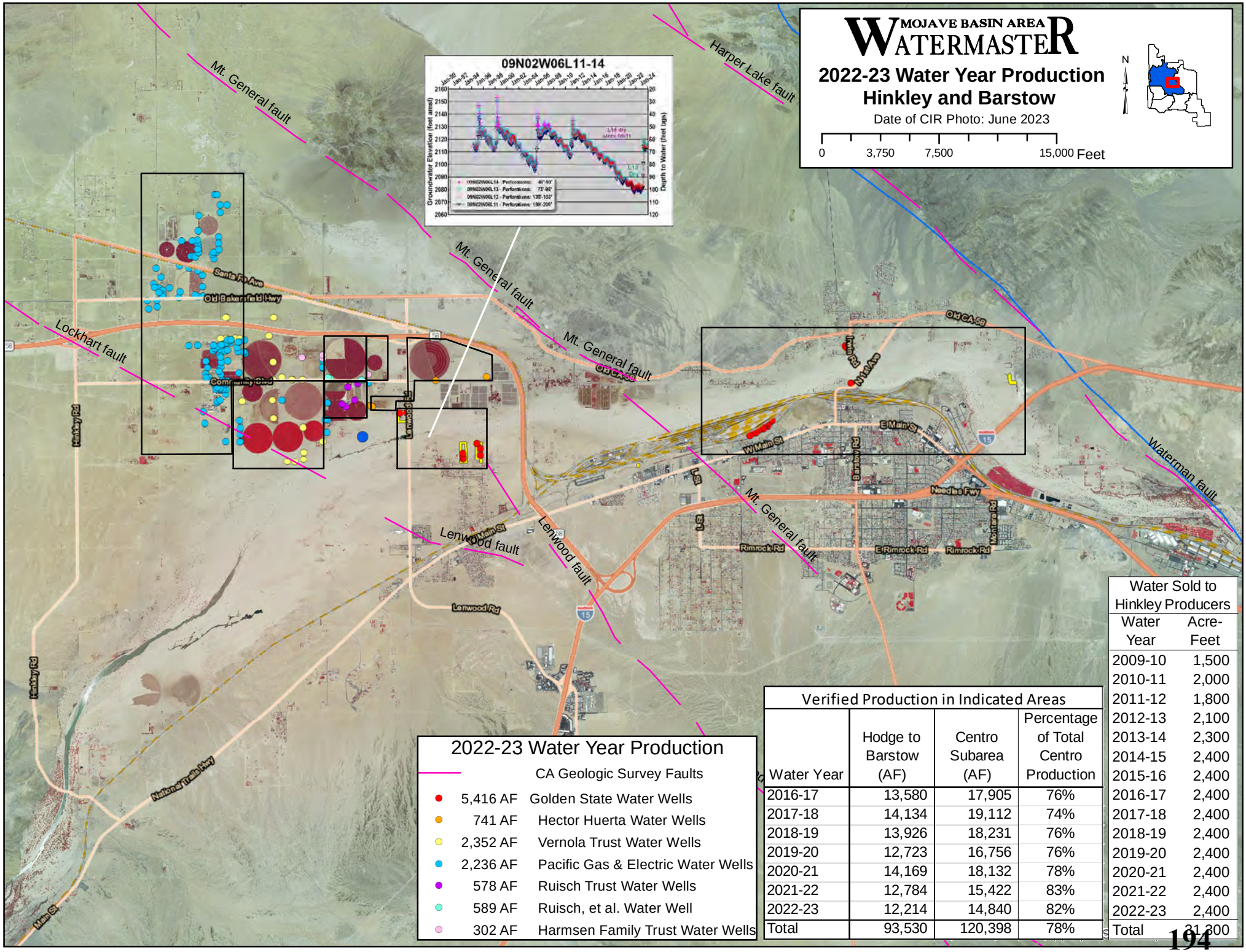

Centro's Cumulative Production by Sub Location
(1993 to 2025)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
49,870 AF
553,046 AF
14,894 AF
80,143 AF
697,953 AF
2%
7%
11%
79%
Helendale Fault to Hodge Gauge
Hodge Gauge to Barstow Gauge
Barstow Gauge to Waterman Fault
Harper Basin
Grand Total


Centro Verified Production by Sub Location (1993 to 2025)
Harper Basin
Helendale Fault to Hodge Gauge
Hodge Gauge to Barstow Gauge
Barstow Gauge to Waterman Fault
30,000
25,000
20,000
15,000
10,000
5,000
0
1993-94
1994-95
1995-96
1996-97
1997-98
1998-99
1999-00
2000-01
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
2024-25

Attachment E

Average Production 2016-17 Water Year through 2022-23 Water Year





2022-23 Water Year Production

CA Geologic Survey Faults

5,416 AF	Golden State Water Wells
741 AF	Hector Huerta Water Wells
2,352 AF	Vernola Trust Water Wells
2,236 AF	Pacific Gas & Electric Water Wells
578 AF	Ruisch Trust Water Wells
589 AF	Ruisch, et al. Water Well
302 AF	Harmsen Family Trust Water Wells

Verified Production in Indicated Areas

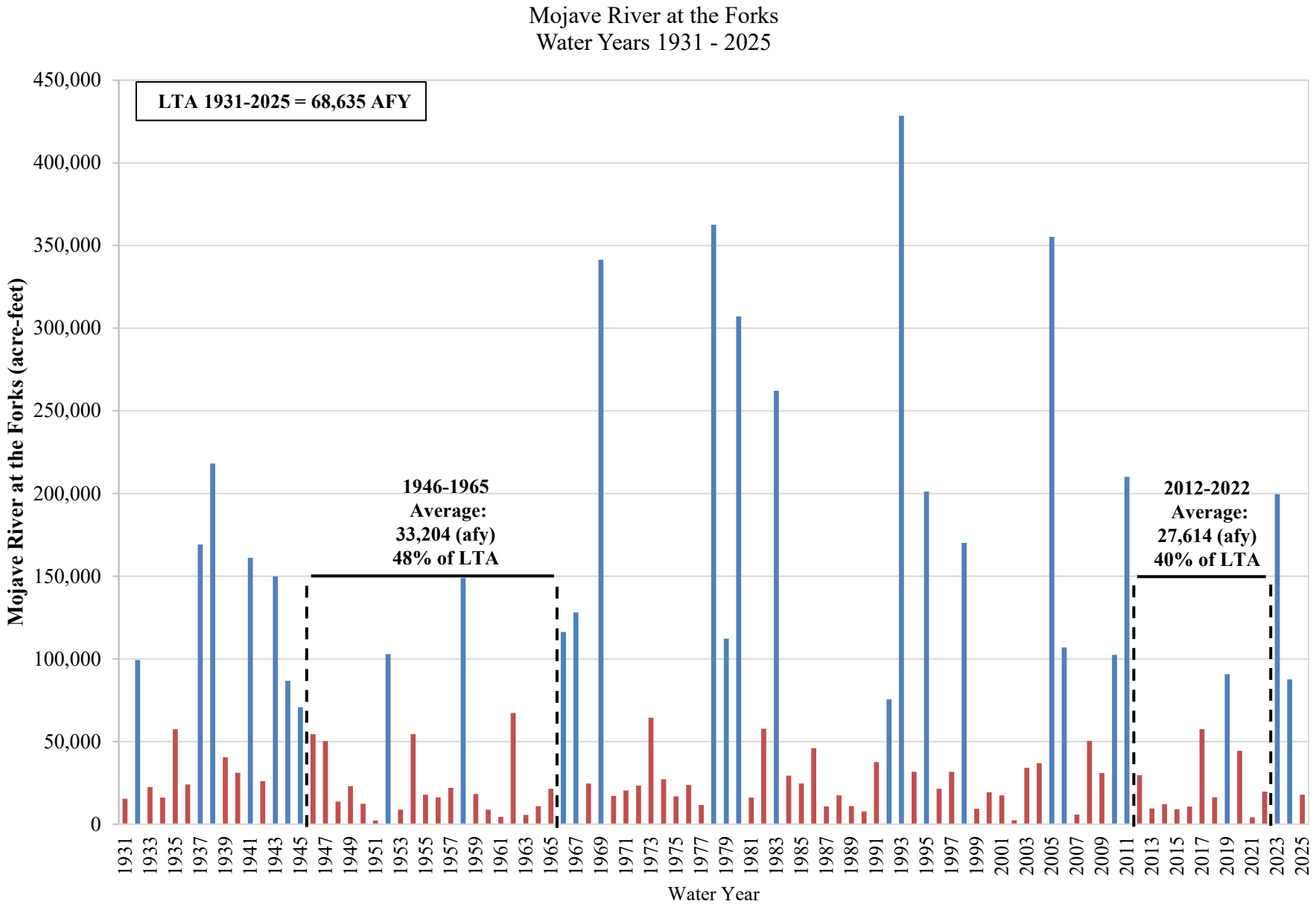
Water Year	Hodge to Barstow (AF)	Centro Subarea (AF)	Percentage of Total Centro Production
2016-17	13,580	17,905	76%
2017-18	14,134	19,112	74%
2018-19	13,926	18,231	76%
2019-20	12,723	16,756	76%
2020-21	14,169	18,132	78%
2021-22	12,784	15,422	83%
2022-23	12,214	14,840	82%
Total	93,530	120,398	78%

Water Sold to Hinkley Producers

Water Year	Acre-Feet
2009-10	1,500
2010-11	2,000
2011-12	1,800
2012-13	2,100
2013-14	2,300
2014-15	2,400
2015-16	2,400
2016-17	2,400
2017-18	2,400
2018-19	2,400
2019-20	2,400
2020-21	2,400
2021-22	2,400
2022-23	2,400
Total	31,300

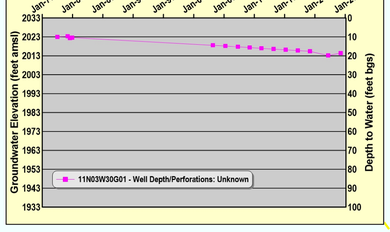
Attachment F

Historical dry periods at the Forks

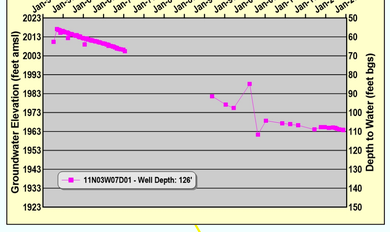


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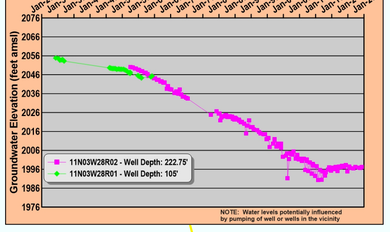
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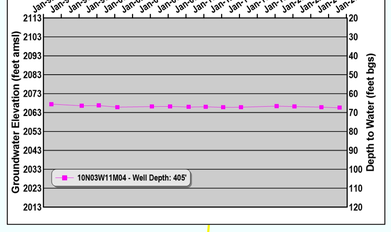
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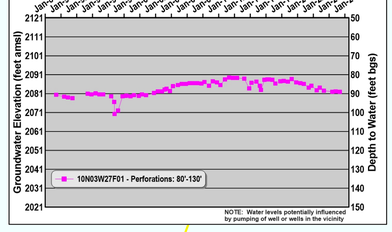
11N03W28R01 and R02 Composite



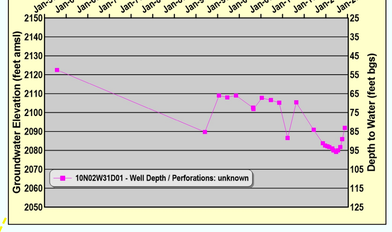
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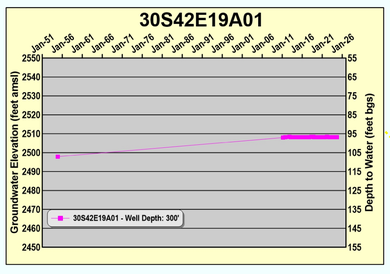
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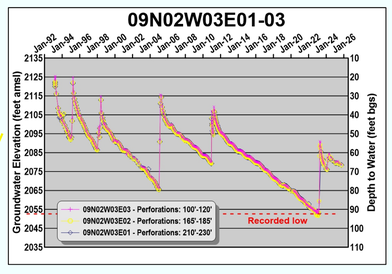
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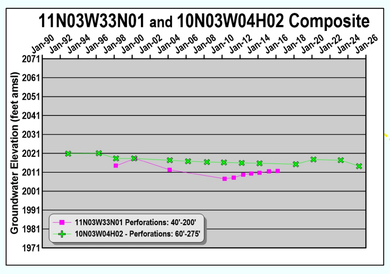
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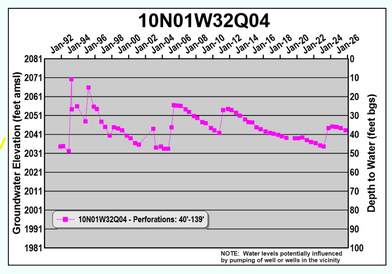
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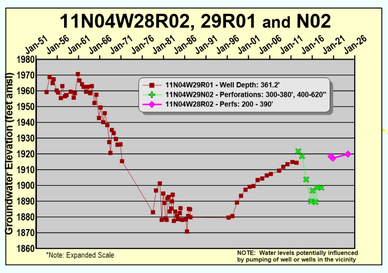
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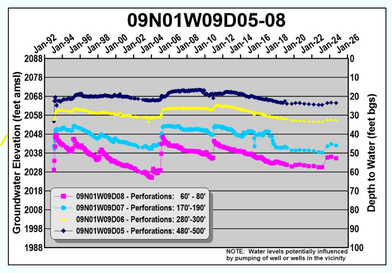
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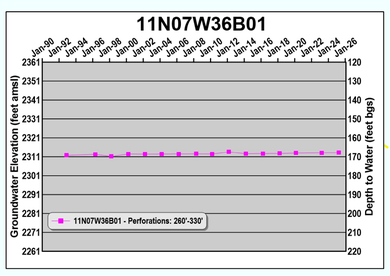
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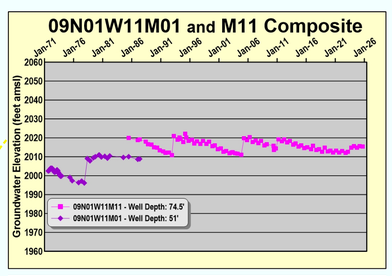
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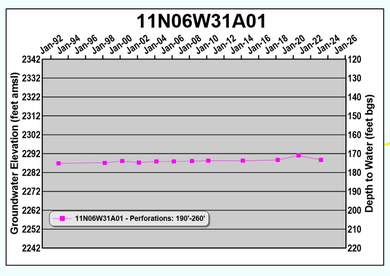
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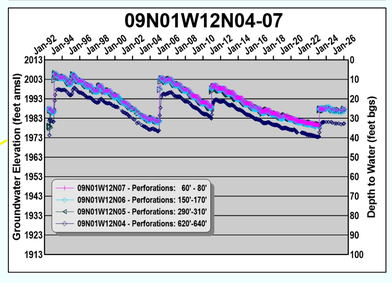
09N01W11M01 and M11 Composite



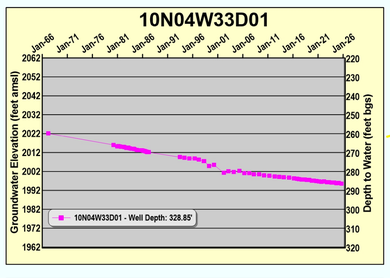
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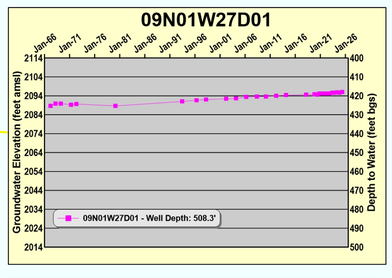
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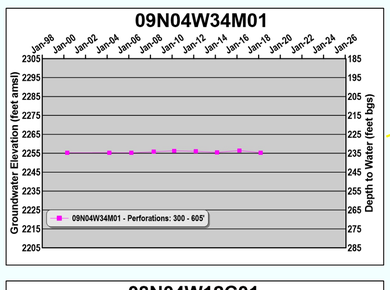
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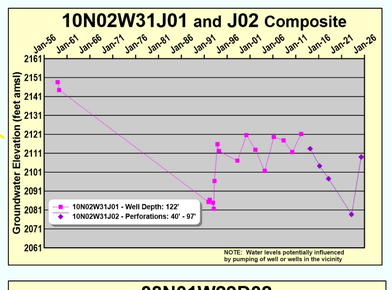
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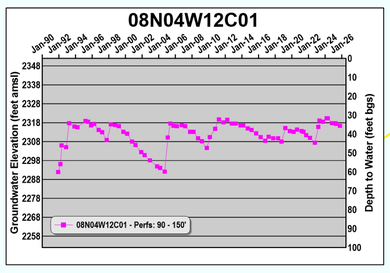
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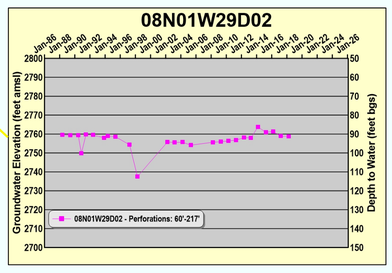
10N02W31J01 and J02 Composite



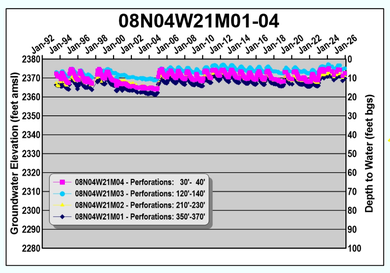
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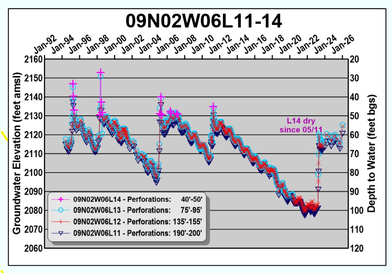
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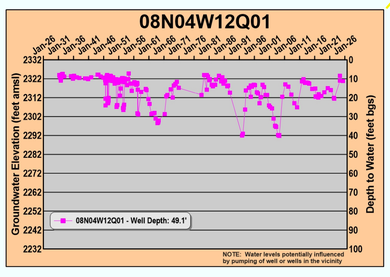
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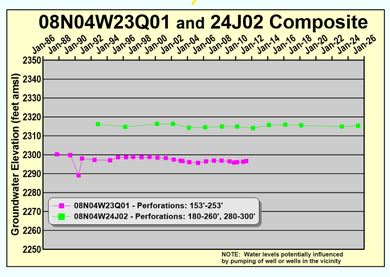
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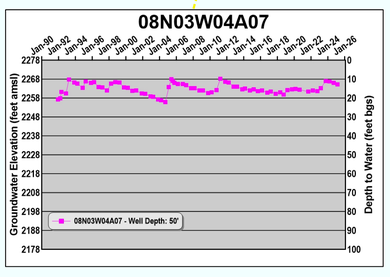
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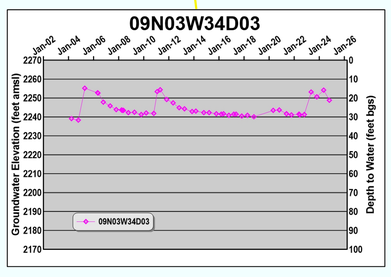
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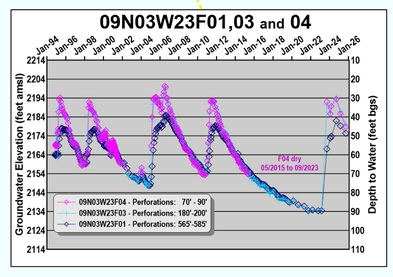
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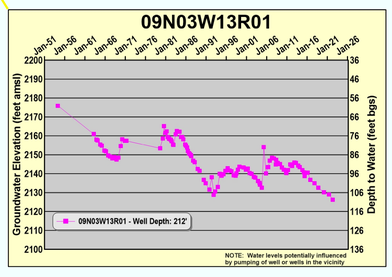
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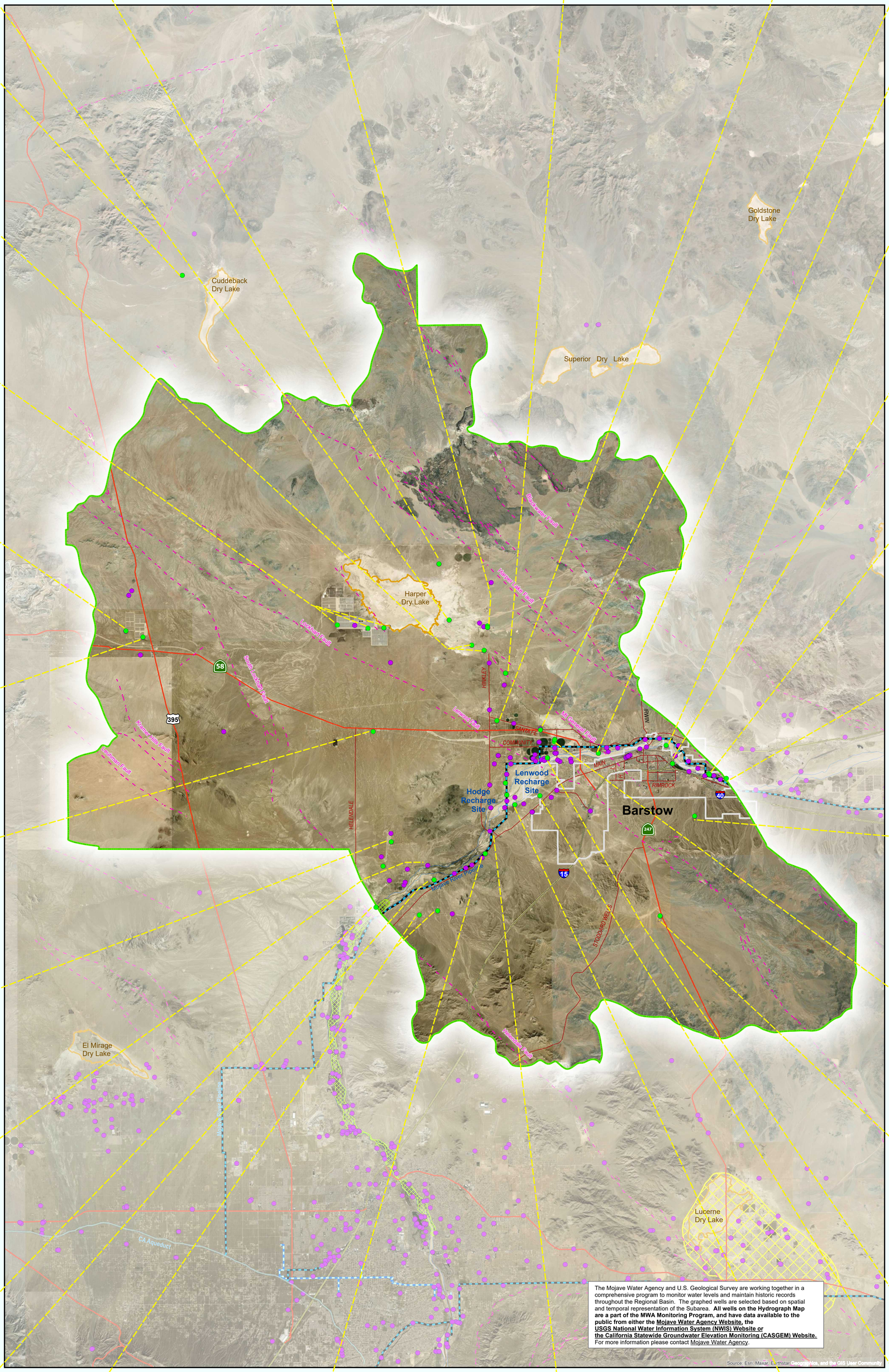


09N03W23F01,03 and 04



09N03W13R01





The Mojave Water Agency and U.S. Geological Survey are working together in a comprehensive program to monitor water levels and maintain historic records throughout the Regional Basin. The graphed wells are selected based on spatial and temporal representation of the Subarea. **All wells on the Hydrograph Map are a part of the MWA Monitoring Program, and have data available to the public from either the Mojave Water Agency Website, the USGS National Water Information System (NWIS) Website or the California Statewide Groundwater Elevation Monitoring (CASGEM) Website.** For more information please contact Mojave Water Agency.

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Mojave Water Agency

Data Sources:
MWA, US Census
USGS/NWIS,
DWR Bulletin 84 1967
Date: 02/2026
Mojave Water Agency
Water Resources Department

- Graphed Wells
- MWA Monitoring Program Wells
- CA Geologic Faults (CGS, USGS)
- Exhibit H Riparian Habitat Area
- MWA Recharge Site
- MWA Potable Pipeline
- MWA Recharge Pipeline

Centro Subarea Hydrographs 2026

- Recent record
- Long-term record (begins ~1950 to ~1980)
- Very long-term record (begins ~1920)

0 1 2 4 Miles

N

EXHIBIT 6

TABLE 4-2

STATUS OF SUBAREA OBLIGATIONS AT THE END OF WATER YEAR 2024-25

Subareas	Este	Oeste	Alto	Centro	Baja
Obligation to	Alto	Alto	Transition Zone	Baja	Afton
Average Annual Obligation in acre-feet	200	800	23,000	1,200	400
Status at Beginning of 2024-25					
Cumulative Obligation	6,200	24,800	713,000	37,200	12,400
Cumulative Flow	6,200	24,800	699,195	37,200	8,536
Net cumulative Credit (Debit)	0	0	(13,805)	0	(3,864)
Flow During 2024-25					
Base Flow	---	---	5,695	---	---
Subsurface Flow	200	800	2,000	1,200	249
Other Water	0	0	14,615	0	0
Makeup Water Purchased	0	0	0	0	0
Total Flow	**200**	**800**	**22,310**	**1,200**	**249**
Minimum Obligations for 2024-25	160	640	23,002	960	3,784
Makeup Obligation Incurred	**0**	**0**	**692**	**0**	**3,535**
Status at End of 2024-25					
Cumulative Obligation	6,400	25,600	736,000	38,400	12,800
Cumulative Flow	6,400	25,600	721,505	38,400	8,785
Net Cumulative Credit (Debit)	0	0	(14,495)	0	(4,015)
Minimum Obligation for 2025-26					
Annual Minimum	160	640	18,400	960	320
+ 1/3 of Cumulative Debit	0	0	4,832	0	1,338
+ Additional to reduce Cumulative Debit to Annual Obligation	0	0	0	0	2,277
Alternative Minimum for Alto [1]	---	---	---	---	---
Minimum Obligation for 2025-26	**160**	**640**	**23,232**	**960**	**3,935** [2]

1) Annual Minimum minus Cumulative Credit but not less than 15,000 acre-feet.

2) The accounting for the Baja Subarea Obligation is shown for illustrative purposes only. Pursuant to Paragraph 6 of Appendix G of the Judgment, subsurface flow obligations are assumed to have been met. Pursuant to the Court order dated 6/5/2006, Watermaster is relieved of evaluation of the subsurface flow from BAJA across the Mojave Water Agency administrative boundary about six miles upstream of Afton.

TABLE 4-3

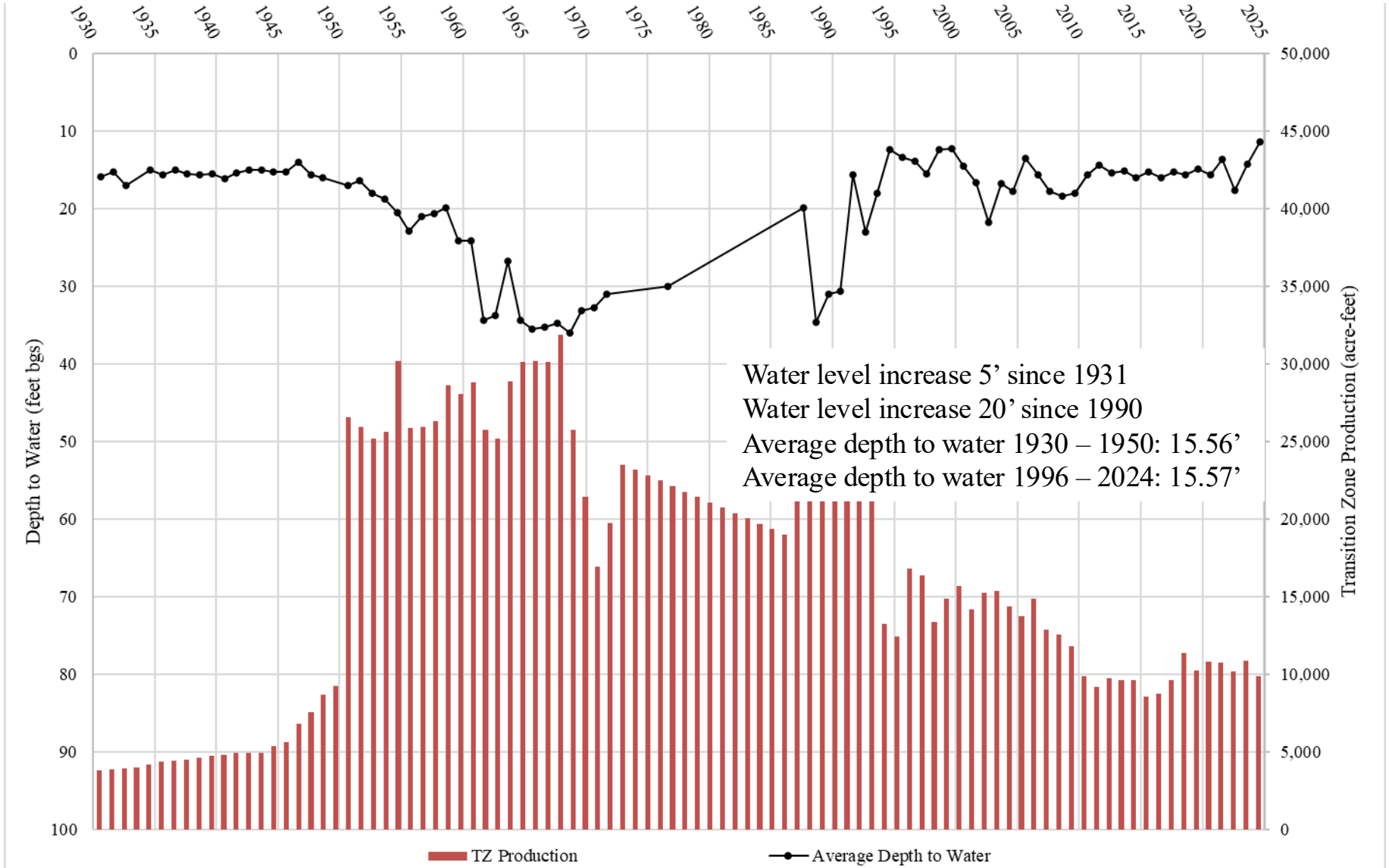
STATUS OF ALTO SUBAREA OBLIGATIONS
WATER YEARS 2015-16 THROUGH 2024-25

Water Year	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**
Average Annual Obligation in acre-feet	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000
Status at Beginning of Water Year										
Cumulative Obligation	506,000	529,000	552,000	575,000	598,000	621,000	644,000	667,000	690,000	713,000
Cumulative Flow	490,268	511,465	533,205	554,196	577,480	600,435	622,857	646,122	674,269	699,195
Net cumulative Credit (Debit)	(15,732)	(17,535)	(18,795)	(20,804)	(20,520)	(20,565)	(21,143)	(20,878)	(15,731)	(13,805)
Flow During Water Year										
Base Flow	4,851	4,031	3,662	4,533	5,185	4,791	3,337	9,690	8,636	5,695
Subsurface Flow	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Other Water	12,940	13,262	12,824	13,077	13,719	13,346	15,095	14,274	14,290	14,615
Makeup Water Purchased	1,406	2,447	2,505	3,674	2,051	2,285	2,833	2,183	0	0
Total Flow	**21,197**	**21,740**	**20,991**	**23,284**	**22,955**	**22,422**	**23,265**	**28,147**	**24,926**	**22,310**
Minimum Obligations	23,644	24,245	24,665	25,335	25,240	25,255	25,448	25,359	23,644	23,002
Makeup Obligation Incurred	**2,447**	**2,505**	**3,674**	**2,051**	**2,285**	**2,833**	**2,183**	**0**	**0**	**692**
Status at End of Water Year										
Cumulative Obligation	529,000	552,000	575,000	598,000	621,000	644,000	667,000	690,000	713,000	736,000
Cumulative Flow	511,465	533,205	554,196	577,480	600,435	622,857	646,122	674,269	699,195	721,505
Net Cumulative Credit (Debit)	(17,535)	(18,795)	(20,804)	(20,520)	(20,565)	(21,143)	(20,878)	(15,731)	(13,805)	(14,495)
Minimum Obligation for Next Year										
Annual Minimum	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400
+ 1/3 of Cumulative Debit	5,845	6,265	6,935	6,840	6,855	7,048	6,959	5,244	4,602	4,832
+ Additional to reduce Cumulative Debit to Annual Obligation	0	0	0	0	0	0	0	0	0	0
Alternative Minimum [1]	---	---	---	---	---	---	---	---	---	---
Minimum Obligation for Next Year	**24,245**	**24,665**	**25,335**	**25,240**	**25,255**	**25,448**	**25,359**	**23,644**	**23,002**	**23,232**

1) Annual Minimum minus Cumulative Credit but not less than 15,000 acre-feet.

EXHIBIT 7

Transition Zone Production & Average Water Level for **ALL** Wells



Note:
1931 - 1993 data from USGS "Simulation of Ground-Water Flow in the Mojave River Basin, California", Stamos. 2001
1994 - 2023 data from Mojave Watermaster.

Average of 41 wells in the Transition Zone less 50' depth to water

EXHIBIT 8

TECHNICAL MEMORANDUM

To: Mojave Basin Area Watermaster

From: Kapo Coulibaly, PhD, P.G

Date: May 30, 2025

Re: **Statistical Analysis of Groundwater Levels in The Transition Zone**

In October 2024, the Superior Court of California, County of Riverside ordered the Watermaster to provide a statistical analysis of the groundwater levels in the Transition Zone. The goal being to establish the trends in groundwater level changes.

1. Approach

The Mann-Kendall (MK) statistical test was used to establish groundwater level trends. This approach was chosen for two reasons:

- The purpose of the MK test is to statistically assess if there is a monotonic upward or downward trend of the variable of interest over time.
- Unlike linear regression it does not require that the data or the residual be normally distributed

The MK test was applied to the depth to water of 39 shallow wells from 1990 to 2024, 40 wells from 1996 to 2024 and 7 wells from 1931 to 1990.

2. Results

a. Period from 1990 to 2024

Of the 39 wells analyzed 34 wells had trends that were significant at the 95% confidence level (pvalue < 0.05). Of these wells 31 (80%) exhibit a negative correlation with time, meaning the depth to water got smaller over time, in other words the groundwater levels have been rising between 1990 and 2024.
The correlation derived from the MK test can be classified as Very Strong, Strong, Moderate, Weak, or Negligible. The number of wells in each category was respectively: 5, 8, 13, 5, and 0 for the rising water level trend.

b. Period from 1996 to 2024

Of the 40 wells analyzed 33 wells had trends that were significant at the 95% confidence level (pvalue < 0.05). Of these, 29 showed an upward water level trend.
The number of wells in the categories Very Strong, Strong, Moderate, Weak, or Negligible were respectively 5, 5, 16, 3,0. Only 4 wells show moderate to strong downward trend for water levels.

c. Period from 1931 to 1990

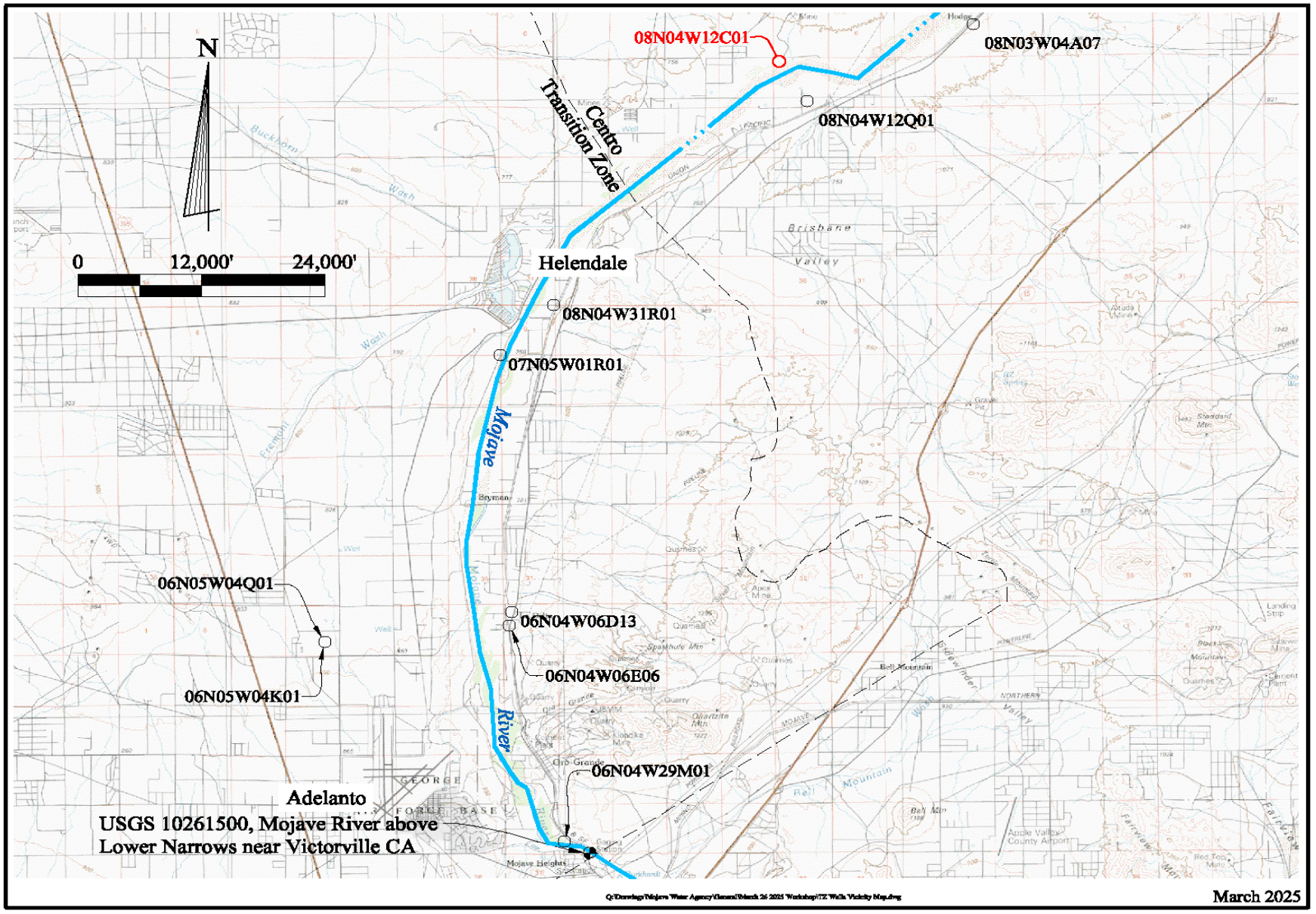
Only 7 wells had data for this period and 4 of them have a lot of missing data making the results of the MK test unreliable. Of the remaining 3 only one showed a significant trend at the 95% confidence level, which was a groundwater level downward trend.

3. Conclusion

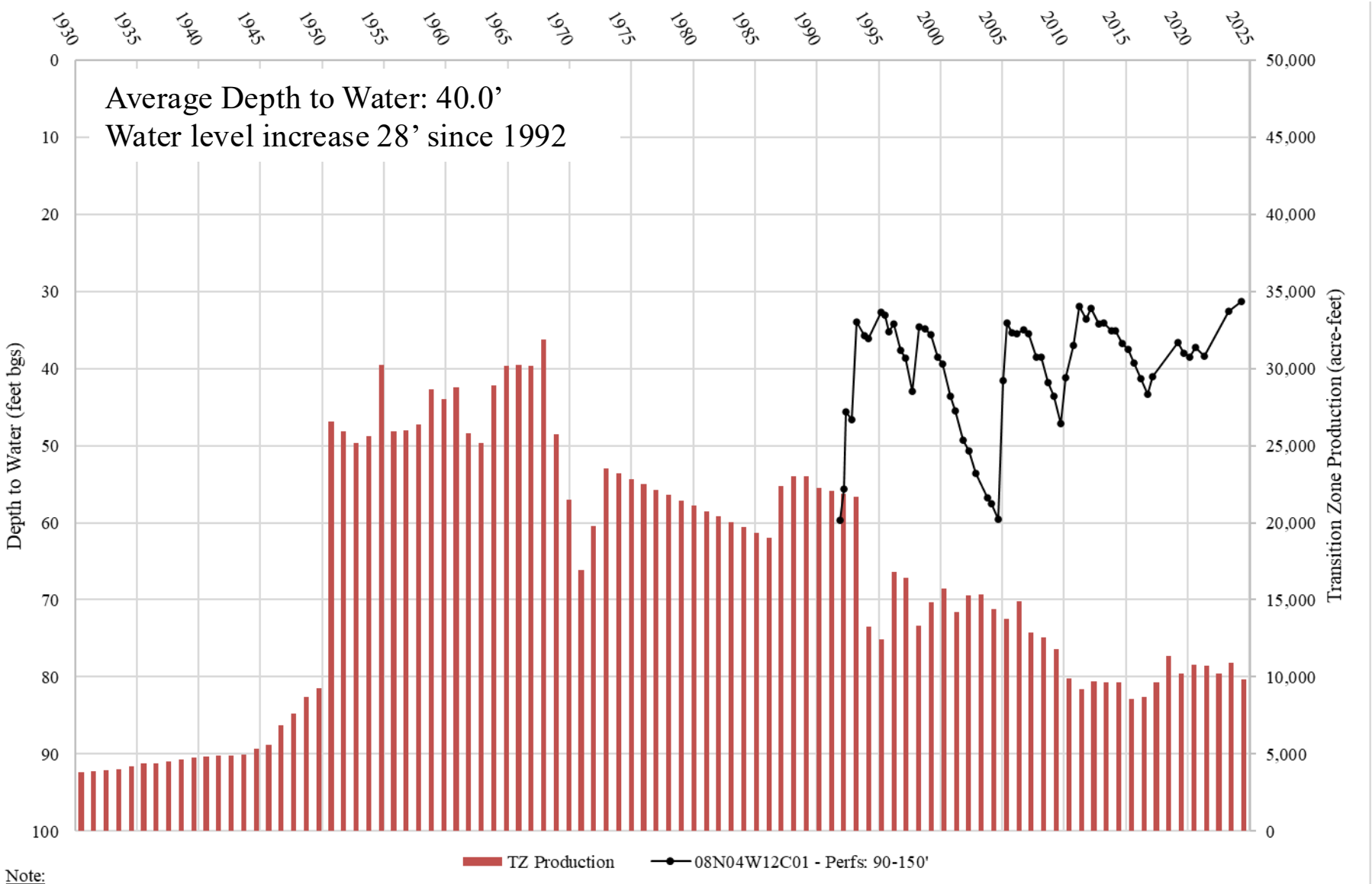
The MK test analysis shows that approximately 70% (1996-2024) to 80% (1990-2024) of the shallow wells in the Transition Zone show either a rise of groundwater levels (Moderate to very strong upward trend) or no change (weak to negligible trend) for the periods from 1996 to 2024 and 1990 to 2024.

EXHIBIT 9

Map Showing Location of Presented Well

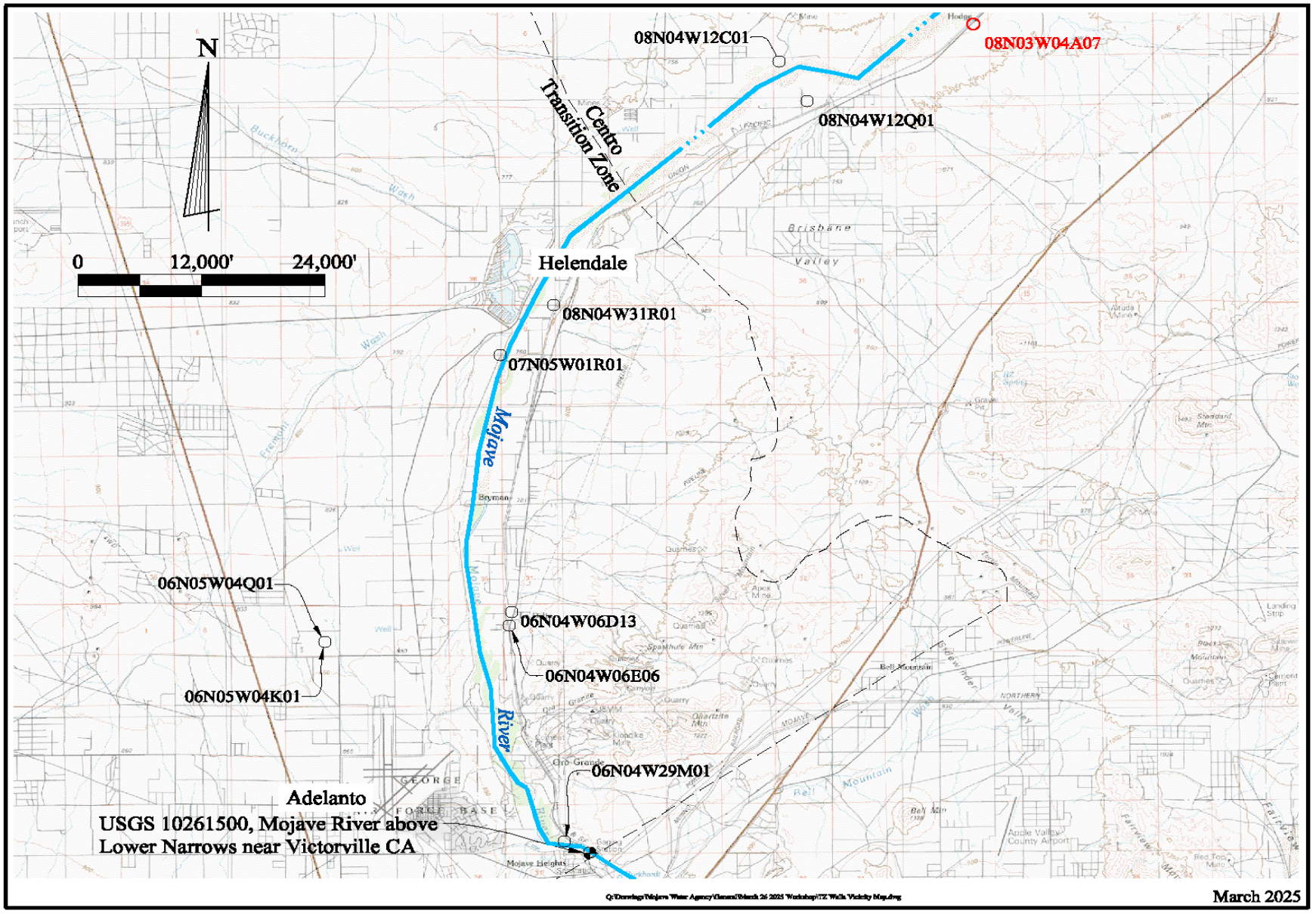


Transition Zone Production &Water Level for Well 08N04W12C01 (Centro)

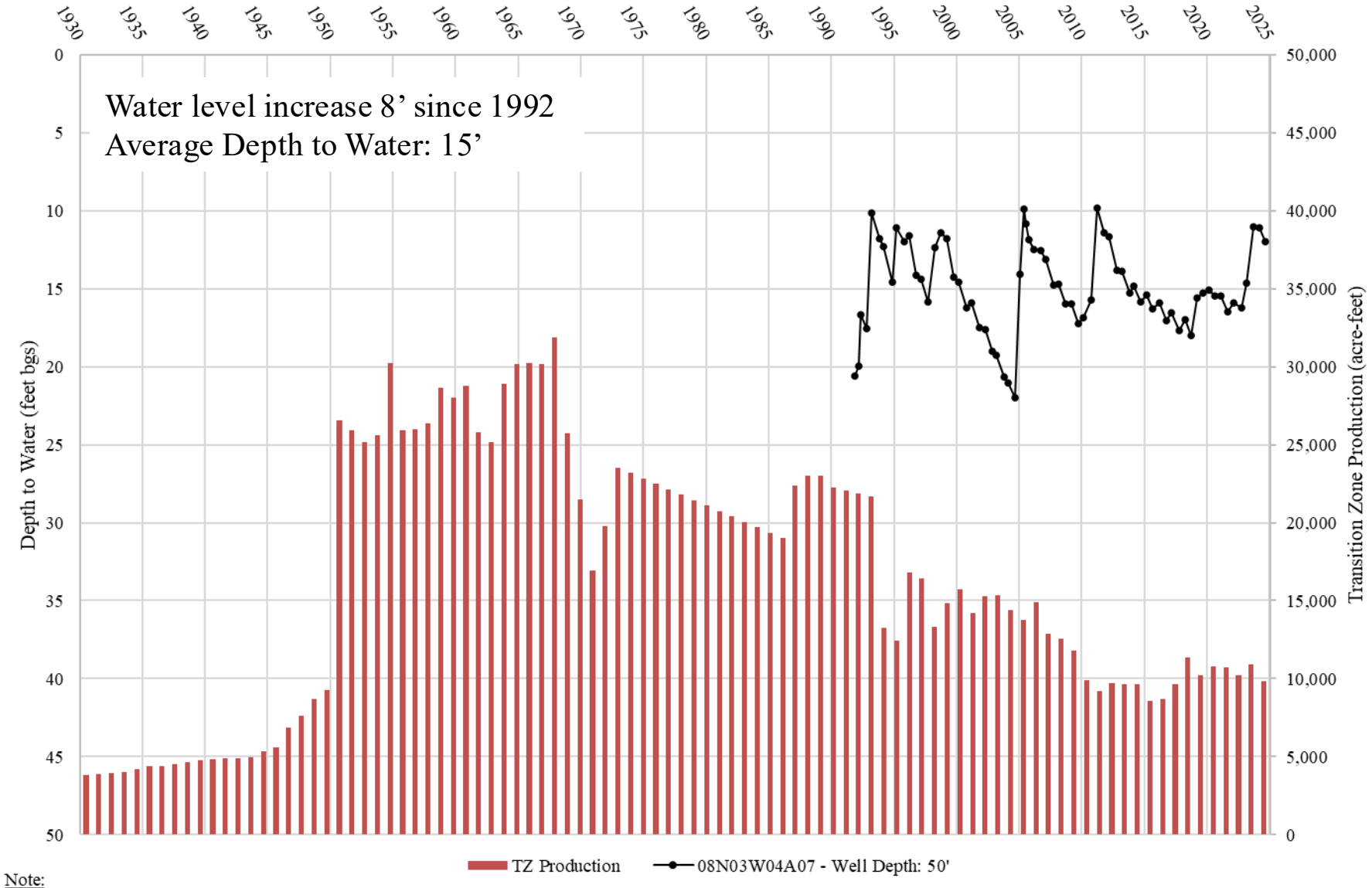


Note:
1931 - 1993 data from USGS "Simulation of Ground-Water Flow in the Mojave River Basin, California", Stamos. 2001
1994 - 2023 data from Mojave Watermaster.

Map Showing Location of Presented Well



Transition Zone Production & Water Level for Well 08N03W04A07 (Centro)

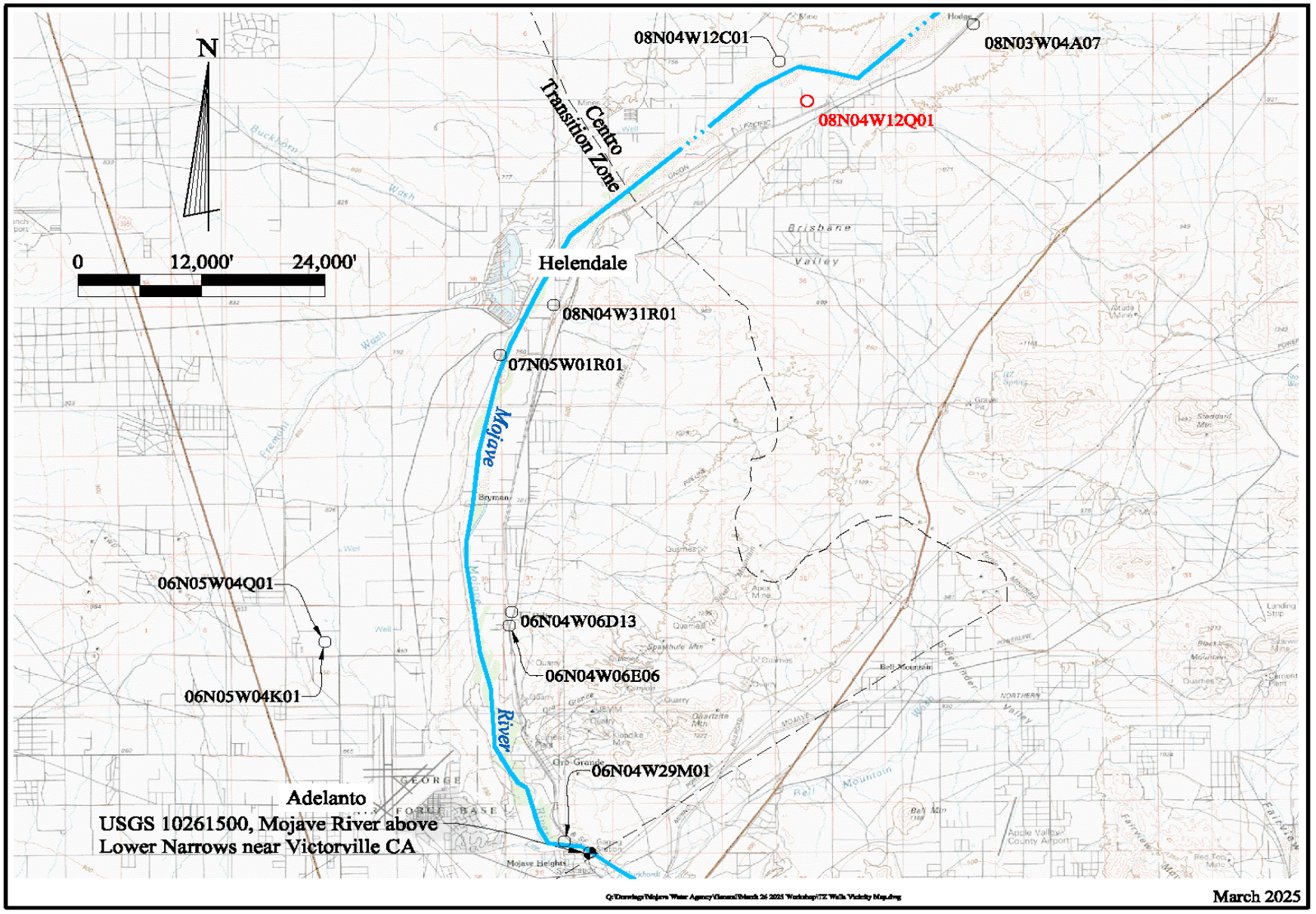


Note:
1931 - 1993 data from USGS "Simulation of Ground-Water Flow in the Mojave River Basin, California", Stamos. 2001
1994 - 2023 data from Mojave Watermaster.

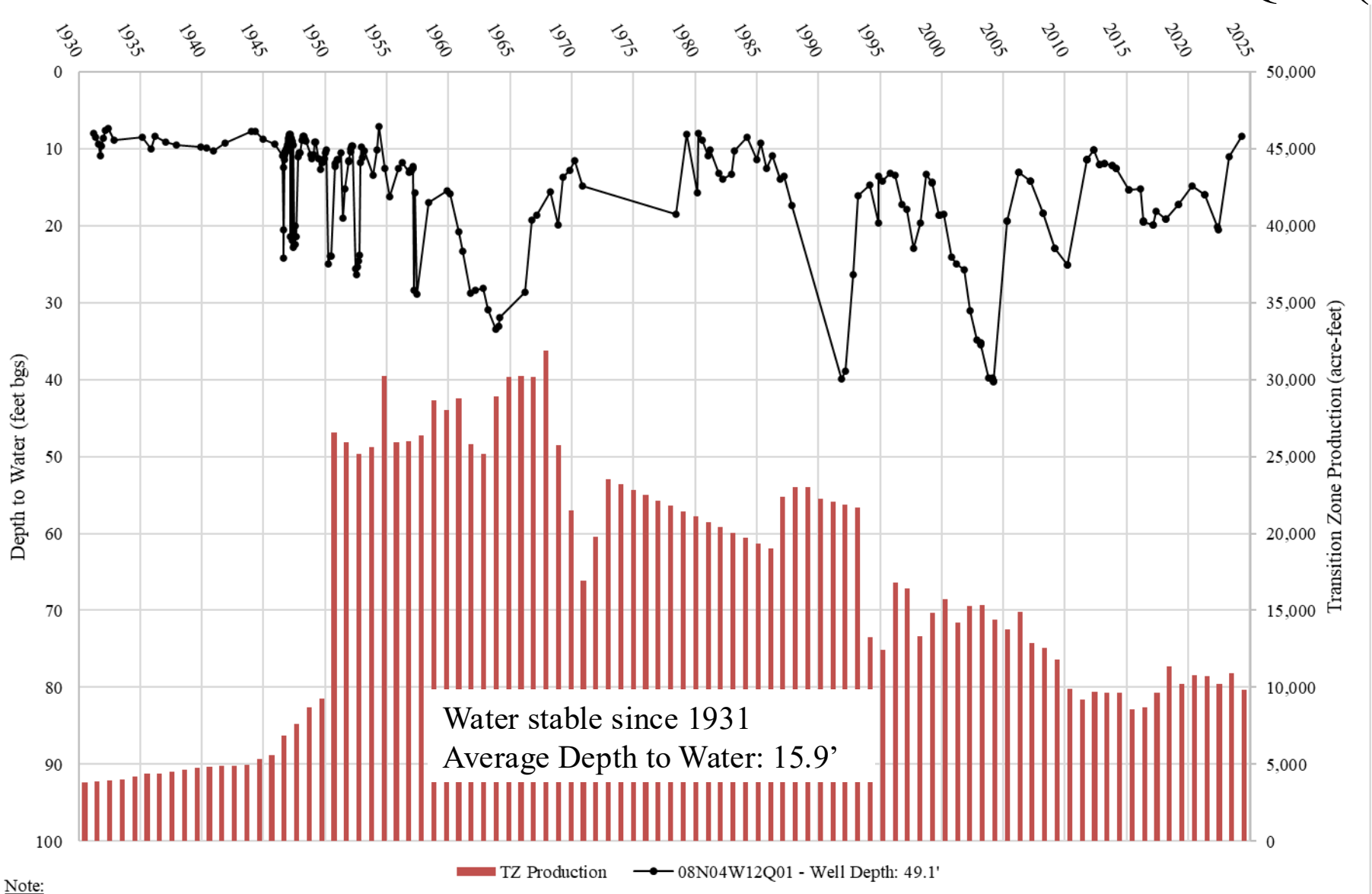
Wagner&Bon
Consulting Civil Engineers, A

MOJAVE BASIN AREA WATERMASTER

Map Showing Location of Presented Well



Transition Zone Production &Water Level for Well 08N04W12Q01 (Centro)



Note:
1931 - 1993 data from USGS "Simulation of Ground-Water Flow in the Mojave River Basin, California", Stamos. 2001
1994 - 2023 data from Mojave Watermaster.
Water levels potentially influenced by pumping of well or wells in the vicinity.

Wagner&Bon
Consulting Civil Engineers, A

MOJAVE BASIN AREA WATERMASTER

PROOF OF SERVICE

STATE OF CALIFORNIA }
COUNTY OF SAN BERNARDINO}

I am employed in the County of the San Bernardino, State of California. I am over the age of 18 and not a party to the within action; my business address is 13846 Conference Center Drive, Apple Valley, California 92307.

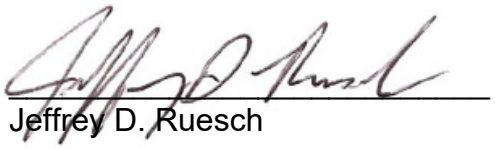
July 6, 2026, the document(s) described below were served pursuant to the Mojave Basin Area Watermaster's Rules and Regulations paragraph 8.B.2 which provides for service by electronic mail upon election by the Party or paragraph 10.D, which provides that Watermaster shall mail a postcard describing each document being served, to each Party or its designee according to the official service list, a copy of which is attached hereto, and which shall be maintained by the Mojave Basin Area Watermaster pursuant to Paragraph 37 of the Judgment. Served documents will be posted to and maintained on the Mojave Water Agency's internet website for printing and/or download by Parties wishing to do so.

Document(s) filed with the court and served herein are described as follows:

Notice of Motion and Motion (1) for Approval of Production Safe Yield Calculations and (2) To Adjust Free Production Allowance for Water Year 2026-2027; Memorandum of Points and Authorities; Supporting Declaration of Robert C. Wagner (Watermaster Engineer)

_X_ (STATE) I declare under penalty of perjury under the laws of the State of California that the above is true and correct.

Executed on July 6, 2026 at Apple Valley, California.



Jeffrey D. Ruesch

Mojave Basin Area Watermaster Service List as of July 06, 2026

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CDFW - Mojave Narrows Regional Park
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Contratto, Ersula
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daggettcsd@outlook.com;
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Mojave Basin Area Watermaster Service List as of July 06, 2026

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Gabrych Family Trust dated October 9, 2007
2006 Old Highway 395
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Attn: Jeremy McDonald (tsouza@cityofhesperia.us)
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Hesperia, CA 92345-3493

Attn: Carabeth Carter ()
Hettinga Revocable Trust (via email)
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47716 Fairview Road
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Hubbard, Ester and Mizuno, Arlean
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Mojave Basin Area Watermaster Service List as of July 06, 2026

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Attn: Bobby Boytor (bboytorjrwc@outlook.com.com)
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Trabuco Canyon, CA 92678-0542

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Attn: Paul Johnson (johnsonfarming@gmail.com)
Johnson, Paul - Industrial (via email)
10456 Deep Creek Road
Apple Valley, CA 92308-8330

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Dammeron Valley, UT 84783-5211

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Johnston, Harriet and Johnston, Lawrence W.
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Attn: Magdalena Jones (mygoldenbiz9@gmail.com)
Jones Trust dated March 16, 2002 (via email)
35424 Old Woman Springs Road
Lucerne Valley, CA 92356-7237

Attn: Paul Jordan
Jordan Family Trust
1650 Silver Saddle Drive
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Attn: Ray Gagné
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Mojave Basin Area Watermaster Service List as of July 06, 2026

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Mojave Basin Area Watermaster Service List as of July 06, 2026

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Attn: Jeff Gaastra (jeffgaastra@gmail.com)
Newberry Springs Recreational Lakes Association (via email)
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9876 Moon River Circle
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9154 Golden Seal Court
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Mojave Basin Area Watermaster Service List as of July 06, 2026

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Mojave Basin Area Watermaster Service List as of July 06, 2026

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