FINAL REPORT

A STATISTICAL STUDY OF THE HYDROLOGICAL CHARACTER OF THE EDWARDS AQUIFER

David Tomasko, Ann-Marie Fisher, Gustavious P. Williams,
and Edwin D. Pentecost

Argonne National Laboratory[1]

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1 INTRODUCTION

The Edwards Aquifer is located in south-central Texas and underlies all or parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays counties, Texas (Figure 1). It has a length of about 180 miles, and it varies in width from 5 to 40 miles. It is one of the most permeable and productive artesian limestone aquifers in the United States.

In 1979, the U.S. Environmental Protection Agency (EPA) designated the Edwards as a sole-source aquifer. Between the Balcones Fault Zone and the interface between fresh water and saline water (Figure 2), the aquifer supplies drinking water to more than 1.5 million people in San Antonio and the Austin-San Antonio corridor. Water from the aquifer is also vital to the agricultural and light industrial economy of the region. Discharge from the aquifer provides water to many springs in the area, including San Marocs and Comal Springs. Flows from the these springs provide water for the tourist and recreation industry, critical habitat for several endangered species, appropriated water use downstream on the Gulf Coastal Plain, and the San Antonio Bay ecosystem.

This report describes the results of a statistical study performed by Argonne National Laboratory (ANL) on the hydrological character of the Edwards Aquifer with respect to its response to an extremely high precipitation event that occurred in October 1998. The purpose of this project was to study the effects of the October 1998 precipitation event as the water and increased hydrostatic pressure moved through the Edwards Aquifer system. The review and analysis of empirical data will assist an Edwards Aquifer groundwater modeling project by assisting with calibration decisions and providing information on the sources of water emanating from San Marcos and Comal Springs.

Specific topics addressed by this study include the following:

- Precipitation in the area of the Edwards Aquifer,
- River responses,
- Water-level responses in monitor wells,
- Spring discharge responses,
- Lag times to achieve maximum indicator parameter values,
- Cross-correlation relationships between river flow, water-levels in monitor wells, and spring discharges,
- Regression modeling of spring flow at San Marcos Springs, and
- Model inference.

2 PRECIPITATION EVENT

Severe flooding occurred in portions of south-central Texas because of a major storm that occurred on October 17, 1998, through October 19, 1998. The meteorological conditions that produced the storm were dominated by Hurricane Madeline in the Eastern Pacific near the tip of Baja, California, and Hurricane Lester in the Eastern Pacific near Acapulco, Mexico (USGS 1999). Most of the precipitation fell within the first 24 hours of the storm. Isohyetals produced by the United States Geological Survey (USGS) for the storm indicate two main centers of rainfall. The largest documented rainfall occurred in southern Hays County, just south of San Marcos, Texas, where at least 30 inches of rainfall was recorded. A second center was documented at a site in western Comal County, where about 22 inches of rain fell. The USGS report (USGS 1999) indicates that approximately 2,300 square miles in 12 counties received at least 12 inches of rain, and about 5,000 square miles in 19 counties received at least 8 inches of rain.

The October 1998 rainfall event produced flooding of major rivers and tributaries of the San Jacinto, San Benard, Colorado, Lavaca, Guadalupe, and San Antonio River Basins, increases in water levels in monitor wells, and increased flows in discharge springs. Substantial flood peaks were recorded by 27 gaging stations operated by the USGS (USGS 1999). One gage in the Guadalupe River measured a peak flow that was 2.6 times the previous maximum recorded in 1833.

Twenty-nine precipitation gages are located within the area of the Edwards Aquifer (Figure 3). Information from 24 of these gages was useful for this study. A summary of precipitation gage data obtained from the Edwards Aquifer Authority (EAA 2000) is given in Table 1.

Figure 4 shows precipitation data from September 7, 1998, to February 19, 1999. The large spike occurring on Julian dates 289 through 291, 1998, corresponds with the October rainfall event. The rainfall event is shown in finer resolution in Figure 5, which plots daily precipitation for the period October 17, 1998, through January 31, 1999. Most of rainfall during this period was clustered around the October precipitation event; little rainfall of consequence fell between October 19, 1998, and January 31, 1999. The total precipitation for the October 1998 event (sum of precipitation on October 17 through October 19, 1998) is shown in Figure 6. Most of the rainfall occurred in the eastern region of the Edwards Aquifer. The maximum recorded rainfall for the October event was 21.12 inches at the Bulverde gage (411215); the next greatest precipitation was 20.95 inches at the New Braunfels gage (416276) (See Table 1). The distribution of rainfall for the Edwards Aquifer region is consistent with the description presented by the USGS (USGS 1999).

3 RIVER FLOWS

Twenty-four river-flow gages were considered in this study. These gages are located on the following bodies of water: the Blanco River, Cibolo Creek, Frio River, Guadalupe River, Hondo Creek, Medina Lake, Nueces River, Plum Creek, Salado Creek, Seco Creek, West Nueces River, Dry Frio River, and Sabinal River. The locations of these gages are shown in Figure 7 and listed in Table 2. Although many records of river flow were available, this study concentrated on flows from the Blanco and Guadalupe Rivers because of their proximity to Comal and San Marcos Springs.

Average daily flows for the bodies of water in the area of the Edwards Aquifer are shown in Figure 8 for the period October 15, 1998, to November 15, 1998. More detailed plots of the river flows are provided in Appendix A. The maximum recorded average daily flow (approximately 37,500 cubic feet per second [cfs]) occurred in Comal County for stream gage 8168500 in the Guadalupe River at the confluence with Comal River at New Braunfels. Peak flows occurred on about October 18, 1998, indicating that runoff from the land surface was very rapid. Peak flows in the Blanco River near Kyle were about 26,000 cfs (Figure 8 and Appendix A). For a given river (e.g., the Guadalupe River), all gages showed a maximum average flow on the same day (Figures 8 and 9). Flow increased in a downstream direction along the Guadalupe River from Comfort to Spring Branch and then from Sattler to New Braunfels. Flow decreased in the Guadalupe River between Spring Branch and Sattler because of the presence of Canyon Lake and the results of dam operations. Finer resolution of the storm surge was not possible because hourly information was not available. Although the measured flows in the rivers were very large, the high-flow period was short; flows returned to their normal values in less than about four days.

4 WATER-LEVELS IN MONITOR WELLS

There are 39 monitor wells in the area of the Edwards Aquifer. These wells are used to measure the elevation of groundwater (Figure 10). Of these wells, only 14 had daily data. However, groundwater elevations in wells at the City of Sabinal and Knippa were not used in the study because the data were either very incomplete over the period of interest (Knippa) or showed anomalous trends (City of Sabinal). The 12 remaining wells used in the study are summarized in Table 3 and shown in Figure 11. This figure also shows the locations of Comal Springs and San Marcos Springs.

Figures 12 through 17 show the elevation of groundwater in the Edwards Aquifer for all 14 wells (including Knippa and the City of Sabinal) over the period October 11, 1998, through January 31, 1999. A number of these wells have incomplete data over the full period of interest: 41301 – City of Castroville; 19806 – La Escondida; 43607 – Knippa; 45401; City of Sabinal; and 40102 – Quihi. Cubic splining (Davis 1986) was used to fill the missing data for all wells except 45401 (City of Sabinal) and 43607 (Knippa). Because of the very large data gaps for the City of Sabinal and Knippa wells, they were excluded from further analyses. An International Mathematics and Statistics Library (IMSL) subroutine (CSIEZ) was used to perform the cubic spline interpolation (Visual Numerics 1997). IMSL subroutines are written in Fortran and in C, and are typically used in Fortran or C programs to perform standard programming operations efficiently.

After the data gaps were filled with information from the IMSL cubic spline subroutine, a new set of monitor-well elevation figures was produced. For a quick comparison, the elevations for all 12 wells are shown in Figure 18. Because trend analysis can not be performed easily using Figure 18, the ordinate scale was expanded. The resulting plots are shown in Figures 19 through 24. In most cases, the response to the precipitation event is smooth, and peaks in groundwater elevations occur a few weeks after the rainfall.

As indicated in Table 3, the responses in the wells ranged from very small (1.2 feet change in water elevation for the Ehler well [51406] to more than 25 feet (29.8 feet – Trio – 36402; 29.7 feet – Hill Country – 29103; 28.6 feet – City of Castroville – 41301; 26.8 feet- City of Hondo – 47306; and 24.7 feet- J-17 – 37203). The time to reach the maximum water elevation ranged from 37 days at J-17 to 104 days at Quihi. Tabulated water elevations are given in Appendix B. Because the precipitation in the vicinity of Trio was small for the October 1998 event (approximately 2 inches), it is possible that the response in this well was not related to the rainfall.

5 SPRING DISCHARGES

Discharge measurements were available for two of the springs in the area of the Edwards Aquifer: Comal Springs, and San Marcos Springs. The locations of these springs are shown in Figure 10. Flow rate data from the springs were provided by the Edwards Aquifer Authority (EAA 2001) and are shown in Figure 25. The estimated peak discharge at Comal Springs was approximately 440 cfs for the October 1998 event; the estimated peak discharge at San Marcos Springs was about 400 cfs.

Examination of Figure 25 indicates that (1) the peak discharge from San Marcos Springs was less than that from Comal Springs for the October 1998 event, and (2) the response of the San Marcos Springs was different. That is, the recession curve for San Marcos Springs appears to have two recession slopes (Julian days 289 to 309 and after Julian day 346), both of which are steeper than the recession curve for Comal Springs. The peak discharge at Comal Springs occurred about 11 days after the start of the October 1998 event; peak discharge for San Marcos

Springs occurred two days earlier, approximately 9 days after the start of the rainfall. The earlier peak at San Marcos Springs is attributed either to the smaller size of its watershed or a higher underlying transmissivity in the Edwards Aquifer.

6 LAG TIMES TO ACHIEVE MAXIMUM INDICATOR PARAMETER VALUES

As discussed in Section 2, the October 1998 precipitation event was a high-intensity, short-duration storm. Most of the rainfall occurred on the first day of the event, October 17, 1998, with lesser amounts on October 18 and 19. No additional precipitation occurred for approximately 10 days, after which 1 inch of rainfall was recorded in gages near Comal and San Marcos Springs (New Braunfels, Bulverde, Canyon Dam No. 1, Canyon Dam Daily, and Wimberly 2 ESE) (Figure 26).

The October 1998 precipitation event produced immediate responses in river flows. Peak flows, in general, occurred on October 18, 1998. Recession of the discharge took about two to three days. By October 24, 1998, most of the river flows had returned to prestorm values.

Discharge from Comal and San Marcos Springs also responded rapidly to the precipitation event. The peak discharge at San Marcos Springs occurred about 9 days after the start of rainfall; peak discharge occurred about 2 days later at Comal Springs. As shown in Figure 27, flow at San Marcos Springs returned to its prestorm value (approximately 215 cfs) about 166 days later (mid-February 1999); average flow conditions (160 cfs) were reached approximately 282 days after the event. Comal Springs returned to an average flow condition of approximately 300 cfs after about 220 days (early May 1999) (Figure 27). Flow from Comal Springs did not return to its prestorm value (270 cfs) for about one year. During recovery to prestorm flow values, the recession curve for San Marcos Springs exhibited two steep slopes and a flat period, during which time the spring discharge remained constant at about 370 cfs for about 35 days (Figure 27). This constant flow period began about 11 days after peak flow was achieved (approximately 20 days after the beginning of the rainfall event). This behavior may indicate the presence of a significant storage capacity within the San Marcos Springs drainage at a depth below the water level associated with peak discharge, or receipt of groundwater from outside the San Marcos Springs watershed. For this case, the travel time to the springs would be about 20 days.

As discussed in Section 4, the time required for monitor wells to achieve maximum water elevations was considerably longer than the time to maximum spring discharges (Table 3). Index well J-17 exhibited one of the quickest times-to-peak – 37 days. More typical peak times were 50 to 60 days. Very long response times were observed in wells in the western portion of the Edwards Aquifer area (Trio and Quihi). The anomalously large response observed at Trio may not have been caused by the October rainfall event because of the location of the well and the spatial distribution of rainfall.

Following the precipitation event of October 1998, water levels in the monitor wells gradually returned towards their former values (Table 3 and Appendix A). The Ehler monitor well had the quickest recovery period (90 days). Water levels in wells Trio, Quihi, and Hill Country had not recovered to their former values by December 31, 1999, the cut-off date for this analysis. Other wells included in this study recovered in about 225 days, except for the monitor well at La Escondida which had a recovery time of about 309 days. No apparent trends are evident in the recovery times, possibly because local precipitation modified the responses of the water levels in the wells.

Figure 28 illustrates the time-dependent nature of the system responses to the rainfall event for five nearby precipitation gages (New Braunfels, Bulverde, Canyon Dam No. 1, Canyon Dam Daily, and Wimberly 2 ESE), monitor wells J-17 and Hondo City Well, and Comal and San Marcos Springs. All previously discussed responses (except river flow) are shown. On the basis of this figure, a period of time from October 11, 1998, through January 31, 1999, was selected for statistical analyses.

7 CROSS-CORRELATIONS

A single time series can exhibit correlation with itself because of time-dependent relationships. Similarly two time series can be compared to determine positions of pronounced correspondence (Davis 1986). Two pieces of data can be estimated for a pair of time series: the strength of the relationship between them (cross-correlation); and the offset (lag) at their times of maximum correlation (largest cross-correlation parameter). Time series that exhibit a high degree of cross-correlation may have an underlying, physical dependence.

For this study, cross-correlation coefficients were calculated between discharges from Comal and San Marcos Springs; river flows in the same body of water at upstream and downstream gages; and water levels in the 12 associated monitor wells, wells and springs, and rivers and springs. Because of the short duration of the October rainfall event, no cross-correlations were calculated between precipitation and river or spring flows or precipitation and water levels in monitor wells. All calculations were performed with the IMSL subroutine CCF (Visual Numerics 1997).

Figure 29 shows a plot of the cross-correlation parameter for discharge data for Comal and San Marcos Springs as a function of lag time. This type of plot is referred to as a cross-correlogram. Lag was varied over a range of -20 to 20 days. A maximum cross-correlation parameter of 0.8326 was obtained for a zero-day lag using a data set that spanned the interval October 11 through January 31, 1999. The results of cross-correlation analyses for lags greater than about plus or minus 11 days are questionable because of the number of data points in the time series (113 days); accuracy is questionable for lags that exceed the square root of the number of sample points (Davis 1986). The questionable period is clearly seen in the cross-correlogram shown in Figure 29 by the abrupt change in magnitude and sign of the first derivative of the correlogram function. An attempt was made to improve the cross-correlation coefficient between the flows at San Marcos Springs and Comal Springs by adding more data to the time series. Increasing the time base of the calculation from 113 to 182 days (March 31, 1999) decreased the cross-correlation to 0.7253 because of a divergence in the shape of the discharge profiles (Figure 28).

Two additional attempts were made to increase the cross-correlation between discharge data from Comal and San Marcos Springs. First, a moving average filter was applied to the raw data to reduce the variance and smooth the response (Davis 1986). With this method, the value of a filtered point is the numerical average of a specified number of points in an assigned time window. By sliding the window forward in time (adding one new data point at the next time increment and dropping the earliest point in time within the window), a new set of filtered points can be obtained.

Figures 30 through 32 show the results of filtering the Comal and San Marcos Springs discharges for time windows of 3, 5, and 7 days. The effect of the filtering is apparent in the figures, with high-frequency “noise “ (i.e., rapid fluctuations in the measured discharge) being reduced by increasing the width of the window (i.e., including additional data points in the averaging process). Although the noisiness of the data is reduced, there was no significant improvement in the cross-correlation coefficient between the two time series. The cross-correlation coefficients were 0.8328, 0.8318, and 0.8296 for window widths of 3, 5, and 7 days, respectively. All cross-correlations had a maximum for a lag time of zero days.

In the second attempt at improving the cross-correlation coefficient between discharge data at Comal and San Marcos Springs, the time series data were transformed by taking the natural log of the measured values. The results of the logarithmic transform are shown in Figure 33. For this procedure, the cross-correlation increased to 0.8631 for an optimal lag of zero days. Because this improvement in cross-correlation was not significant, untransformed data were used in the remainder of the study.

The degree of cross-correlation was also investigated for two stream gages in the same river (Gage 8171000 Blanco River at Wimberly, and 8171300 Blanco River near Kyle) (see Appendix A). The optimum cross-correlation coefficient for these gages for the October 1998 precipitation event was 0.9998 for an optimal lag of zero days. The high degree of correlation between data obtained from these two gages was expected, as was the zero-day lag time.

The statistical relationship between flow data in the Blanco River (Gage 8171300 near Kyle) and San Marcos Springs was also established. The maximum cross-correlation coefficient found was 0.2931 for a lag time of -9 days. This result was also expected because the Blanco River responded very rapidly to the October 1998 precipitation event and returned to prestorm flows after only about 4 days (Figure 8), whereas the discharge from San Marcos Springs did not achieve a maximum flow for 9 days.

In a similar fashion, cross-correlation parameters were calculated for the 12 wells used in this study (Table 3). Table 4 summarizes the maximum cross-correlation coefficients found and their associated optimal lags. Correlograms for the 12 monitor wells are shown in Appendix A. Cross-correlation coefficients of 1.0 and a zero-day lag correspond to an exact auto-correlation of a time series (i.e., cross-correlation of a time series with itself with no lag). Cross-correlation coefficients greater than 0.9 are highlighted in bold in Table 4. Although several wells had high cross-correlation coefficients, there may be no physical basis for their correlation. The statistical agreement may be simply fortuitous. Where possible, physical arguments are presented to explain high or low correlations.

The following observations are derived from information presented in Table 4 for wells that had a cross-correlation coefficient greater than 0.9:

- Water levels in Index Well J-17 only correlate very well with the City of Hondo well (0.9147); other reasonable correlations are observed for Landa Park (0.8736) and the City of Castroville (0.8658). The City of Hondo well also had a very high correlation (0.9864) with the nearby City of Castroville well.
- Water levels in the La Escondia well correlate very well with water levels in seven of the other wells, although it monitors water levels in the Trinity Aquifer. Particularly high correlations were obtained for nearby wells at Hill Country and North Uvalde.
- The highest cross-correlation coefficient found, 0.9949, was obtained for water levels in the City of Uvalde and the Trio wells.
- Water levels in wells in the northern and western portions of the Edwards Aquifer (La Escondida, Hill Country, Quihi, Trio, North Uvalde, Kyle North, and the City of Uvalde) have very high cross-correlations. These wells are located in both the Trinity and the Edwards Aquifers, and they are separated by almost the entire length of the Edwards Aquifer.
- Water levels in wells in the artesian portion of the Edwards Aquifer (City of Hondo, City of Castroville, and J-17) have very high cross-correlation coefficients.
- Cross-correlation coefficients between water levels in wells located in the recharge and artesian zones of the Edwards Aquifer area were not as high (e.g., Hill Country and J-17 – 0.5879; Quihi and the City of Hondo – 0.8212; and Quihi and the City of Castroville – 0.8792).
- Water levels in Kyle North, the most northern and eastern well used in this study, had high cross-correlation coefficients with water levels in wells at North Uvalde (0.9416), the City of Castroville (0.9227), Hill Country (0.9046), and La Escondida (0.9301).

- Water levels in the Landa Park monitor well did not correlate very well with water levels in any of the other wells.
- All water levels had a maximum cross-correlation coefficient for a lag of zero days, indicative of a quick response to the October 1998 rainfall event.
- Wells that had high cross-correlation coefficients for their water levels had similar completions. For example, La Escondida, Hill Country, Quihi, and Trio are located in the recharge zone of the Edwards Aquifer. Similarly, the City of Hondo well, J-17, and the City of Castroville well are located in the fresh water zone (Figure 3).

Two additional sets of cross-correlations were performed. The first set calculated the relationships between San Marcos Springs and water levels in the 12 monitor wells used in this study. The cross-correlations are summarized in Table 5. The largest cross-correlation coefficient was obtained for water levels in Index Well J-17 (0.8789) with a lag time of zero days.

The second set of cross-correlations was calculated for Comal Springs and water levels in the 12 monitor wells used in this study. A summary of the cross-correlations is presented in Table 6. The largest cross-correlation found was for water levels in the City of Hondo monitor well (0.9430). Other excellent cross-correlations were found for Index Well J-17 (0.9393) and the City of Castroville (0.9001). All of these cross-correlations were optimized for a lag time of zero days.

8 REGRESSION MODEL FOR SAN MARCOS SPRINGS

An empirical, linear model was developed to predict flows emanating from San Marcos Springs for the October 1998 precipitation event and to identify recharge sources for the springs. Linear regression modeling has been performed previously for the Edwards Aquifer (Puente 1976; Jennings et al. 1992; Asquith and Jennings 1993). For the present study, the governing model equation can be written:

$$SM_i = B_1 + B_2CS_i + B_3W_i + B_4R_i \quad \textbf{(1)}$$

where:

B_1 through B_4 = regression coefficients to be determined,

CS_i = discharge from Comal Springs,

R_i = flow in the Blanco River or level of water in a monitor well,

SM_i = discharge from San Marcos Springs, and

W_i = water level in a well.

The subscript I in Equation 1 indicates that the parameter is a time series. For this analysis, the time series spanned 113 days (October 11, 1998, through January 31, 1999).

As a first step, regression coefficient B_2 was assumed to be equal to 1.0, and B_3 and B_4 were assumed to be equal to zero; flow from the San Marcos Springs was assumed to be a simple translation of flow in Comal Springs. A computer program was written to estimate the B_1 constant. A copy of this program is given in Appendix B. The constant was found by finding the B_1 that produced the minimum sum of squared residuals between the predicted and measured flows, RES. That is:

$$RES = \sum_{i=1}^{n} (CP_i - CM_i)^2 \quad \textbf{(2)}$$

where:

CP_i = predicted flow from San Marcos Springs;

CM_I = measured flow from San Marcos Springs, and

n = number of observations (113).

The summation in Equation 2 is performed for the 113 days of observations (October 11, 1998, through January 31, 1999).

The results for this simple case are listed in Table 7. Constant B_1 has an approximate value of -92.2. The sum of the squared residuals for this calculation is 125,208. The cross-correlation coefficient between measured and predicted flows from San Marcos Springs is approximately 0.8325. Figure 34 shows a comparison of the predicted results with those measured.

The second case involved replacing flow at Comal Springs with water levels in Index Well J-17. The results of this case are given in Table 7, and a comparison of the predicted and measured flows is shown in Figure 35. The constant for this calculation was about -360.0. The sum of the squared residuals for the calculation was 188,624, and the cross-correlation coefficient was 0.8789.

The next step in developing the empirical model was to calculate a two-parameter model, using one constant (B_1) plus a second constant (B_2) times flow at Comal Springs or water levels at Index Well J-17. The results of these analyses are presented in Table 7. A comparison between the predicted and measured flows for the Comal Springs model is shown in Figure 36. The sum of the squared residuals for this calculation decreases to 67,948, and the cross-correlation coefficient is about 0.8326.

In finding the above constants, the response surface in the vicinity of the minimum of the sum of the squared residuals is fairly flat, and many fine steps had to be made with the computer program to isolate the minimum. This procedure can produce inaccurate results. In order to expedite the process and improve the accuracy of the calculations, a linear regression model (Draper and Smith 1981) was developed using subroutines in the IMSL computer package (Visual Numerics 1997).

For the IMSL regression model, the regression coefficients in Equation 1 were calculated by using matrix and vector manipulation subroutines. Specific subroutines included TRNRR (matrix transpose), MURRV (multiply a matrix by a vector), MRRRR (multiply two matrices), and LINRG (invert a square matrix). A copy of this program is provided in Appendix B.

As an initial step in using the IMSL regression model, the two-constant case discussed above was implemented. The results of this calculation are listed in Table 7. As indicated, the results for the sum of the squared residuals and the cross-correlation coefficient are essentially the same as those discussed above. However, the computational time was significantly reduced. As expected, the IMSL regression model experienced difficulties with the flatness of the response curve in the vicinity of the minimum, and a warning was given that the data were ill-conditioned. That is, the solutions are very sensitive to small changes in the coefficients of the governing equations (Noble 1969). Because the IMSL computer model produced results that were as good, if not better than, those of the trail-and-error search algorithm and because the

IMSL model ran much more quickly, the IMSL regression model was used for the remainder of the calculations presented.

In the next most complex regression model for flows at San Marcos Springs, the following time series of data were used: spring discharges at Comal Springs, water level elevations for Index Well J-17; and flow data in the Blanco River. The river flow time series was obtained from the Blanco River gage near Kyle (8171300 – Table 2). Well J-17 was selected for this analysis because its water levels had a high cross-correlation coefficient with flow from San Marcos Springs for the rainfall event (0.8789 – Table 5).

The following regression coefficients were obtained by using the linear regression model of the San Marcos Springs: B_1 = -3927.8, B_2 = 0.1140, B_3= 6.1632, and B_4 = 0.0016 (Table 7). As shown in Figure 37, the predicted flows compare favorably with those measured. The pronounced spike at Julian day 289 occurs because Blanco River flow was included in the model. This flow is marked by a high flow of short duration at the time of the precipitation event (a maximum flow of about 26,000 cfs was recorded in the stream gage on October 18, 1998). The cross-correlation coefficient between predicted and measured flows at San Marcos Springs is about 0.8834, and the sum of the squared residuals is about 46,955.

In attempting to reduce the effect of the high-flow period in the Blanco River, its flow was set equal to its value at the start of the precipitation event (60 cfs). The sum of the squared residuals increased to a very large value, 3,694,260, indicating that the procedure failed.

One final set of regression models was analyzed. In this set, a second well was added to the model, the flow data from the Blanco River was removed, and water-level data from Index Well J-17 was retained. All 12 monitor wells in the study were evaluated to determine which well produced the best overall result. As indicated in Table 8, the monitor well at Quihi produced the best-fit model with a cross-correlation coefficient of 0.9834 and a sum of the squared residuals of 8,747. The agreement between the predicted and measured flows is excellent (Figure 38). Introduction of water levels from the Quihi well produce the “best-fit” model because of the shape of the water-level response curves observed (Figure 23). That is, water levels in the Quihi well rise rapidly at the initiation of the rainfall event and continue to rise during the entire period included in these statistical analyses. Other wells did not behave similarly. There is no apparent physical basis for the Quihi water-level response.

9 MODEL INFERENCE

A number of parameters can be calculated to determine the quality of a statistical model. One of these, the sum of the squared differences between model predictions and measured values, was discussed above. Other parameters include the coefficient of determination, the standard error, and the 95% confidence interval for the estimated parameters.

The coefficient of determination (Draper and Smith 1981), D, is expressed as:

$$D = \sum_{i=1}^{n} \frac{\left(y_{iC} - y_b\right)}{\left(y_{iM} - y_b\right)^2}^{2} \qquad \textbf{(3)}$$

where:

n = the number of observations,

y_{iC} = the computed value for flow at San Marcos Springs,

y_{iM} = the measured flow at San Marcos Springs, and

y_b = the average of the measured flows for the 113 days (338.39 cfs) used in the analysis.

As written in Equation 3, D is a measure of the proportion of total variation about the mean explained by regression. A D value of 0.0 indicates no correlation; a value of 1.0 is a perfect fit.

The second parameter of interest for inference analyses is the standard error of the model. The standard error, *SE*, for a calculation is given by the expression:

$$SE = \sqrt{\frac{\sum_{i=1}^{n}\left(y_{iM} - y_{iC}\right)^2}{n-\left(k+1\right)}} \qquad \textbf{(4)}$$

where k is the number of parameters being estimated in the model (Wonnacott and Wonnacott 1986).

The 95% confidence interval for the estimated parameters can be found from the expression:

$$\beta_i = \beta_{ie} \pm t_{0.025} SE_i \tag{5}$$

where:

β_i = estimated parameter for a 95% confidence limit,

β_{ie} = original parameter estimate,

SE_i = standard error for parameter $\exists_{ie}$, and

$t_{0.025}$ = Student’s t parameter for a 95% confidence interval (approximately 1.982) (Wonnacott and Wonnacott 1986).

Confidence intervals are only calculated for multiplicative regression constants; a confidence interval is not calculated for an additive constant (B_1).

The standard error for the first two regression parameters are given by the following expressions:

$$SE_1 = \sqrt{\frac{\sum_{i-1}^{n} \left(y_{iM} - y_{iC}\right)^2}{n - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{\sum_{i=1}^{n} X_i^2}}} \tag{6}$$

and:

$$SE_2 = \sqrt{\frac{\sum_{i=1}^{n} \left(y_{iM} - y_{iC}\right)^2}{\sum_{i=}^{n} X_i^2 - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n}}} \tag{7}$$

Standard errors for higher order parameters (i.e., SE_3 and SE_4) were found by dividing the square root of the sum of the squared residuals by the square root of the corresponding diagonal element of the variance-covariance matrix of the governing equations (Draper and Smith 1981).

Tables 8 and 9 list the values for the squared residuals, coefficients of determination, and the 95% confidence intervals for various models developed for this study. As indicated in Table 8, the four-parameter model using flow from Comal Springs and water levels from monitor wells J-17 and Quihi did best (largest cross-correlation parameter and smallest sum of squared residuals).

Increasing the number of parameters in a model decreases the sum of the squared residuals. In principle, the sum can be reduced to zero by simply adding more fitting parameters. However, a model with many parameters can be very misleading. In order to determine the significance of additional fitting parameters, a statistical null hypothesis can be used (Draper and Smith 1981).

For this study, two null tests were used to assess the utility of including additional regression coefficients in the model. The first null test was used to determine if at least one of the regression coefficients was non-zero. This evaluation was performed with the standard F-test (Draper and Smith 1986).

In the F-test, the F statistic is calculated with the following expression:

$$F = \frac{\sum_{i=1}^{n} (y_{iC} - y_b)^2}{\sum_{i=1}^{n} (y_{iM} - y_{iC})^2} \qquad \textbf{(8)}$$

The F statistic is then compared to tabulated critical values of $F(<_1, <_2)$ at a desired level of confidence (95% probability), where $<_1$ and $<_2$ are appropriate degrees of freedom for the calculation ($<_1$ is equal to the number of estimated parameters and $<_2$ is equal to n-2). If the F statistic exceeds the critical value (approximately 5.70 [Wonnacott and Wonnacott 1986]), the null hypothesis is rejected.

In the second null hypothesis evaluation, use is made of the T statistic (Wonnacott and Wonnacott 1986). The T statistic is given by the expression:

$$T_{\beta} = \frac{\beta}{SE_{\beta}} \qquad \textbf{(9)}$$

In performing the test, the T statistic is compared to tabulated critical values of Student's t for the desired confidence level (95% confidence) and degrees of freedom (n-[number of regression parameters +1]). For a 95% confidence level and a one-sided null hypothesis test (increasing the value of the regression coefficient increases spring flow), the critical Student's t value is approximately 1.661. If the T statistic exceeds the critical value, the null hypothesis is rejected and the regression coefficient is retained.

Table 10 lists the values associated with both null hypothesis tests. As indicated in this table, the null hypothesis is rejected for the four-parameter model using the F statistic; at least one of the estimated parameters is non-zero. Examination of the T statistic for the four-parameter models shows that inclusion of the fourth parameter is questionable (with the exception of the model that includes data from the Ehler monitoring well). Although inclusion of the fourth parameter in the model is questionable, it is retained because it significantly decreases the sum of the squared residuals.

One additional calculation was performed with the "best-fit" J-17/Quihi model. This operation involved calculating the 95% confidence envelope about the predicted flow. The 95% confidence value for the predicted flow value is given by the expression (Draper and Smith 1981):

$$y_{i\,95\%} = y_{i\,C} \pm t_{0.025}\, S\sqrt{\frac{1}{n} + X_0^t \left(X^t X\right)^I X_0} \qquad \textbf{(10)}$$

where S is the square root of the sum of the squared residuals, X_0 is a vector of parameter values, and the superscripts t and I represent transpose and invert, respectively.

A plot of the 95% confidence envelope for the calculated flow at San Marcos Springs for the four-parameter model including water levels in monitor well Quihi is shown in Figure 39. As expected, the 95% confidence envelope does not contain the measured values throughout the period of interest because of imprecision in the linear regression model.

10 DISCUSSION

An analysis was performed on data from the October 1998 precipitation in the area of the Edwards Aquifer. Lag times and cross-correlation coefficients were found for the independent variables, including spring flow and water levels in monitor wells. Conclusions derived from the measured data include the following:

- Most of the precipitation from the October 1998 event fell on the eastern portion of the Edwards Aquifer area. This finding is consistent with published information from the USGS.
- Response of river and stream flow to the precipitation event were very rapid and produced sharp peaks in flow with fast recession curves. Because hourly data were not available for the rivers or streams, the storm surge could not be tracked downstream.
- Responses of flows from San Marcos and Comal Springs were rapid, indicating a strong connection with surface water. Peak flows were achieved at San Marcos and Comal Springs in 9 and 11 days, respectively. Because hourly data were not available, the peak could not be further delineated. The more rapid rise to peak flow in San Marcos Springs is indicative of a smaller watershed or a higher transmissivity aquifer.
- Flows in San Marcos and Comal Springs returned to their pre-event values after 166 and 220 days, respectively. The longer recession at Comal Springs may be caused by a larger watershed, a lower transmissivity, or a combination of both.
- The recession curve for flow from San Marcos Springs has a pronounced flat period that starts about 20 days after the rainfall event and lasts about 35 days. The slope of the recession curve is about the same for earlier and later times. This behavior may indicate that there is a substantial storage in the Edwards Aquifer at a depth less than that of peak conditions, or that flow may be arriving from outside its watershed. For the latter case, the travel time is about 20 days.
- Cross-correlation between flows from San Marcos and Comal Springs was very good. Filtering the field data with a moving average window did not significantly improve the results. Similarly, significant improvements were not produced by

taking a log transformation of the field data. Maximum cross-correlations were obtained for a zero-day lag time. This finding is consistent with a conceptual model in which there is strong communication with surface water (rivers, streams, and runoff).

- Water levels in monitor wells in the northern portion of the Edwards Aquifer area had very high cross-correlation coefficients, as did water levels in wells in the southern portion of the area. Cross-correlations, however, between water levels in wells in the northern and southern portions of the aquifer were, in general, low. This finding is consistent with the wells' being completed similarly in the recharge and fresh-water zones, and, as with all statistical correlations, the results may be fortuitous.
- A four-parameter linear regression model demonstrated that inclusion of time series data from the Blanco River was not warranted because of its very high and rapid runoff response to the precipitation event.
- The best overall four-parameter model included flow from Comal Springs and water levels in monitor wells J-17 and Quihi.
- More complex models that include more than four estimated parameters could be constructed, but the inclusion of additional parameters is questionable.
- Results of the model may not be applicable for analysis of other, lower flows because the linear regression model was developed for flood conditions.

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Table 1. Summary of precipitation data.

Gage*	Name	File name	Precipitation (sum of October 17-19,1998) (inches)
410832	Blanco	382995606dat.xls	7.31
410902	Boerne	382995606dat.xls	5.59
411007	Bracketville	382995606dat.xls	0.00
411215	Bulverde	382995606dat.xls	21.12
411398	Camp Wood	382995606dat.xls	1.11
411429	Canyon Dam Daily	382995606dat.xls	0.00
411431	Canyon Dam No. 1	382995606dat.xls	0.00
411492	Carta Valley 4 W	382995606dat.xls	2.10
414254	Hondo	382995606dat.xls	0.00
414374	Hunt	382995606dat.xls	2.10
414782	Kerrville 3 NNE	382885606dat.xls	2.46
415113	Leakey Daily	382995606dat.xls	1.68
415742	Medina 2 W	382995606dat.xls	2.55
415746	Medina Lake	966949462dat.xls	11.88
426276	New Braunfels	966949462dat.xls	20.95
417628	Rio Medina	966949462dat.xls	10.46
417706	Rocksprings	966949462dat.xls	0.20
417873	Sabinal	966949462dat.xls	0.00
417945	San Antonio International Airport	966949462dat.xls	15.61
418169	San Antonio Seaworld	966949462dat.xls	11.15
418845	Tarpley	966949462dat.xls	3.55
419260	Utopia	966949462dat.xls	3.36

419268	Uvalde Research Center	966949462dat.xls	1.79
419815	Wimberly 2 ESE	966949462dat.xls	13.02

* The following daily precipitation gagers were excluded from this study because no 1998 daily data were available:

411437 Canyon Dam 7 (data: May 1948 - April 1993)
414256 Hondo Municipal Airport (data: March 1975 to June 1996, and February 1999 to April 2000)
414780 Kerrville (data: January 1897 to July 1974)
415114 Leakey 2 (data: November 1963 to January 1971)
419265 Uvalde (data: March 1905 to May 1985).

Table 2. River gage stations used in this study.

Name	**Number**	**County**
Blanco River at Wimberly	8171000	Hays
Blanco River near Kyle	8171300	Hays
Cibolo Creek at 1H-10 above Bourne	8183850	Kendall
Cibolo Creek at Selma	8185000	Bexar
Frio River at Concan	8195000	Uvalde
Guadalupe River at Comal River at New Braunfels	8168500	Comal
Guadalupe River at Comfort	8167000	Kendall
Guadalupe River near Spring Branch	8167500	Comal
Hondo Creek at King Waterhole near Hondo	8200700	Medina
Hondo Creek near Tarpley	8200000	Medina
Medina Lake near San Antonio	8179500	Medina
Medina Lake at Bandera	8178880	Bandera
Nueces River at Laguna,	8190000	Uvalde
Nueces River below Uvalde	8192000	Uvalde
Plum Creek at Lockhart	8172400	Caldwell
Salado Creek (upper station) at San Anontio	8178700	Bexar
Seco Creek at Miller Ranch near Utopia	8201500	Medina
Seco Creek at Rowe Ranch near D'Hanis	8202700	Medina
West Nueces River near Bracketville	8190500	Kinney
Dry Frio River near Reagan	8196000	Uvalde
Sabinal River near Sabinal	8198000	Uvalde
Sabinal River at Sabinal	8198500	Uvalde
Guadalupe River at Sattler	8167800	Comal

Table 3. Monitor wells with daily data in the area of the Edwards Aquifer

Well number	Name	Index Number	Highest water level (ft)	Changes in water level (ft)	Lag time to peak elevation (days)	Recovery time (days)
51406	Ehler (Trinity well)	1	846.8	1.2	50	90
50302	City of Uvalde	2	880.8	3.4	88	237
47306	City of Hondo	3	744	26.8	64	223
43409	North Uvalde	4	886.7	7.4	96	237
37203	J-17	5	689	24.7	37	233
36402	Trio	6	820	29.8	105	NR*
41301	City of Castroville	7	717	28.6	49	233
40102	Quihi	8	844	10.4	104	NR
01303	Kyle North	9	568.5	14.1	64	209
23302	Landa Park	10	565.5	4.3	63	244
29103	Hill Country	11	715	29.7	93	NR
19806	La Escondida (Trinity well)	12	1,066	15.9	98	307

* NR = not recovered by December 31, 1999.

Table 4. Cross-correlation coefficients for Edwards Aquifer monitor wells*

	Coefficient/lag (days)					
Well	**Ehler**	**City of Uvalde**	**City of Hondo**	**North Uvalde**	**J-17**	**Trio**
Ehler	1.0/0	0.2592/20	0.2213/4	0.2452/20	0.3016/0	0.2441/20
City of Uvalde	0.2592/-20	1.0/0	0.7768/0	**0.9786/0**	0.5108/0	**0.9949/0**
City of Hondo	0.2213/-4	0.7768/0	1.0/0	0.8831/0	**0.9147/0**	0.7338/1
North Uvalde	0.2452/-20	**0.9786/0**	0.8831/0	1.0/0	0.6581/0	**0.9623/0**
J-17	0.3016/0	0.5108/0	**0.9147/0**	0.6581/0	1.0/0	0.4790/6
Trio	0.241/-20	**0.9949/0**	0.7338/-1	**0.9623/0**	0.4790/-6	1.0/0
City of Castroville	0.2020/-18	0.8571/0	**0.9864/0**	**0.9409/0**	0.8658/0	0.8211/0
Quihi	0.1892/-20	**0.9185/0**	0.8212/0	**0.9282/0**	0.6843/0	**0.9149/0**
Kyle North	0.2475/-18	0.8945/0	0.8726/0	**0.9416/0**	0.6718/0	0.8700/0
Landa Park	0.2337/0	0.5142/0	0.7921/0	0.6269/2	0.8736/0	0.4775/5
Hill Country	0.2387/-20	**0.9917/0**	0.8169/0	**0.9854/0**	0.5879/0	**0.9870/0**
La Escondida	0.2216/-20	**0.9378/0**	0.8823/0	**0.9666/0**	0.7184/0	**0.9177/0**

Table 4. Cross-correlation coefficients for Edwards Aquifer monitor wells (Continued)

	Coefficient/lag (days)					
Well	**City of Castroville**	**Quihi**	**Kyle North**	**Landa Park**	**Hill Country**	**La Escondida**
Ehler	0.2020/18	0.1892/20	0.2475/18	0.2337/0	0.2387/20	0.2216/20
City of Uvalde	0.8571/0	**0.9185/0**	0.8945/0	0.5142/0	**0.9917/0**	**0.9378/0**
City of Hondo	**0.9864/0**	0.8212/0	0.8726/0	0.7921/0	0.8169/0	0.8823/0
North Uvalde	**0.9409/0**	**0.9282/0**	**0.9416/0**	0.6269/-2	**0.9854/0**	**0.9666/0**
J-17	0.8658/0	0.6843/0	0.6718/0	0.8736/0	0.5879/0	0.7184/0
Trio	0.8211/0	**0.9149/0**	0.8700/0	0.4775/-5	**0.9870/0**	**0.9177/0**
City of Castroville	1.0/0	0.8792/0	**0.9227/0**	0.7869/0	0.8912/0	**0.9409/0**
Quihi	0.8792/0	1.0/0	0.8140/0	0.6678/-1	**0.9557/0**	**0.9370/0**
Kyle North	**0.9227/0**	0.8140/0	1.0/0	0.6769/0	**0.9046/0**	**0.9301/0**
Landa Park	0.7869/0	0.2278/1	0.6769/0	1.0/0	0.5867/0	0.7859/0
Hill Country	0.8912/0	**0.9557/0**	**0.9046/0**	0.5867/0	1.0/0	**0.9632/0**
La Escondida	**0.9409/0**	**0.9370/0**	**0.9301/0**	0.7589/0	**0.9632/0**	1.0/0

* Bold = Cross-corrleation coefficients greater than 0.9.

Table 5. Cross-correlation coefficients between San Marcos Springs and the 12 monitor wells in the Edwards Aquifer area

Well	**Cross-correlation coefficient**	**Optimum lag (days)**
Ehler	0.5581	5
City of Uvalde	0.3254	-20
City of Hondo	0.7207	0
North Uvalde	0.3396	-20
J-17	0.8789	0
Trio	0.2975	-20
City of Castroville	0.6203	0
Quihi	0.3084	0
Kyle North	0.5080	-16
Landa Park	0.7308	0
Hill Country	0.2856	-20
La Escondida	0.3912	0

Table 6. Cross-correlation coefficients between Comal Springs and the 12 monitor wells in the Edwards Aquifer area*

Well	**Cross-correlation coefficient**	**Optimum lag (days)**
Ehler	0.2034	2
City of Uvalde	0.6122	0
City of Hondo	**0.9430**	0
North Uvalde	0.7383	0
J-17	**0.9393**	0
Trio	0.5733	-1
City of Castroville	**0.9001**	0
Quihi	0.7364	0
Kyle North	0.7242	0
Landa Park	0.8040	0
Hill Country	0.6751	0
La Escondida	0.7708	0

* Bold = Cross-correlation coefficient greater than 0.9

Table 7. Summary of linear regression models*

Model	B1	B2	B3	B4	Sum of squared residuals	Correlation coefficient
Constant + Comal flow	-92.1951	-	-	-	125,208	0.8325
Constant + J-17	-360.002	-	-	-	188,624	0.8789
Constant + constant times Comal flow	-61.001	0.9769	-	-	67,948	0.8326
IMSL constant + constant times Comal flow	-12.8405	0.8602	-	-	65,205	0.8326
IMSL Comal + J-17 + Blanco River	-3927.8	0.1140	6.1632	0.0016	46,955	0.8834
IMSL Comal + J-17 + Quihi	6394.5	0.6468	5.8930	-12.3069	8,747	**0.9834**

* Bold = Cross-correlation coefficient greater than 0.9

Table 8. Inference parameters for four-parameter San Marcos Springs flow model*

Monitor well	**Squared residual**	**Cross-correlation coefficient**	**Coefficient of determination**	**Standard error**
Ehler	78440	0.8931	1.3862	26.95
Uvalde	221907	**0.9676**	1.9561	45.33
Hondo	34210	**0.9208**	0.8591	17.80
North Uvalde	17277	**0.9595**	0.8939	12.65
Trio	14423	**0.9741**	0.9654	11.56
Castroville	25259	**0.9418**	0.8933	15.29
Quihi	8747	**0.9834**	1.0025	9.00
Kyle North	31467	**0.9239**	0.8545	17.07
Landa Park	48136	0.8818	0.7775	21.11
Hill Country	10142	**0.9759**	0.9534	9.69
La Escondida	16596	**0.9602**	0.9242	12.40

* Bold = Cross-correlation coefficient greater than 0.9

Table 9. Estimated regression parameters and their 95% confidence range

Well	**B_1**	**B_2** **B_2+*** **B_2-+**	**B_3** **B_3+** **B_3-**	**B_4** **B_4+** **B_4-**
Ehler	-39214	0.5491 0.918 0.180	1.28 4.413 -1.590	45.47 56.385 34.560
Uvalde	16435	0.6329 1.274 -0.008	4.60 9.026 0.176	-22.13 -12.069 -32.186
Hondo	-1384	0.7050 0.998 0.412	7.86 9.626 6.094	-5.34 -3.842 -6.830
North Uvalde	6296	0.6859 0.874 0.498	4.63 5.874 3.390	-10.64 -9.050 -12.221
Trio	-515	0.7276 0.897 0.558	3.54 4.700 2.381	-2.32 -2.042 -2.590
Castroville	-1716	0.6533 0.883 0.424	7.37 8.855 5.884	-4.57 -3.682 -5.465
Quihi	6394	0.6468 0.774 0.520	5.89 6.760 5.026	-12.31 -11.261 -13.353
Kyle North	-1464	0.4108 0.650 0.172	6.01 7.650 4.361	-4.39 -3.257 -5.528
Landa Park	-1128	0.0595 0.333 -0.214	6.96 9.359 4.555	-5.28 5.540 -16.100
Hill Country	-928	0.6986 0.839 0.558	4.51 5.462 3.564	-2.98 -2.692 -3.278
La Escondida	1118	0.5659 0.741 0.391	6.15 7.339 4.952	-4.92 -4.239 -5.595

[*] + Denotes the upper bound of the 95% confidence interval
[+] - Denotes the lower bound of the 95% confidence interval

Table 10. Additional inference information

Well	F statistic	Standard error SEB_1	Standard error SEB_2	Standard error SEB_3	Standard error SEB_4
Ehler	3.7556	-	0.035	2.091	30.314
Uvalde	1.8732	-	0.105	4.985	25.756
Hondo	5.3366	-	0.022	0.794	0.568
North Uvalde	10.995	-	0.009	0.392	0.640
Trio	14.224	-	0.007	0.342	0.019
Castroville	7.5151	-	0.013	0.562	0.202
Quihi	24.354	-	0.004	0.191	0.278
Kyle North	5.7706	-	0.015	0.688	0.328
Landa Park	3.4327	-	0.019	1.469	29.803
Hill Country	19.977	-	0.005	0.229	0.022
La Escondida	11.834	-	0.008	0.362	0.117

Table 10. Additional inference information (continued)

Well	**Test statistic TB_1**	**Test statistic TB_2**	**Test statistic TB_3**	**Test statistic TB_4**
Ehler	-	2.950	0.883	8.259
Uvalde	-	1.958	2.061	-4.360
Hondo	-	4.774	8.821	-7.079
North Uvalde	-	7.225	7.394	-13.295
Trio	-	8.519	6.053	-16.756
Castroville	-	5.641	9.831	-10.169
Quihi	-	10.104	13.474	-23.321
Kyle North	-	3.407	7.238	-7.666
Landa Park	-	0.431	5.740	-0.967
Hill Country	-	9.865	9.423	-20.191
La Escondida	-	6.401	10.208	-14.369

Figure 1. Edwards Aquifer in south central Texas

Source - R. W. Maclay and L. F. Land, 1988, "Simulation of the flow in the Edwards aquifer, San Antonio region, Texas, and refinement of storage and flow concepts", U. S. Geological Survey Water-Supply Paper 2336-A, 48p.

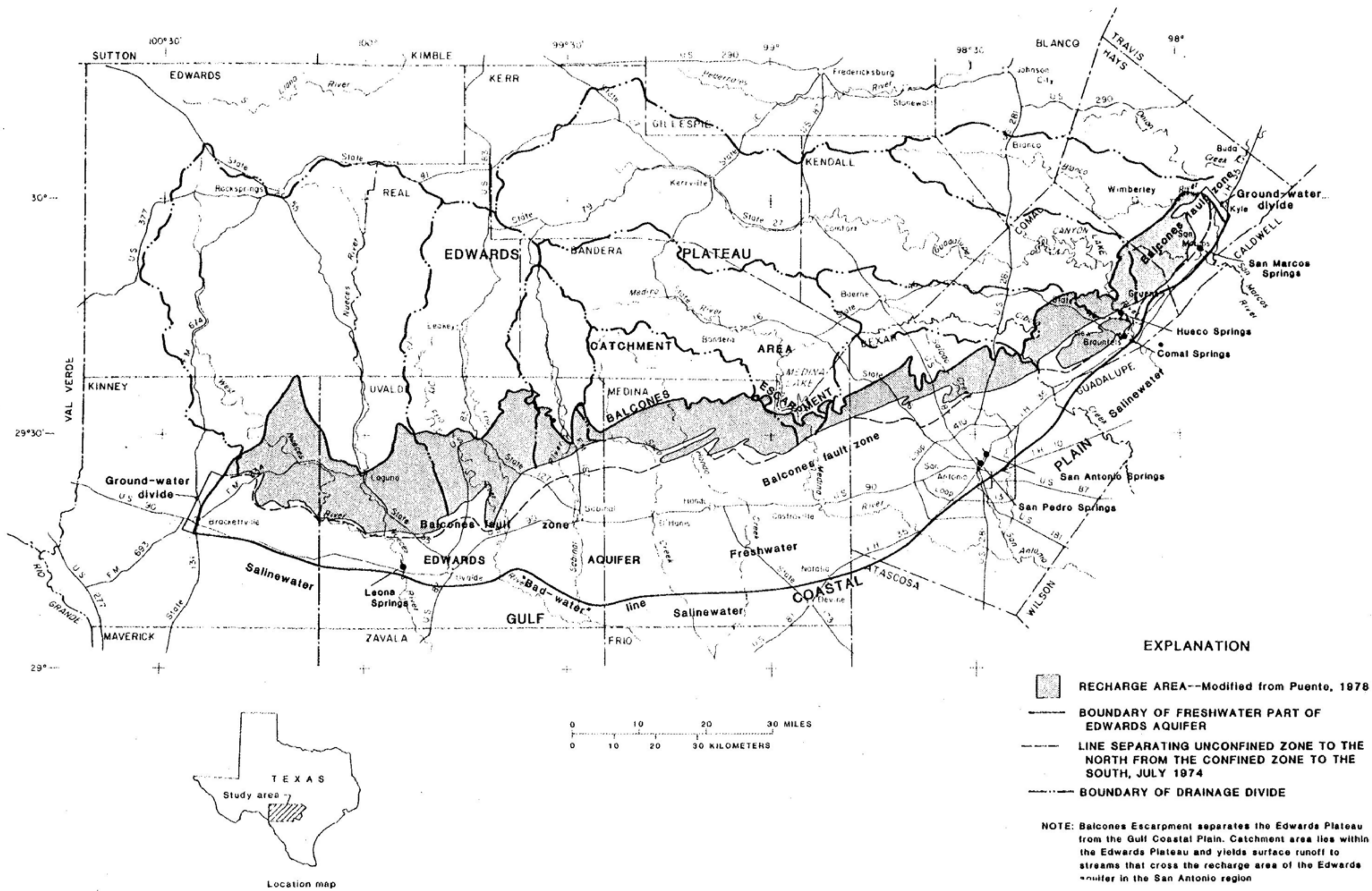
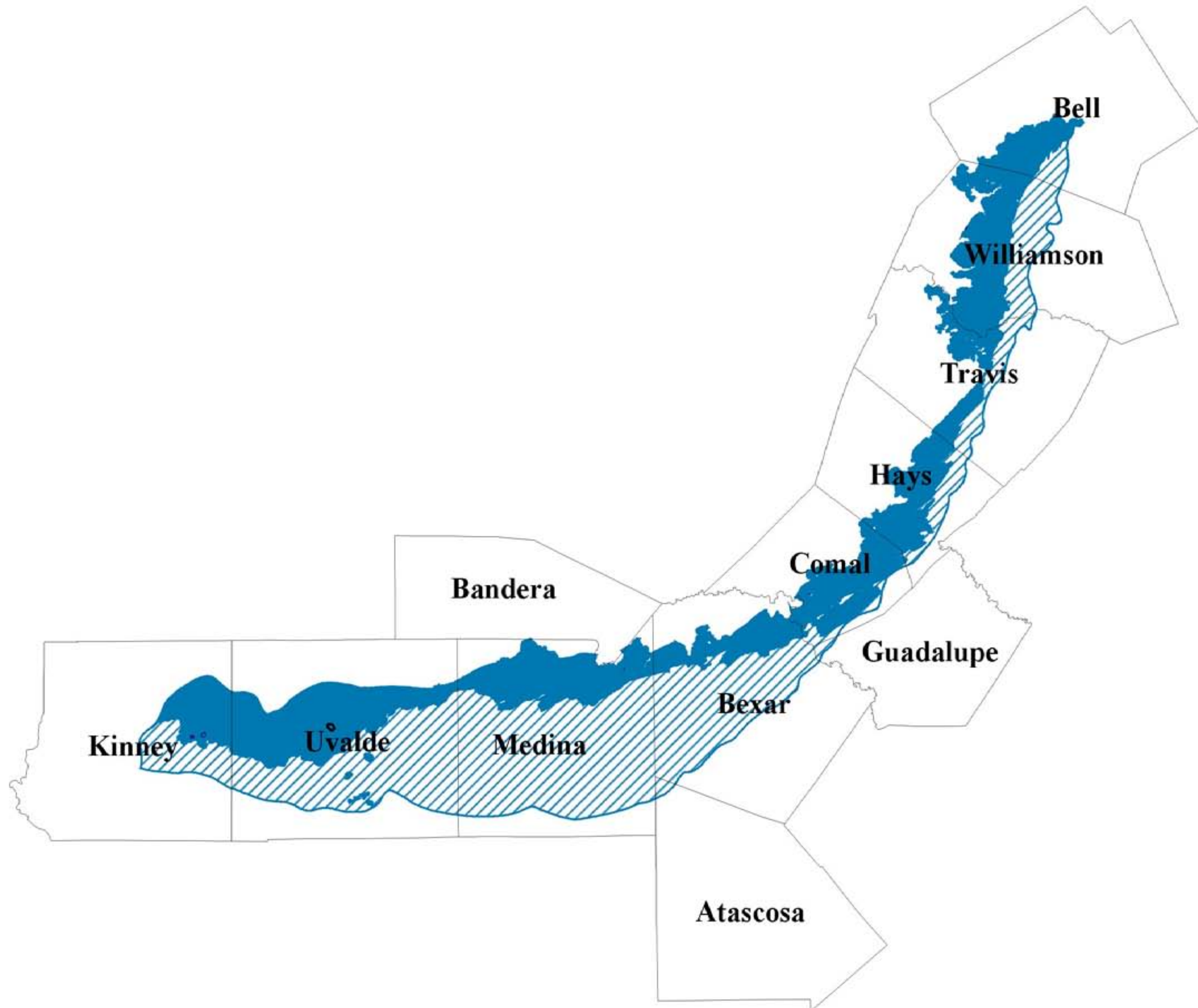


Figure 2. Texas Edwards Aquifer Balcones Fault Zone



Source: Modified from Maclay and Small, 1986

Figure 3. Daily precipitation stations in the vicinity of the Edwards Aquifer

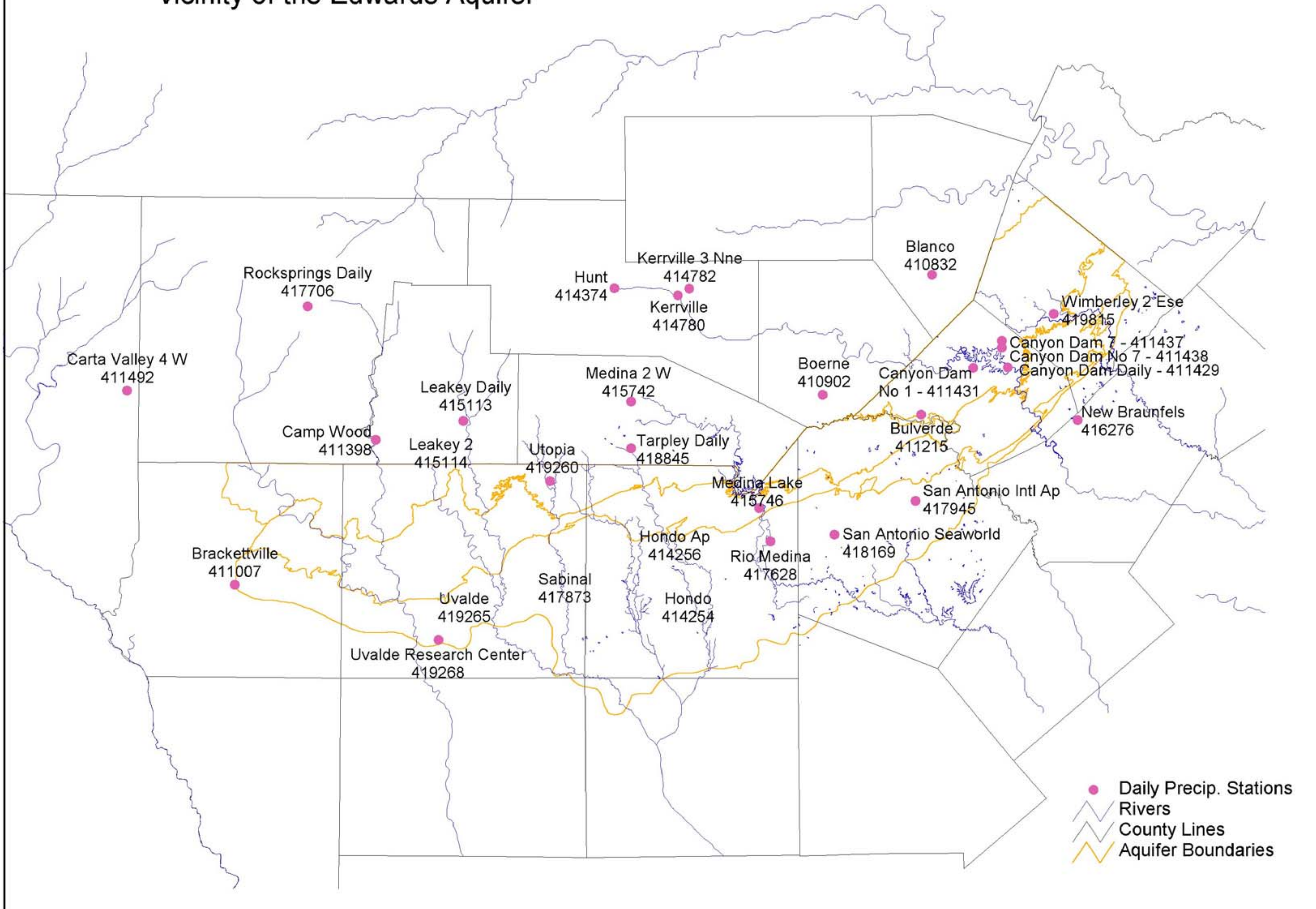


Figure 5. Daily precipitation in the vicinity of the Edwards Aquifer (October 17, 1998 to January 31, 1999)

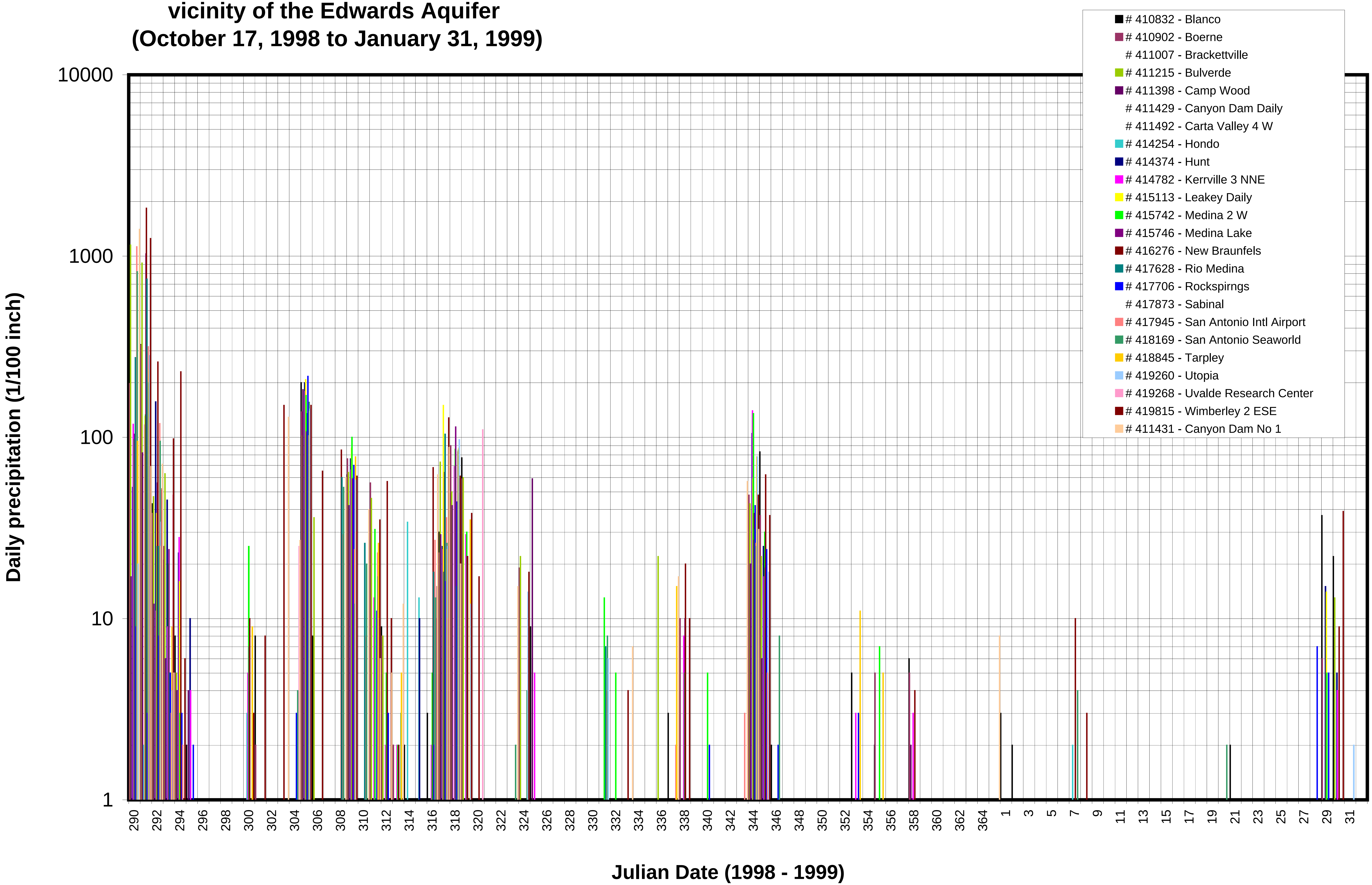


Figure 6. Distribution of rainfall for October 17-19, 1998 in the vicinity of the Edwards Aquifer

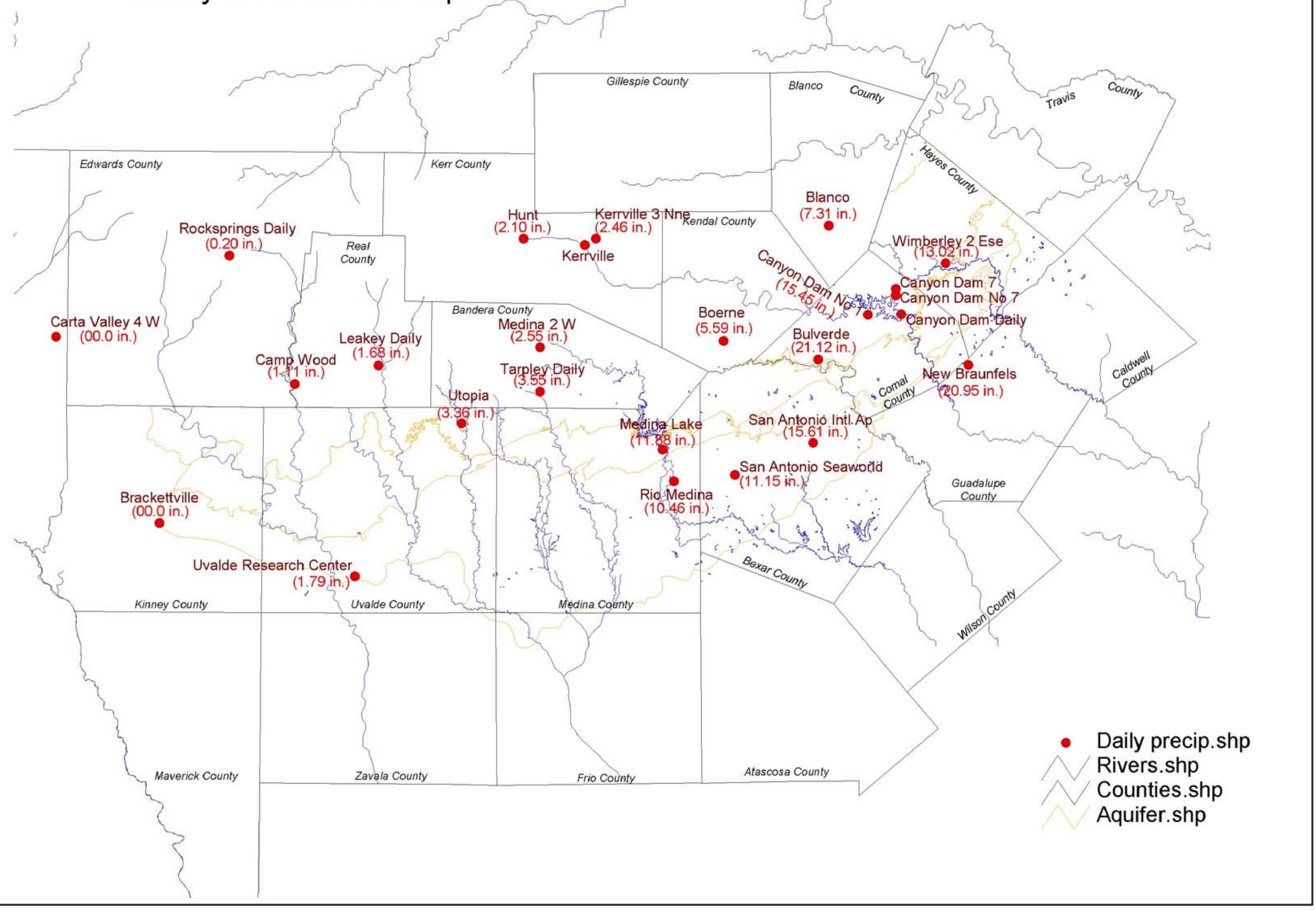


Figure 7. Location of stream gages in the vicinity of the Edwards Aquifer

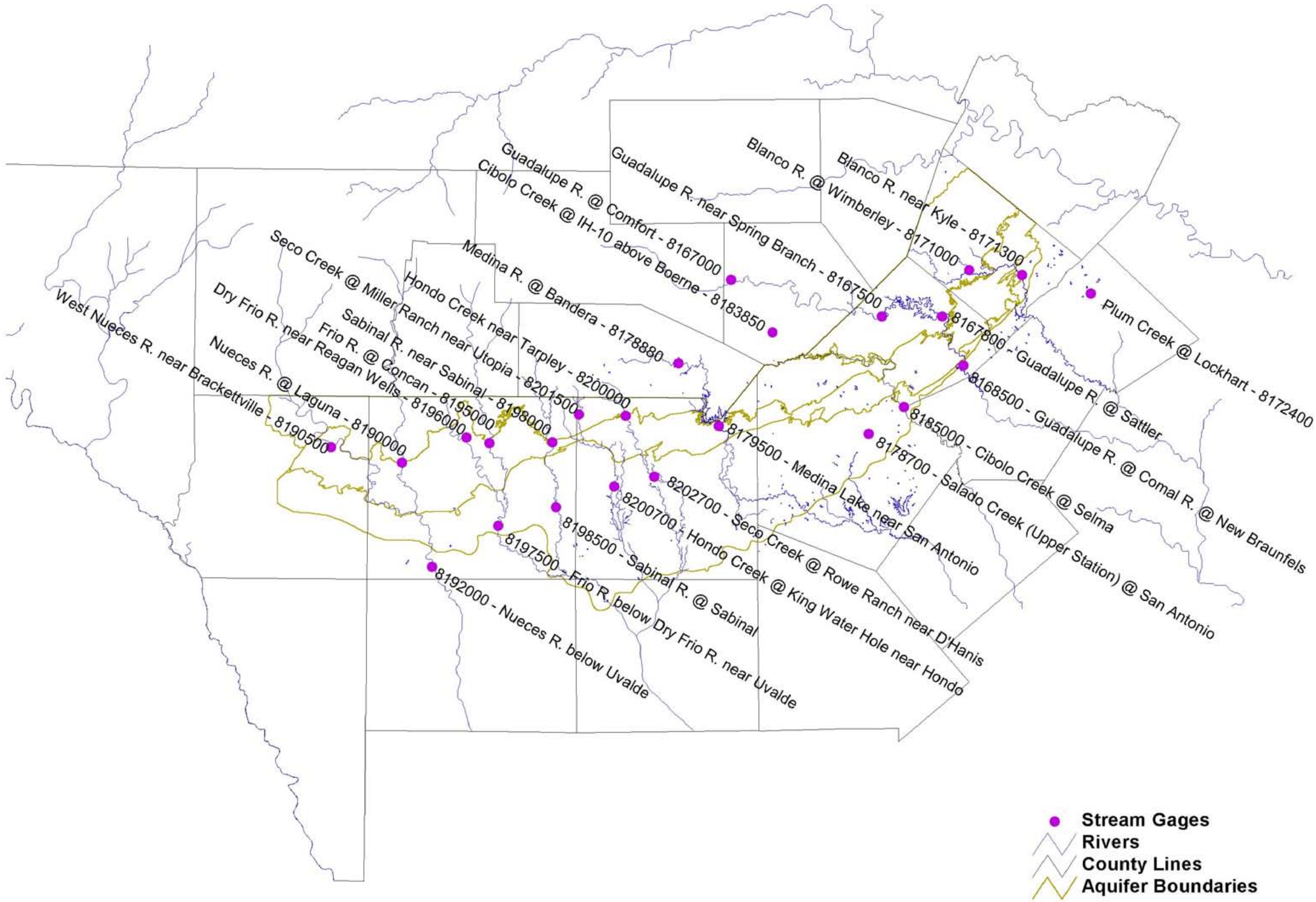


Figure 8. Stream flows in the vicinity of the Edwards Aquifer
(October 15, 1998 to November 15, 1998)

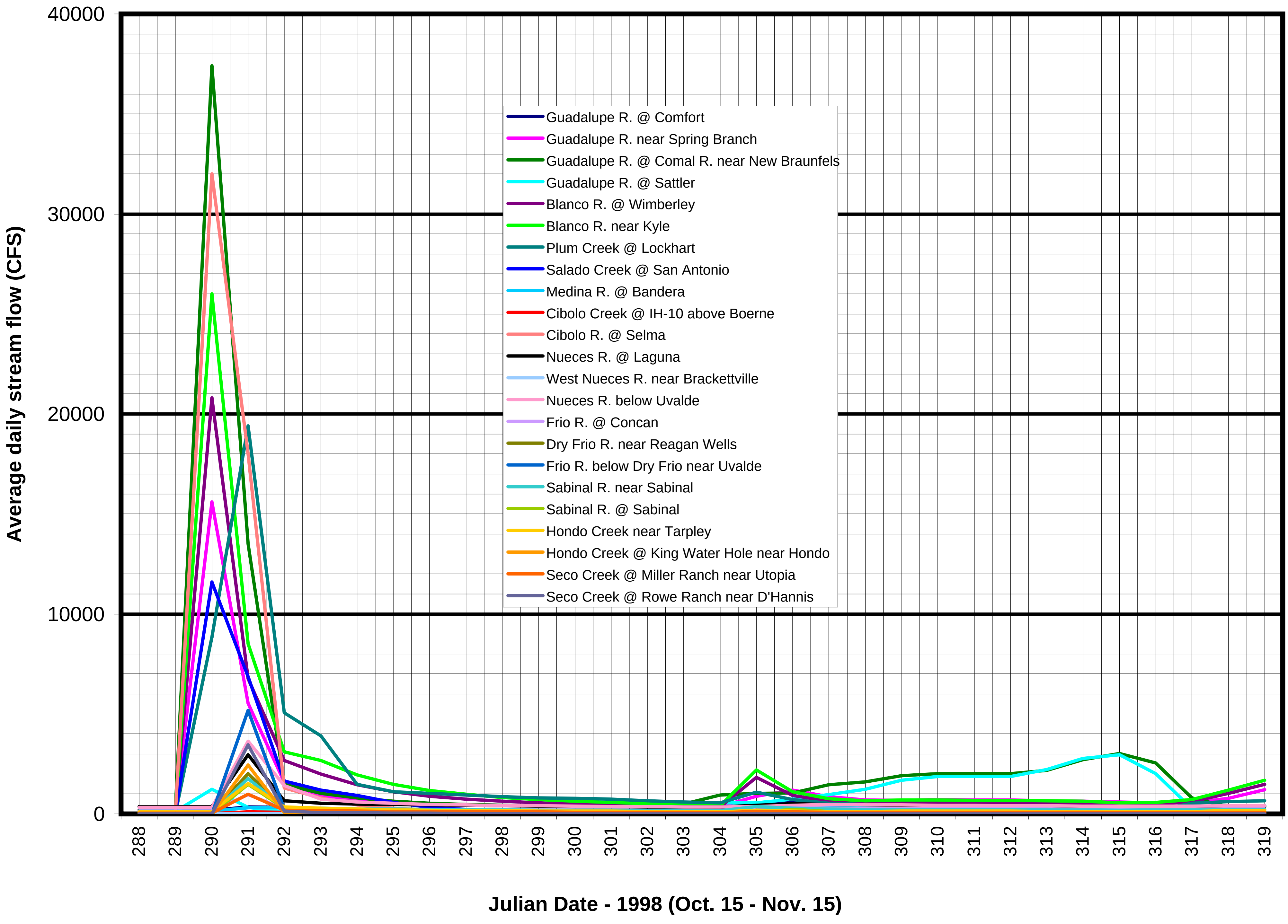


Figure 9. Stream flows in the Guadalupe River from October 15, 1998 to November 15, 1998

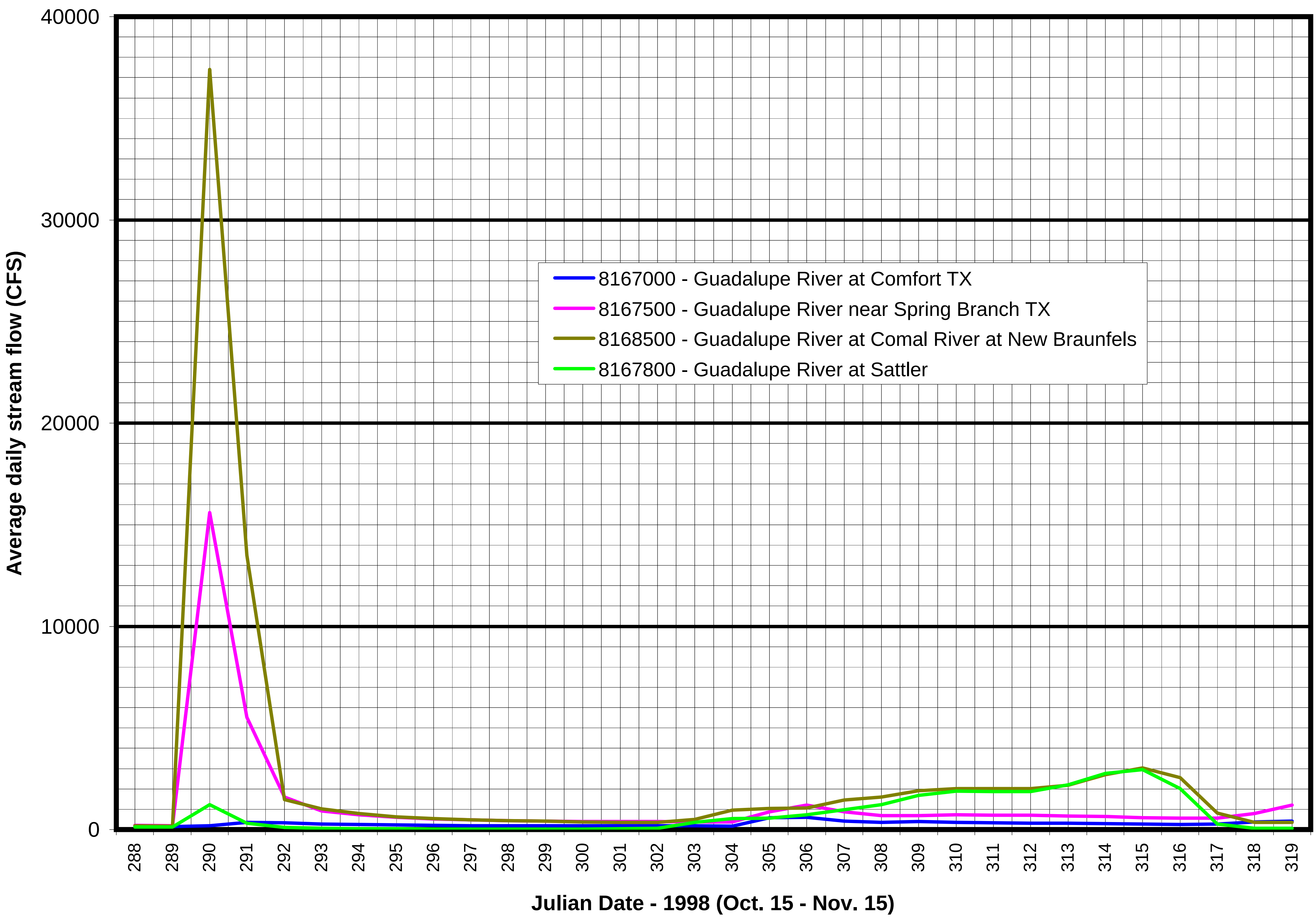


Figure 10. Daily wells in the vicinity of the Edwards Aquifer

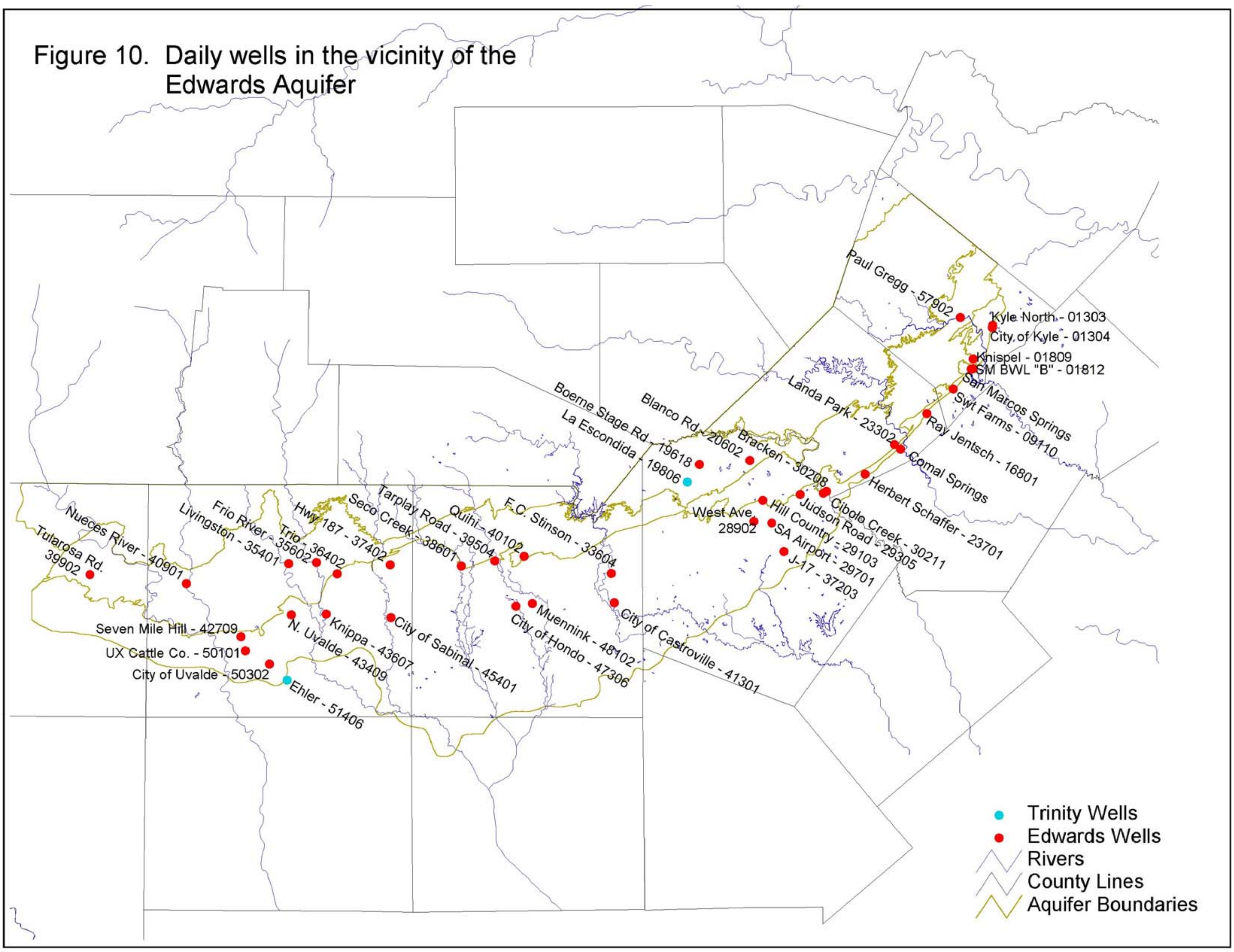


Figure 11. Wells in the vicinity of the Edwards Aquifer that have useful daily data

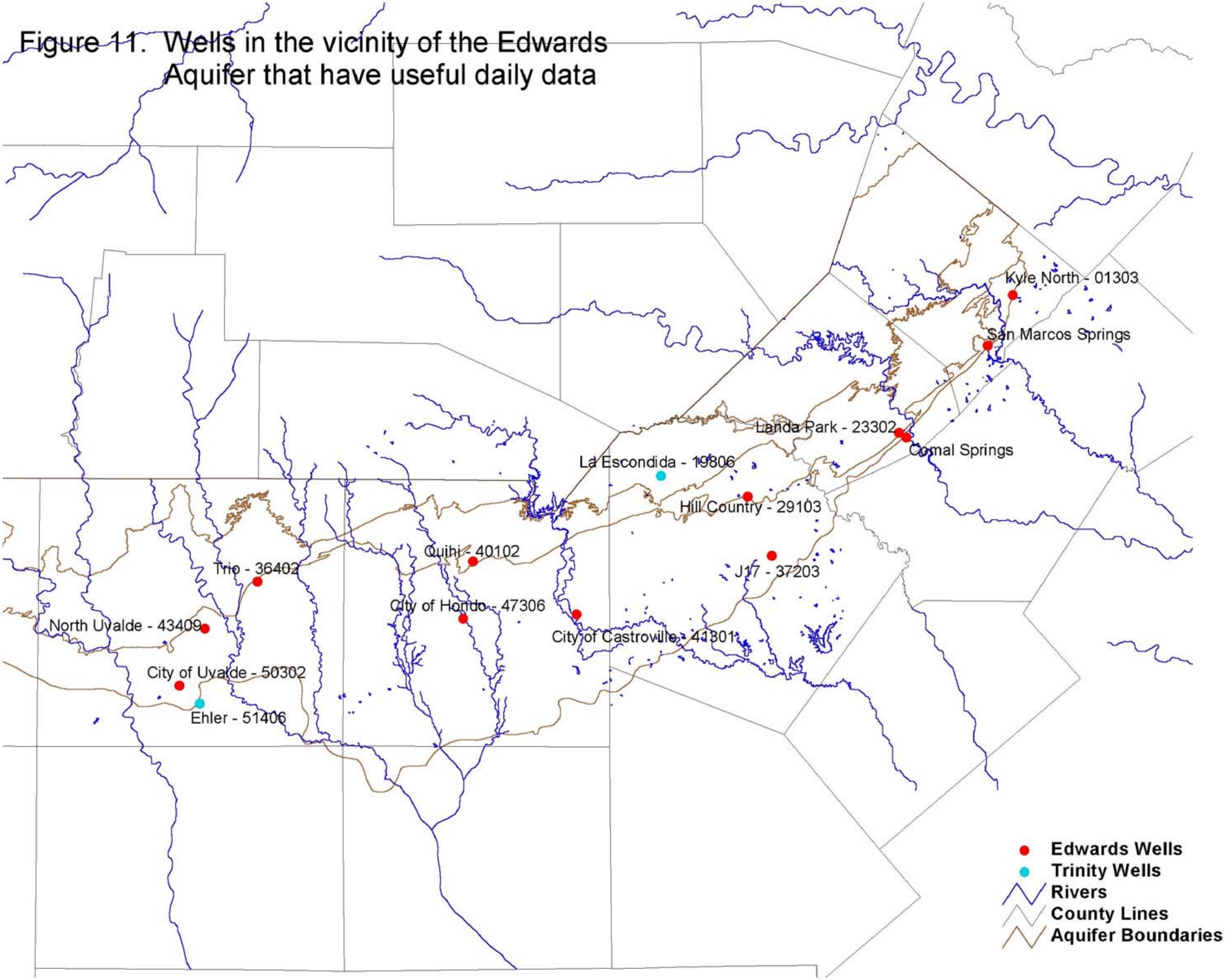


Figure 12. Daily water elevations in monitor wells Kyle North and Landa Park (October 11, 1998 to January 31, 1999)

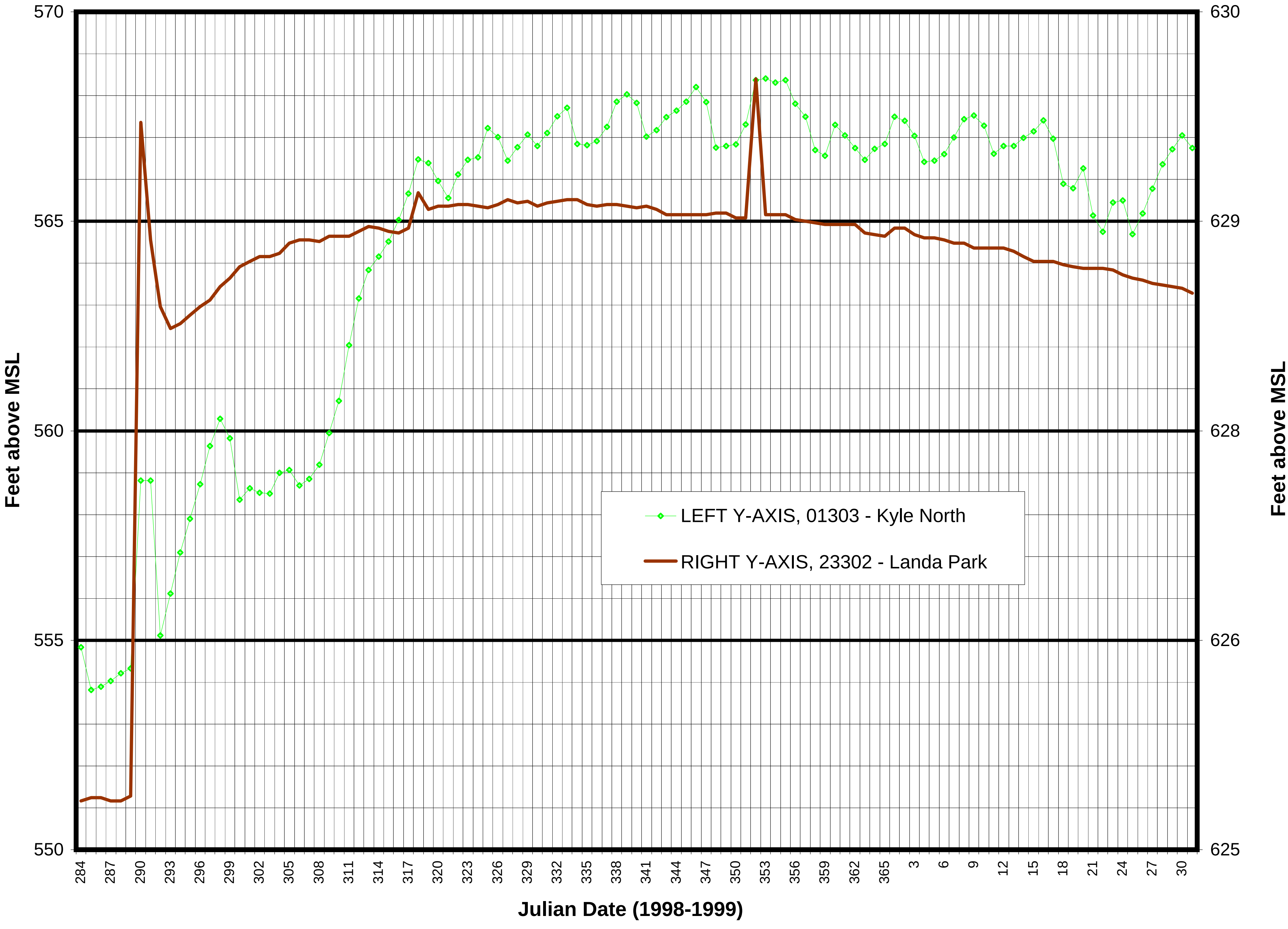


Figure 13. Daily water elevations in monitor wells J-17, Hill Country, City of Hondo, and City of Castroville (October 11, 1998 to January 31, 1999)

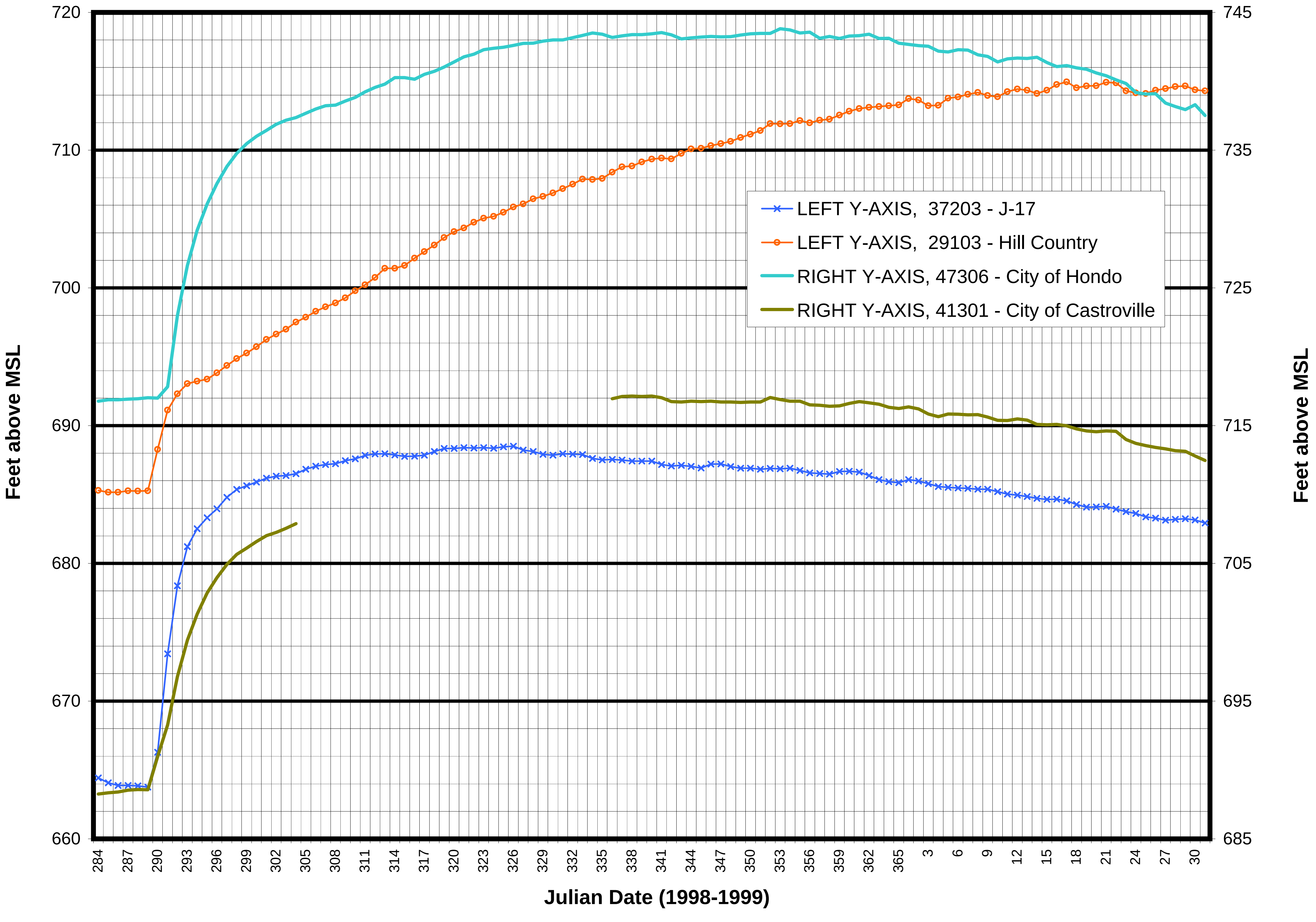


Figure 14. Daily water elevations in monitor well La Escondida (October 11, 1998 to January 31, 1999)

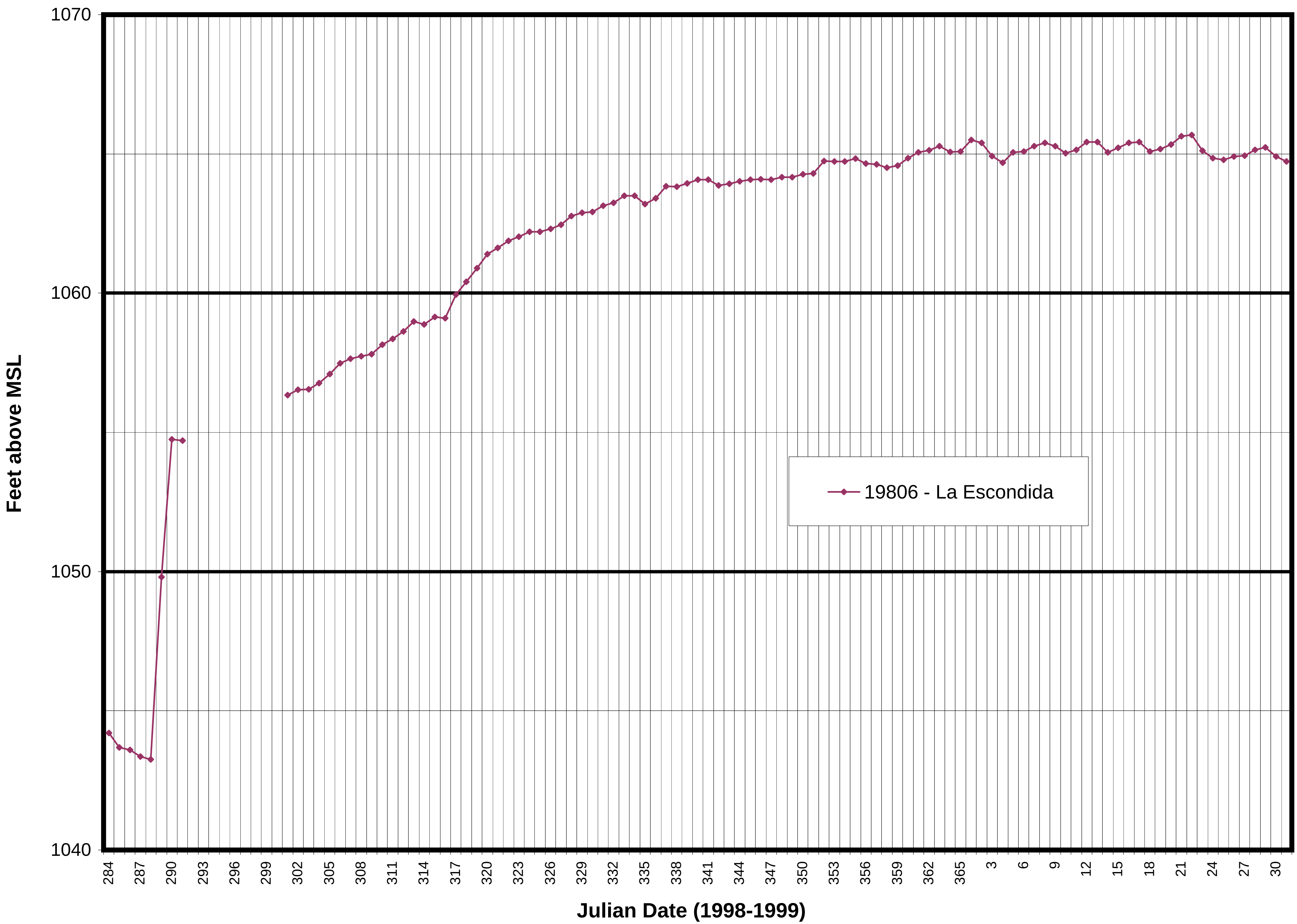


Figure 15. Daily water elevations in monitor wells City of Sabinal, Knippa, and Trio (October 11, 1998 to January 31, 1999)

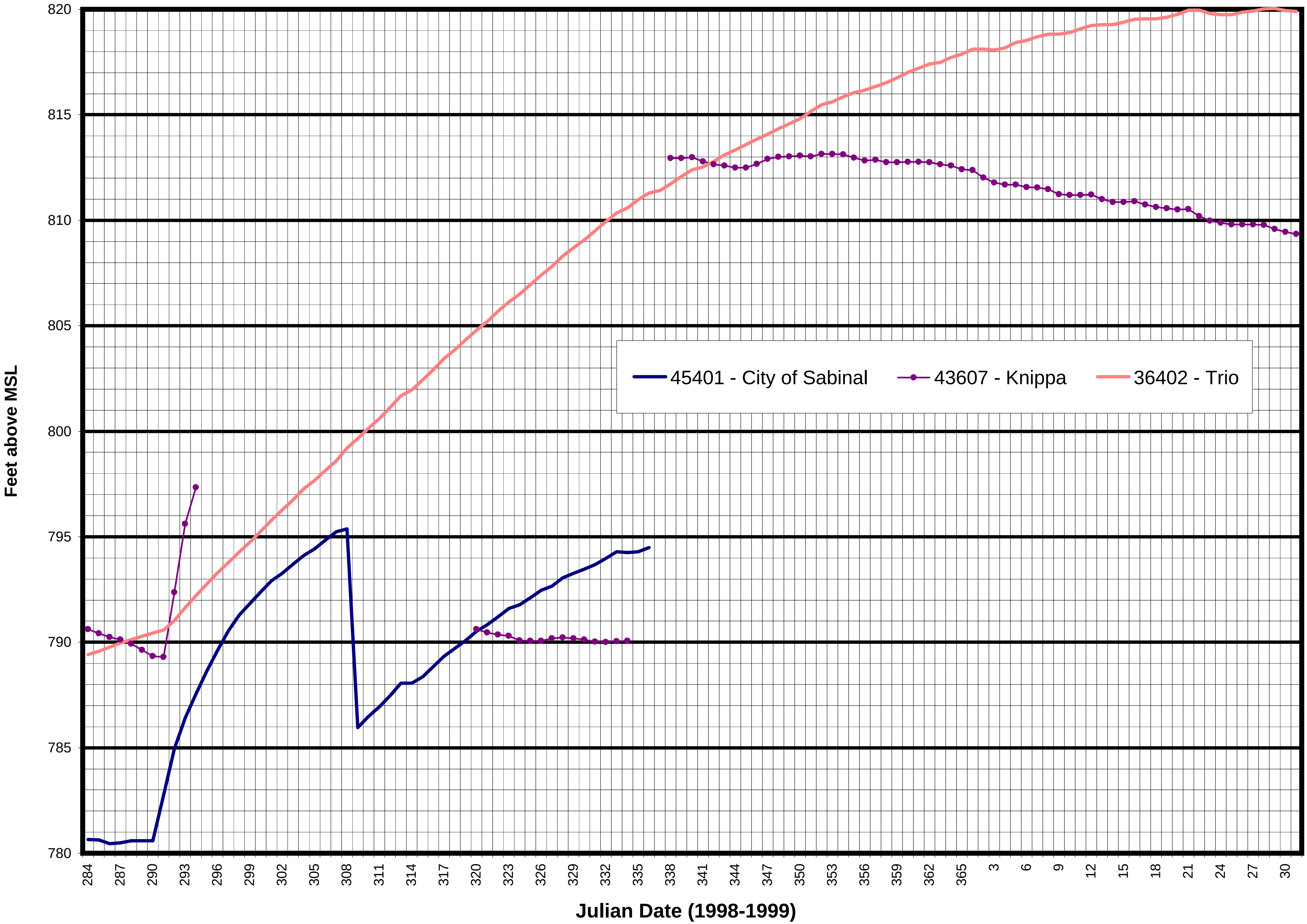


Figure 16. Daily water elevations in monitor wells Ehler and Quihi (October 11, 1998 to January 31, 1999)

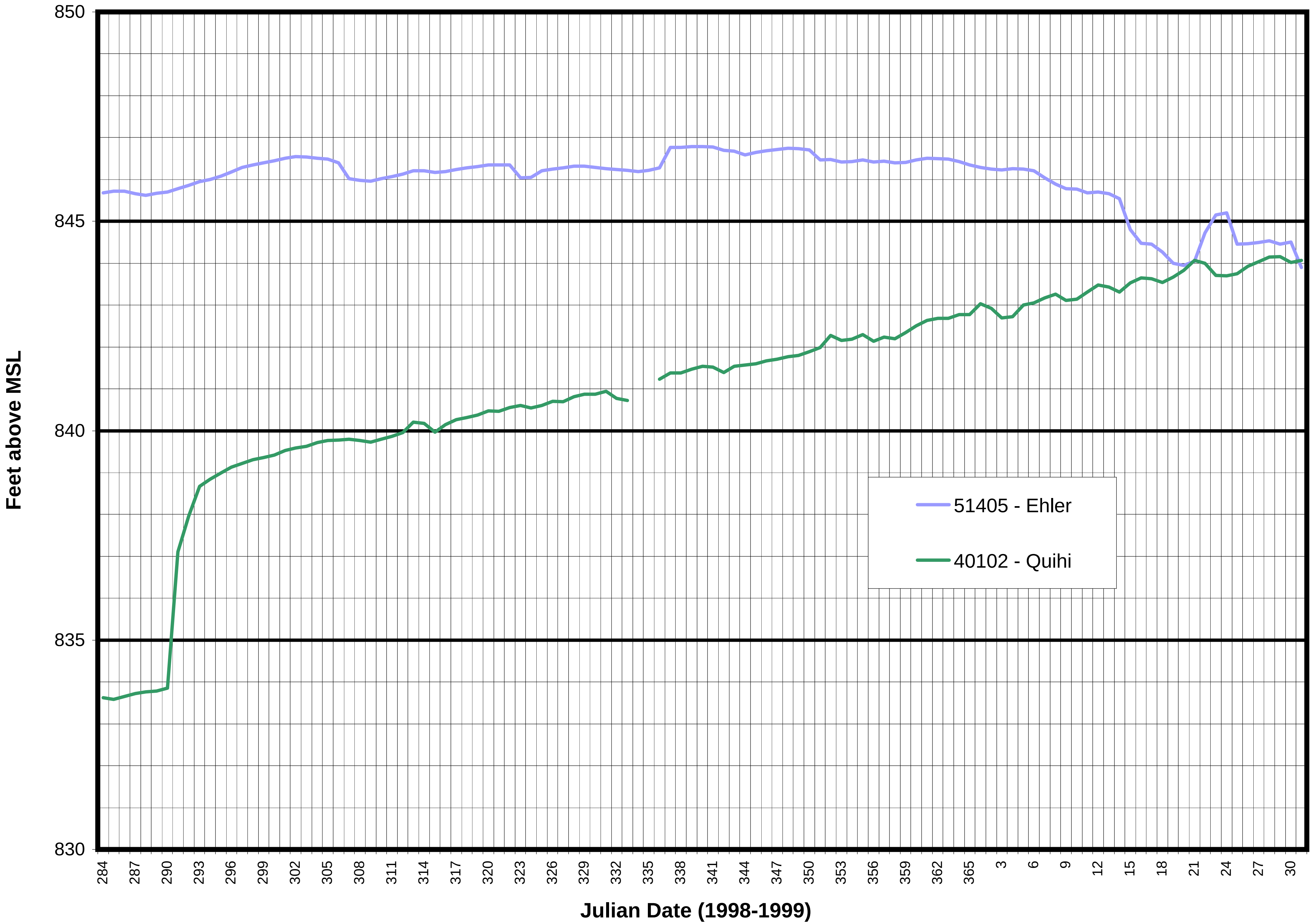


Figure 17. Daily water elevations in monitor wells City of Uvalde and North Uvalde (October 11, 1998 to January 31, 1999)

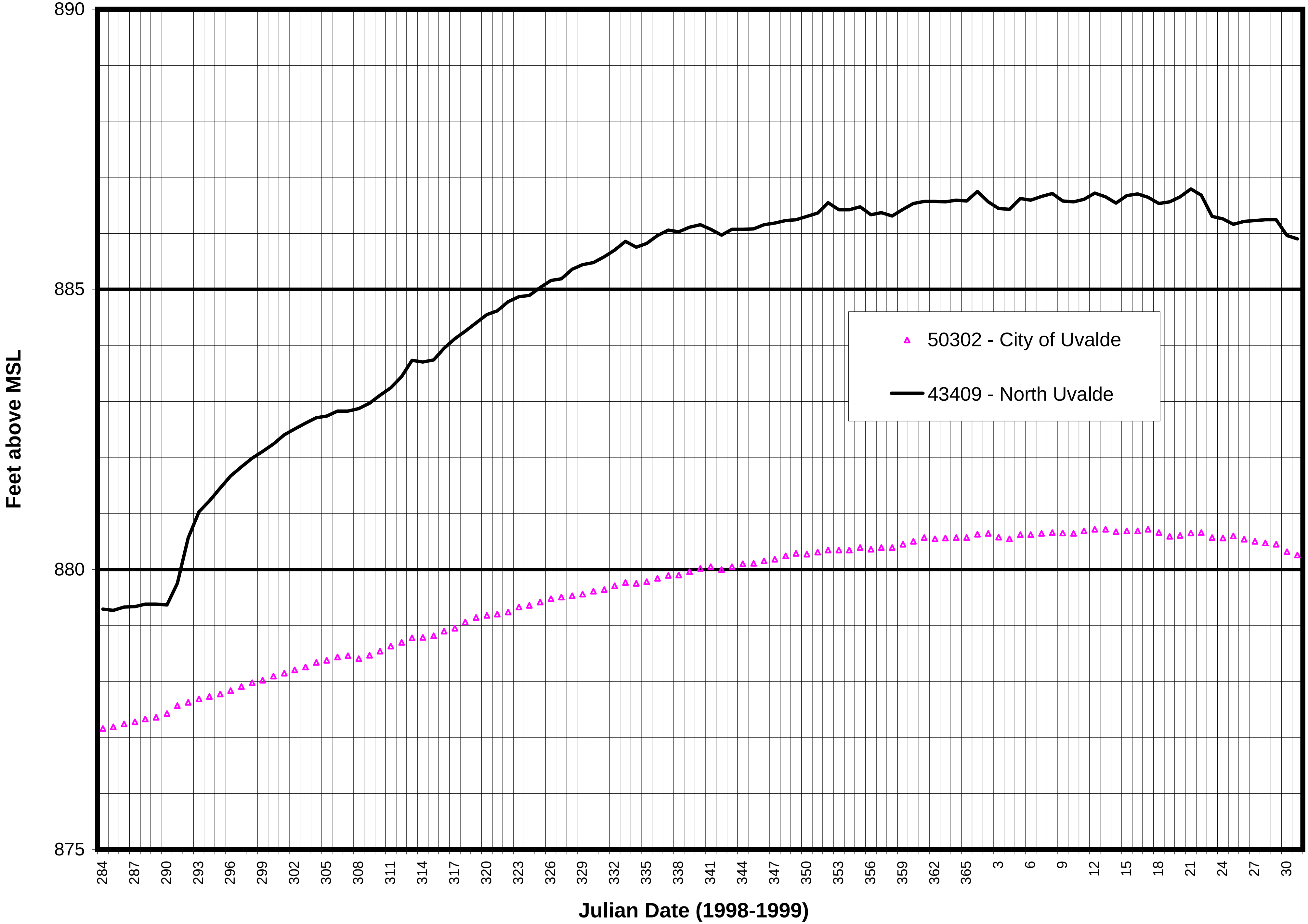


Figure 18. Daily water elevations in all monitor wells after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

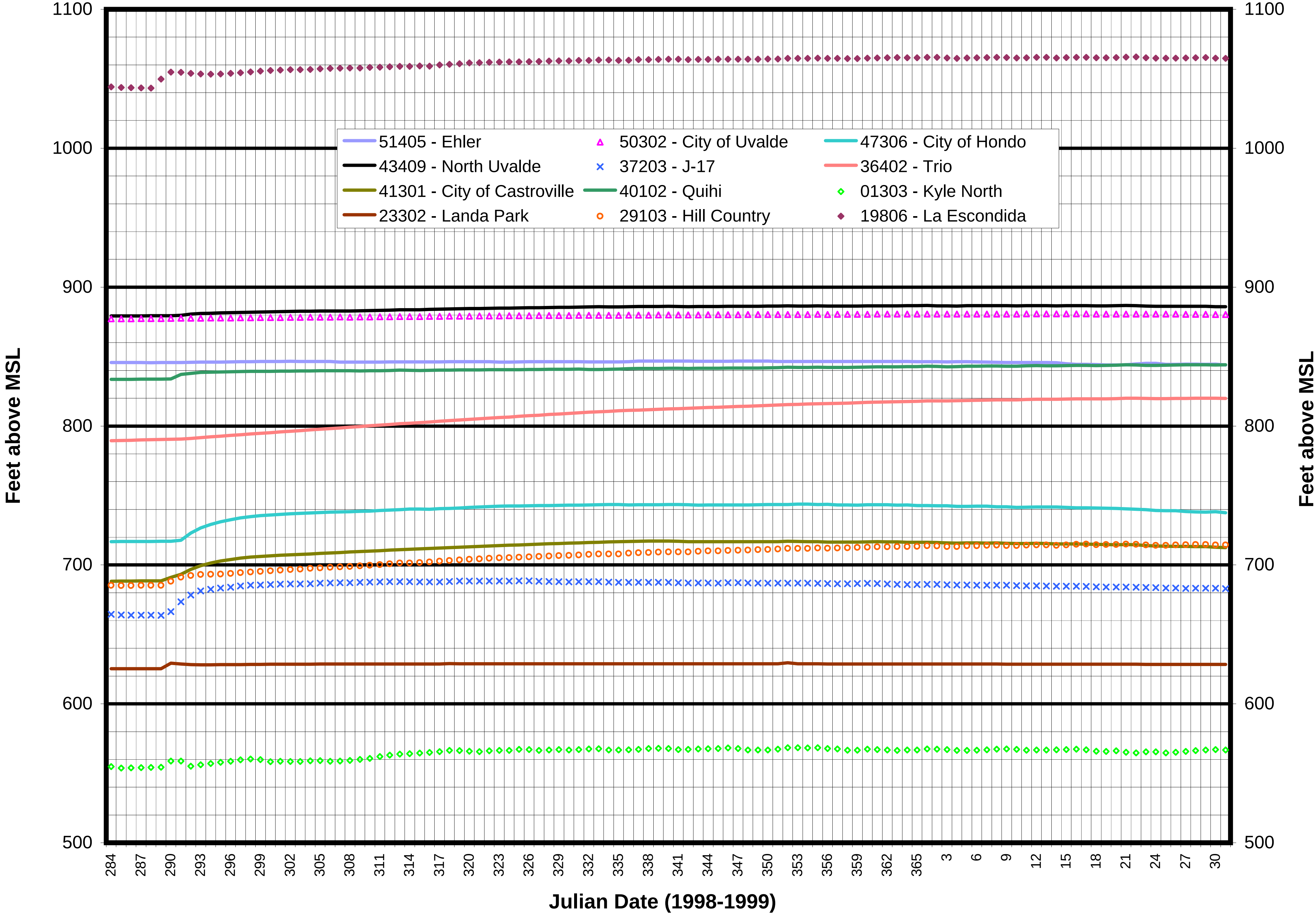


Figure 19. Daily water elevations in monitor wells Kyle North and Landa Park after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

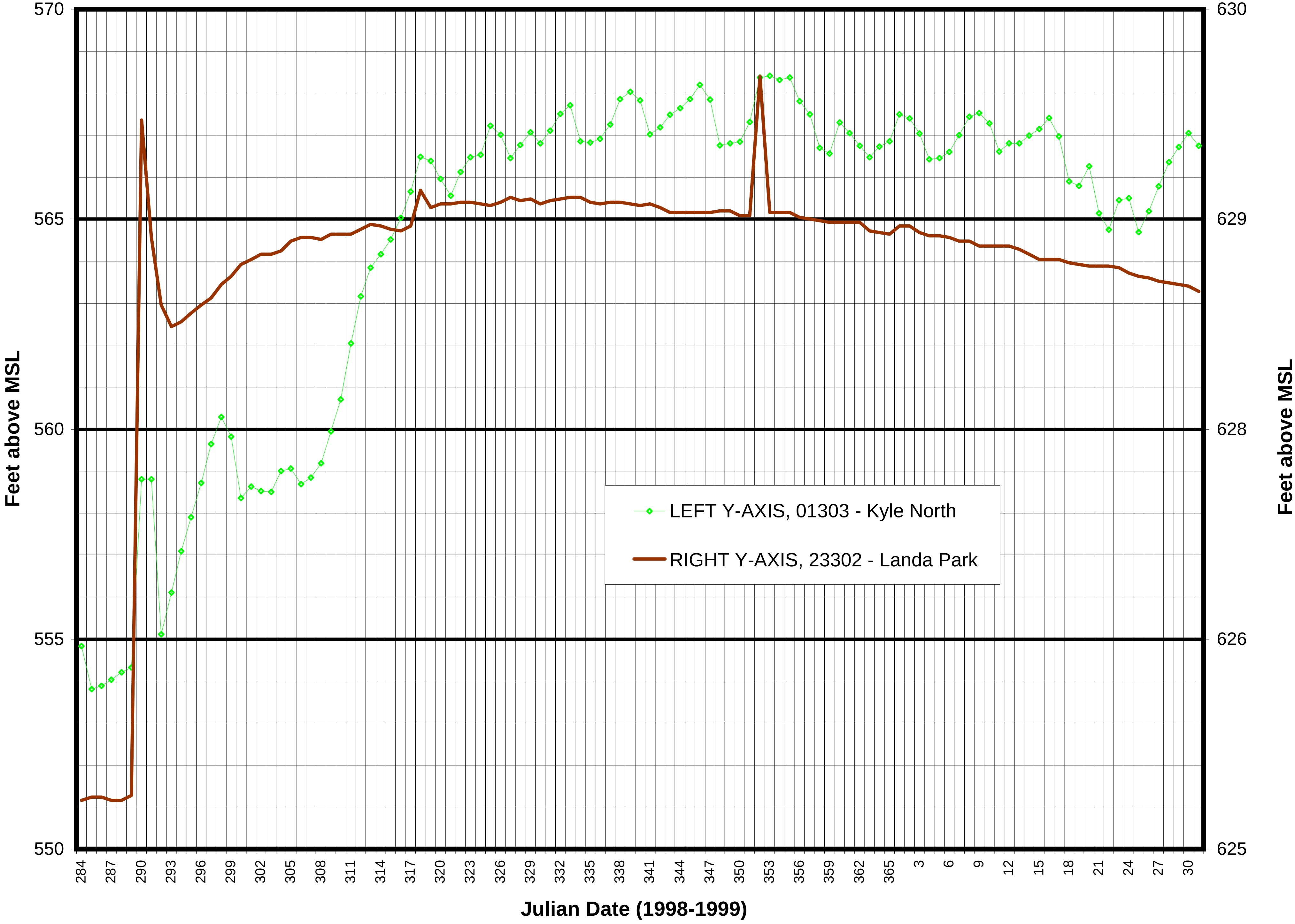


Figure 20. Daily water elevations in monitor wells J-17, Hill Country, City of Hondo, and City of Castroville after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

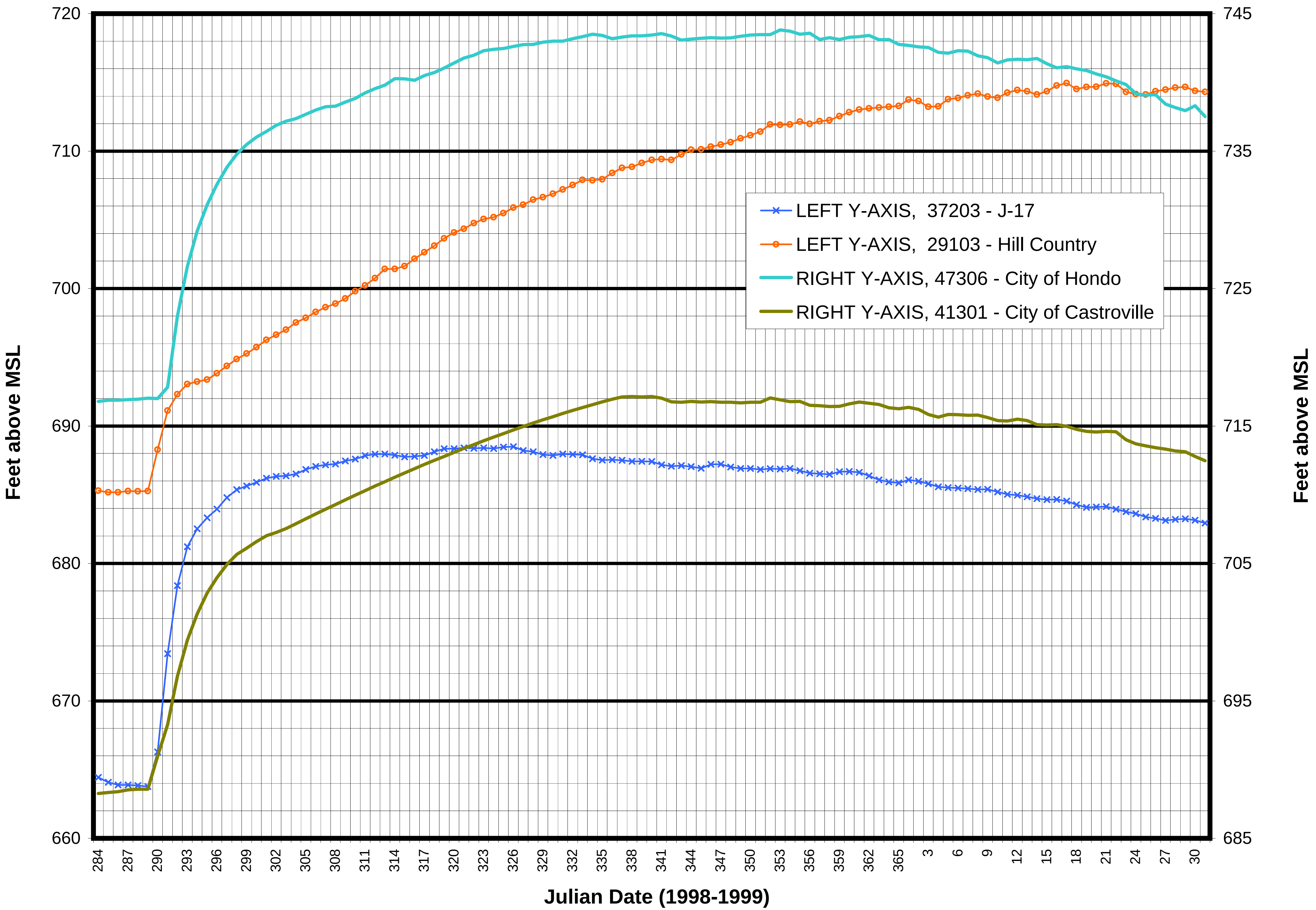


Figure 21. Daily water elevations in monitor well La Escondida after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

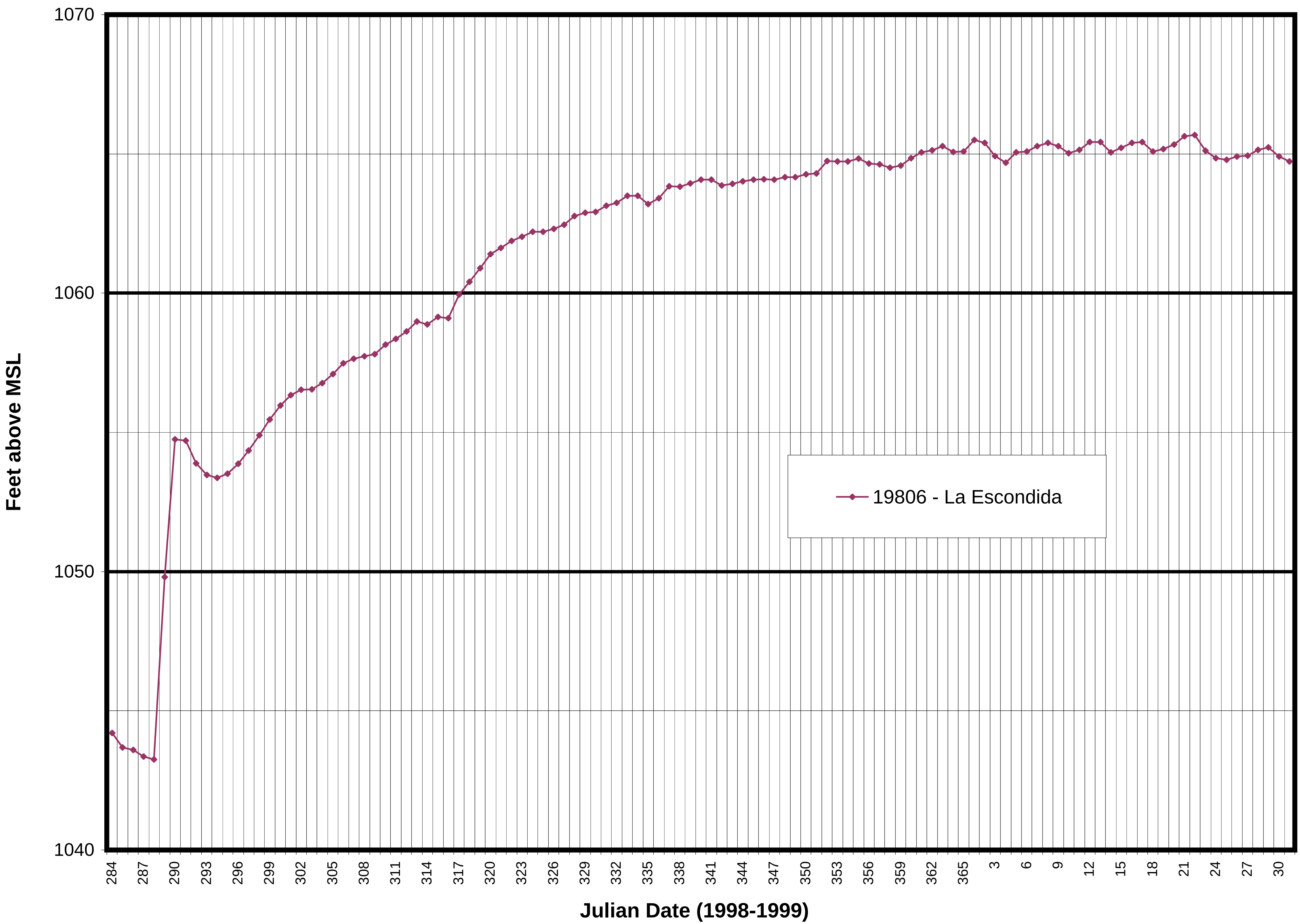


Figure 22. Daily water elevations in monitor wells City of Sabinal, Knippa, and Trio after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

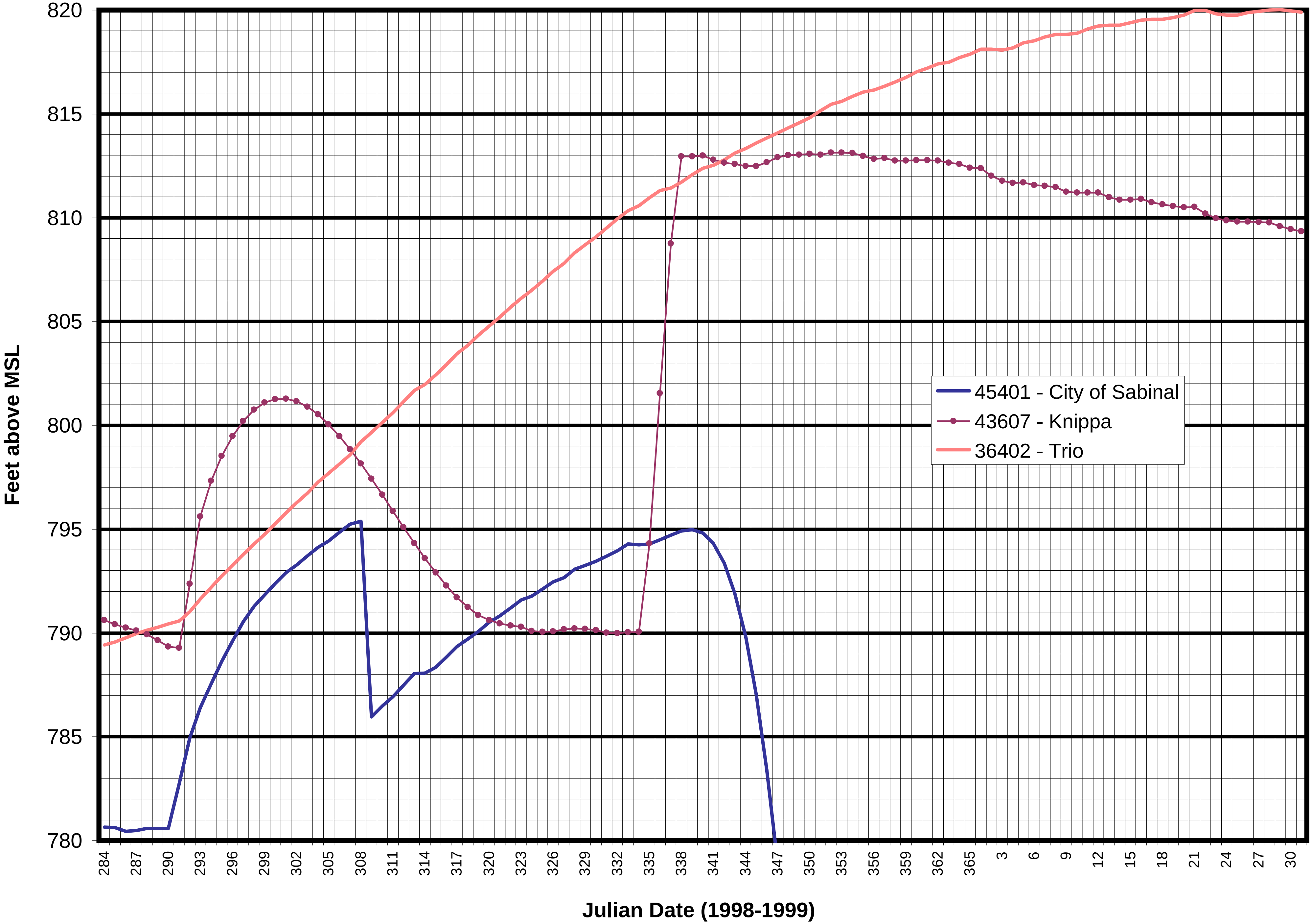


Figure 23. Daily water elevations in monitor wells Ehler and Quihi after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

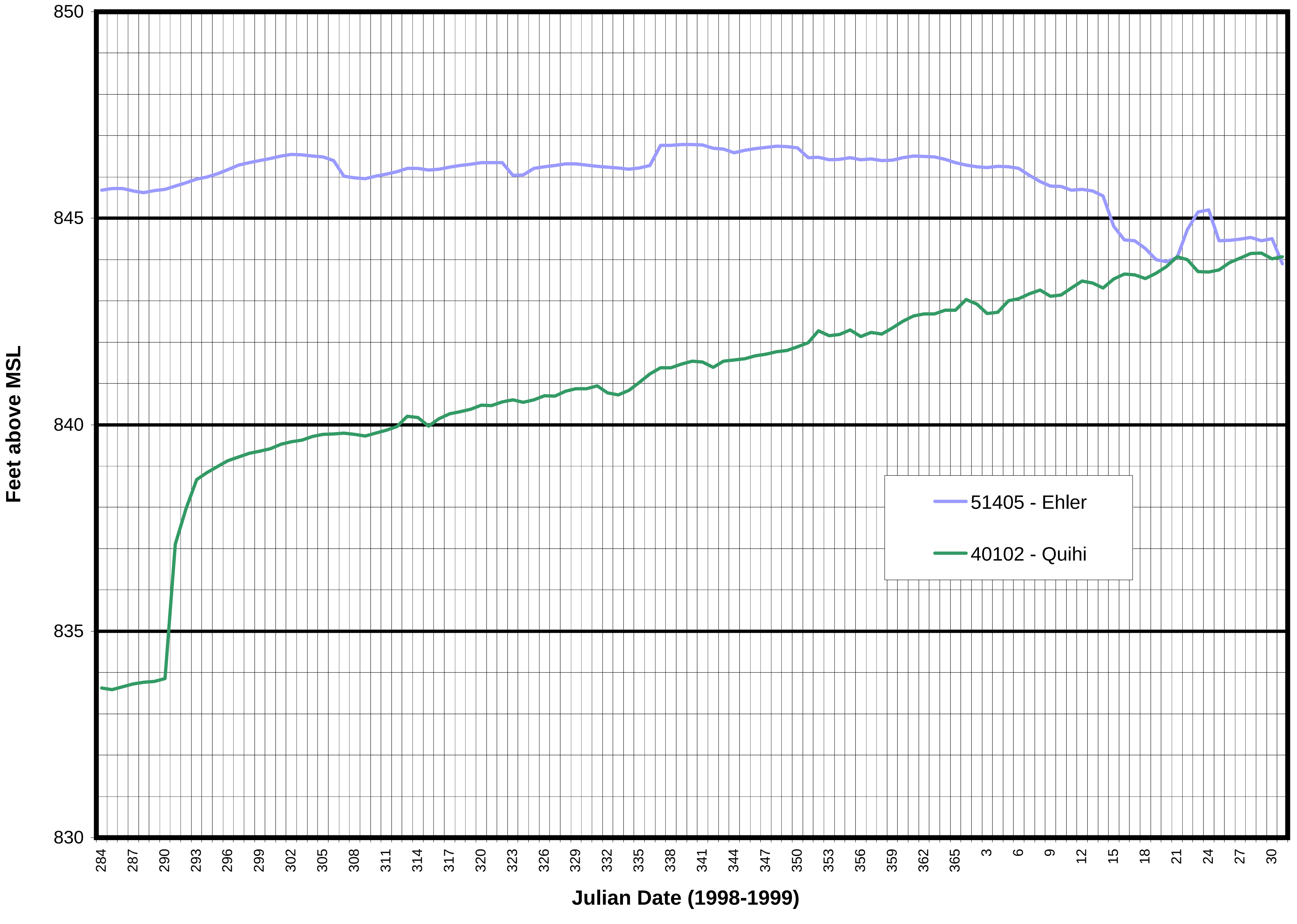


Figure 24. Daily water elevations in monitor wells City of Uvalde and North Uvalde after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

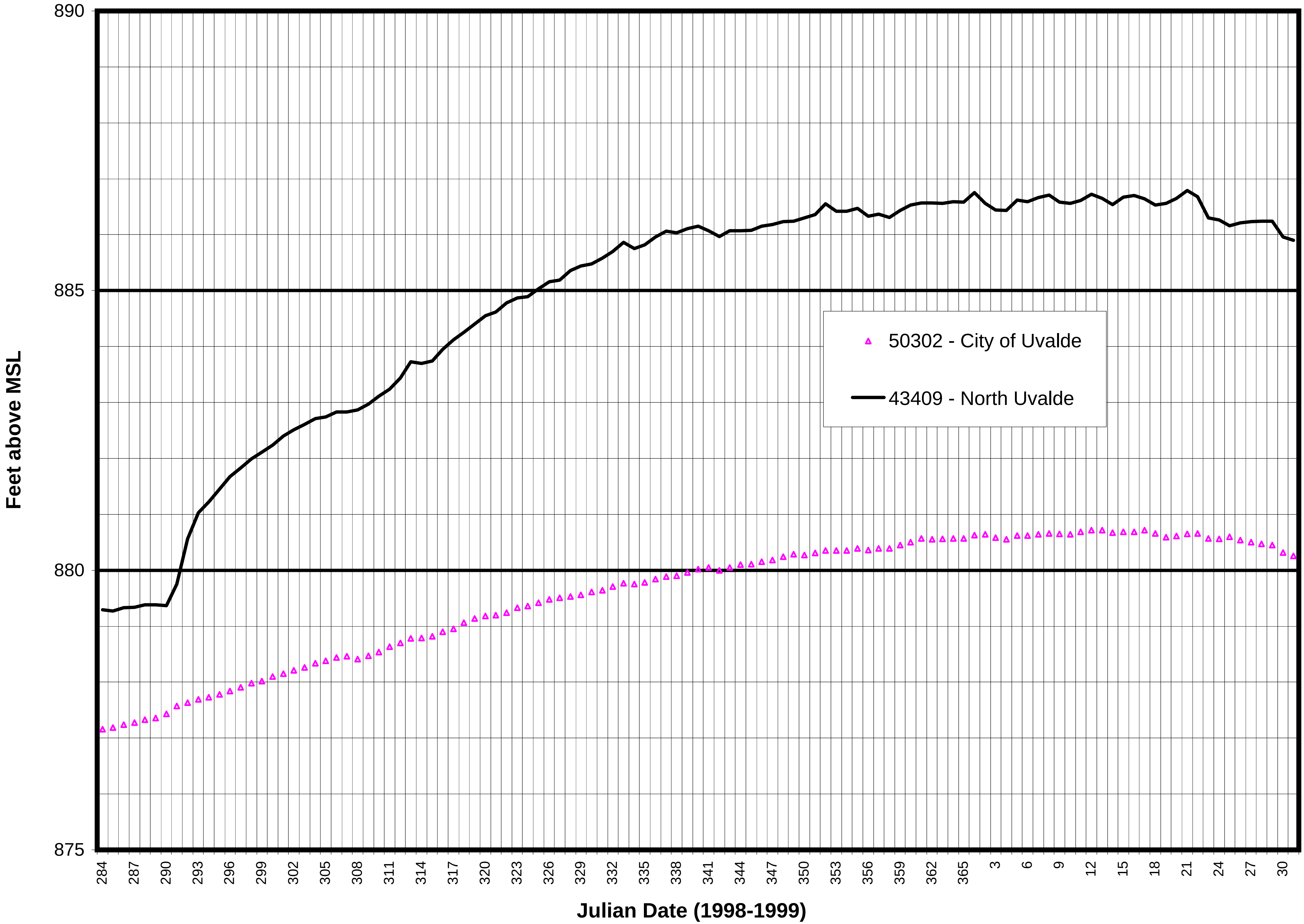


Figure 25. USGS measured discharges (January 1, 1998 through December 31, 1999) from Comal and San Marcos Springs

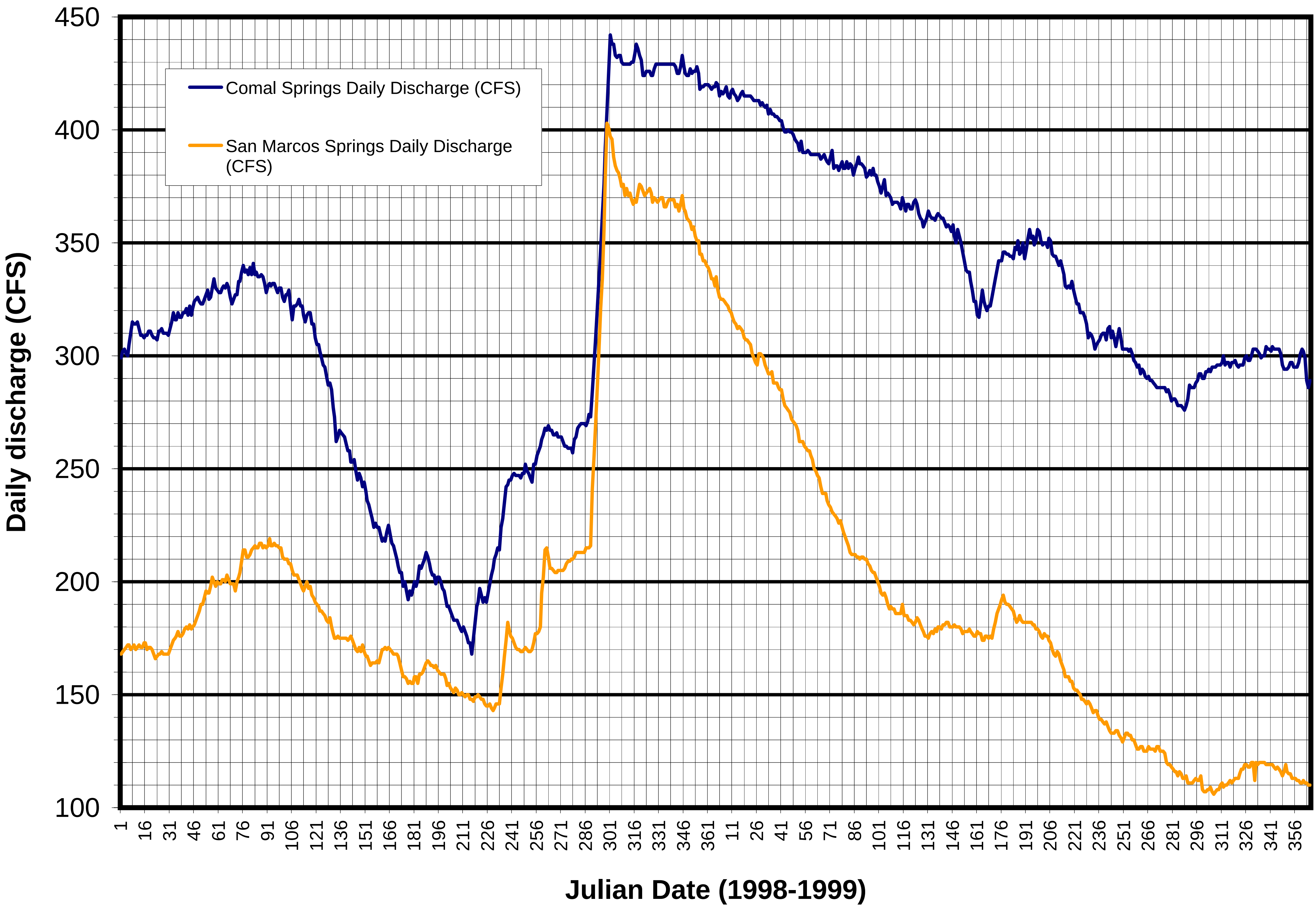


Figure 26. Preciptation in five stations in the vicinity of San Marcos Springs (October 17, 1998 to January 31, 1999)

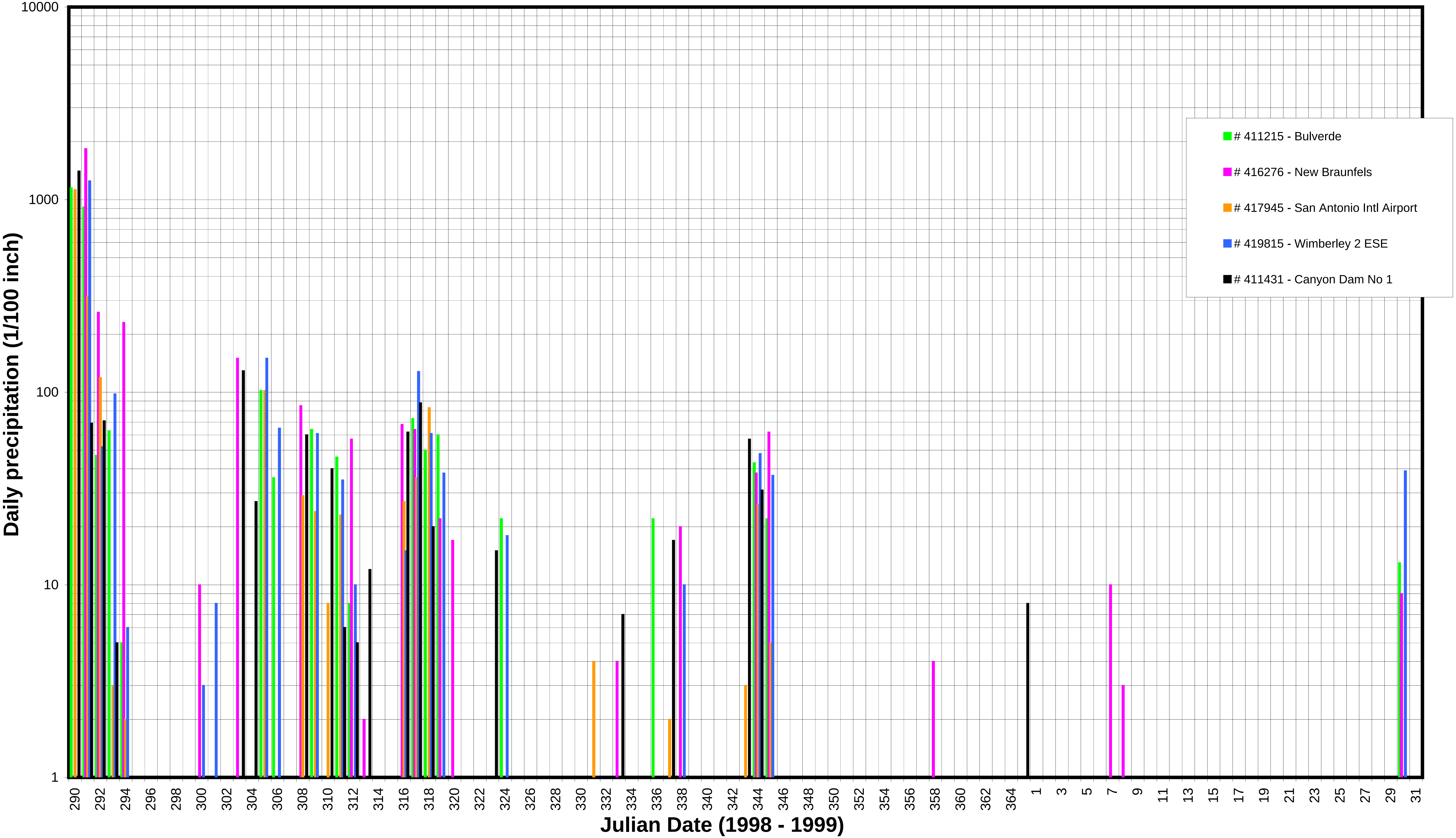


Figure 27. Responses of Comal Springs, San Marcos Springs, J-17, and the Hondo index well to the October 1998 precipitation event

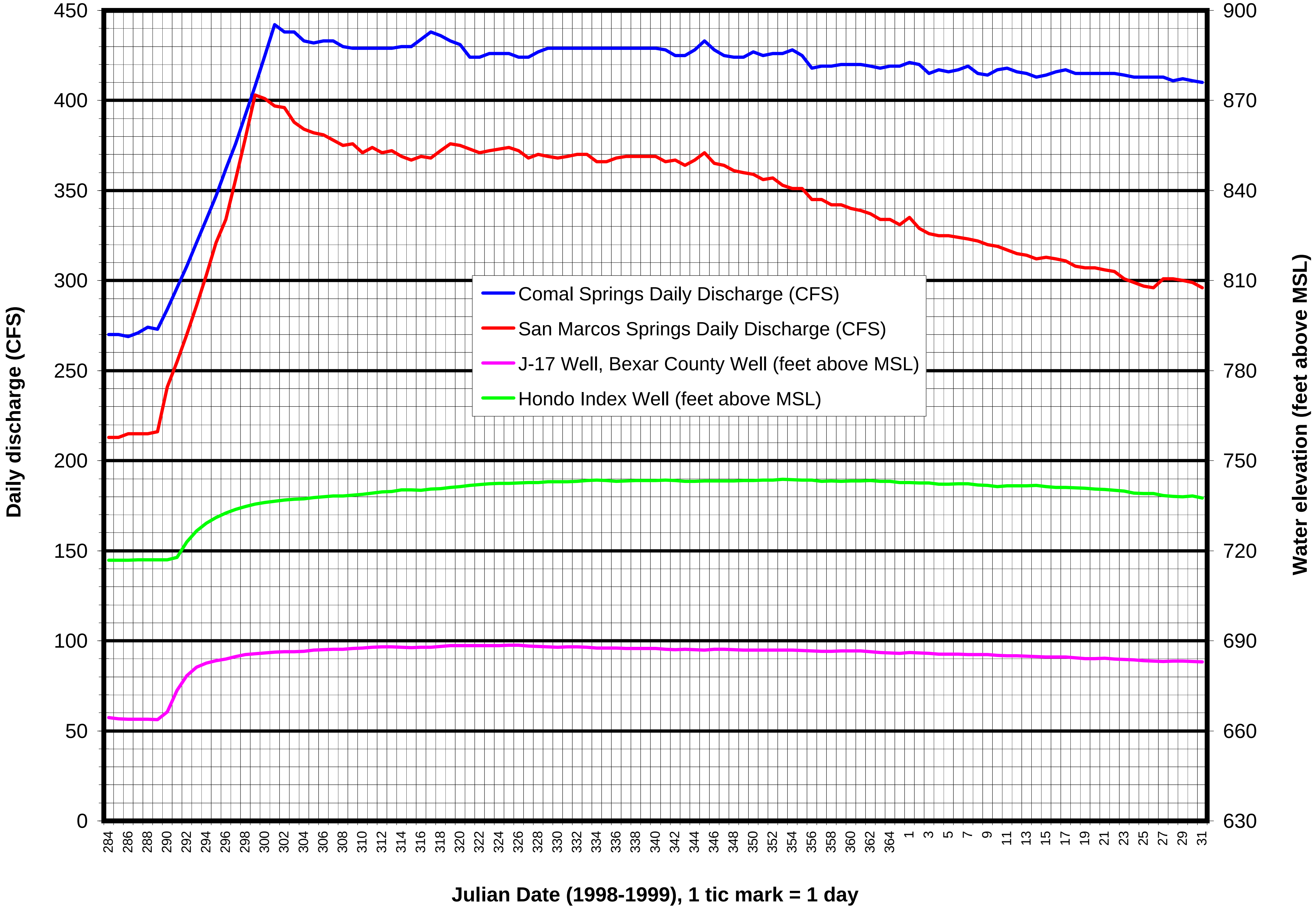


Figure 28. Responses of Comal Springs, San Marcos Springs, J-17, City of Hondo Well, and precipitation stations near San Marcos Springs to the October 1998 precipitation event

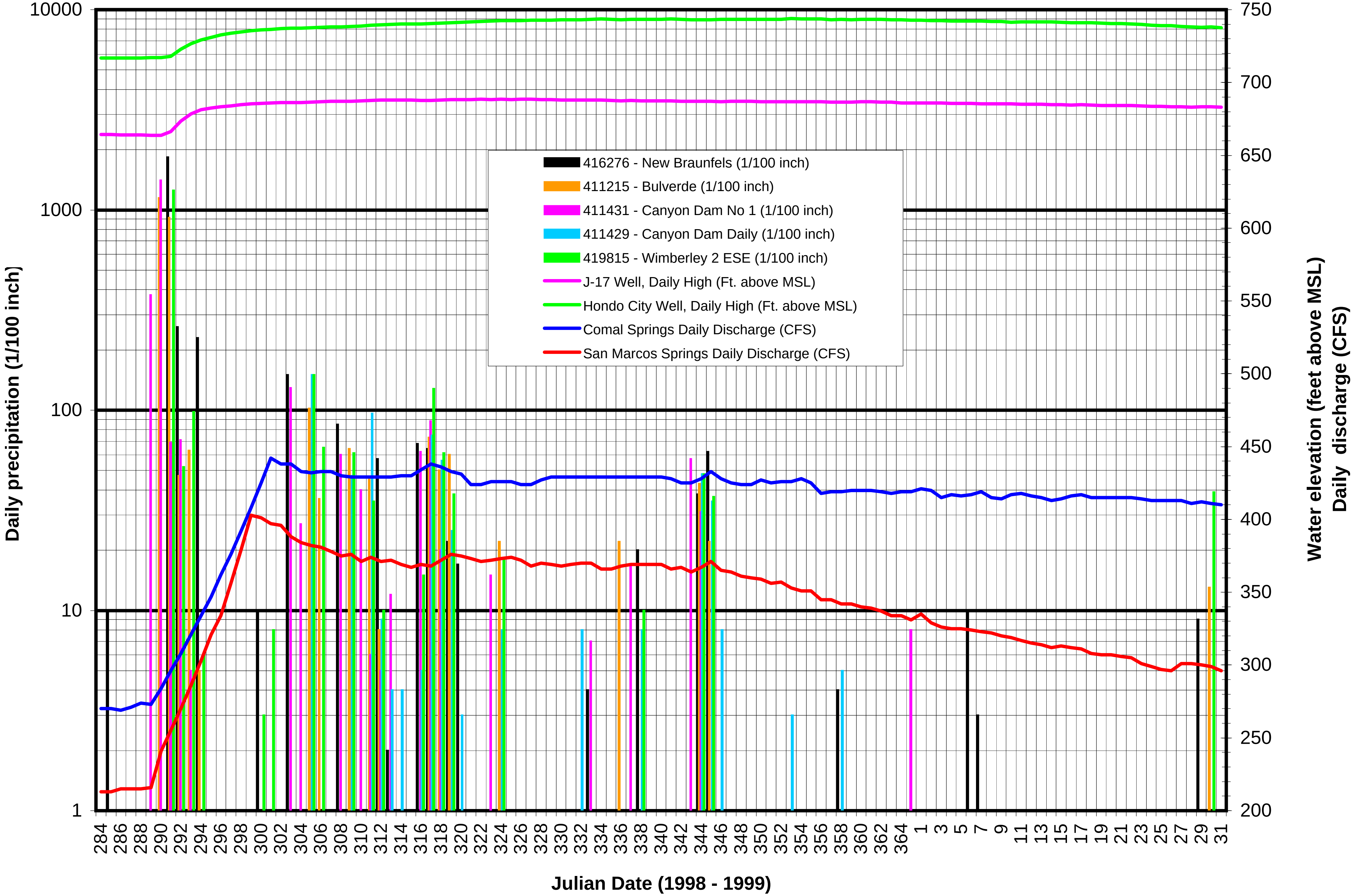


Figure 29. Correlagram of the cross-corrolation between discharges at Comal and San Marcos Springs as a function of lag time

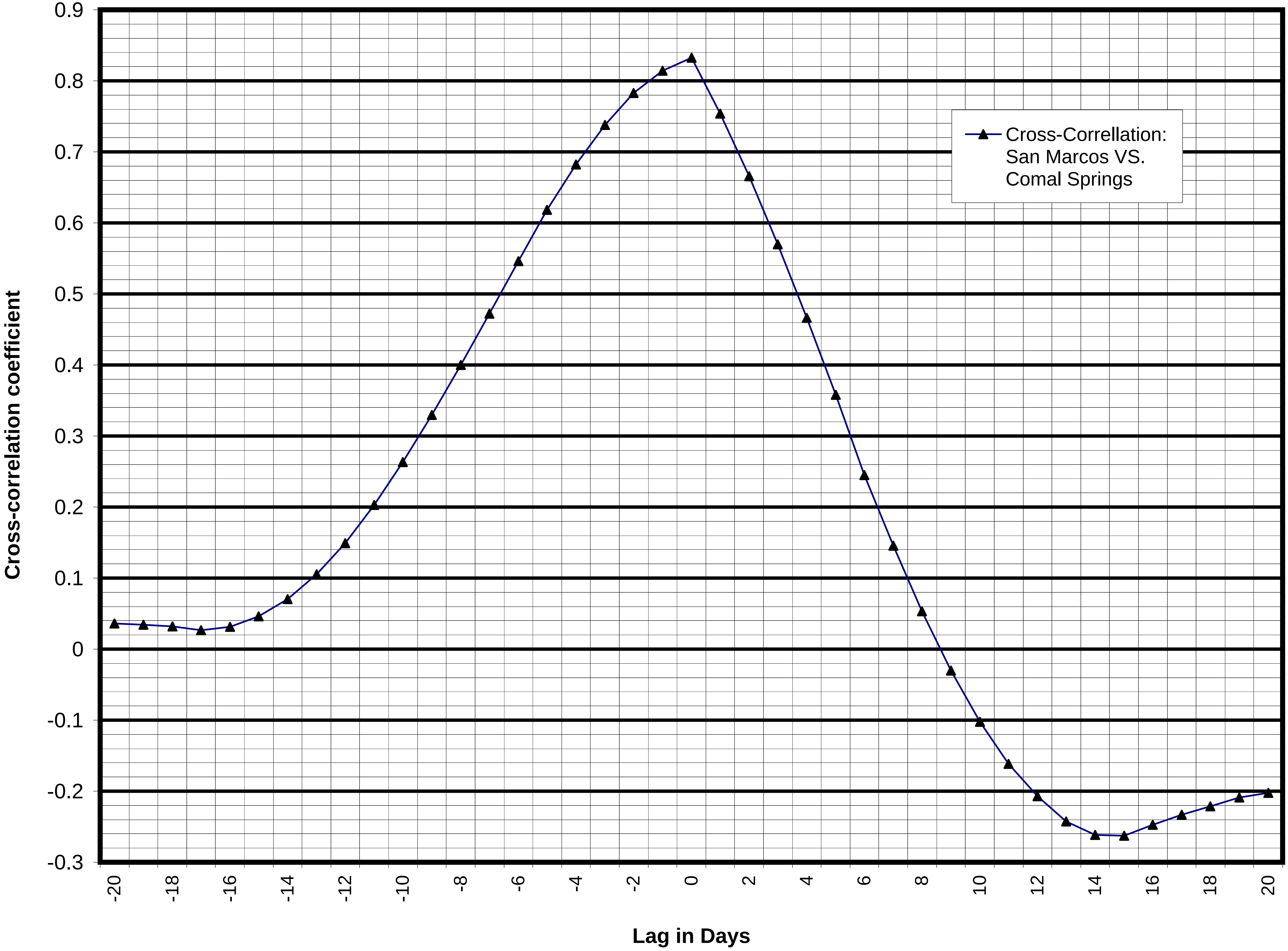


Figure 30. A comparison of measured flows in Comal and San Marcos Springs after using a three-day moving average filter

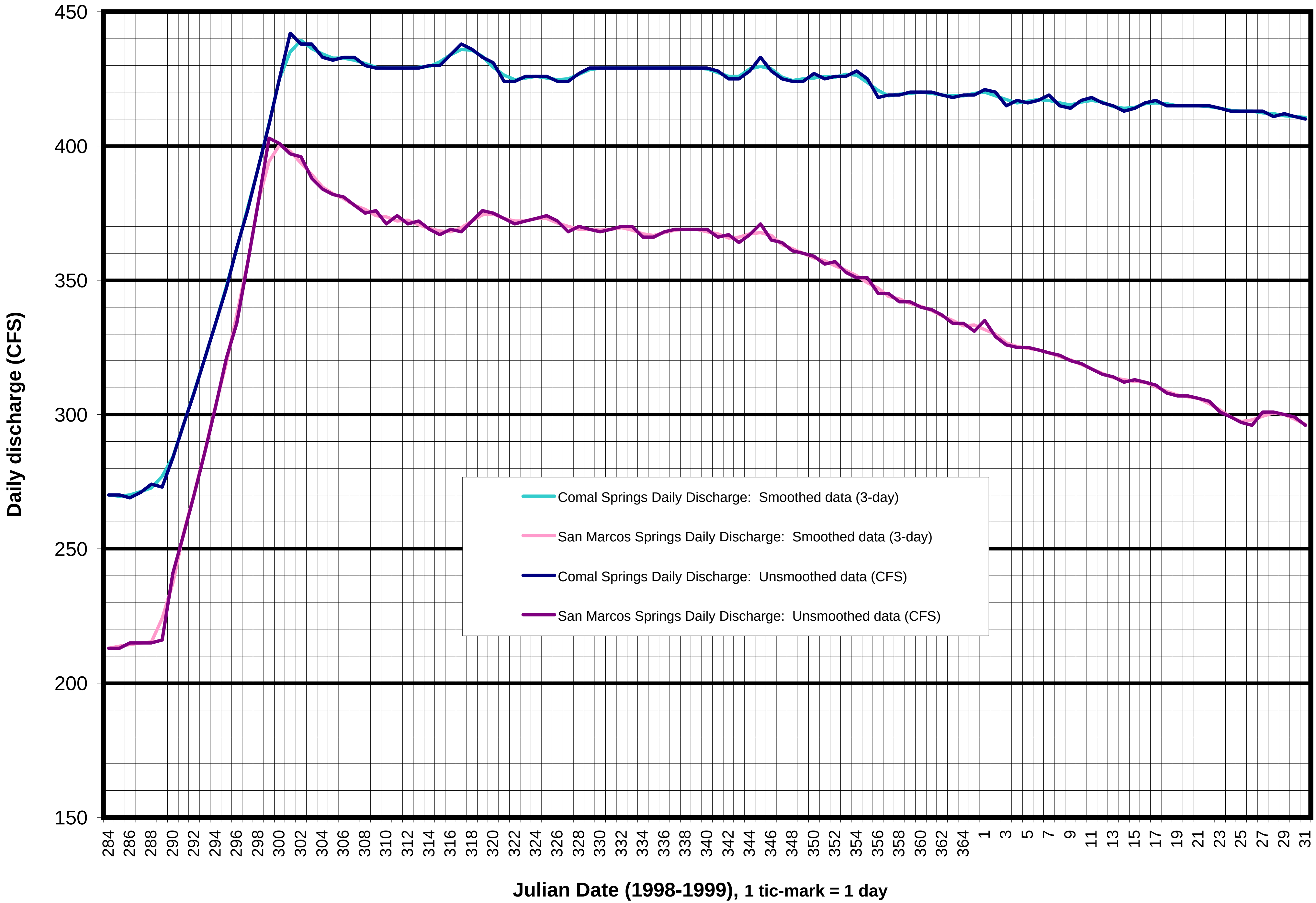


Figure 31. A comparison of measured flows in Comal and San Marcos Springs after using a five-day moving average filter

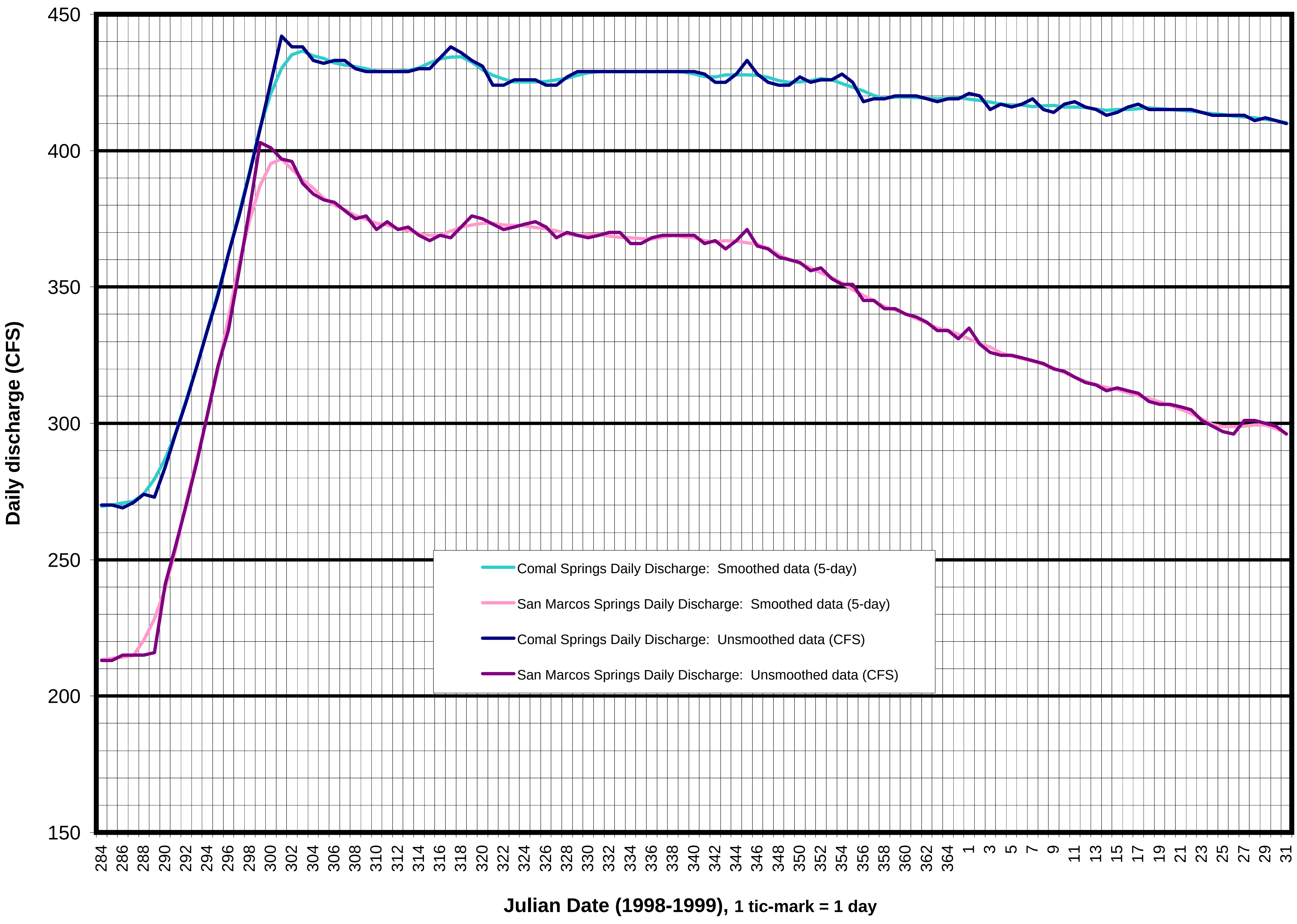


Figure 32. A comparison of measured flows in Comal and San Marcos Springs after using a seven-day moving average filter

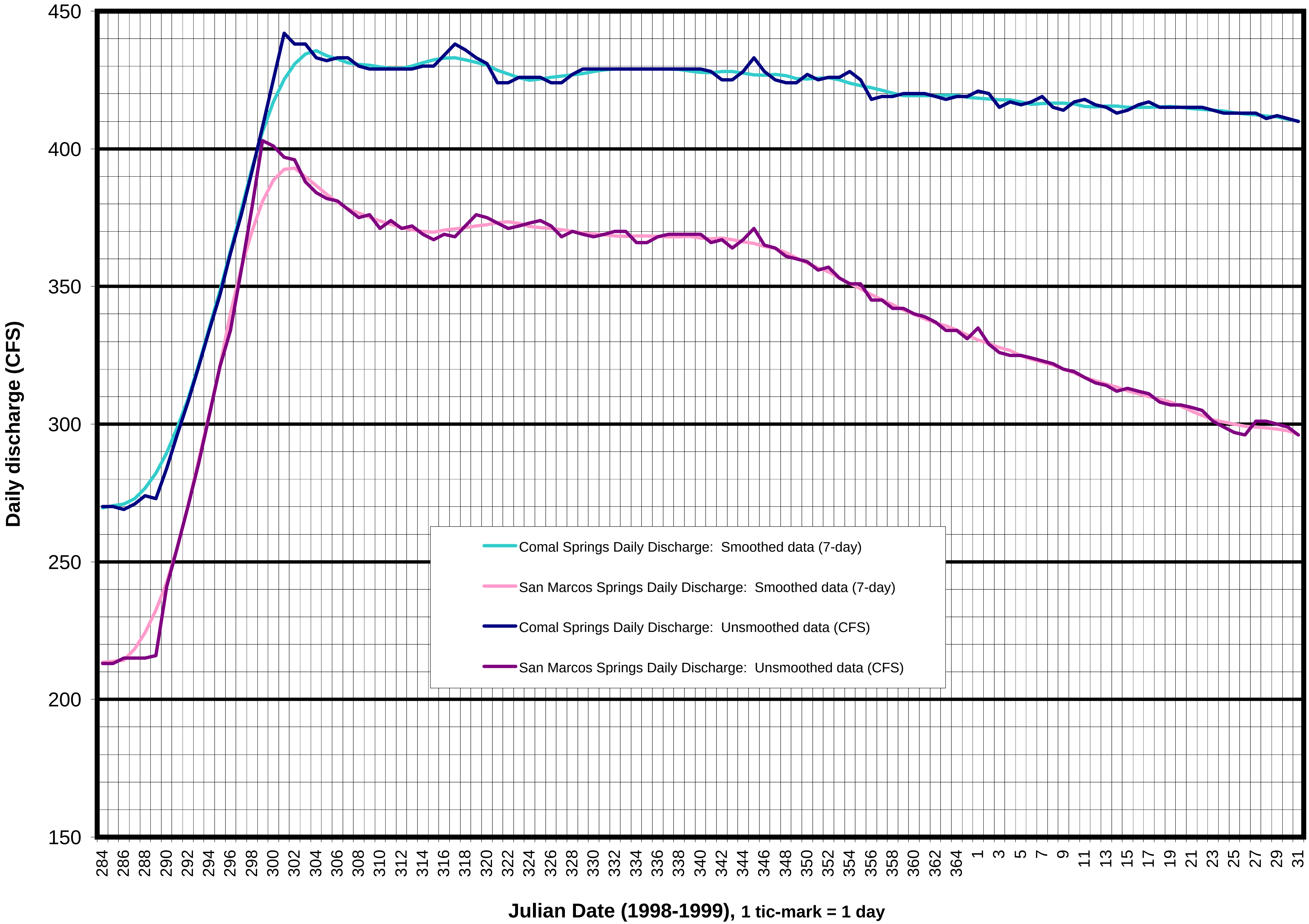


Figure 33. Discharges at Comal and San Marcos Springs as a function of time using log transformed data

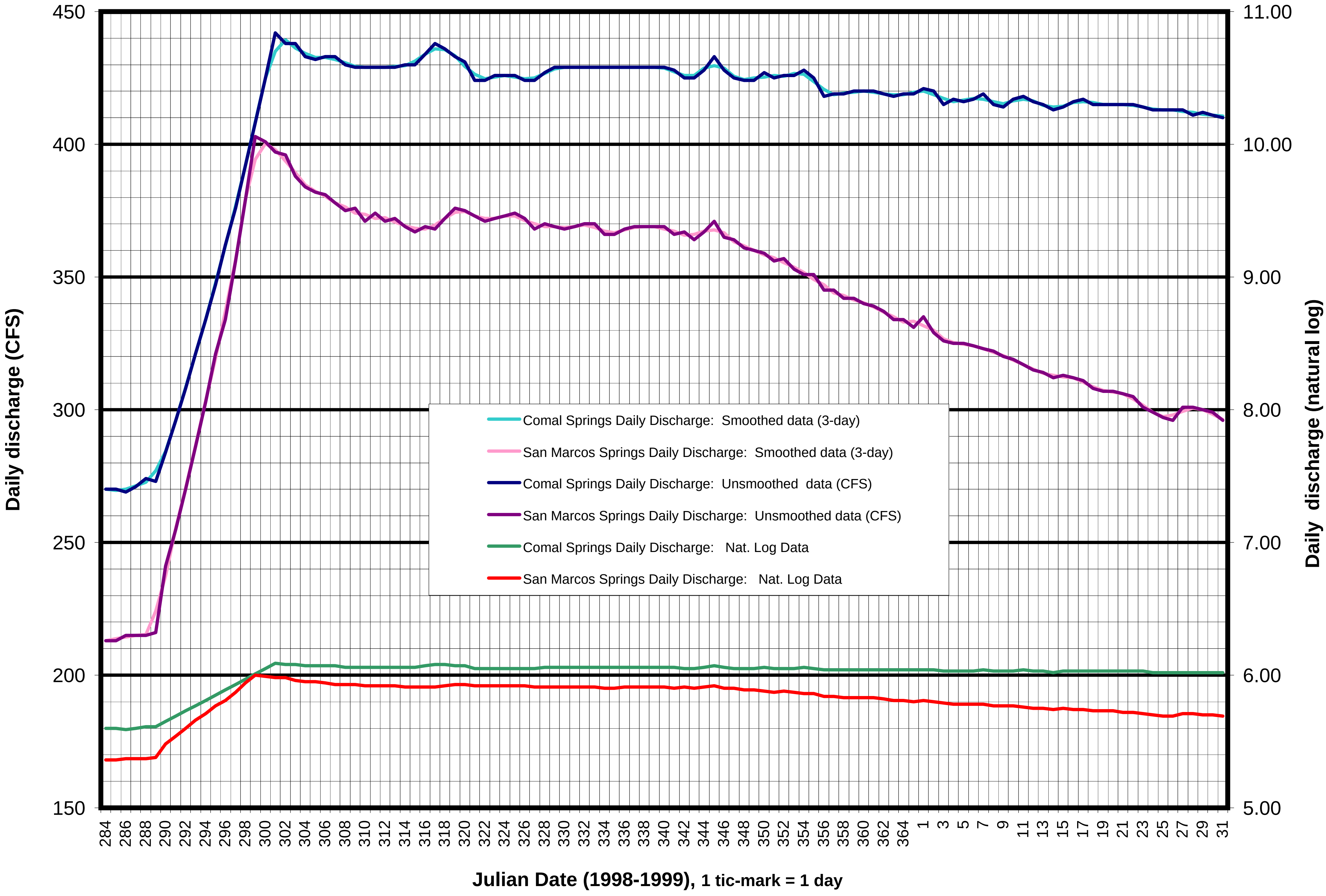


Figure 34. San Marcos Springs predicted discharges using one estimated parameter and the discharge from Comal Springs

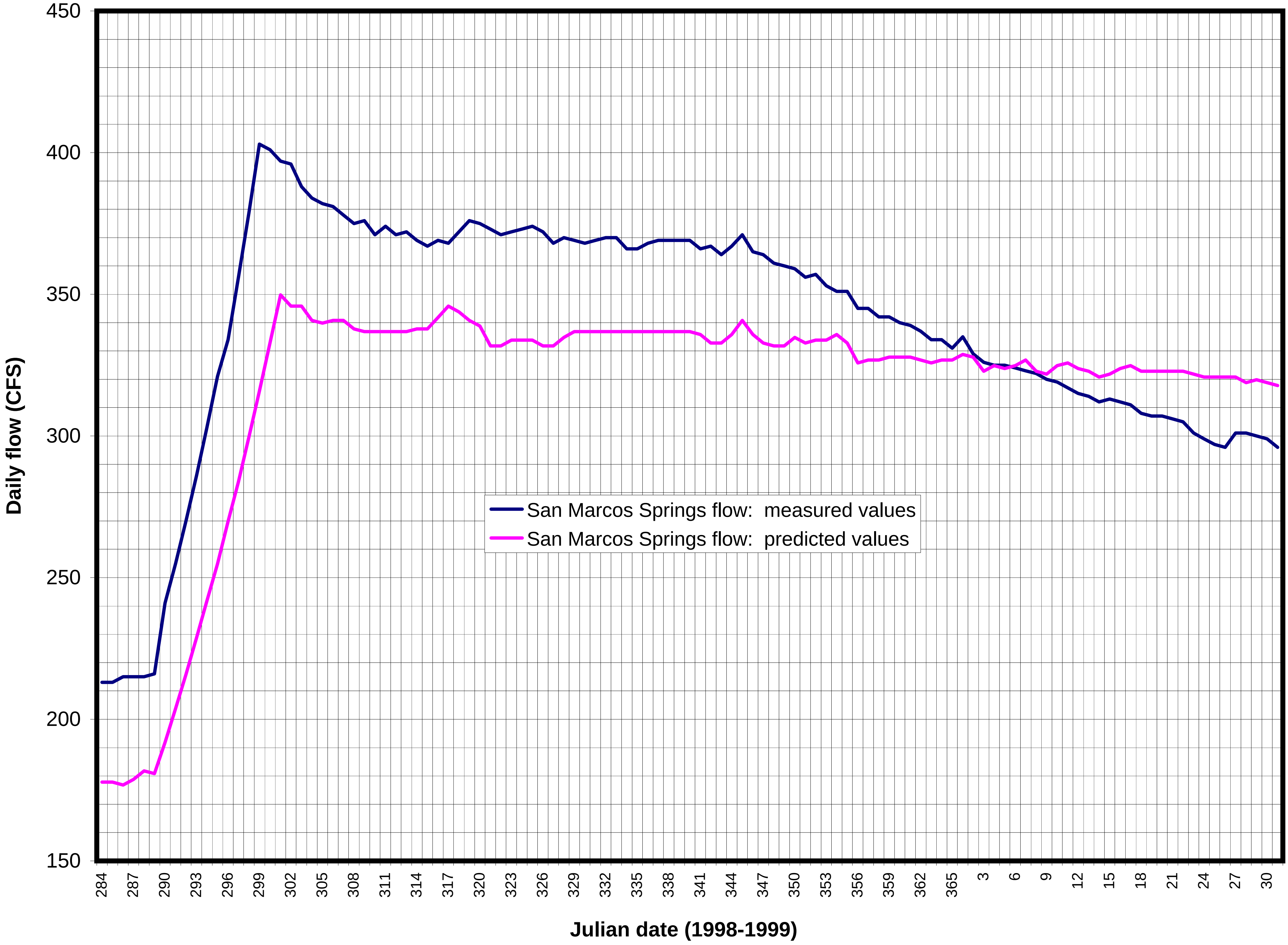


Figure 35. San Marcos Springs predicted discharges using one estimated parameter and the water level in monitor well J-17

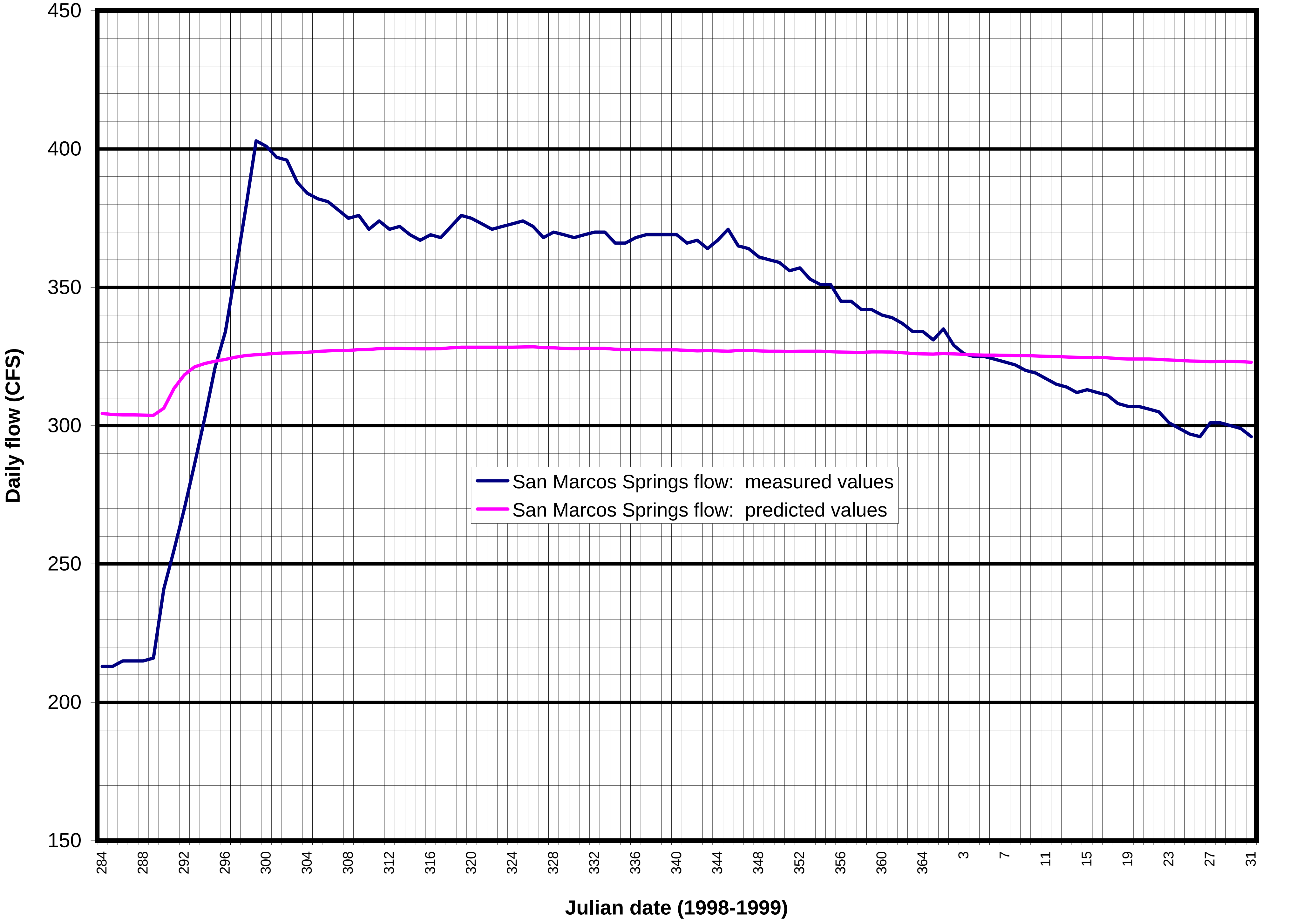


Figure 36. San Marcos Springs predicted discharges using two estimated parameters and the flow in Comal Springs

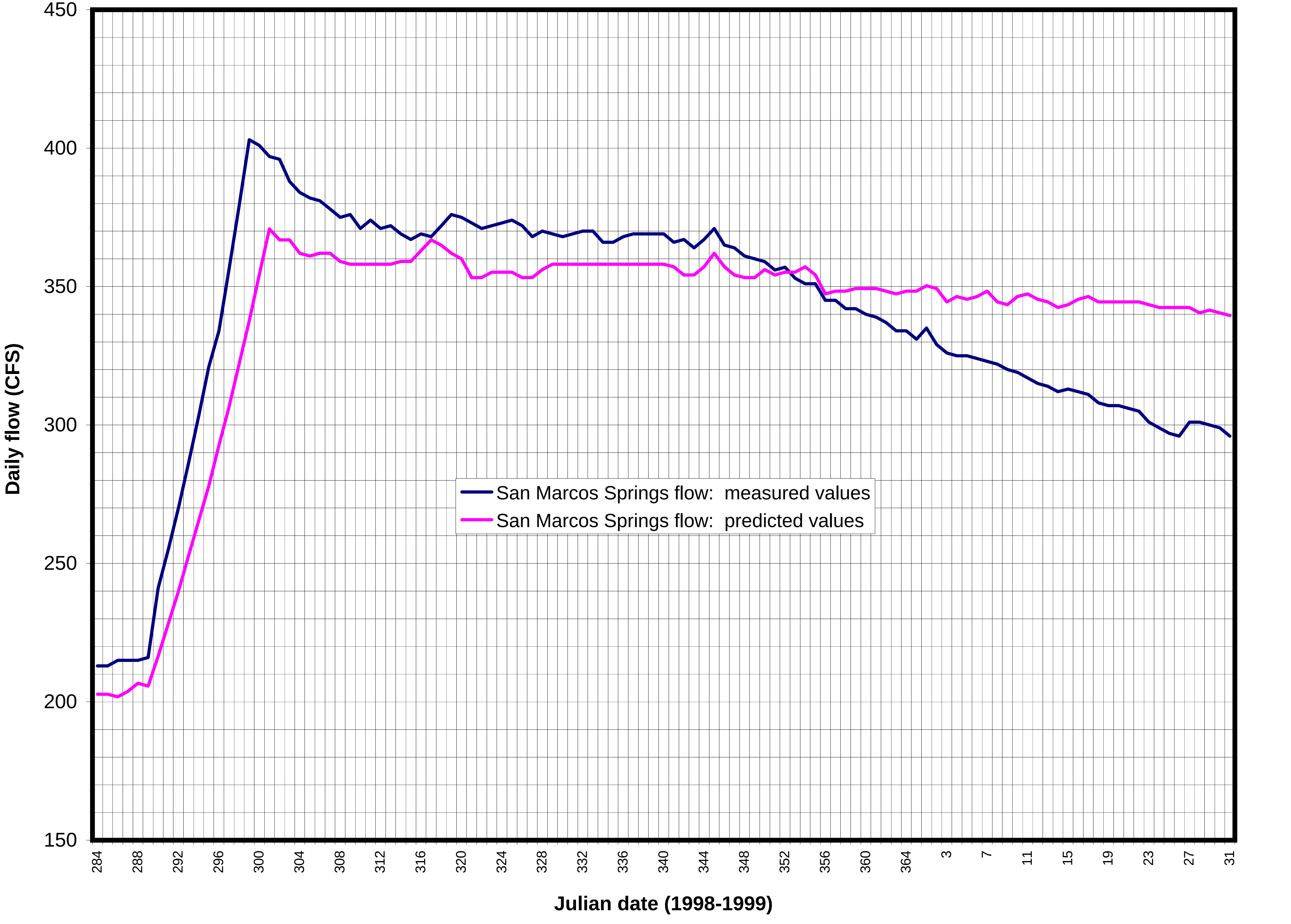


Figure 37. San Marcos Springs predicted discharges using four estimated parameters and the flow in Comal Springs, the flow in the Blanco River, and the water level in monitor well J-17

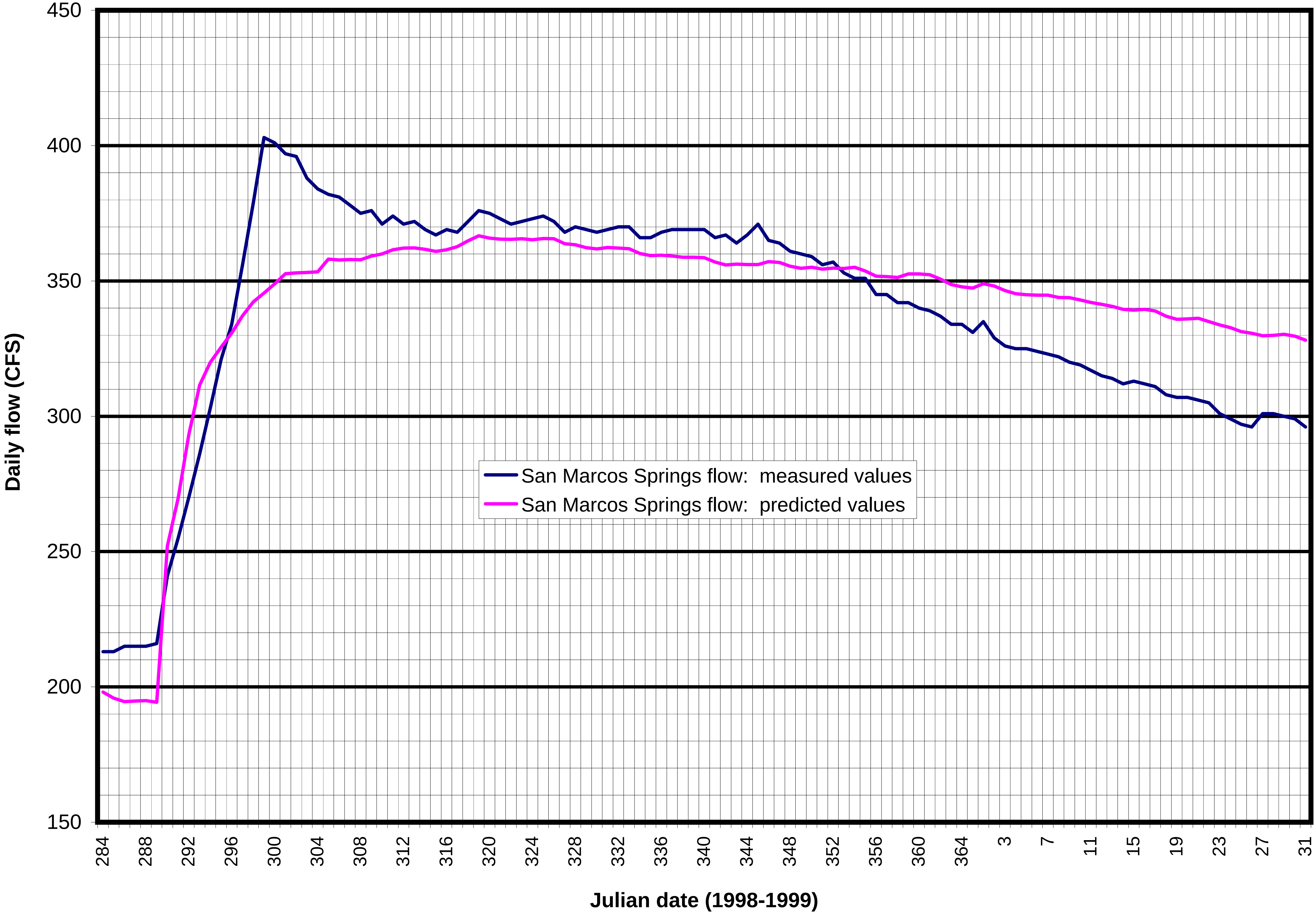


Figure 38. San Marcos Springs predicted discharges using four estimated parameters and the flow in Comal Springs, and the water levels in monitor wells J-17 and Quihi

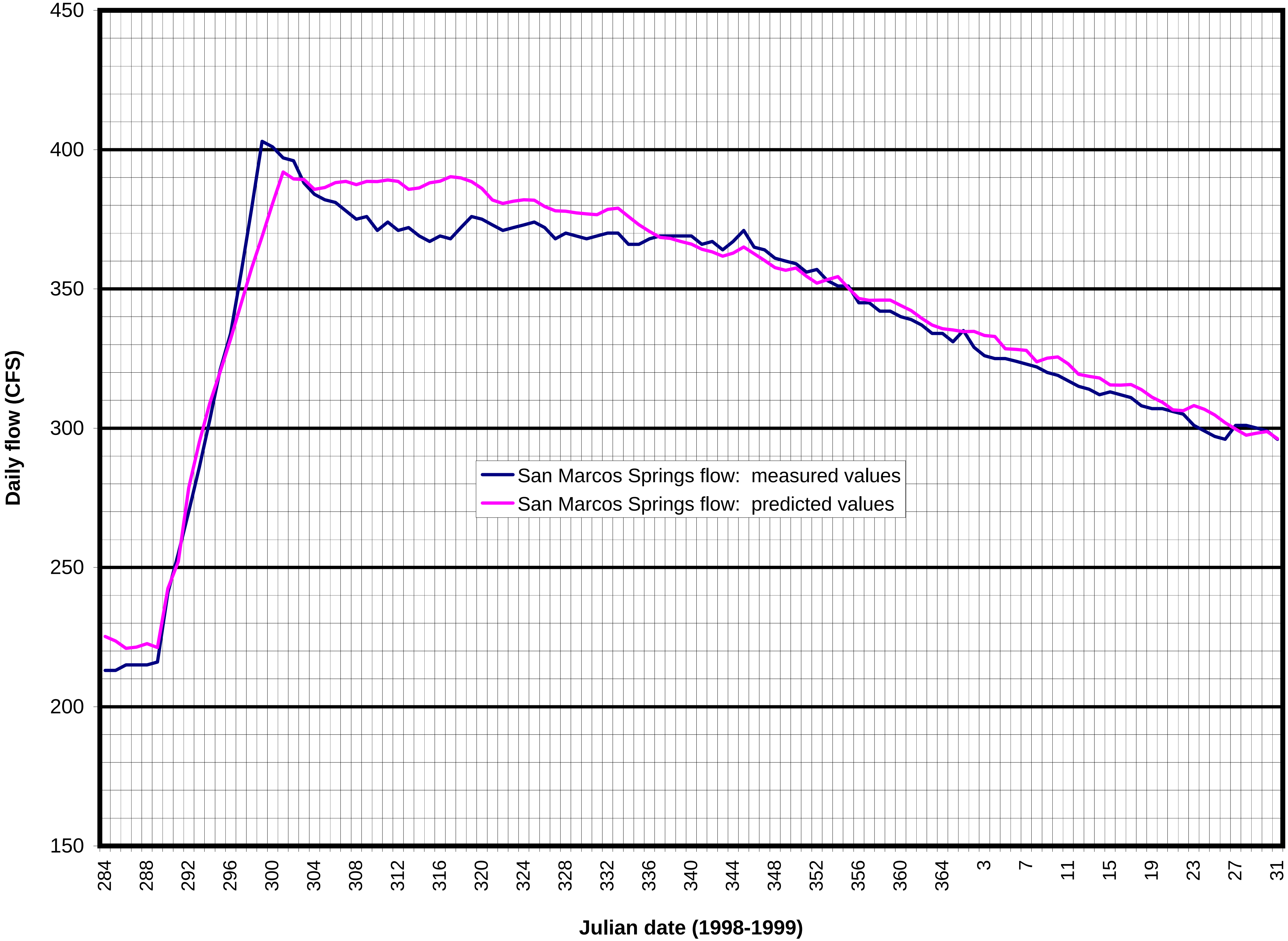


Figure 39. 95% confidence limits for San Marcos Springs predicted flow model (using Quihi well data and regression parameters)

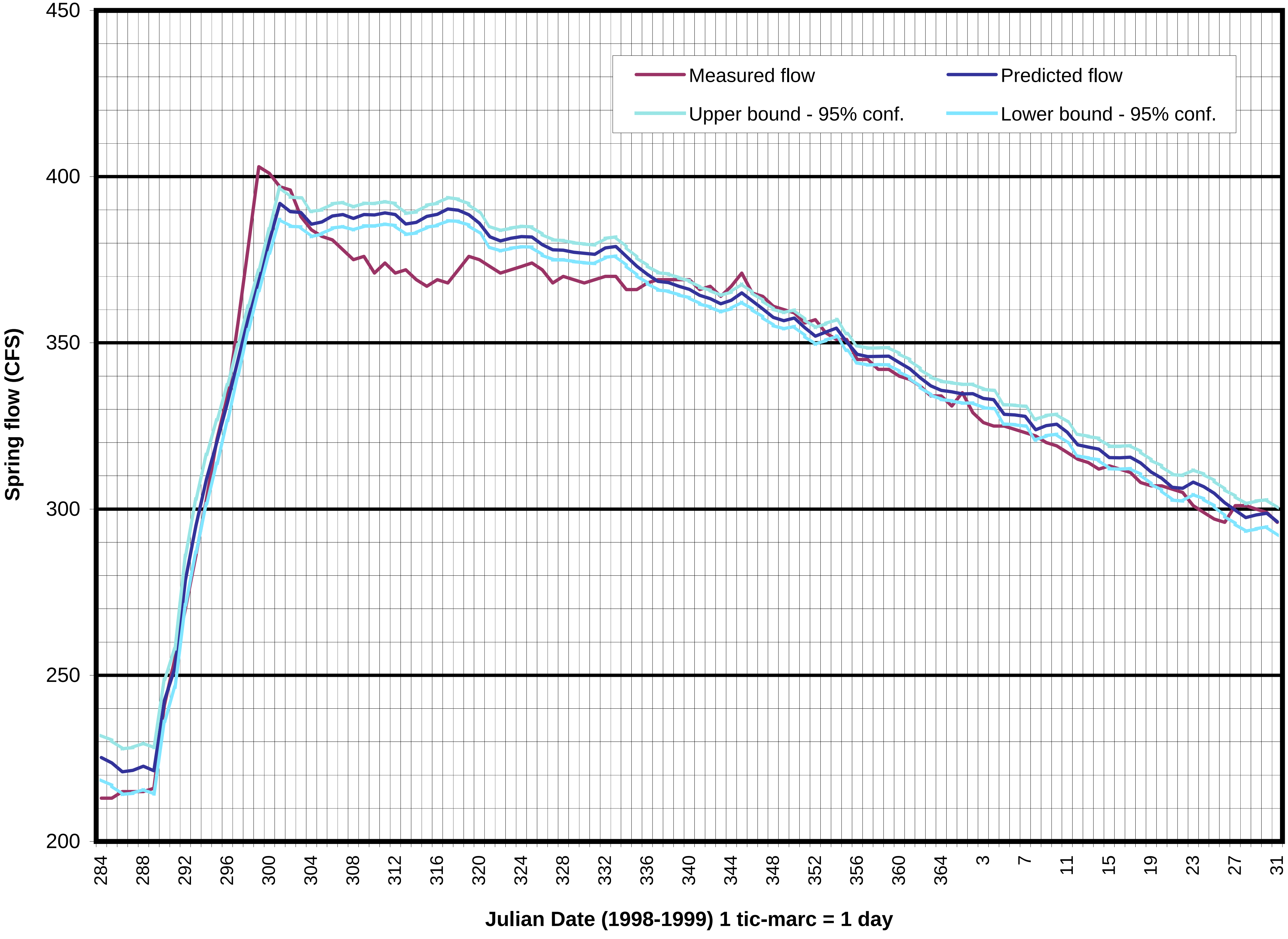


Figure A-1. Stream flows in the Guadalupe River
(October 15, 1998 to November 15, 1998)

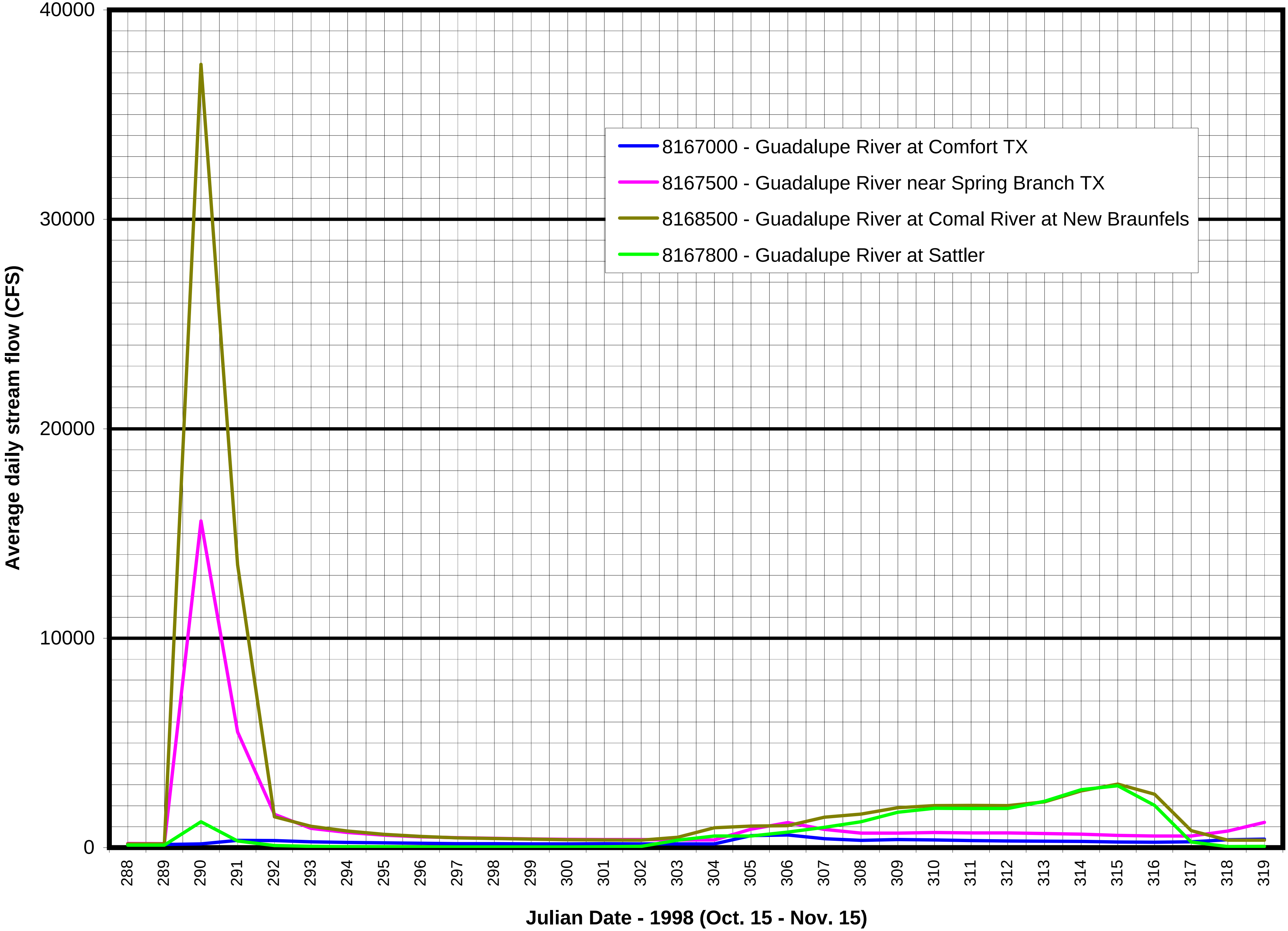


Figure A-2. Stream flows in the Guadalupe River (October 15,1998 to November 15, 1998)

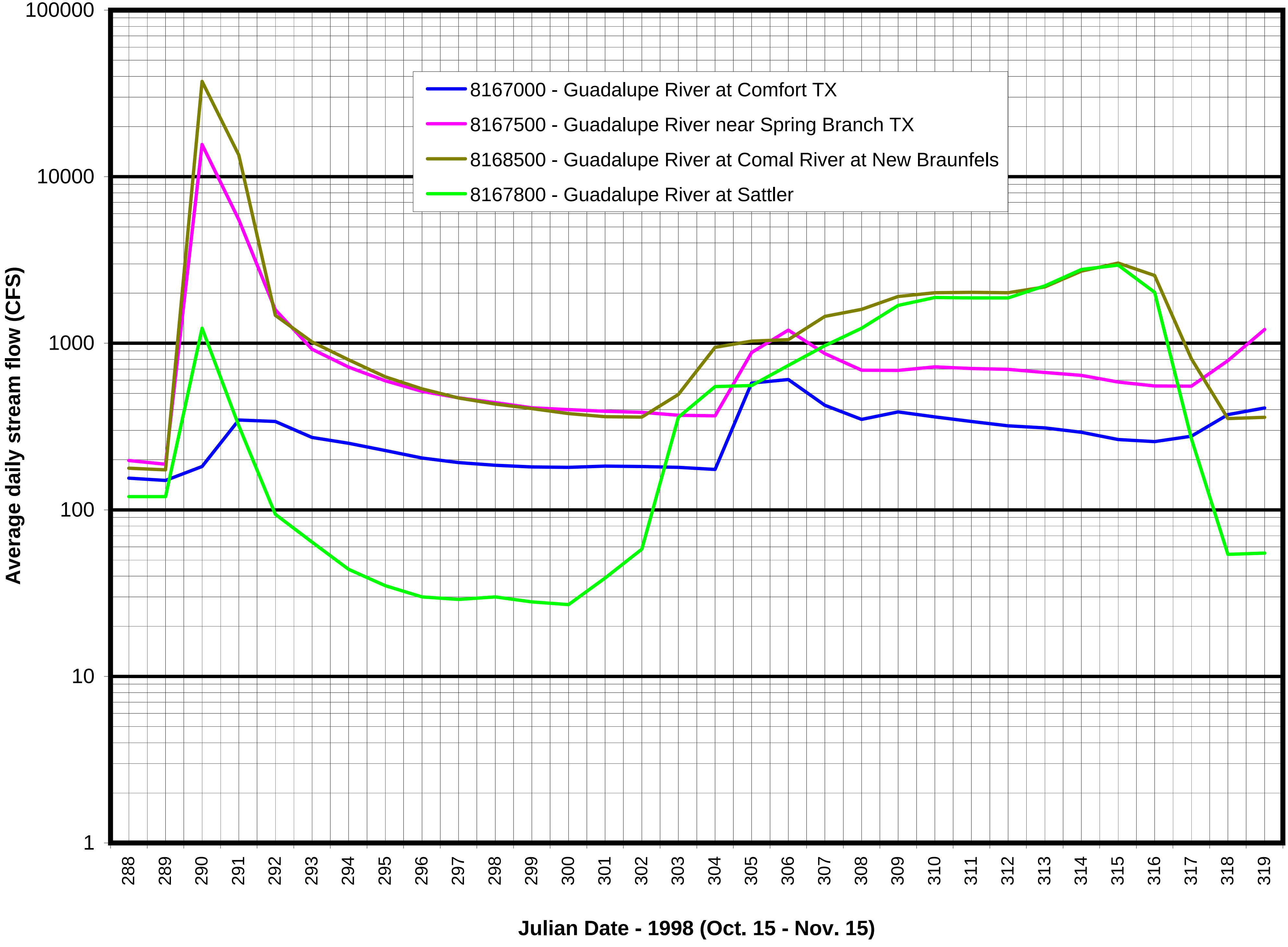


Figure A-3. Stream flows in the Cibolo Creek
(October 15, 1998 to November 15, 1998)

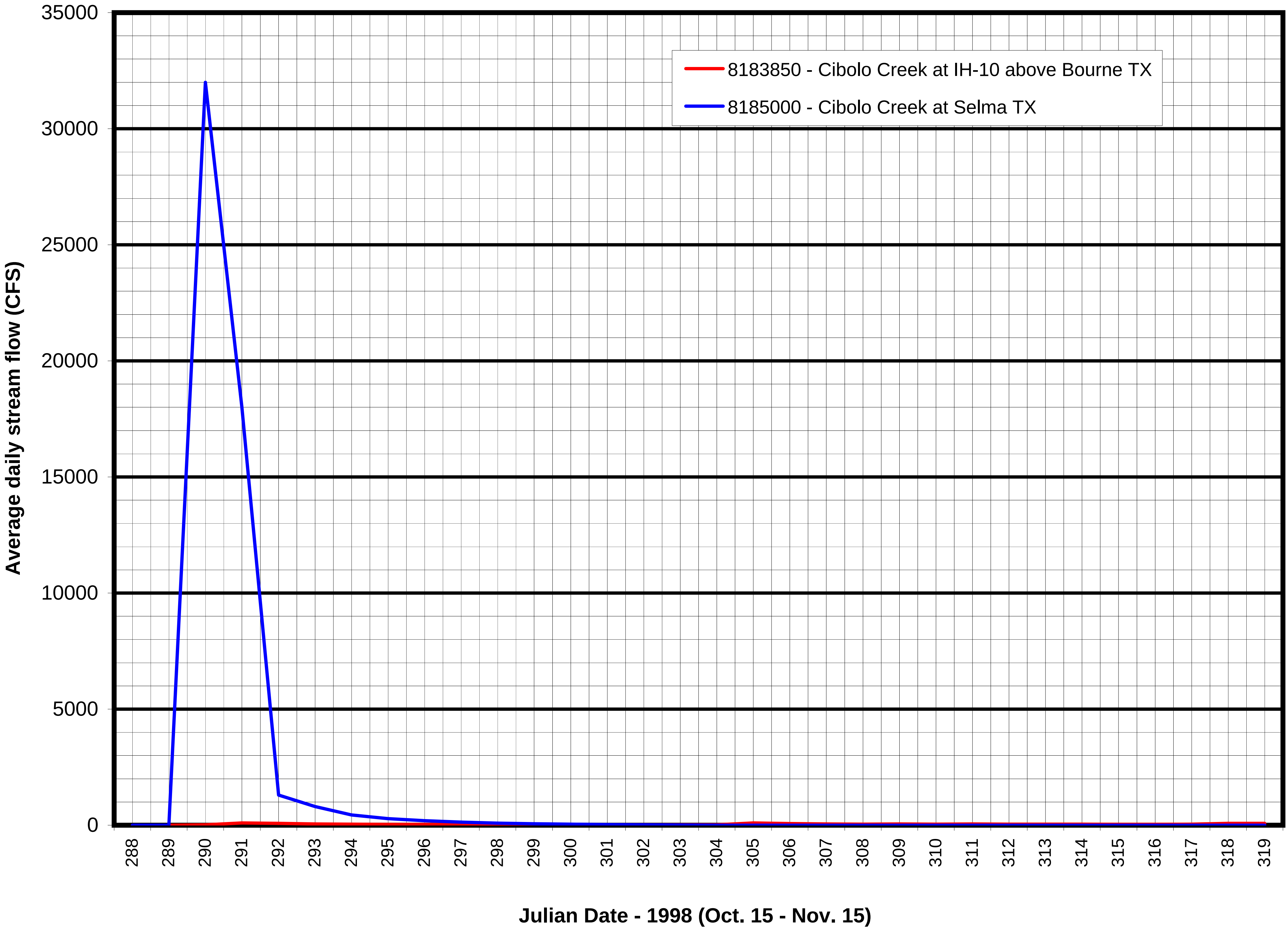


Figure A-4. Stream flows in the Cibolo Creek
(October 15, 1998 to November 15, 1998)

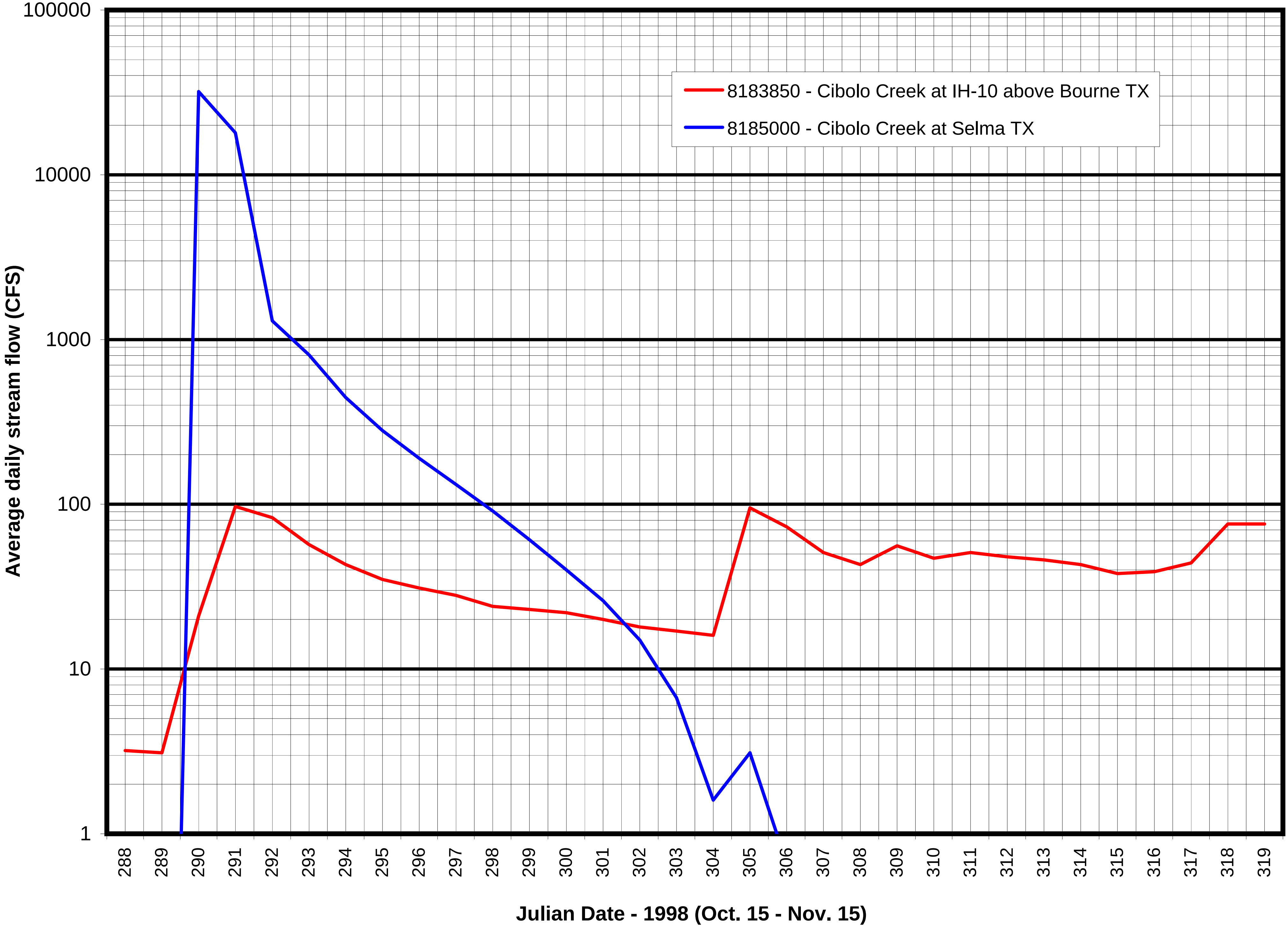


Figure A-5. Stream flows in the Blanco River
(October 15, 1998 to November 15, 1998)

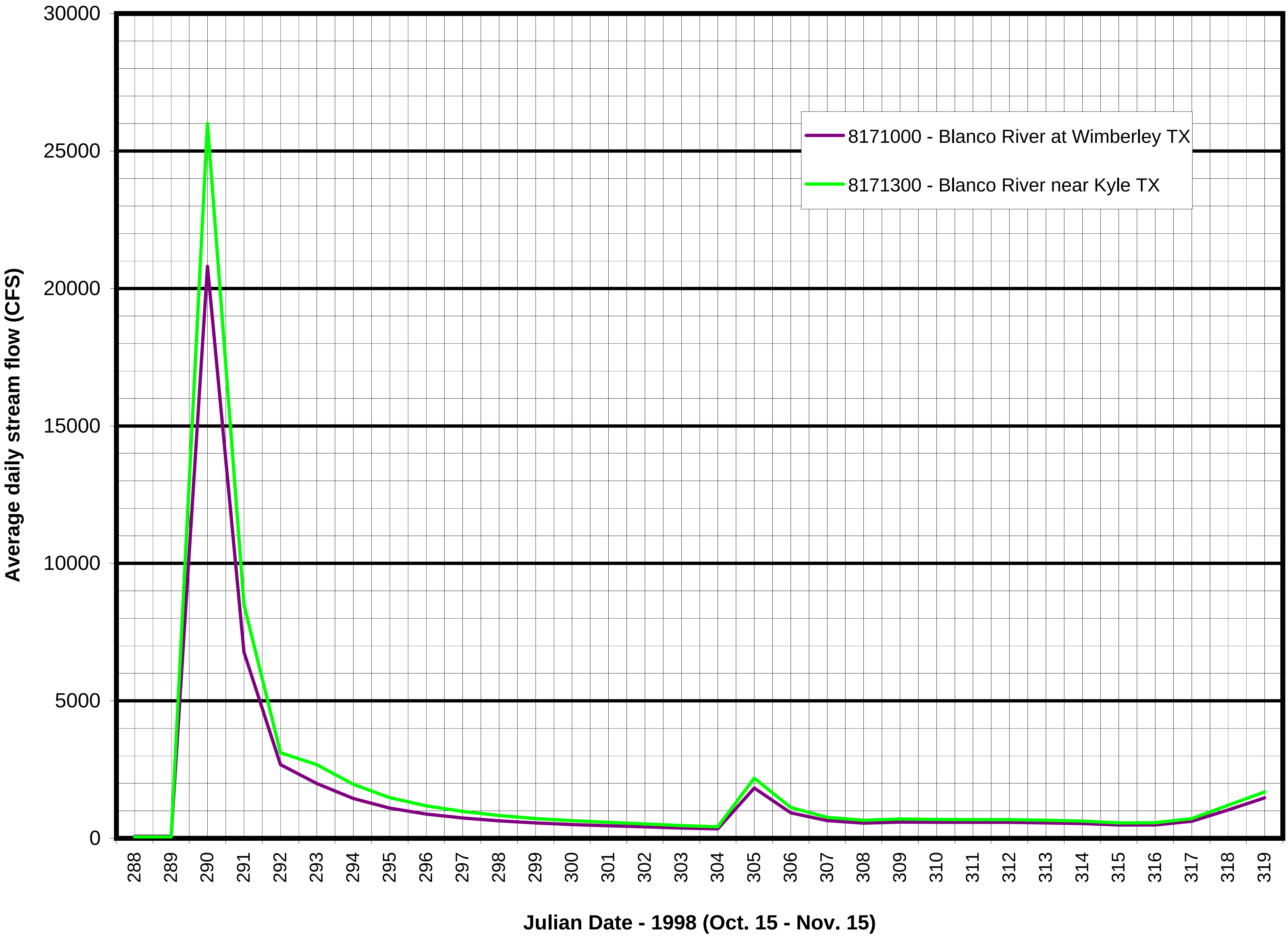


Figure A-6. Stream flows in the Blanco River
(October 15, 1998 to November 15, 1998)

Figure A-7. Stream flows in the Hondo Creek
(October 15, 1998 to November 15, 1998)

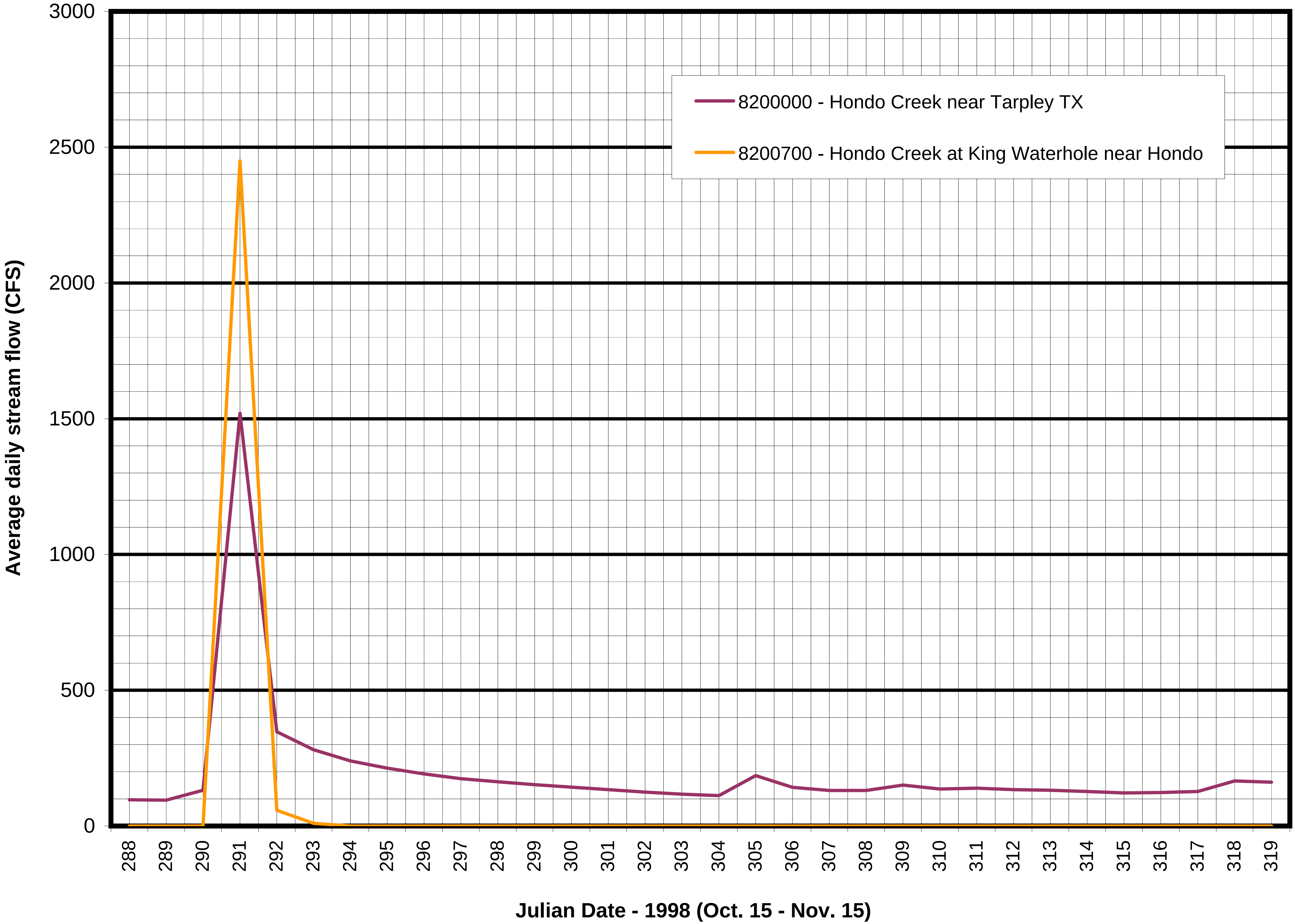


Figure A-8. Stream flows in the Hondo Creek
(October 15, 1998 to November 15, 1998)

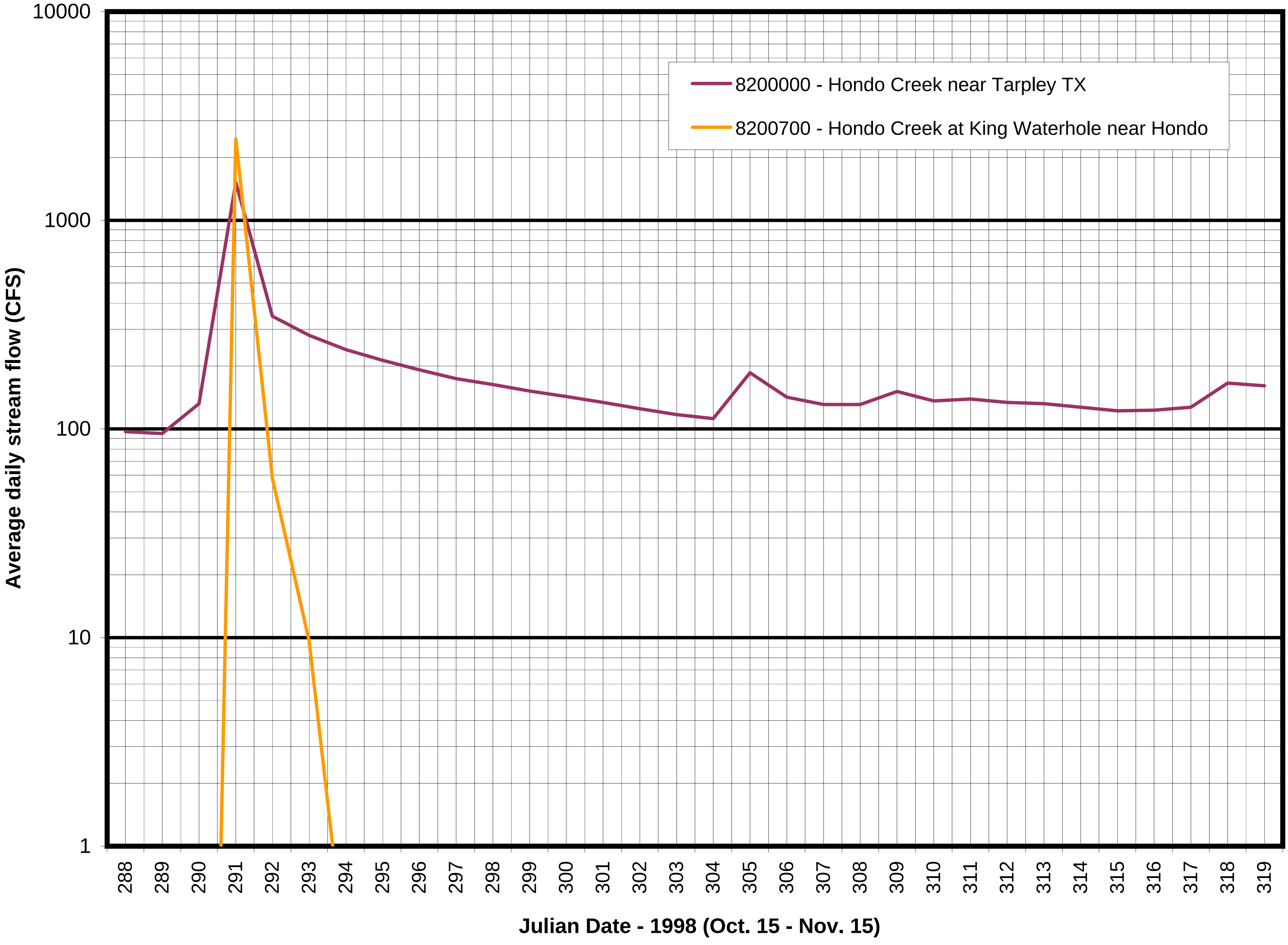


Figure A-9. Stream flows in the Nueces River
(October 15, 1998 to November 15, 1998)

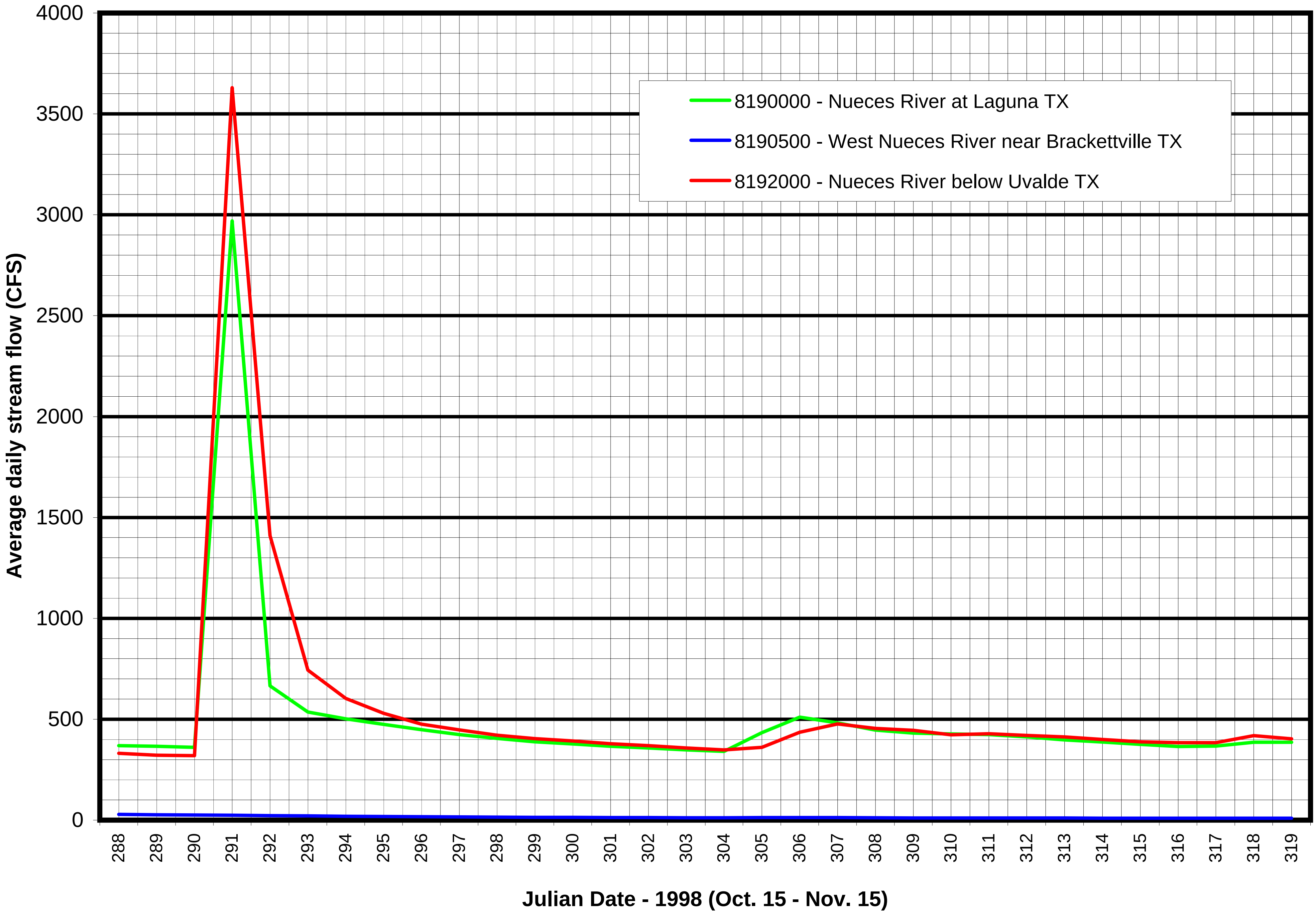


Figure A-10. Stream flows in the Nueces River
(October 15, 1998 to November 15, 1998)

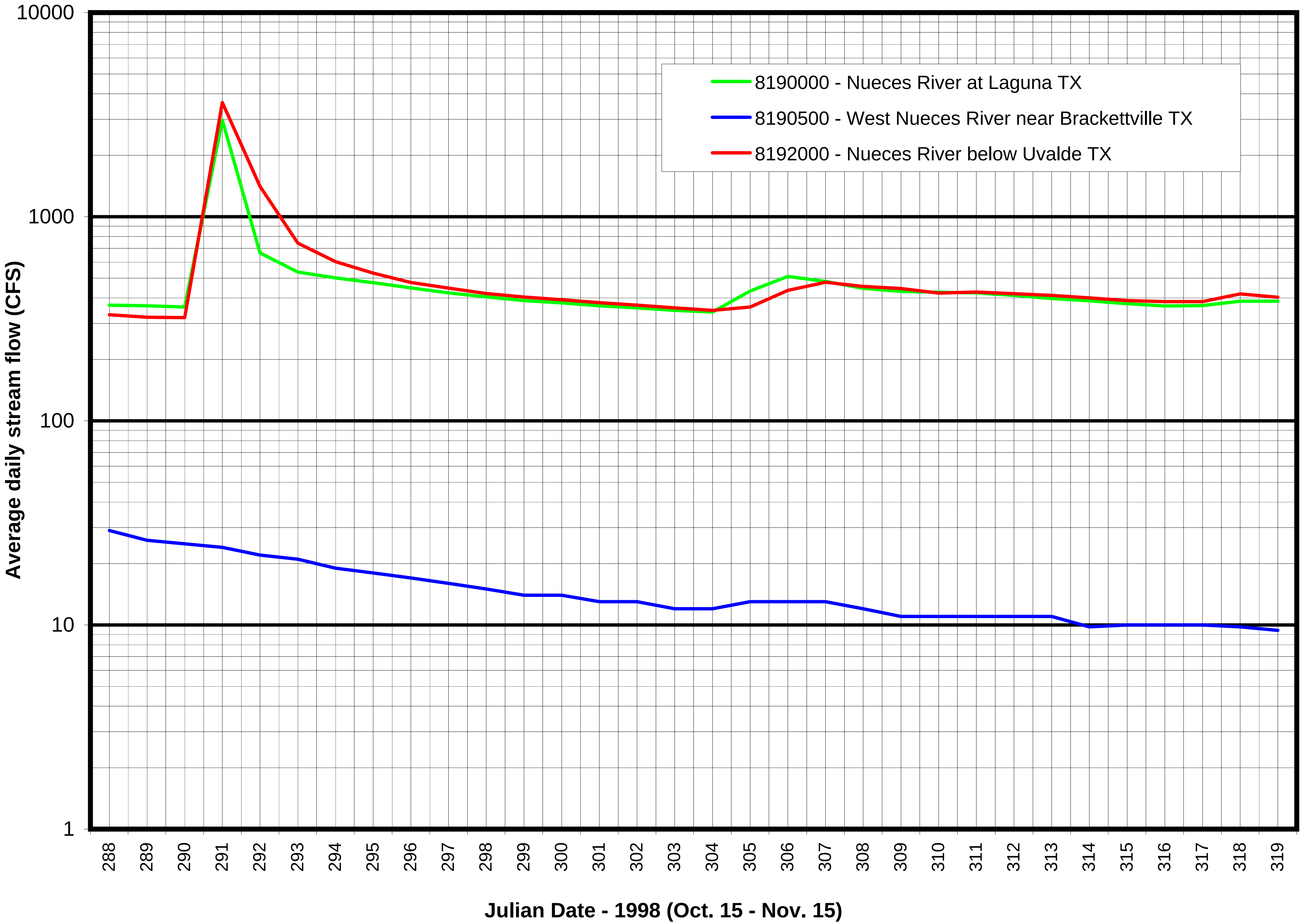


Figure A-11. Stream flows in the Frio River
(October 15, 1998 to November 15, 1998)

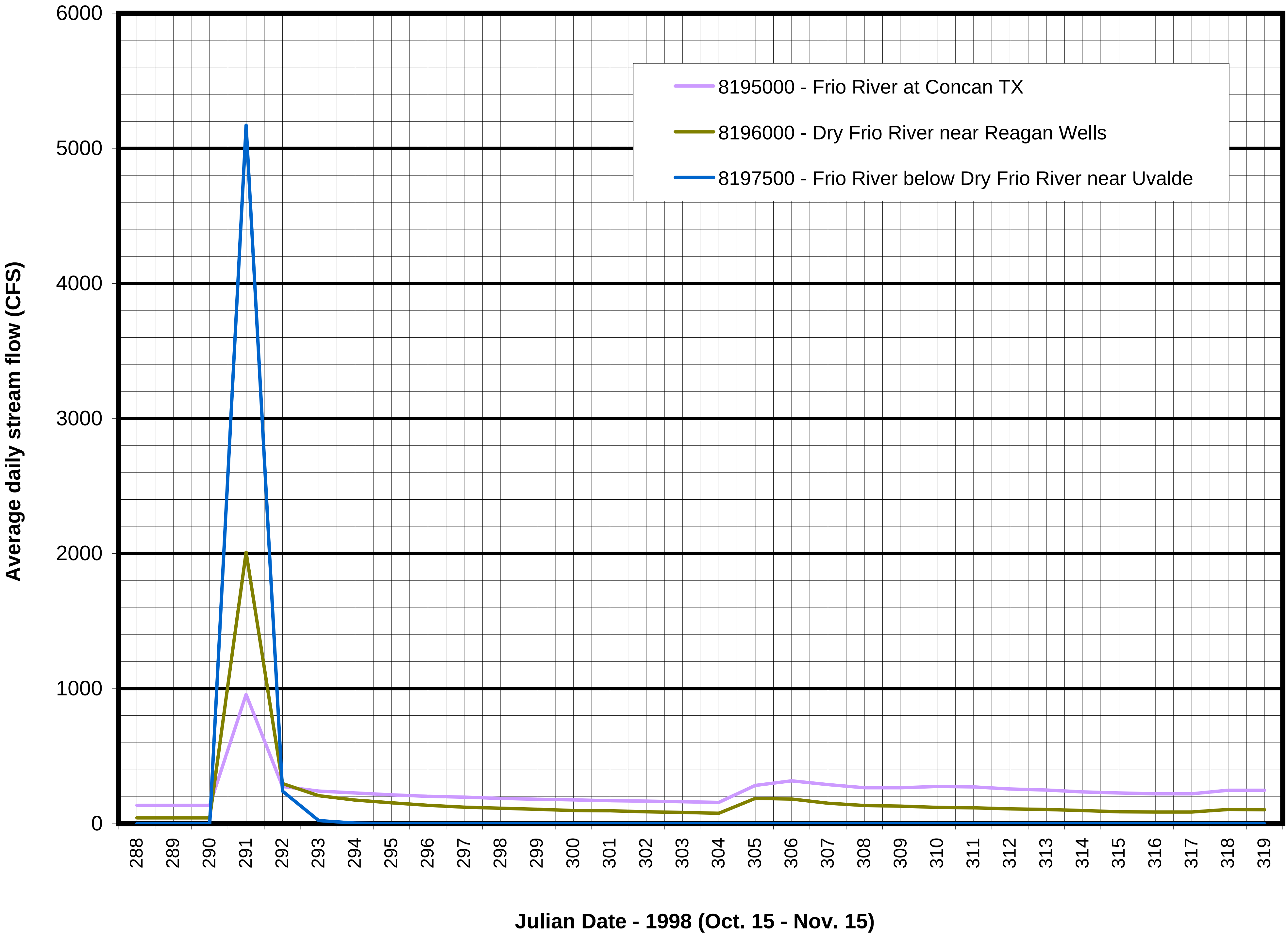


Figure A-12. Stream flows in the Frio River
(October 15, 1998 to November 15, 1998)

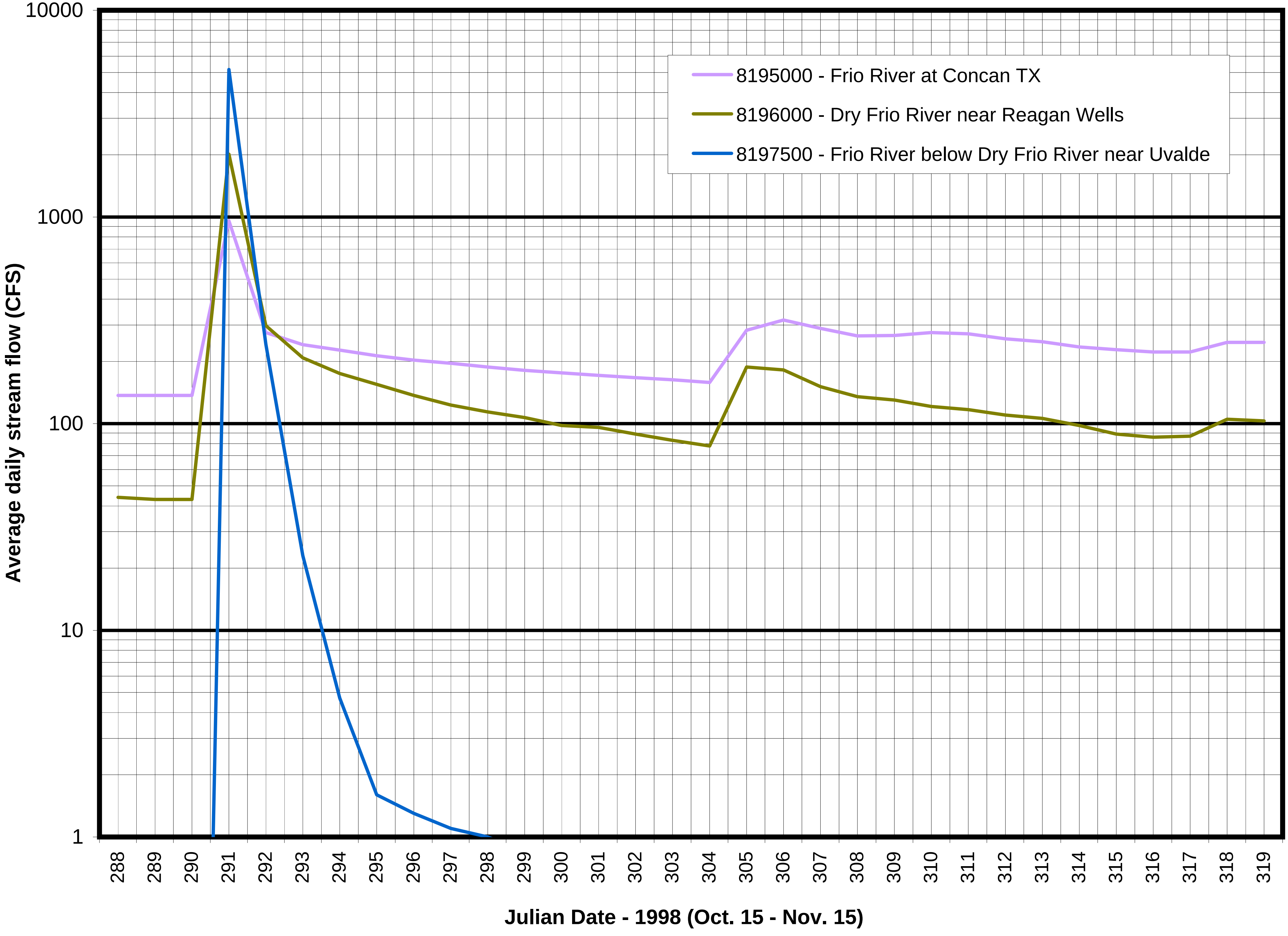


Figure A-13. Stream flows in the Sabinal River
(October 15, 1998 to November 15, 1998)

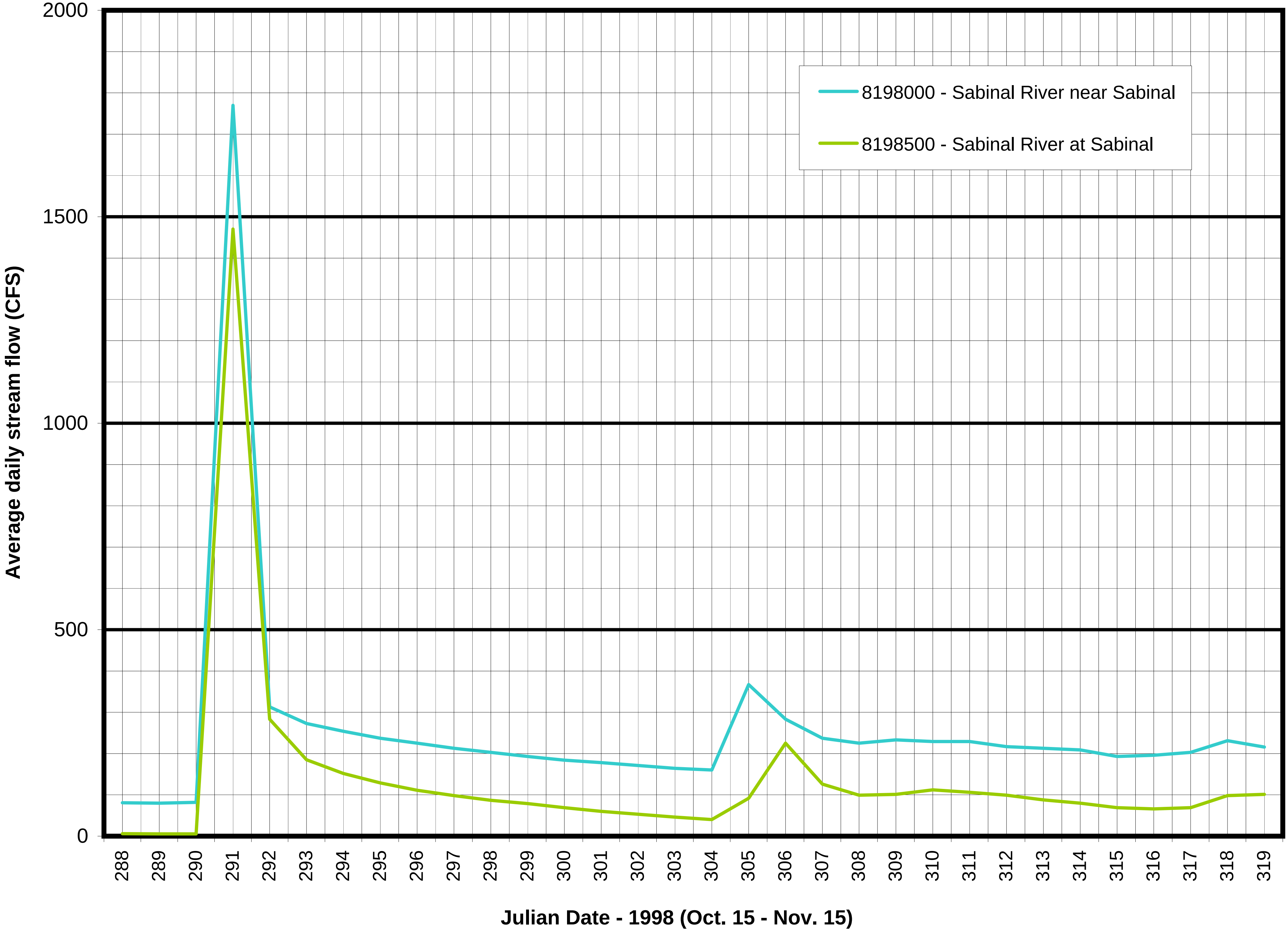


Figure A-14. Stream flows in the Sabinal River
(October 15, 1998 to November 15, 1998)

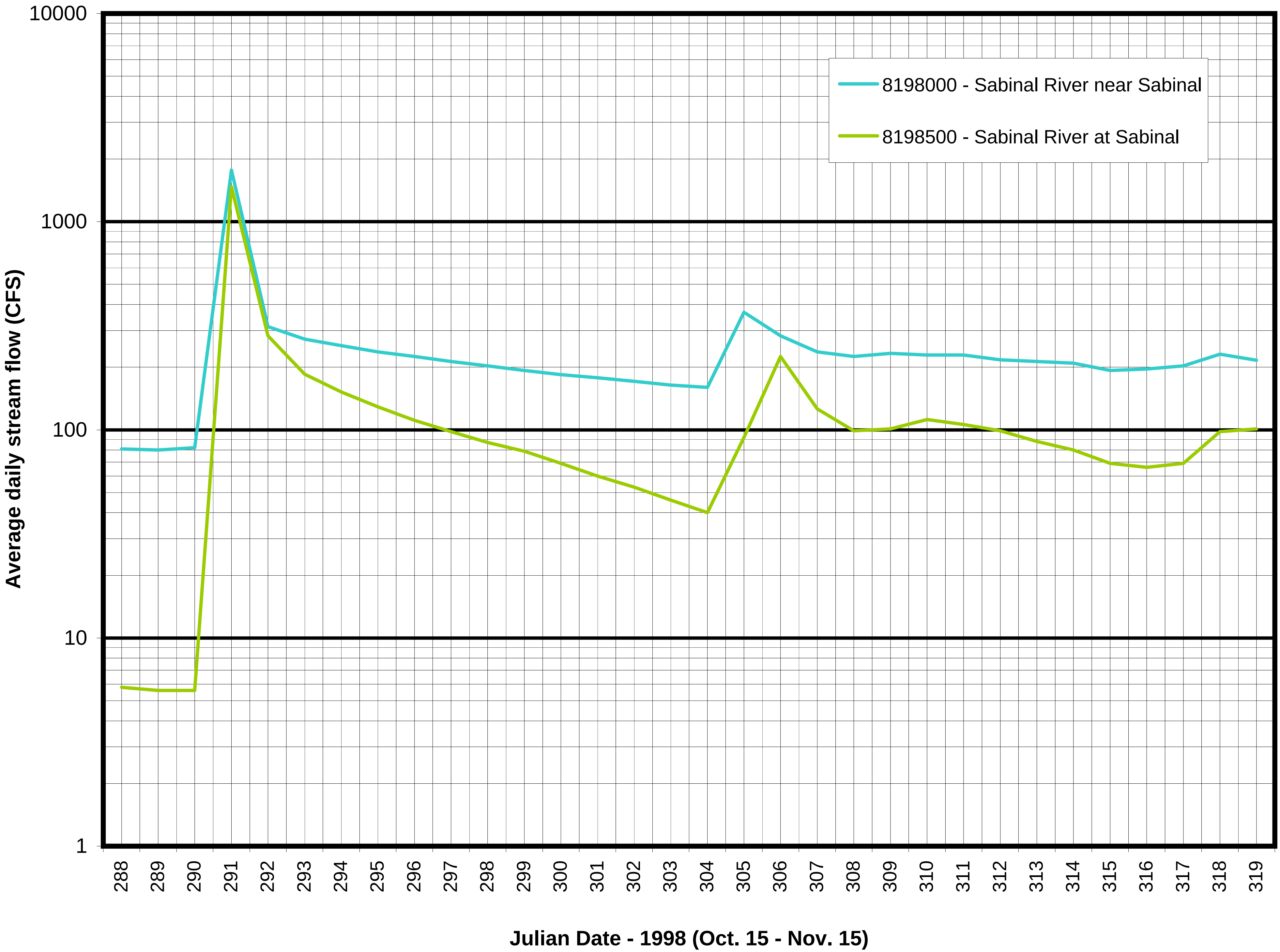


Figure A-15. Stream flows in the Medina River, Salado Creek, and Plum Creek (October 15, 1998 to November 15, 1998)

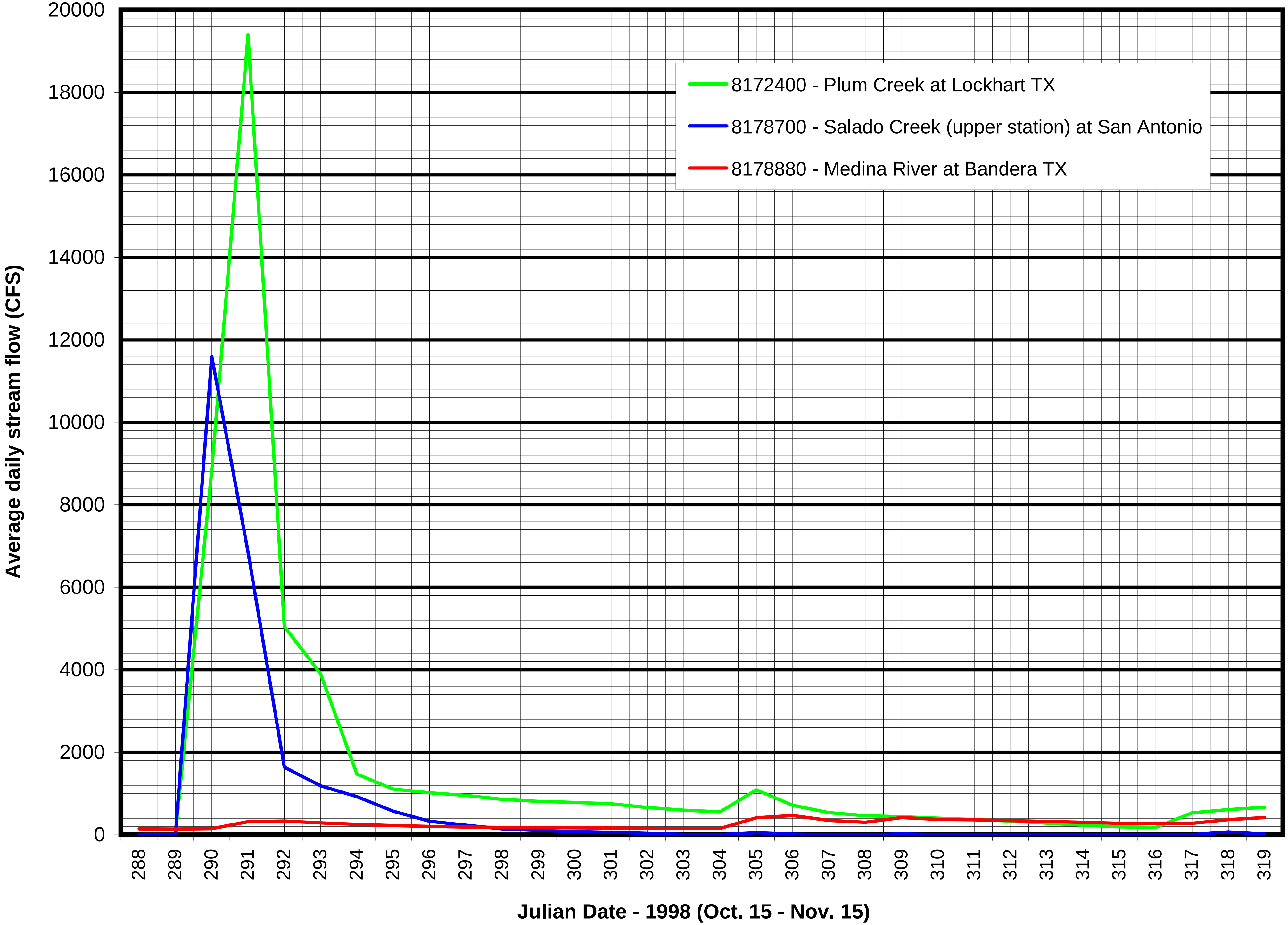


Figure A-16. Stream flows in the Medina River, Salado Creek, and Plum Creek (October 15, 1998 to November 15, 1998)

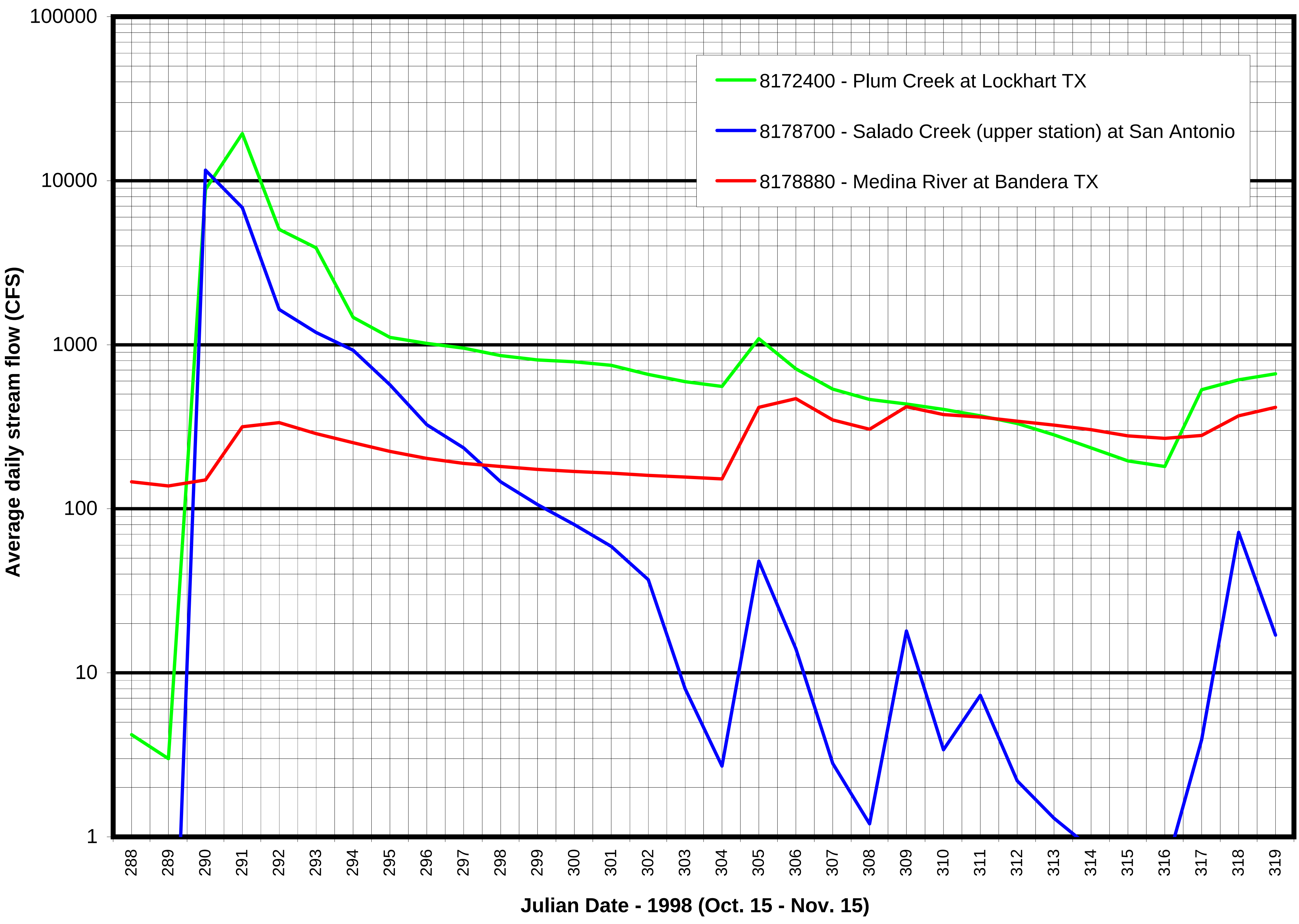


Figure A-17. Stream flows in the Seco Creek (October 15, 1998 to November 15, 1998)

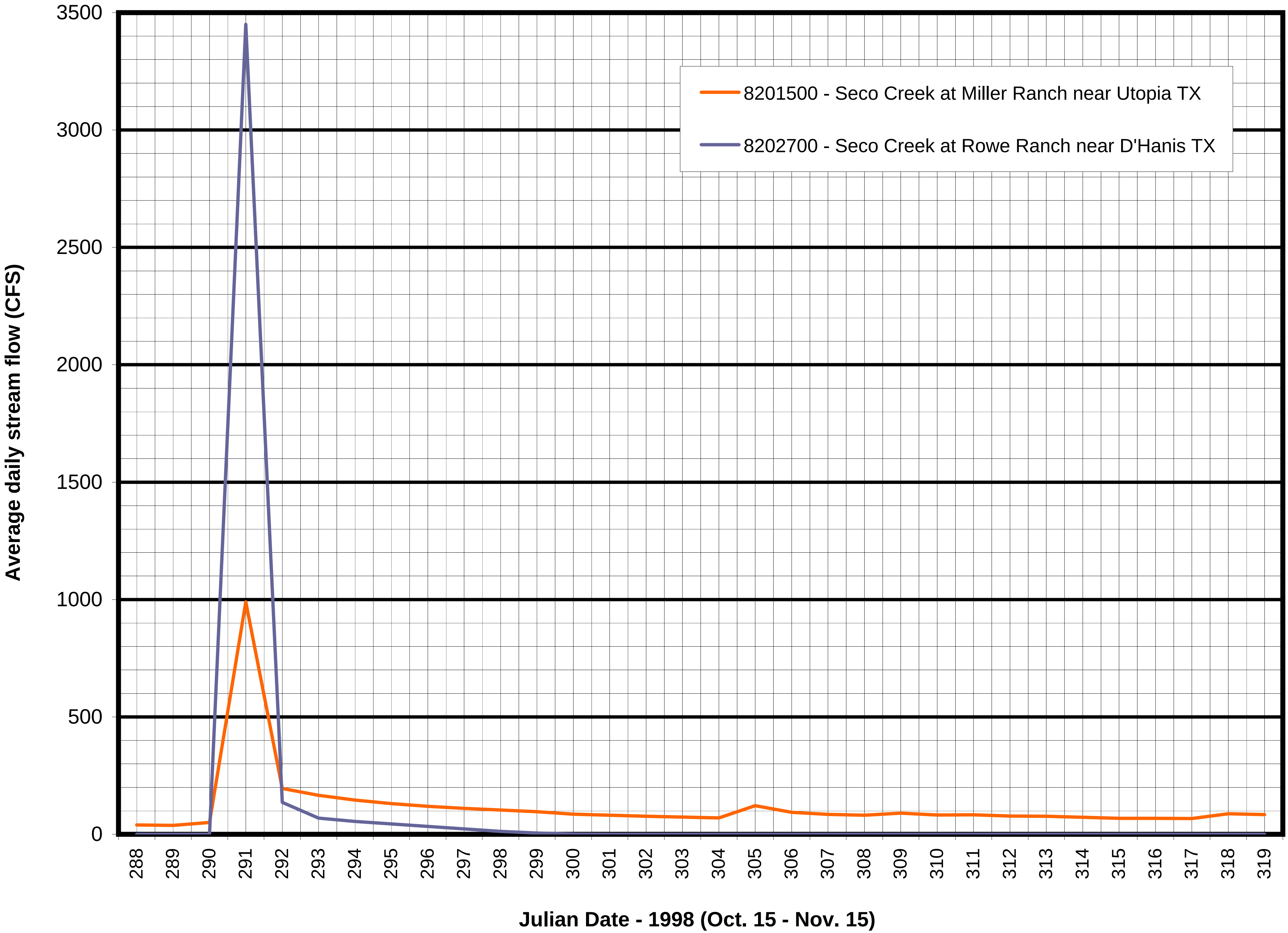


Figure A-18. Stream flows in the Seco Creek
(October 15, 1998 to November 15, 1998)

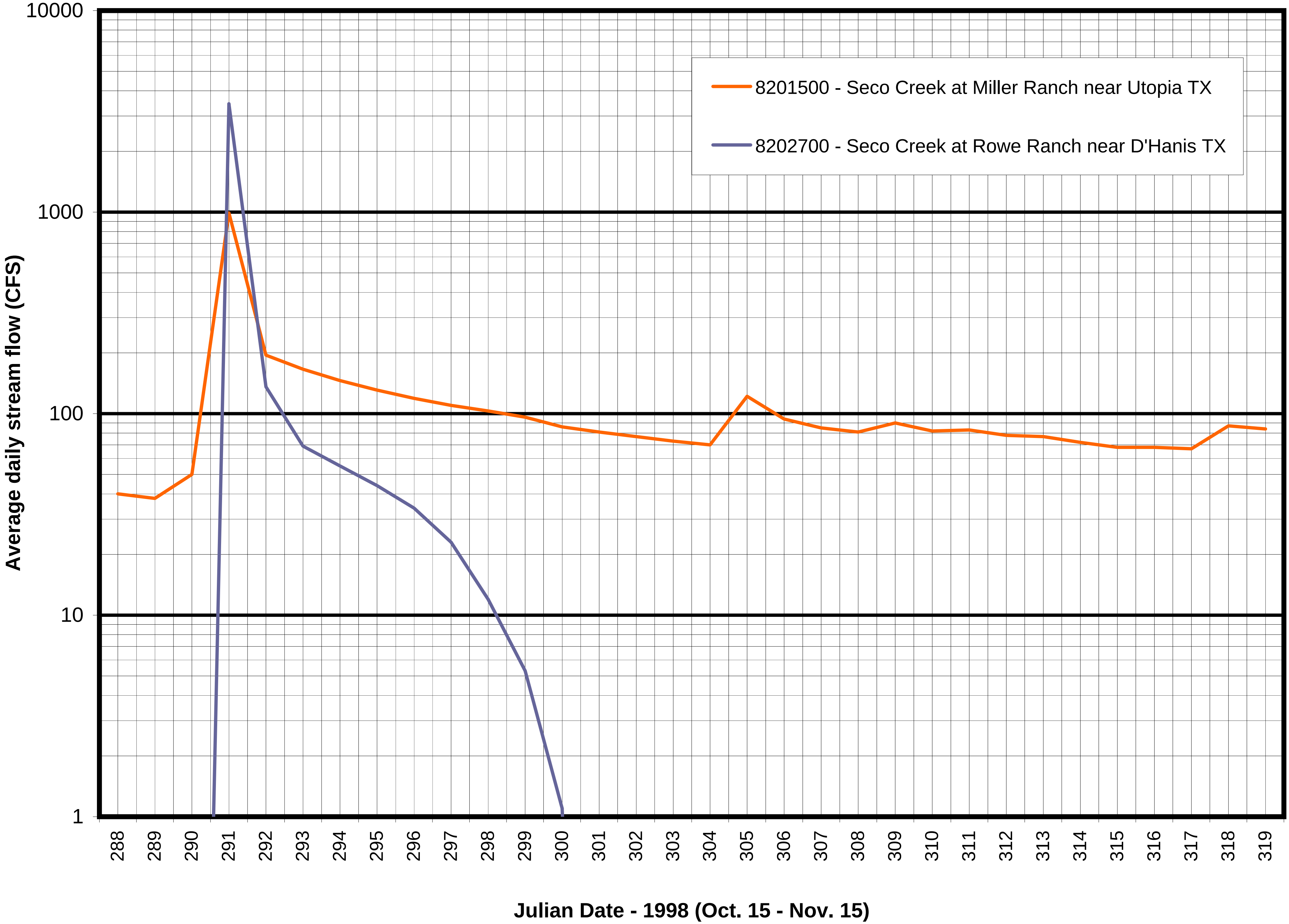


Figure A-19. Daily water elevations in 12 monitor wells
(October 1, 1998 to December 31, 1999)

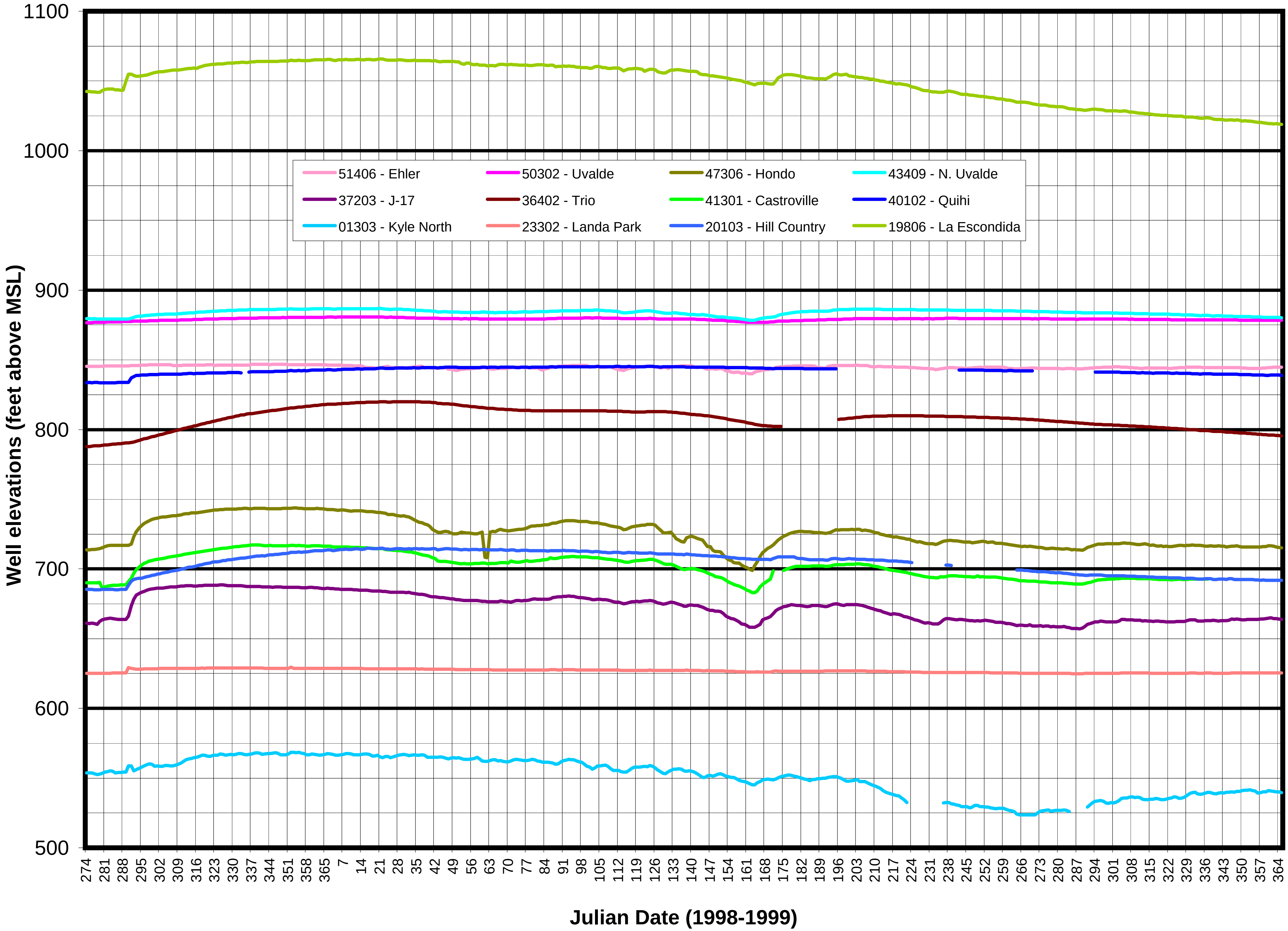


Figure A-20. Daily water elevations in monitor well La Escondida (October 1, 1998 to December 31, 1999)

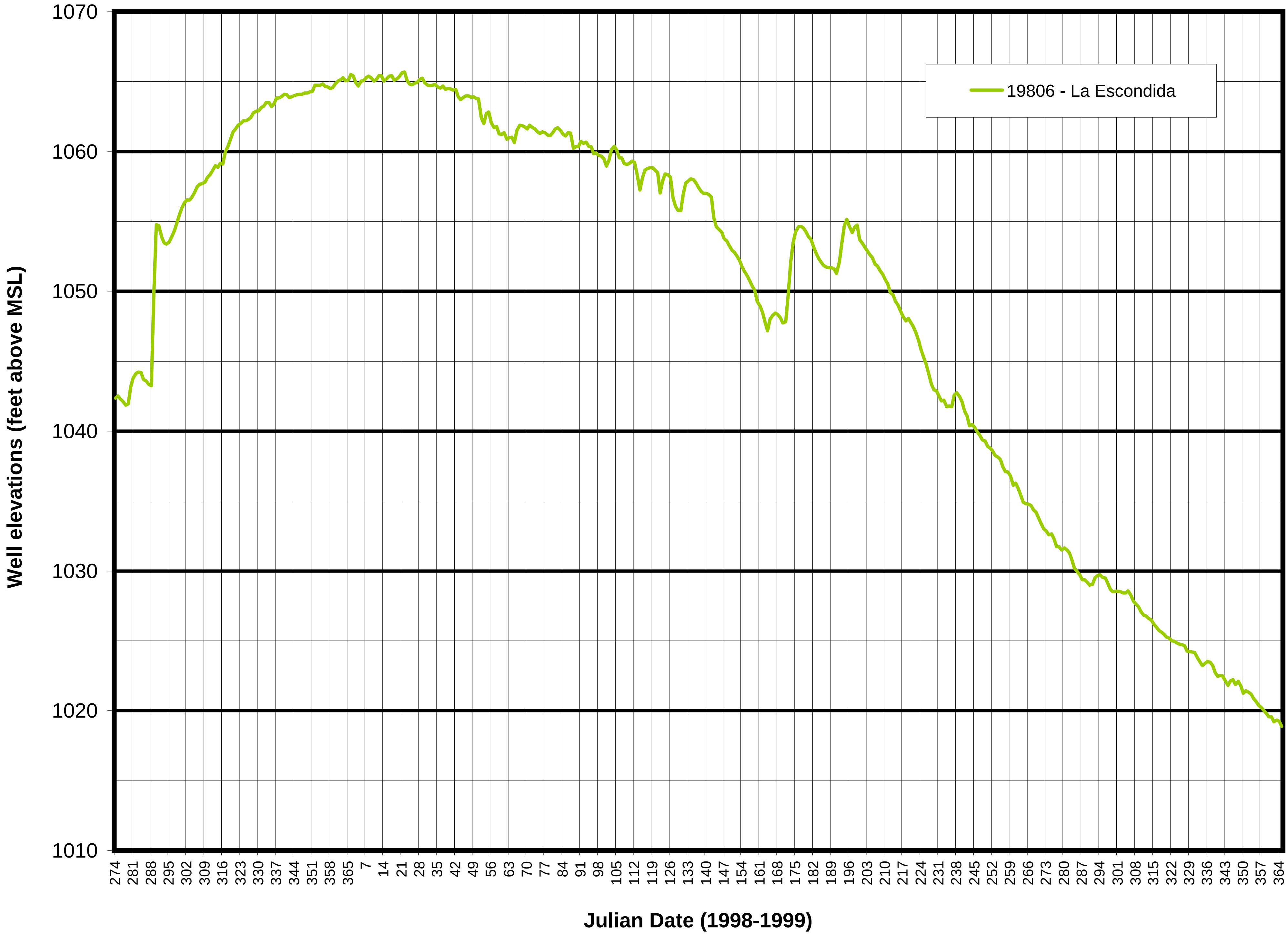


Figure A-21. Daily water elevations in monitor wells Ehler, Trio, and Quihi (October 1, 1998 to December 31, 1999)

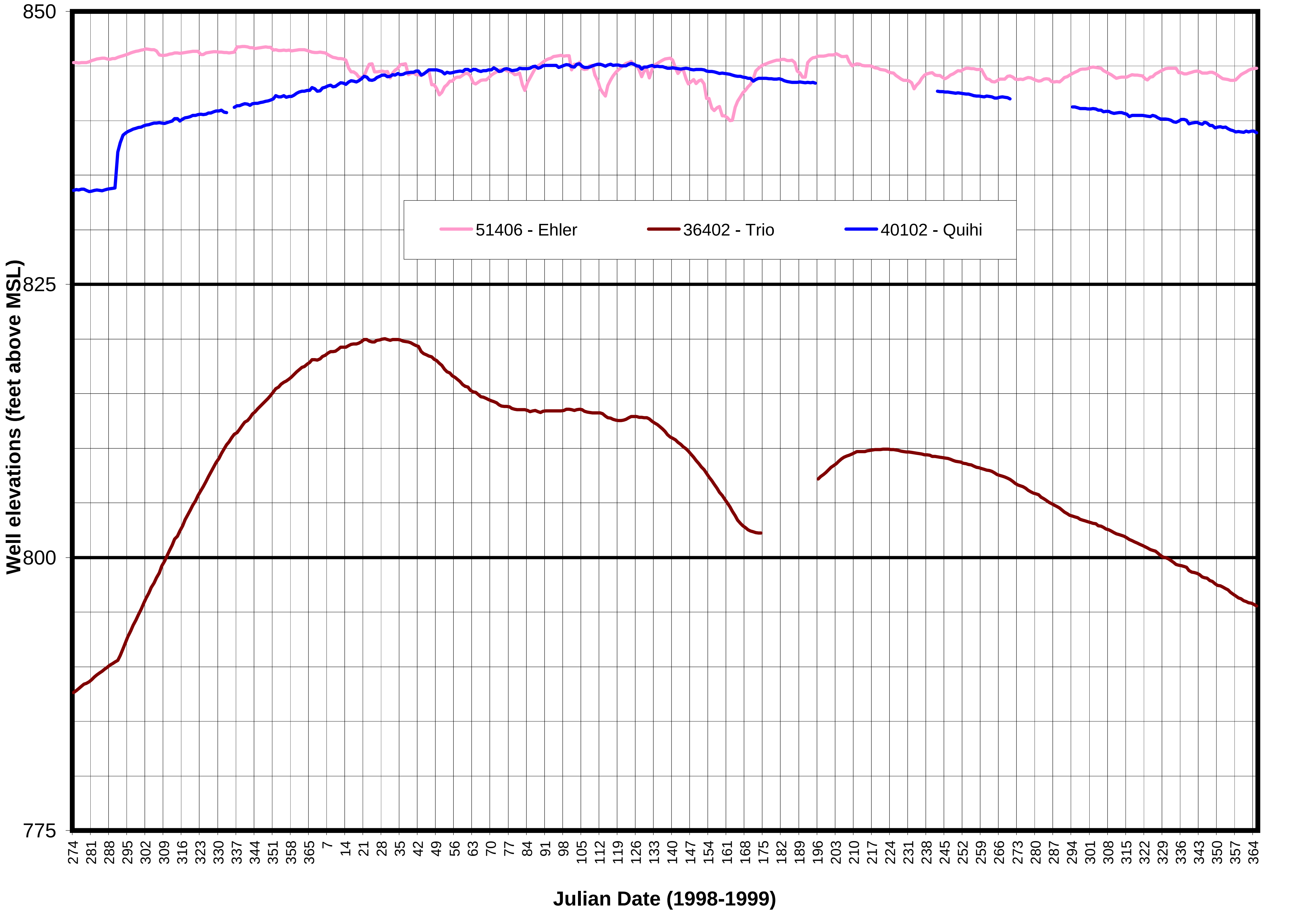


Figure A-22. Daily water elevations in monitor wells Uvalde and North Uvalde (October 1, 1998 to December 31, 1999)

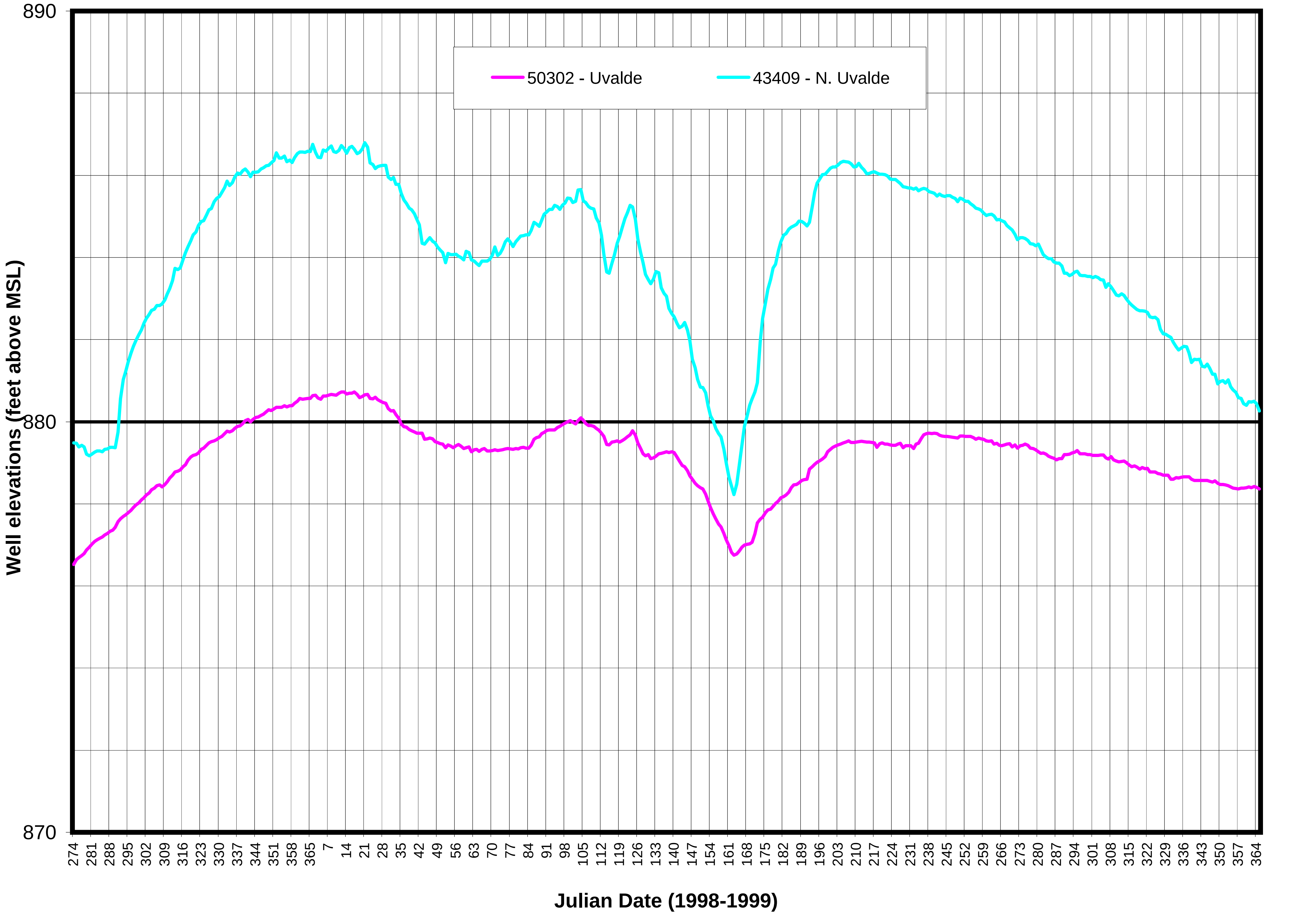


Figure 23. Daily water elevations in monitor wells Ehler and Quihi after removing any data gaps with cubic splining (October 11, 1998 to January 31, 1999)

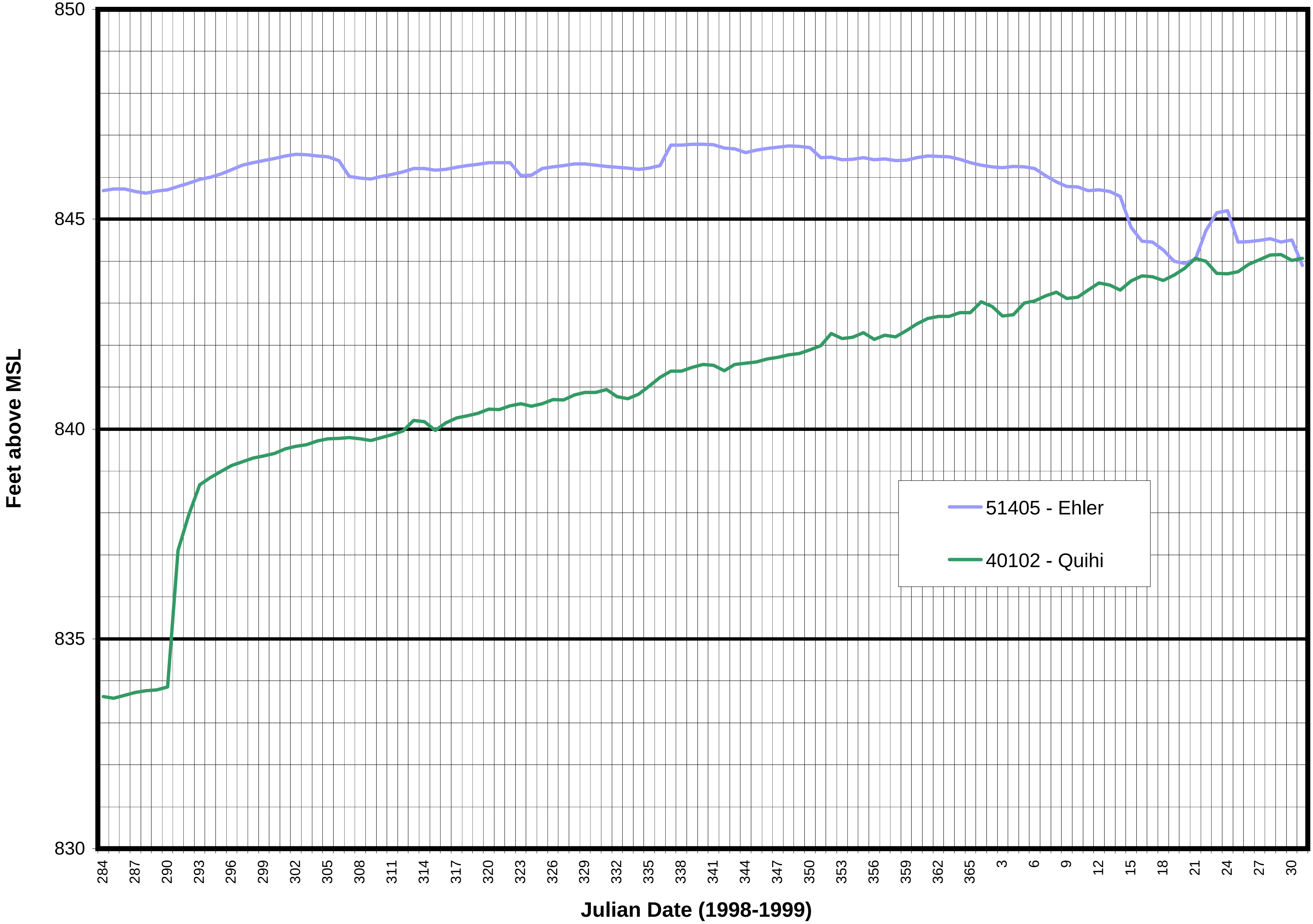


Figure A-24. Daily water elevations in monitor wells Hondo, J-17, Castroville, and Hill Country (October 1, 1998 to December 31, 1999)

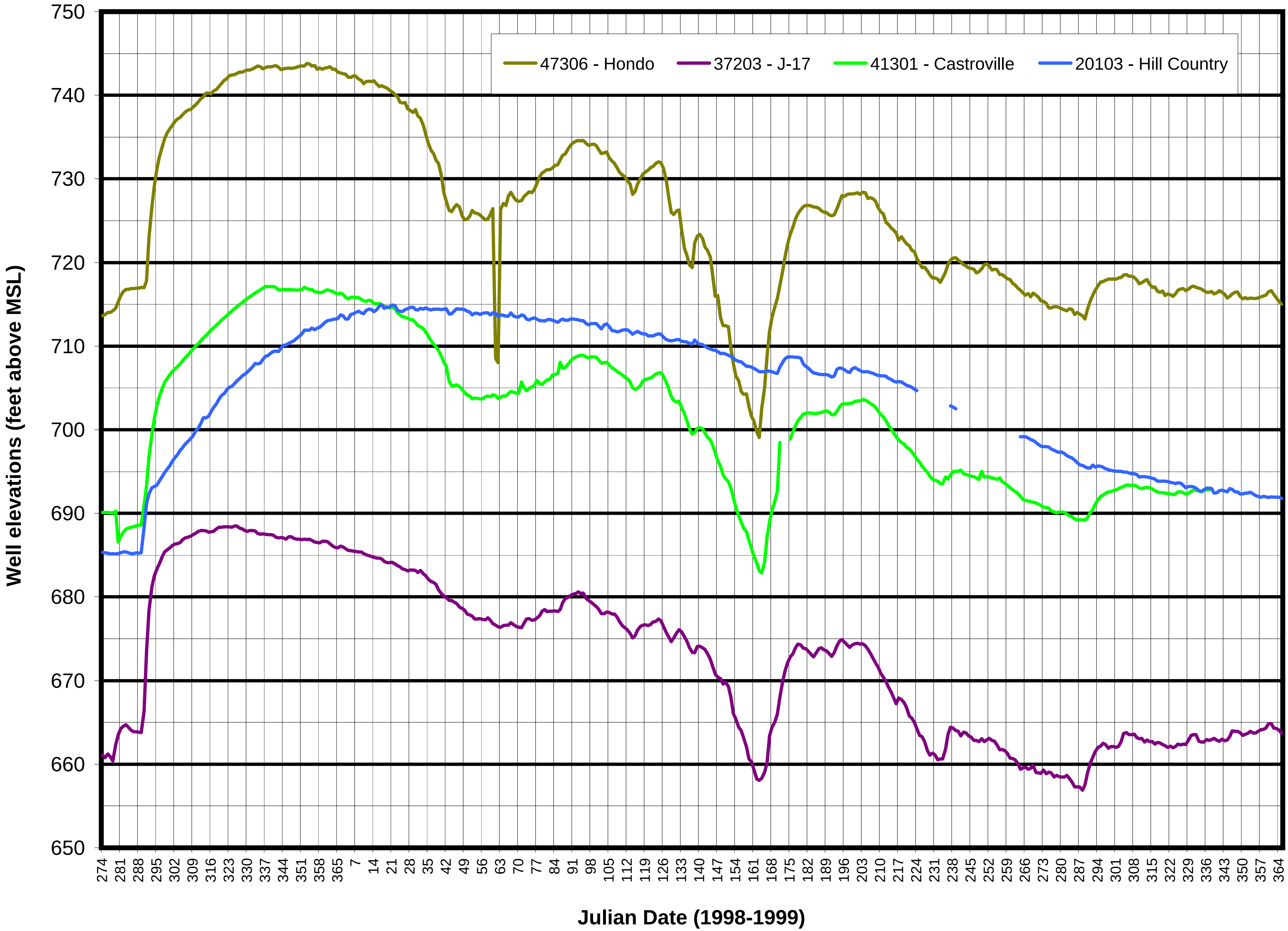


Figure A-25. Daily water elevations in 12 monitor wells using cubic splining to estimate missing data(October 1, 1998 to December 31, 1999)

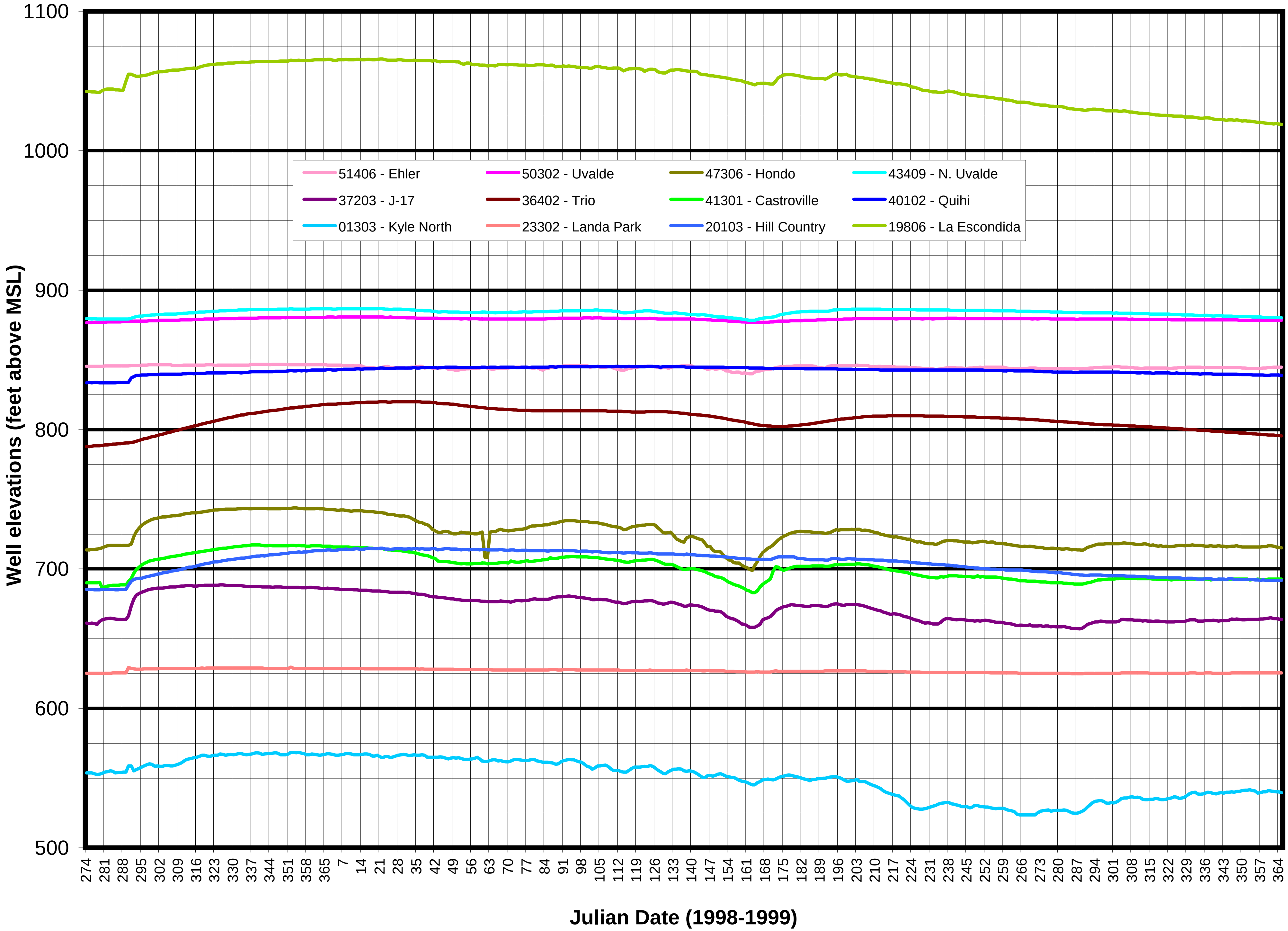


Figure A-26. Daily water elevations in 7 northern monitor wells using cubic splining to estimate missing data (October 1, 1998 to December 31, 1999)

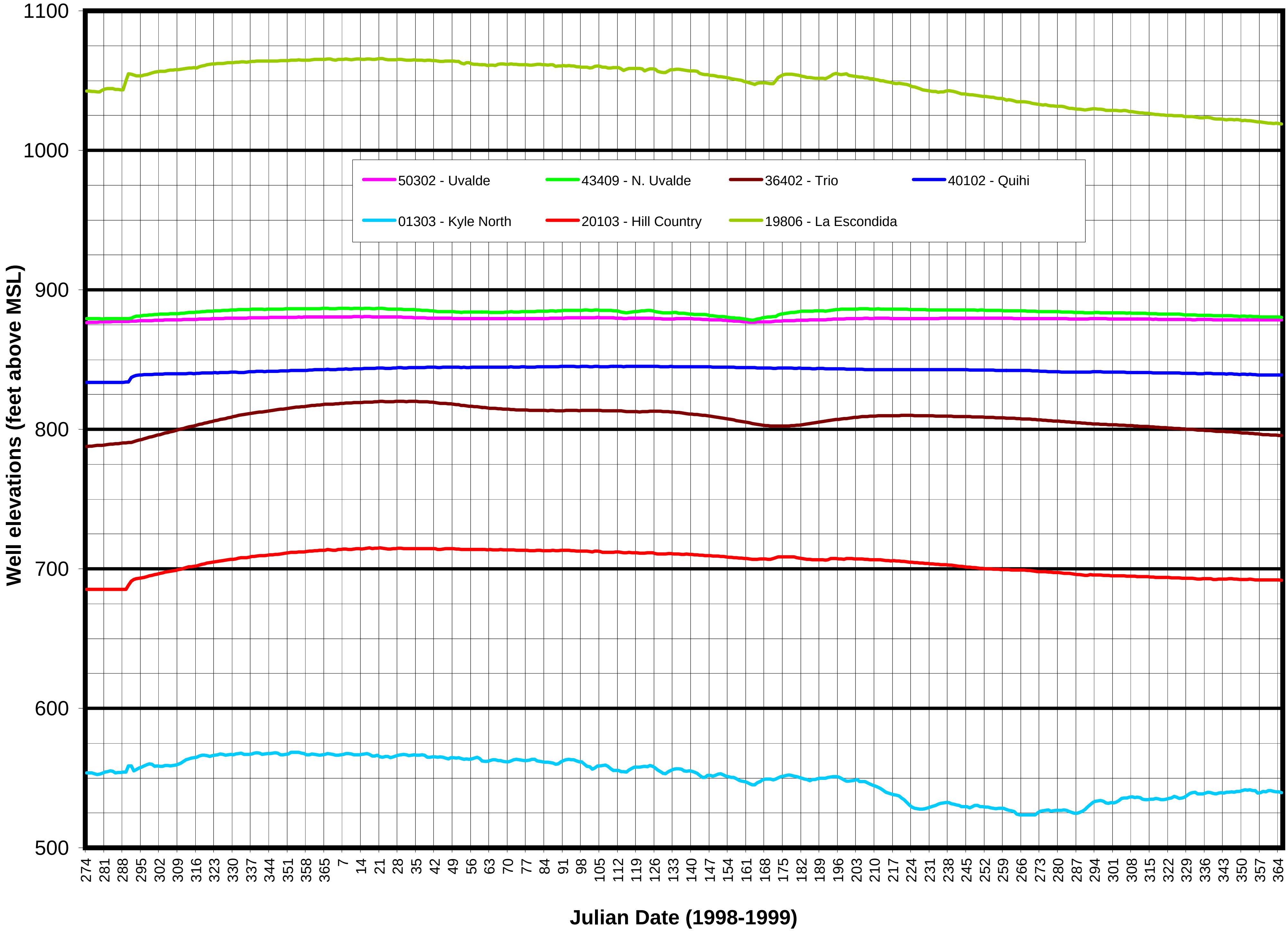


Figure A-27. Daily water elevations in 3 southern monitor wells using cubic splining to estimate missing data (October 1, 1998 to December 31, 1999)

Figure A-28. Correlation of Blanco River flow gages
(11 Oct., 1998 - 31 Jan., 1999)

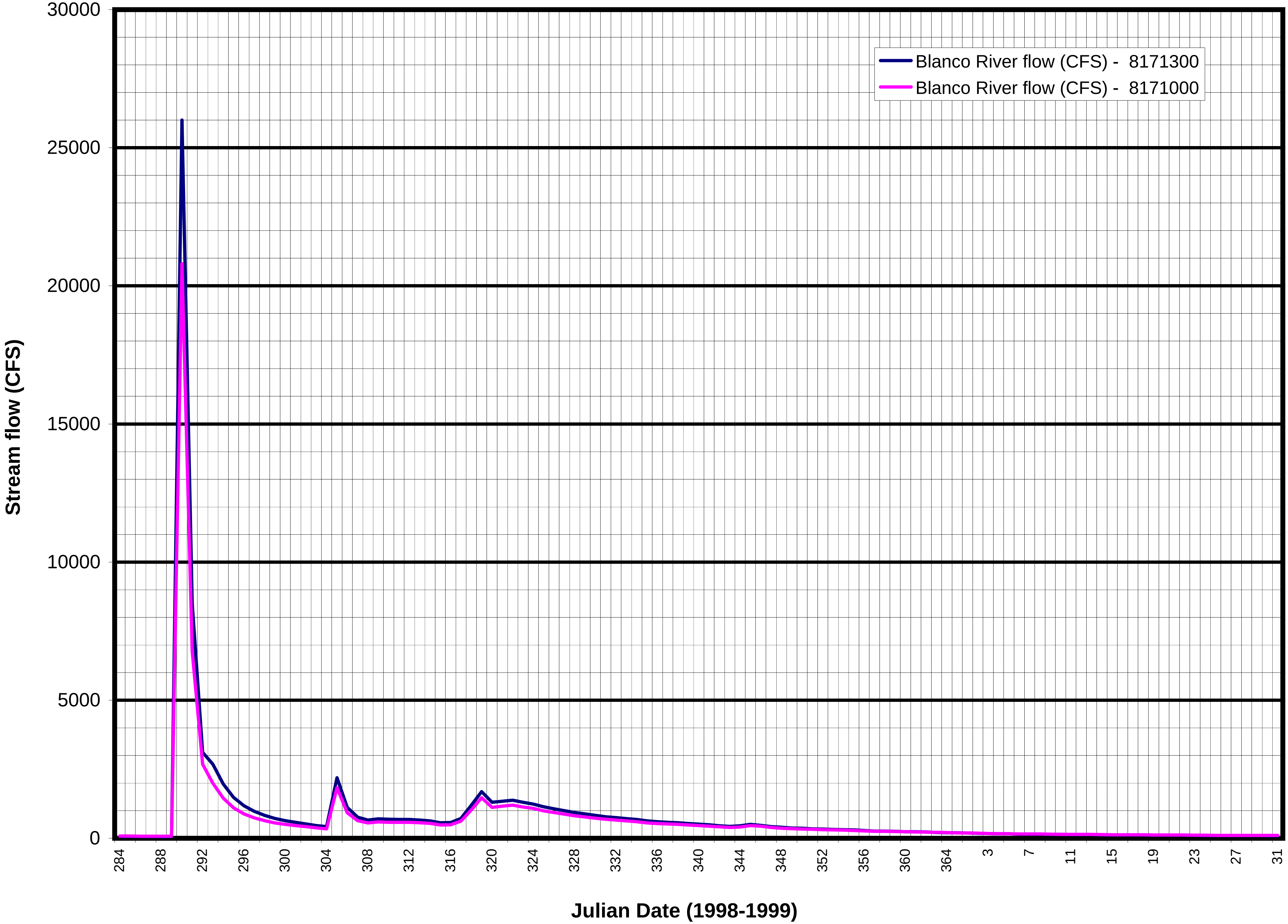


Figure A-29. Correlogram for cross-correlation of Ehler well (51406) vs. 11 other monitor wells

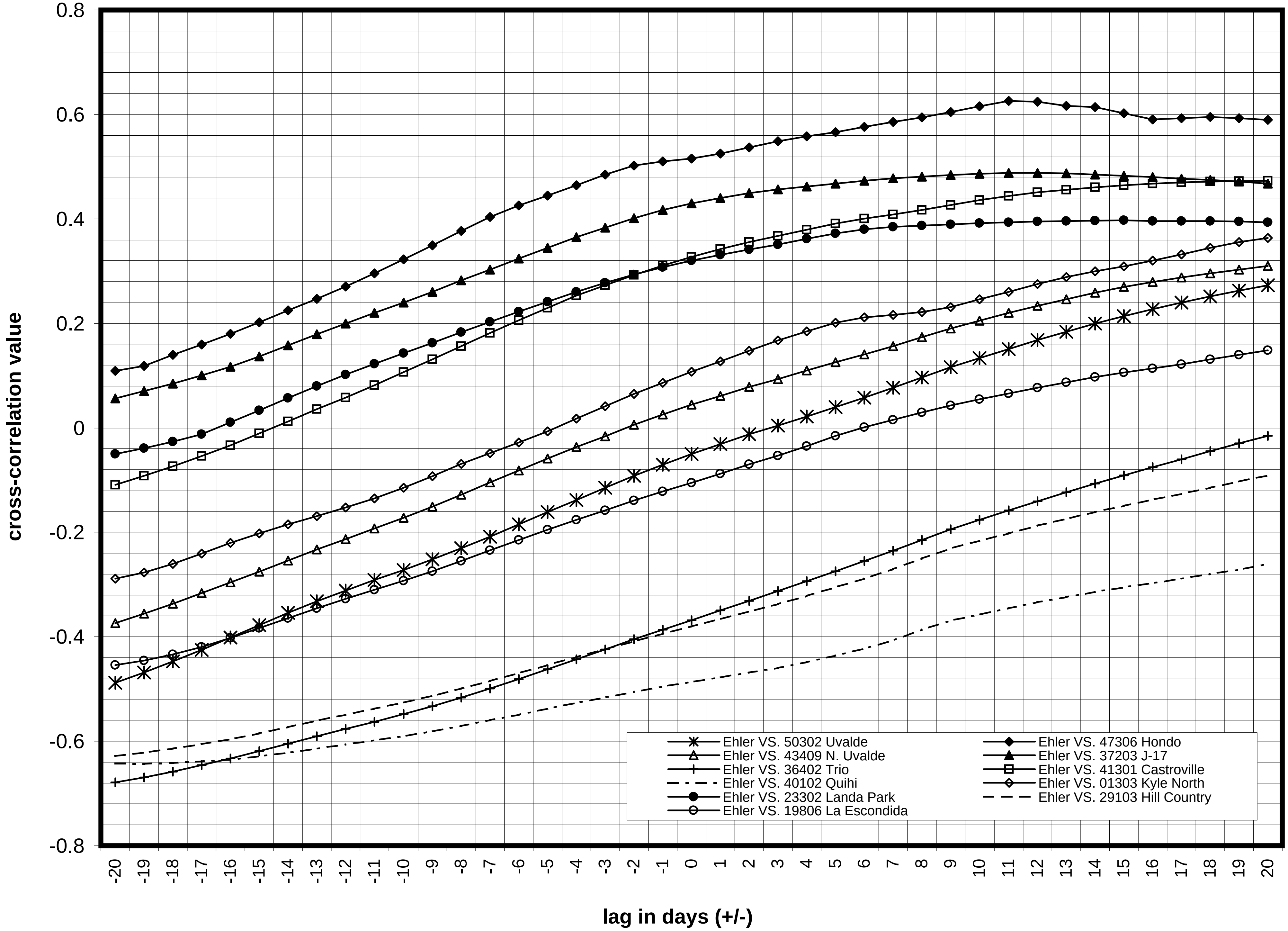


Figure A-30. Correlogram for cross-correlation of Uvalde well (51302) vs. 11 other monitor wells

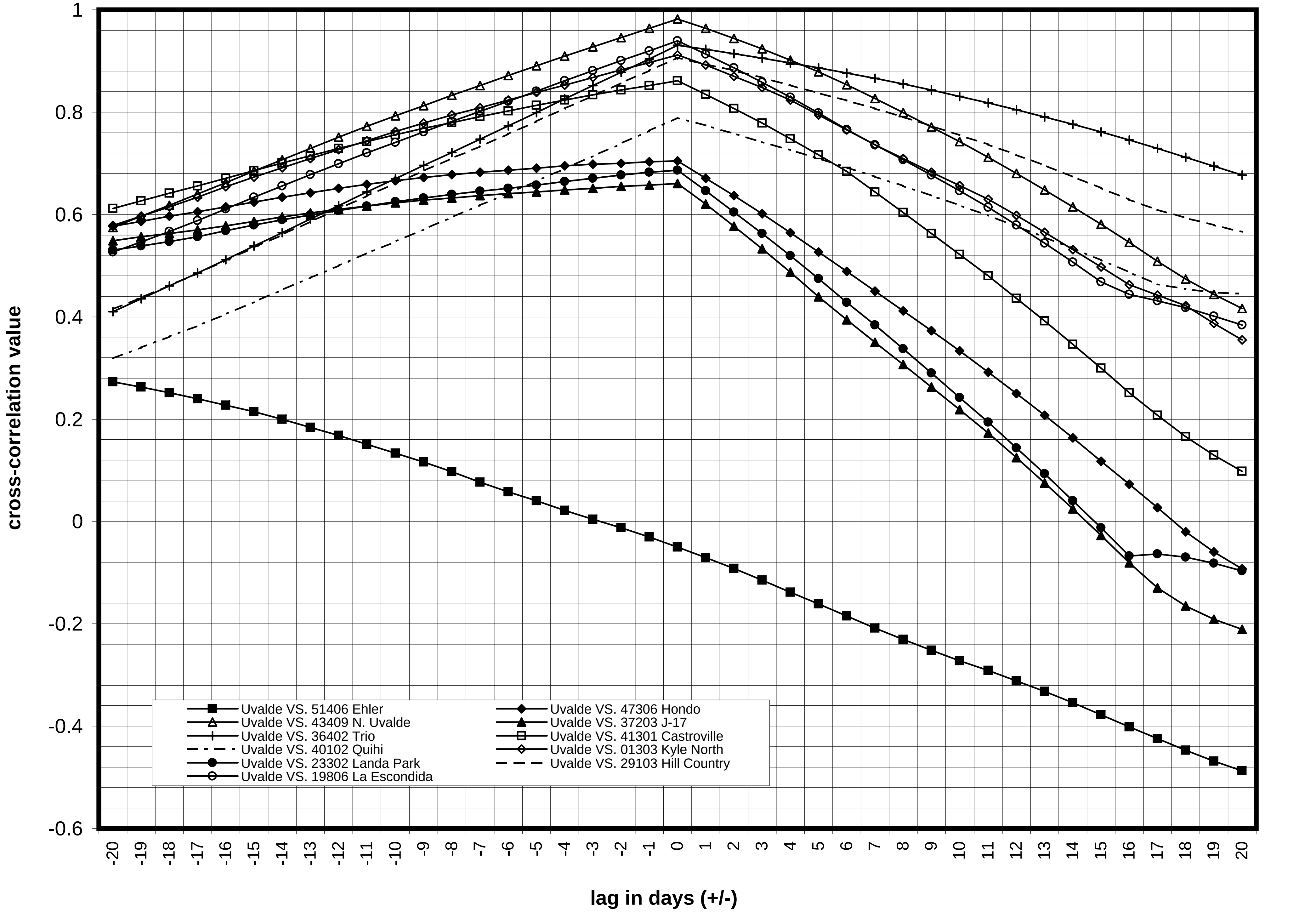


Figure A-31. Correlogram for cross-correlation of Hondo well (47306) vs. 11 other monitor wells

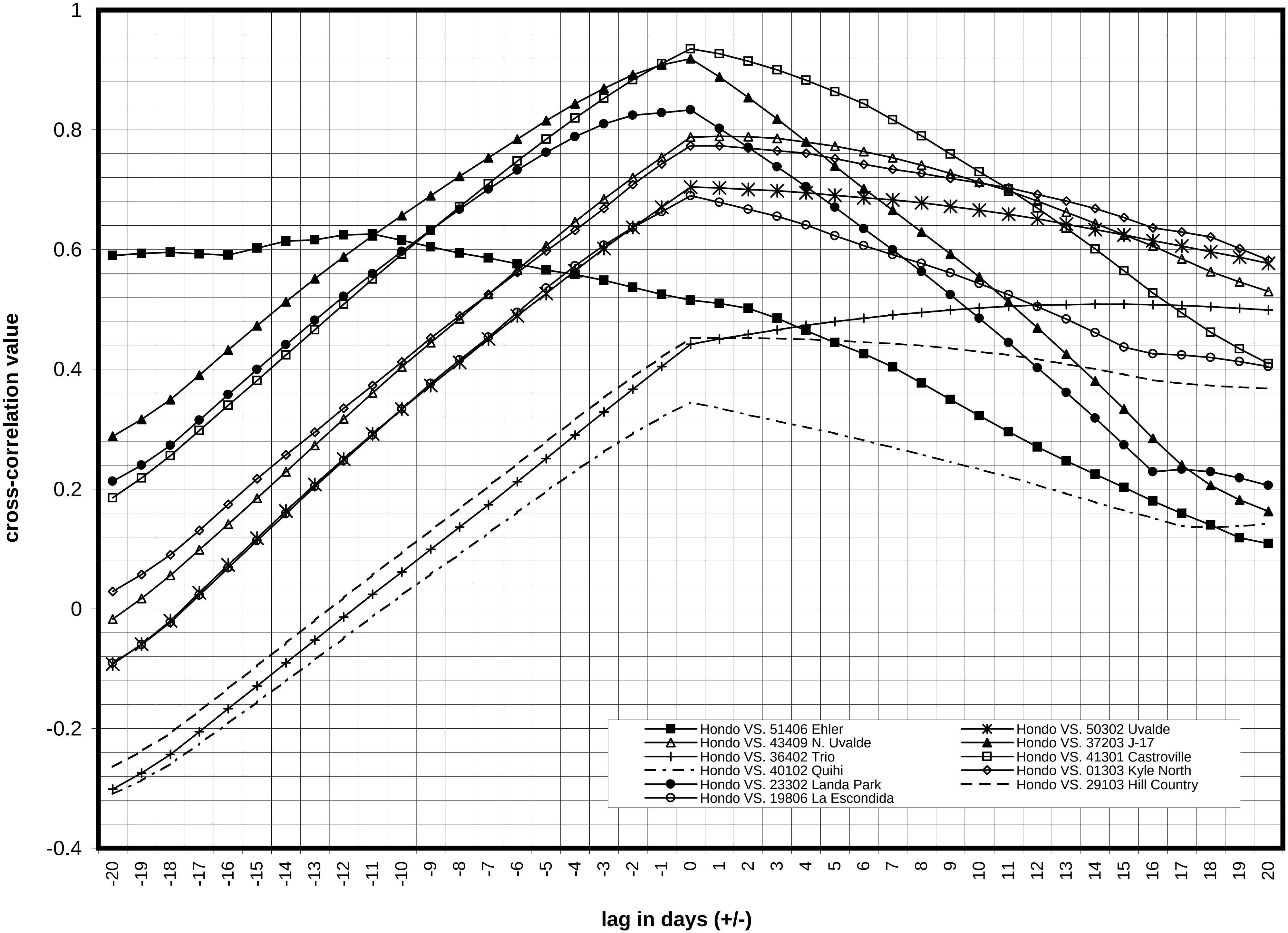


Figure A-32. Correlogram for cross-correlation of North Uvalde well (43409) vs. 11 other monitor wells

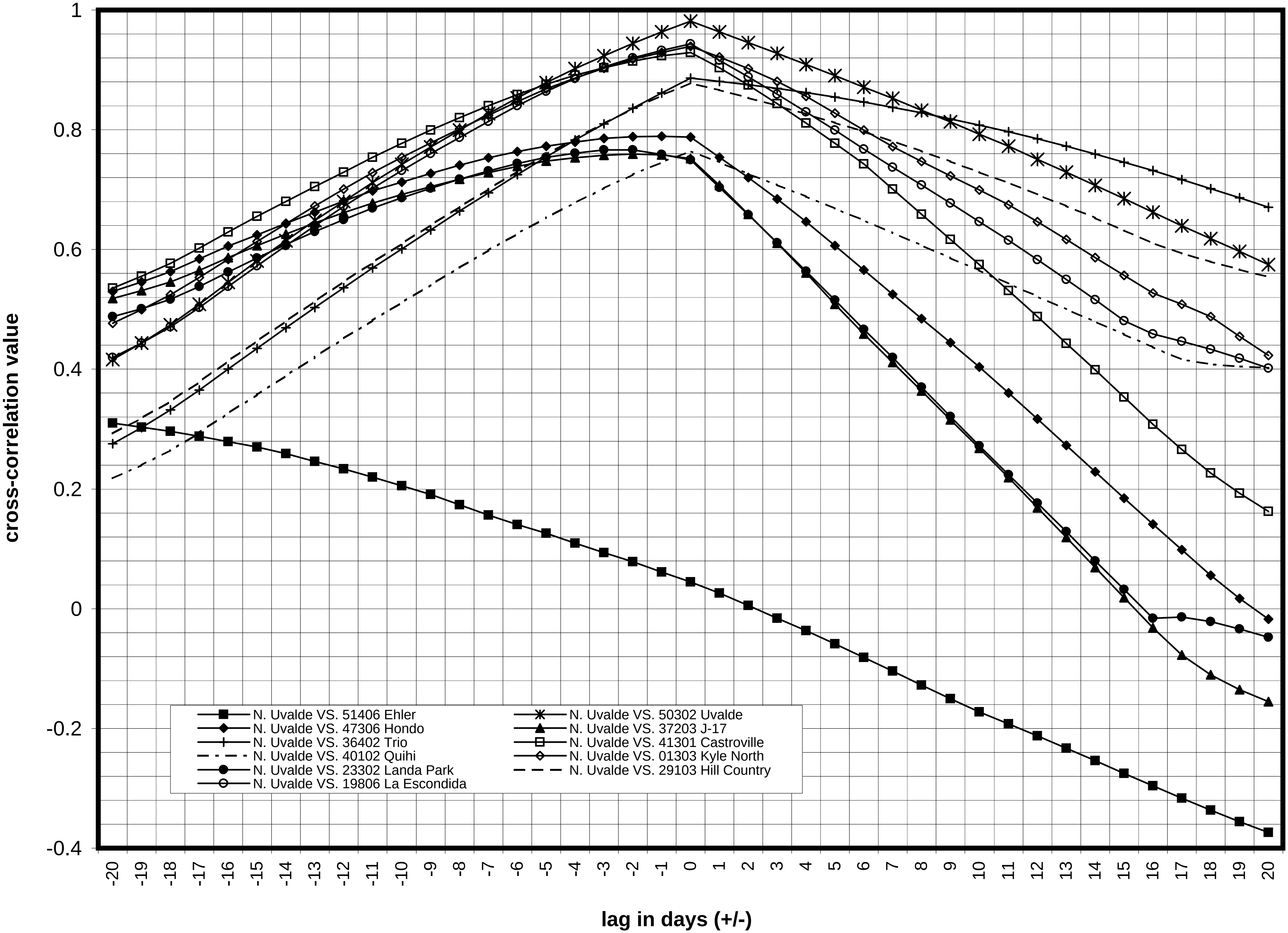


Figure A-33. Correlogram for cross-correlation of J-17 well (37203) vs. 11 other monitor wells

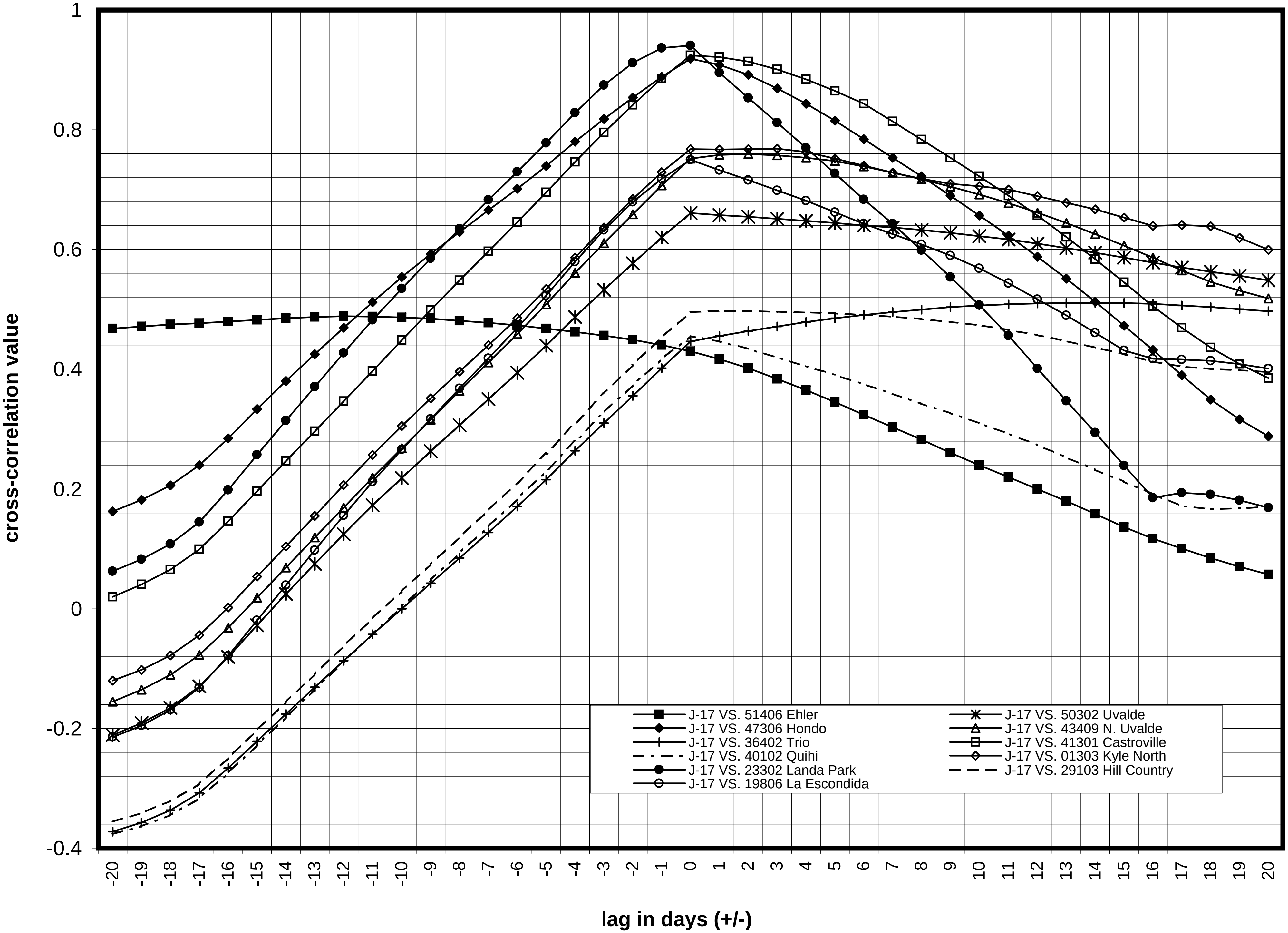


Figure A-34. Correlogram for cross-correlation of Trio well (36402) vs. 11 other monitor wells

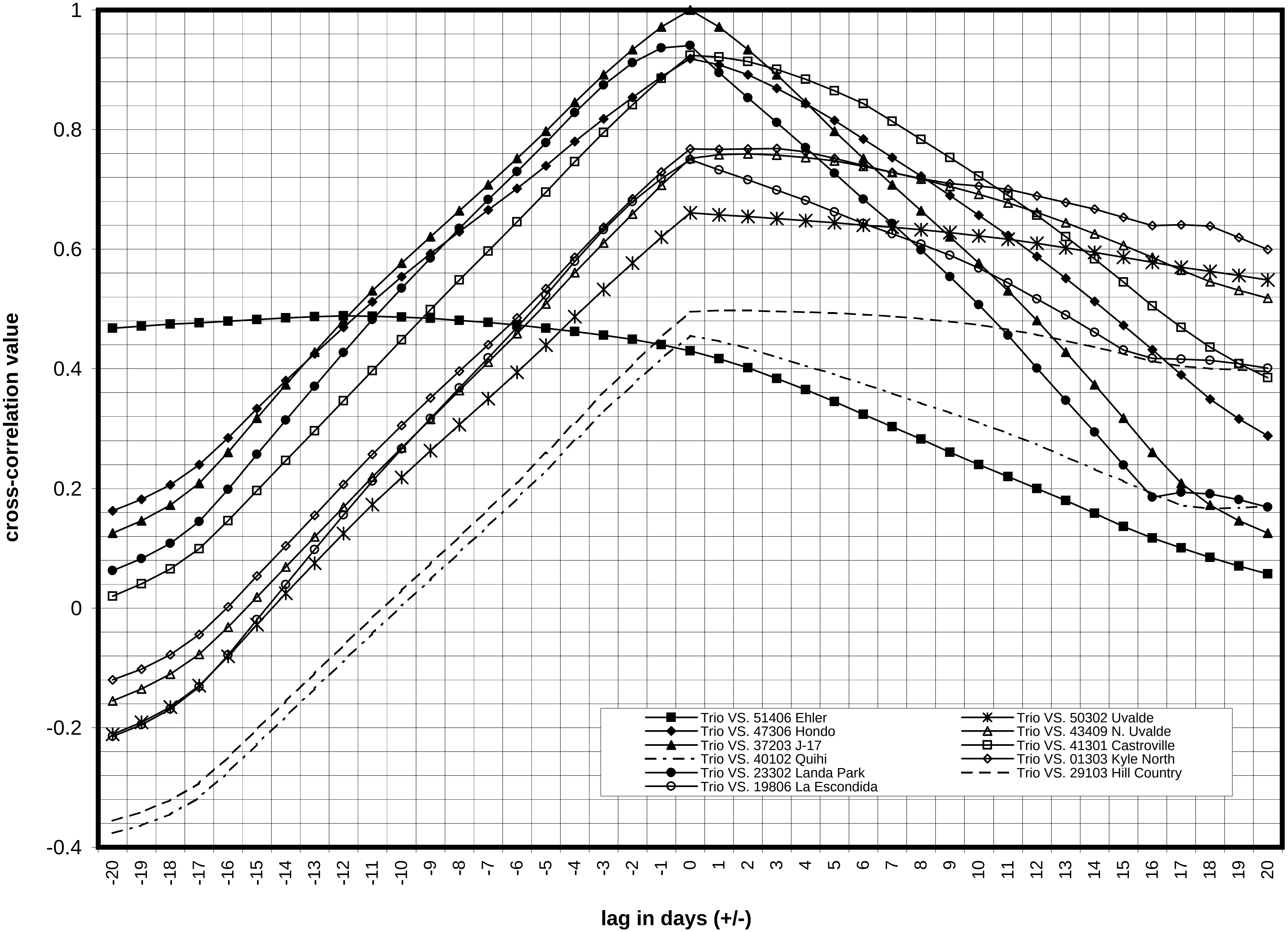


Figure A-35. Correlogram for cross-correlation of Castroville well (41301) vs. 11 other monitor wells

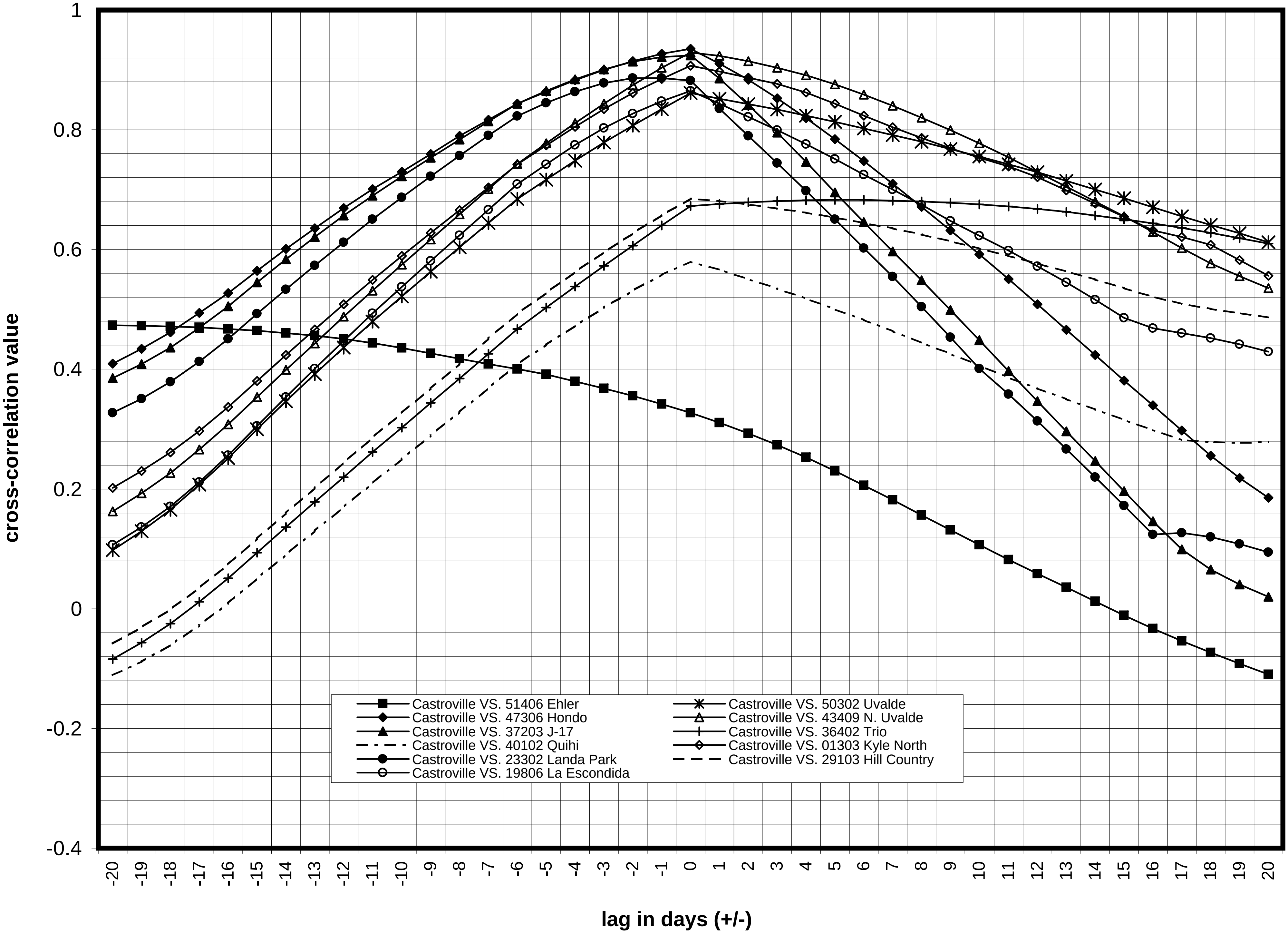


Figure A-36. Correlogram for cross-correlation of Quihi well (40102) vs. 11 other monitor wells

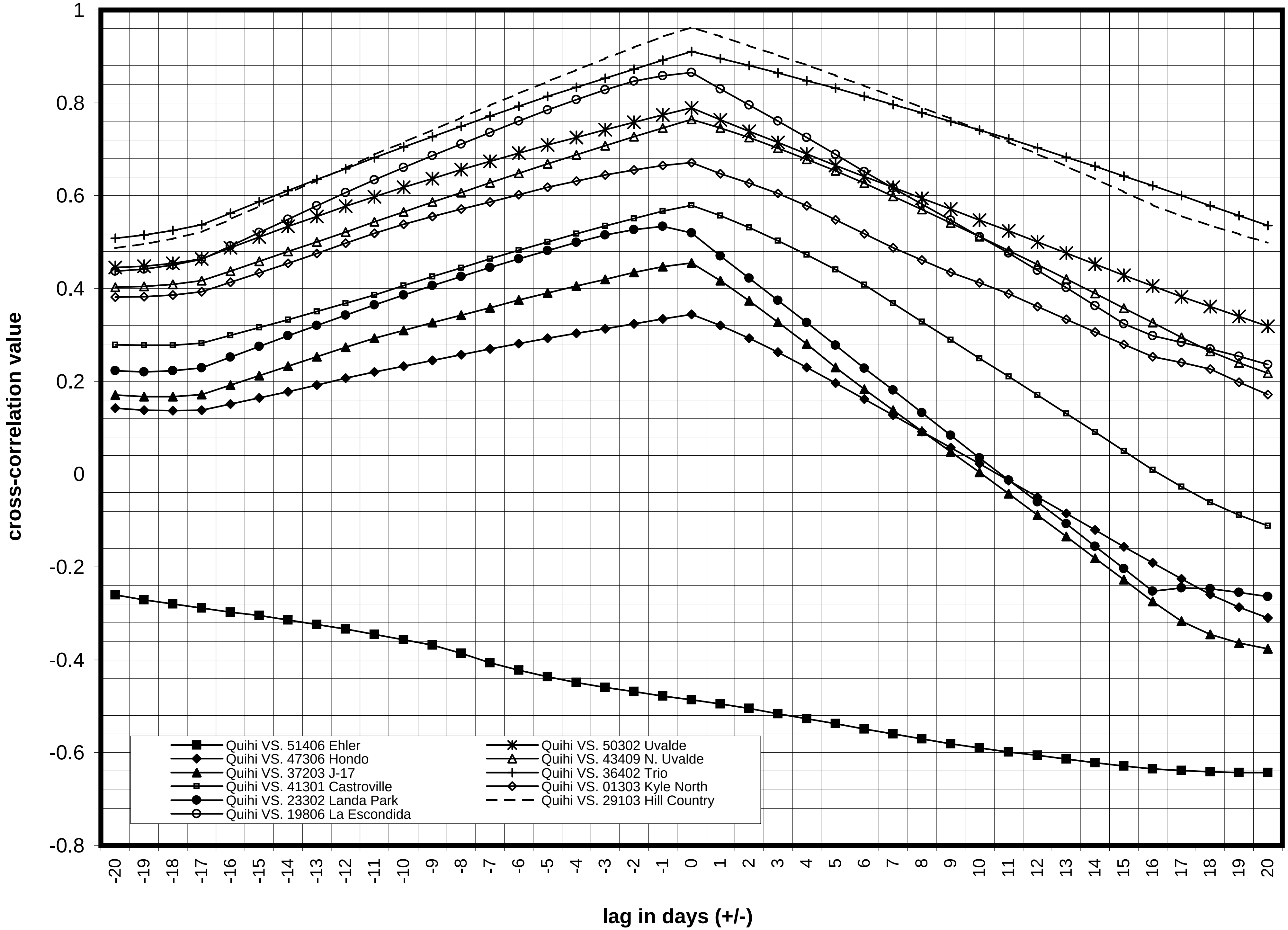


Figure A-37. Correlogram for cross-correlation of Kyle North well (01303) vs. 11 other monitor wells

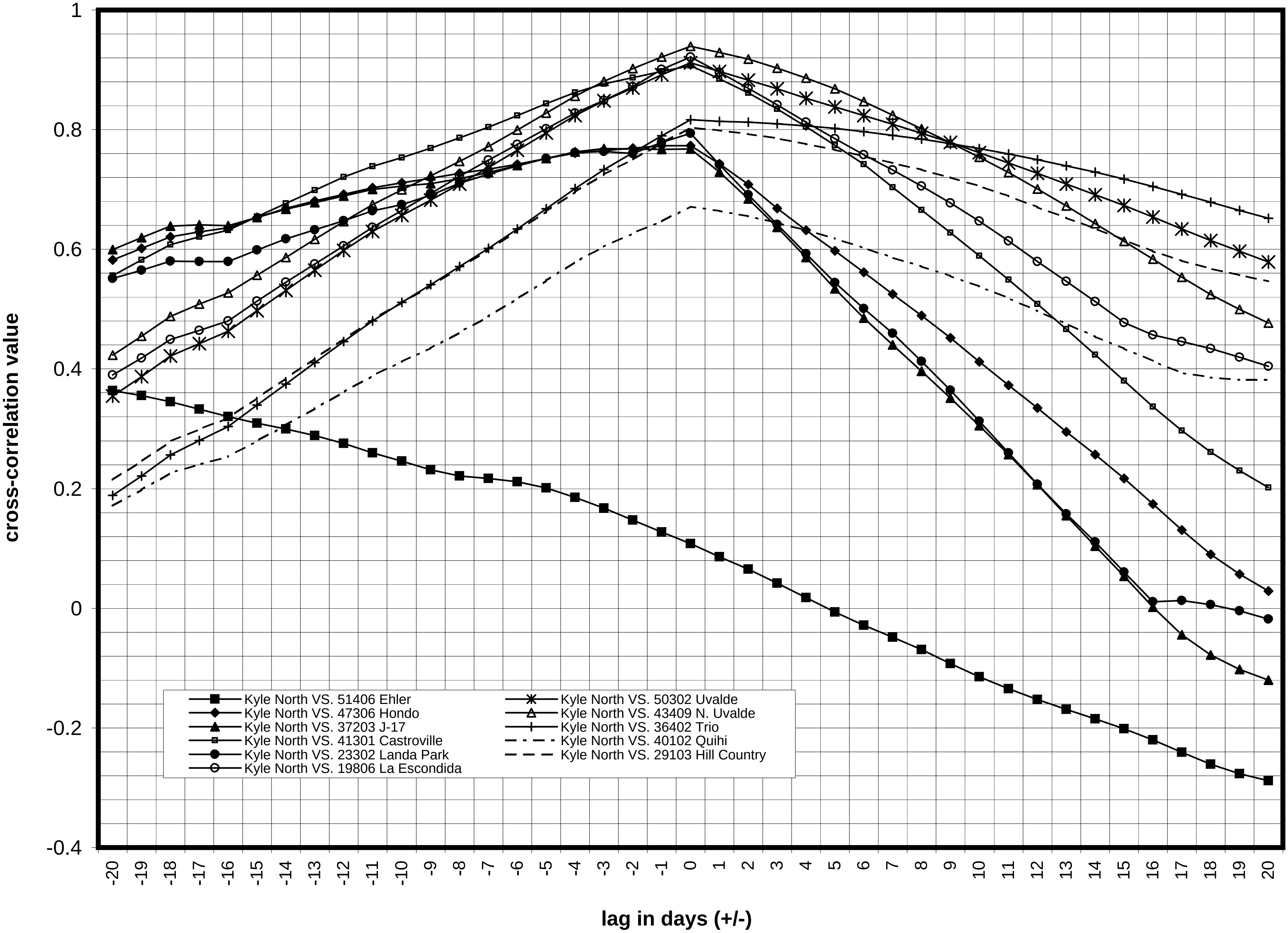


Figure A-38. Correlogram for cross-correlation of Landa Park well (23302) vs. 11 other monitor wells

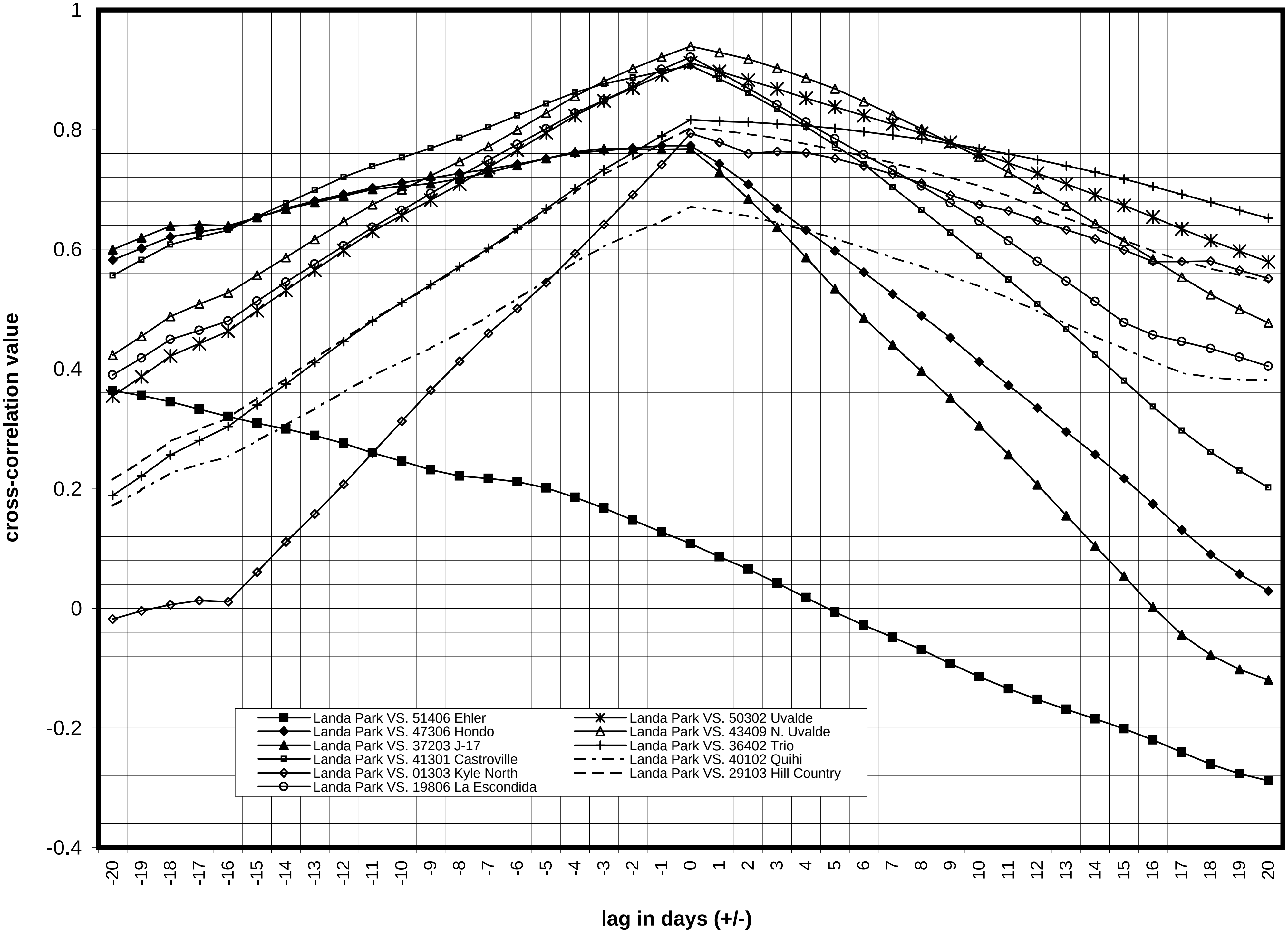


Figure A-39. Correlogram for cross-correlation of Hill Country well (29103) vs. 11 other monitor wells

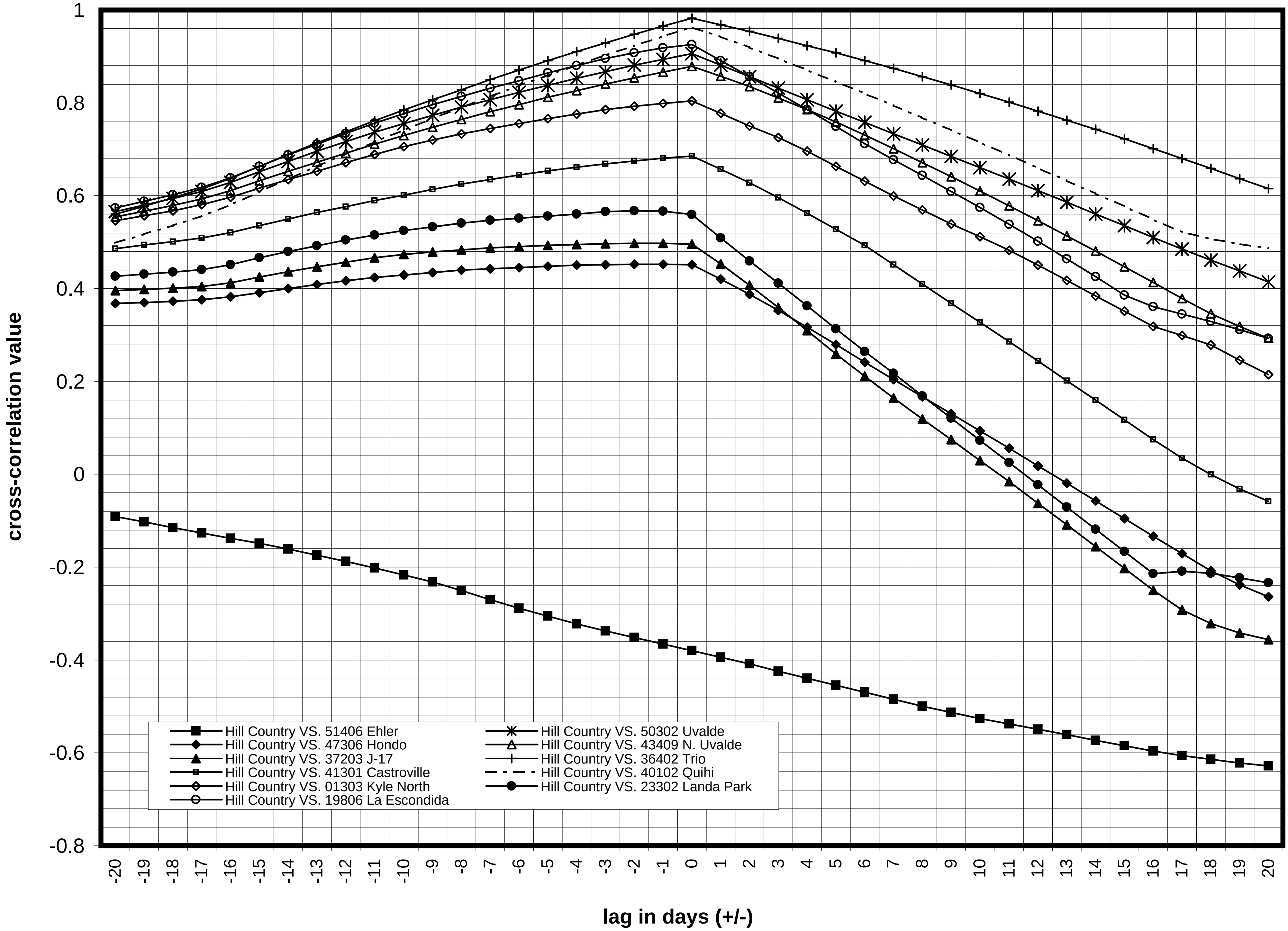
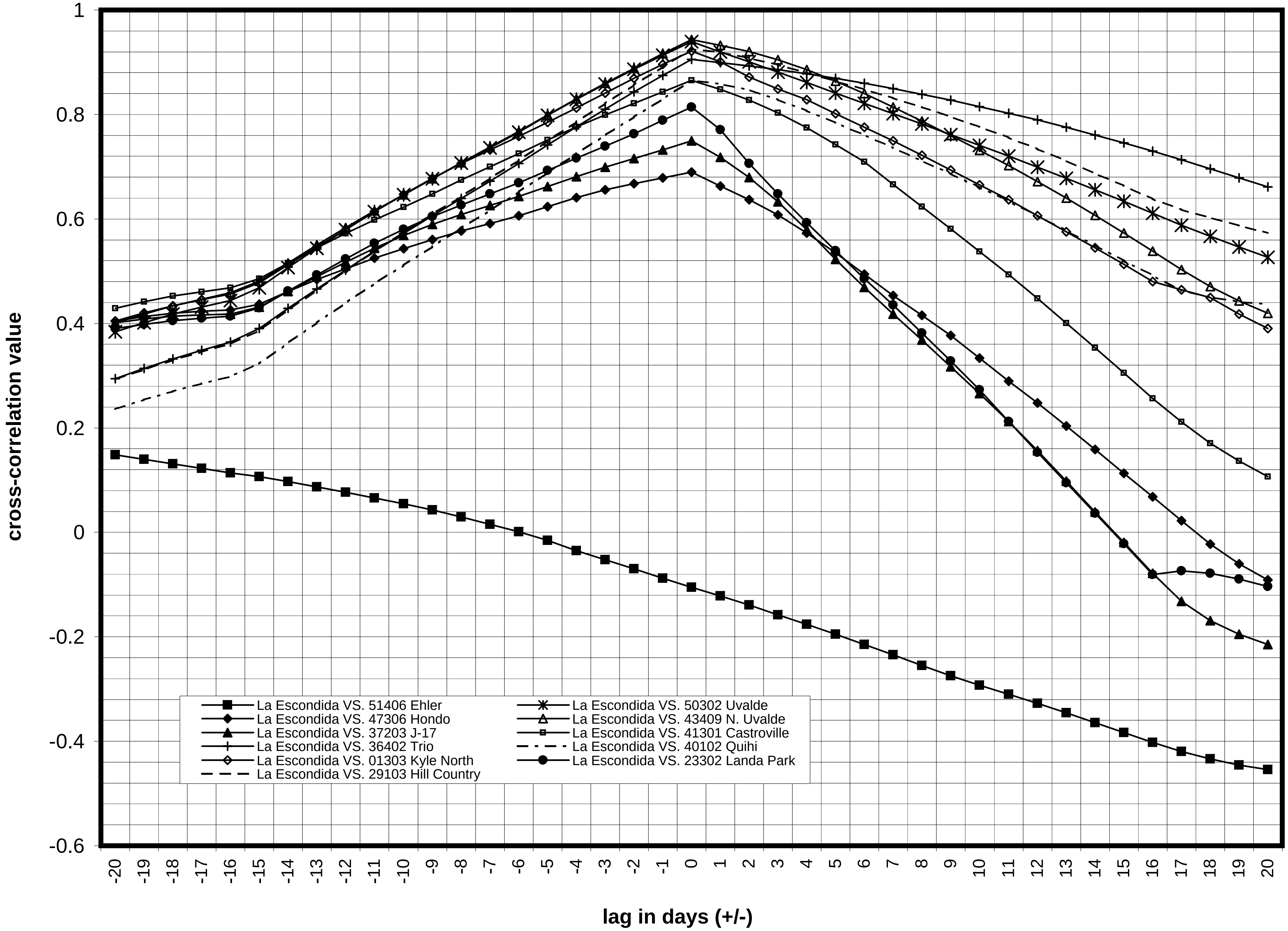


Figure A-40. Correlogram for cross-correlation of La Escondida well (19806) vs. 11 other monitor wells



B-1. Daily Precipitation Data (1998-1999)

Given in 1/100 inch **Note: n/d = no data**

Index of Precipitation Gages

1	**410832 - Blanco**	13	**415742 - Medina 2 W**
2	**410902 - Boerne**	14	**415746 - Medina Lake**
3	**411007 - Brackettville**	15	**416276 - New Braunfels**
4	**411215 - Bulverde**	16	**417628 - Rio Medina**
5	**411398 - Camp Wood**	17	**417706 - Rocksprings**
6	**411429 - Canyon Dam Daily**	18	**417873 - Sabinal**
7	**411431 - Canyon Dam No 1**	19	**417945 - San Antonio Intl Airport**
8	**411492 - Carta Valley 4 W**	20	**418169 - San Antonio Seaworld**
9	**414254 - Hondo**	21	**418845 - Tarpley**
10	**414374 - Hunt**	22	**419260 - Utopia**
11	**414782 - Kerrville 3 NNE**	23	**419268 - Uvalde Research Center**
12	**415113 - Leakey Daily**	24	**419815 - Wimberley 2 ESE**

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
01-Jan-98	1	0	0	n/d	0	5	0	13	0	0	0	0	0
02-Jan-98	2	3	0	9	3	2	9	6	0	8	0	1	0
03-Jan-98	3	0	3	1	5	0	1	2	0	1	0	4	0
04-Jan-98	4	5	3	5	6	0	5	12	0	0	0	0	0
05-Jan-98	5	9	10	20	5	0	20	4	0	3	0	2	0
06-Jan-98	6	4	4	2	6	0	2	84	0	1	211	45	120
07-Jan-98	7	52	65	194	200	4	194	0	0	38	136	46	0
08-Jan-98	8	0	0	1	0	0	1	0	0	0	15	0	0
09-Jan-98	9	0	0	0	0	0	0	0	0	0	0	0	0
10-Jan-98	10	2	0	0	3	0	0	3	0	0	0	0	0
11-Jan-98	11	3	0	0	3	0	0	3	0	6	31	3	0
12-Jan-98	12	0	0	0	0	0	0	0	0	1	0	2	0
13-Jan-98	13	0	0	0	0	0	0	0	0	0	0	0	0
14-Jan-98	14	2	0	0	0	0	0	0	0	2	0	1	0
15-Jan-98	15	0	0	0	0	0	0	0	0	0	0	0	0
16-Jan-98	16	0	0	0	0	0	0	0	0	0	0	0	0
17-Jan-98	17	0	0	0	0	0	0	0	0	0	0	0	0
18-Jan-98	18	0	0	0	0	0	0	0	0	0	0	0	0
19-Jan-98	19	0	0	0	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
20-Jan-98	20	0	0	0	0	0	0	0	0	0	0	0	0
21-Jan-98	21	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan-98	22	0	0	0	0	0	0	0	0	0	0	0	0
23-Jan-98	23	0	0	0	0	0	0	0	0	0	0	0	0
24-Jan-98	24	0	0	0	0	0	0	0	0	0	0	0	0
25-Jan-98	25	0	0	0	0	0	0	0	0	0	0	0	0
26-Jan-98	26	0	0	0	0	0	0	0	0	0	0	0	0
27-Jan-98	27	0	0	0	0	0	0	0	0	0	0	0	0
28-Jan-98	28	0	0	0	0	0	0	0	0	0	0	0	0
29-Jan-98	29	0	0	0	0	0	0	0	0	0	0	0	0
30-Jan-98	30	0	0	0	0	0	0	48	0	0	0	0	0
31-Jan-98	31	82	153	64	106	150	64	133	225	27	151	52	250
01-Feb-98	32	215	184	259	128	0	259	0	5	129	25	85	0
02-Feb-98	33	0	0	0	0	0	0	0	0	0	0	0	0
03-Feb-98	34	0	0	0	0	0	0	0	0	0	0	0	0
04-Feb-98	35	0	0	0	0	0	0	14	0	0	0	0	0
05-Feb-98	36	22	17	4	7	9	4	33	18	10	0	24	0
06-Feb-98	37	0	0	14	8	0	14	0	0	0	2	3	0
07-Feb-98	38	0	0	1	0	0	1	0	0	0	0	0	0
08-Feb-98	39	0	0	0	0	0	0	0	0	0	0	0	0
09-Feb-98	40	0	0	0	0	0	0	13	0	0	0	0	0
10-Feb-98	41	6	12	10	5	20	10	15	15	14	34	84	50
11-Feb-98	42	18	24	12	16	0	12	0	0	5	0	10	0
12-Feb-98	43	0	0	0	124	0	0	0	0	0	0	0	0
13-Feb-98	44	16	18	29	0	0	29	0	0	0	0	3	0
14-Feb-98	45	0	0	73	0	11	73	75	20	34	0	0	0
15-Feb-98	46	106	123	42	0	0	42	58	0	102	23	12	0
16-Feb-98	47	38	22	64	55	28	64	0	50	48	0	10	0
17-Feb-98	48	0	0	0	0	0	0	0	0	0	0	0	0
18-Feb-98	49	0	0	0	0	0	0	0	0	0	0	0	0
19-Feb-98	50	2	0	0	0	0	0	0	0	0	0	0	0
20-Feb-98	51	0	0	0	0	0	0	0	0	0	0	0	0
21-Feb-98	52	0	0	0	0	0	0	94	0	0	3	0	0
22-Feb-98	53	114	208	77	123	52	77	0	0	15	147	83	0
23-Feb-98	54	0	0	0	0	0	0	0	0	0	0	0	0
24-Feb-98	55	0	0	0	0	0	0	0	0	0	0	0	0
25-Feb-98	56	0	0	0	0	0	0	84	0	n/d	2	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
26-Feb-98	57	54	83	56	121	33	56	0	20	35	30	38	67
27-Feb-98	58	0	0	0	0	0	0	0	0	0	0	0	0
28-Feb-98	59	0	0	0	0	0	0	0	0	0	0	0	0
01-Mar-98	60	0	0	0	0	0	0	0	0	0	0	0	0
02-Mar-98	61	0	0	0	0	0	0	0	0	0	0	0	0
04-Mar-98	62	0	0	0	0	0	0	0	0	0	0	0	0
05-Mar-98	63	0	0	0	0	0	0	0	0	0	0	0	0
06-Mar-98	64	4	0	2	0	0	2	0	0	0	1	1	0
07-Mar-98	65	1	2	0	0	0	0	3	0	0	0	0	0
08-Mar-98	66	4	5	2	7	3	2	33	0	3	0	2	0
09-Mar-98	67	8	14	40	0	7	40	0	0	2	9	4	0
10-Mar-98	68	0	0	0	0	0	0	0	0	0	0	0	0
11-Mar-98	69	0	0	0	0	0	0	0	0	0	0	0	0
12-Mar-98	70	0	0	0	0	0	0	0	0	0	0	0	0
13-Mar-98	71	0	0	0	0	0	0	20	0	0	0	0	0
14-Mar-98	72	2	18	19	25	15	19	42	0	28	4	5	0
14-Mar-98	73	23	59	42	95	10	42	40	0	36	9	20	0
15-Mar-98	74	37	68	38	0	15	38	215	0	33	0	24	230
16-Mar-98	75	208	400	166	233	107	166	0	215	264	201	198	0
17-Mar-98	76	0	0	0	0	0	0	0	0	0	0	0	0
18-Mar-98	77	0	0	0	0	0	0	3	0	4	0	0	0
19-Mar-98	78	18	15	4	0	0	4	0	0	0	0	7	0
20-Mar-98	79	0	0	0	0	0	0	0	0	0	0	0	0
21-Mar-98	80	0	0	0	0	0	0	0	0	0	0	0	0
22-Mar-98	81	0	0	0	0	0	0	0	0	0	0	0	0
23-Mar-98	82	0	0	0	0	0	0	0	0	0	0	0	0
24-Mar-98	83	0	0	0	0	0	0	0	0	0	0	0	0
25-Mar-98	84	0	0	0	0	0	0	0	0	0	0	0	0
26-Mar-98	85	0	0	0	0	0	0	0	0	0	0	0	0
27-Mar-98	86	0	0	0	0	9	0	4	0	1	17	14	70
28-Mar-98	87	0	9	6	4	0	6	0	0	0	0	0	0
29-Mar-98	88	0	0	0	0	0	0	0	0	0	0	0	0
30-Mar-98	89	0	0	0	14	1	0	39	0	0	0	0	0
31-Mar-98	90	198	105	25	0	0	25	0	0	2	0	0	0
01-Apr-98	91	0	0	0	0	0	0	0	0	0	0	0	0
02-Apr-98	92	0	0	0	0	0	0	0	0	0	0	0	0
03-Apr-98	93	0	0	0	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
04-Apr-98	94	0	0	0	0	0	0	0	0	0	0	0	0
05-Apr-98	95	0	0	0	0	0	0	0	0	0	0	0	0
06-Apr-98	96	0	0	0	0	0	0	0	0	0	0	0	0
07-Apr-98	97	0	0	0	0	0	0	4	0	0	0	0	0
08-Apr-98	98	65	0	11	0	0	11	0	0	0	0	25	0
09-Apr-98	99	0	0	0	0	0	0	0	0	0	0	0	0
10-Apr-98	100	0	0	0	0	0	0	0	0	0	0	0	0
11-Apr-98	101	0	0	0	0	0	0	0	0	0	0	0	0
12-Apr-98	102	0	0	0	0	0	0	4	0	0	0	0	0
13-Apr-98	103	2	0	3	0	0	3	0	0	0	0	0	0
14-Apr-98	104	0	0	0	0	0	0	0	0	0	0	0	0
15-Apr-98	105	0	0	0	0	0	0	0	0	0	0	0	0
16-Apr-98	106	0	0	0	0	0	0	0	0	0	0	0	0
17-Apr-98	107	0	0	0	0	0	0	3	0	0	0	0	0
18-Apr-98	108	0	0	1	0	0	1	0	0	2	0	0	0
19-Apr-98	109	0	0	0	0	0	0	0	0	0	0	0	0
20-Apr-98	110	0	0	0	0	0	0	0	0	0	0	0	0
21-Apr-98	111	0	0	0	0	0	0	0	0	0	0	0	0
22-Apr-98	112	0	0	0	0	0	0	0	0	0	0	0	0
23-Apr-98	113	0	0	0	0	0	0	0	0	0	0	0	0
24-Apr-98	114	0	0	0	0	0	0	0	0	0	0	0	0
25-Apr-98	115	0	0	0	3	0	0	0	0	0	0	0	0
26-Apr-98	116	0	0	0	4	0	0	13	0	0	0	0	0
27-Apr-98	117	0	57	20	0	0	20	0	0	4	0	3	0
28-Apr-98	118	0	0	0	0	0	0	0	0	0	0	0	0
29-Apr-98	119	0	0	0	0	0	0	0	0	0	0	0	0
30-Apr-98	120	0	0	0	0	0	0	0	0	0	0	0	0
01-May-98	121	0	0	0	0	0	0	0	0	0	0	0	0
02-May-98	122	3	0	7	0	0	7	0	0	0	0	0	0
03-May-98	123	0	0	0	0	0	0	0	0	0	0	0	0
04-May-98	124	0	0	0	0	0	0	0	0	0	0	0	0
05-May-98	125	0	0	0	0	0	0	0	0	0	0	0	0
06-May-98	126	0	0	0	0	0	0	0	0	0	0	0	0
07-May-98	127	0	0	0	0	0	0	0	0	0	0	0	0
08-May-98	128	0	0	0	0	0	0	0	0	0	0	0	0
09-May-98	129	0	0	0	0	0	0	0	0	0	0	0	0
10-May-98	130	0	0	0	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
11-May-98	131	0	0	0	0	0	0	0	0	0	0	0	0
12-May-98	132	0	0	0	0	0	0	0	0	0	0	0	0
13-May-98	133	0	0	0	0	0	0	0	0	0	0	0	0
14-May-98	134	0	0	0	0	0	0	0	0	0	0	0	0
15-May-98	135	0	0	0	0	0	0	0	0	0	0	0	0
16-May-98	136	0	0	0	0	0	0	0	0	0	0	0	0
17-May-98	137	0	0	0	0	0	0	0	27	0	0	0	0
18-May-98	138	0	0	0	0	0	0	0	0	0	0	0	0
19-May-98	139	0	0	0	0	0	0	0	0	0	0	0	0
20-May-98	140	0	0	0	0	0	0	0	0	0	0	0	0
21-May-98	141	0	0	0	0	0	0	0	0	0	0	0	0
22-May-98	142	0	0	0	0	0	0	0	0	0	0	0	0
23-May-98	143	0	0	0	0	0	0	0	0	0	0	0	0
24-May-98	144	0	0	0	0	0	0	0	0	0	0	0	0
25-May-98	145	0	0	0	0	0	0	0	0	0	0	0	0
26-May-98	146	0	0	0	0	3	0	41	0	0	103	7	70
27-May-98	147	55	76	56	42	27	56	0	35	24	97	61	126
28-May-98	148	0	0	0	0	0	0	0	0	0	0	0	0
29-May-98	149	0	0	0	0	0	0	0	0	0	0	0	0
30-May-98	150	0	0	0	0	0	0	0	0	0	0	0	0
31-May-98	151	0	0	0	0	0	0	0	0	0	0	0	0
01-Jun-98	152	0	0	0	0	0	0	0	0	0	0	0	0
02-Jun-98	153	0	0	0	0	0	0	0	0	0	0	0	0
03-Jun-98	154	0	0	0	0	0	0	0	0	0	0	0	0
04-Jun-98	155	0	0	0	0	0	0	0	0	0	0	0	0
05-Jun-98	156	0	0	0	0	0	0	57	0	0	0	0	0
06-Jun-98	157	14	0	74	0	0	74	0	0	0	0	0	0
07-Jun-98	158	0	0	0	0	0	0	0	0	0	3	0	0
08-Jun-98	159	0	0	0	0	0	0	0	0	0	0	0	0
09-Jun-98	160	0	0	0	0	0	0	0	0	0	0	0	0
10-Jun-98	161	0	0	0	0	0	0	91	0	0	41	0	16
11-Jun-98	162	120	238	48	146	245	48	0	212	180	215	239	0
12-Jun-98	163	15	18	0	0	0	0	0	0	1	0	0	0
13-Jun-98	164	0	0	0	0	0	0	0	0	0	0	0	0
14-Jun-98	165	0	0	0	0	10	0	0	30	0	0	0	0
15-Jun-98	166	0	0	0	0	0	0	0	0	0	0	0	0
16-Jun-98	167	0	0	0	0	0	0	0	0	43	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
17-Jun-98	168	0	0	0	0	0	0	0	0	0	0	0	0
18-Jun-98	169	0	0	0	0	0	0	0	0	0	0	0	0
19-Jun-98	170	0	0	0	0	0	0	0	0	0	0	0	0
20-Jun-98	171	0	0	0	0	0	0	0	0	0	0	0	0
21-Jun-98	172	0	0	0	0	0	0	0	0	0	0	0	0
22-Jun-98	173	0	0	0	0	0	0	0	0	0	0	0	0
23-Jun-98	174	0	0	0	0	0	0	0	0	0	0	0	0
24-Jun-98	175	0	0	0	0	0	0	0	0	0	0	0	0
25-Jun-98	176	0	0	0	0	0	0	0	0	0	0	0	0
26-Jun-98	177	0	0	0	0	0	0	0	0	0	0	0	0
27-Jun-98	178	0	0	0	0	0	0	0	0	0	0	0	0
28-Jun-98	179	0	0	0	0	0	0	0	0	0	0	0	0
29-Jun-98	180	0	0	0	83	0	0	17	0	38	0	0	0
30-Jun-98	181	21	67	29	0	0	29	0	0	0	0	0	0
01-Jul-98	182	17	0	n/d	0	0	0	0	0	0	0	27	0
02-Jul-98	183	0	0	n/d	0	0	0	0	0	0	0	0	0
03-Jul-98	184	0	0	n/d	0	0	0	298	0	52	0	1	0
04-Jul-98	185	59	74	n/d	46	0	0	65	0	22	2	10	0
05-Jul-98	186	52	39	n/d	100	0	0	0	0	0	0	9	0
06-Jul-98	187	0	0	n/d	0	0	0	0	0	0	0	0	0
07-Jul-98	188	0	0	n/d	0	0	0	0	0	0	0	0	0
08-Jul-98	189	0	0	n/d	0	0	0	0	0	0	0	0	0
09-Jul-98	190	0	0	n/d	0	0	0	0	0	0	0	0	0
10-Jul-98	191	0	0	n/d	0	0	0	0	0	0	0	0	0
11-Jul-98	192	0	0	n/d	0	0	0	0	0	0	0	0	0
12-Jul-98	193	0	0	n/d	0	0	0	0	0	0	0	0	0
13-Jul-98	194	0	0	n/d	39	0	0	0	0	0	0	0	0
14-Jul-98	195	0	0	n/d	0	0	0	0	0	46	0	0	76
15-Jul-98	196	0	0	n/d	0	50	0	0	0	0	35	10	0
16-Jul-98	197	0	0	n/d	0	0	0	0	0	0	0	0	0
17-Jul-98	198	0	0	n/d	0	0	0	0	0	0	0	95	0
18-Jul-98	199	0	0	n/d	0	0	0	0	0	0	0	0	0
19-Jul-98	200	0	0	n/d	0	0	0	0	0	0	0	0	0
20-Jul-98	201	0	0	n/d	0	0	0	0	0	0	0	0	0
21-Jul-98	202	0	0	n/d	0	0	0	0	0	0	0	0	0
22-Jul-98	203	0	0	n/d	0	0	0	0	0	0	0	0	0
23-Jul-98	204	0	0	n/d	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
24-Jul-98	205	0	0	n/d	0	0	0	0	0	0	0	0	0
25-Jul-98	206	0	0	n/d	0	0	0	0	0	0	0	0	0
26-Jul-98	207	0	0	n/d	0	0	0	0	0	0	0	0	0
27-Jul-98	208	0	0	n/d	0	0	0	0	0	0	0	0	0
28-Jul-98	209	0	0	n/d	0	0	0	0	0	0	0	0	0
29-Jul-98	210	0	0	n/d	0	0	0	0	0	0	0	0	0
30-Jul-98	211	0	0	n/d	0	0	0	0	0	0	0	0	0
31-Jul-98	212	0	0	n/d	0	0	0	0	0	0	0	0	0
01-Aug-98	213	0	0	n/d	0	0	0	0	0	0	0	0	0
02-Aug-98	214	0	0	n/d	0	0	0	0	0	0	0	0	0
03-Aug-98	215	0	0	n/d	0	0	0	0	0	0	0	0	0
04-Aug-98	216	0	0	n/d	3	0	0	0	0	0	0	0	0
05-Aug-98	217	0	20	n/d	0	232	0	57	171	0	31	2	0
06-Aug-98	218	81	127	n/d	16	115	0	0	36	137	31	44	358
07-Aug-98	219	4	0	n/d	44	5	0	0	61	57	0	0	0
08-Aug-98	220	0	58	n/d	7	0	0	0	0	0	0	0	0
09-Aug-98	221	0	0	n/d	0	0	0	0	0	0	0	0	0
10-Aug-98	222	0	0	n/d	0	0	0	0	0	0	0	0	0
11-Aug-98	223	0	0	n/d	0	0	0	0	0	0	0	0	0
12-Aug-98	224	0	0	n/d	0	0	0	0	0	0	0	0	0
13-Aug-98	225	0	0	n/d	0	0	0	0	0	0	0	0	0
14-Aug-98	226	0	0	n/d	47	7	0	13	120	25	27	80	100
15-Aug-98	227	10	31	n/d	22	100	0	0	36	107	54	37	10
16-Aug-98	228	0	0	n/d	0	0	0	0	0	0	0	0	0
17-Aug-98	229	0	12	n/d	7	8	0	118	0	79	1	0	40
18-Aug-98	230	48	7	n/d	0	47	0	0	49	48	31	7	73
19-Aug-98	231	0	0	n/d	0	175	0	0	113	5	13	5	16
20-Aug-98	232	0	0	n/d	0	0	0	13	0	0	0	0	40
21-Aug-98	233	22	13	n/d	0	60	0	27	45	57	8	19	0
22-Aug-98	234	8	26	n/d	3	8	0	358	25	14	25	12	124
23-Aug-98	235	305	402	n/d	337	475	0	8	80	800	400	394	565
24-Aug-98	236	70	0	n/d	103	200	0	12	1075	4	50	38	150
25-Aug-98	237	8	0	n/d	30	175	0	0	140	0	2	0	0
26-Aug-98	238	0	0	n/d	16	0	0	0	21	0	0	0	0
27-Aug-98	239	0	0	n/d	0	0	0	0	0	4	0	0	0
28-Aug-98	240	0	0	n/d	0	0	0	0	0	0	0	0	0
29-Aug-98	241	0	0	n/d	0	0	0	0	0	0	0	0	20

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
30-Aug-98	242	0	0	n/d	0	0	0	0	75	0	0	0	0
31-Aug-98	243	0	7	n/d	0	20	0	0	0	0	0	0	0
01-Sep-98	244	0	0	0	0	10	0	0	0	0	0	70	0
02-Sep-98	245	0	0	0	0	0	0	0	0	0	0	0	0
03-Sep-98	246	0	0	0	0	0	0	0	0	0	0	0	0
04-Sep-98	247	0	0	0	0	0	0	45	0	0	0	0	0
05-Sep-98	248	5	0	28	0	0	28	0	0	0	0	0	0
06-Sep-98	249	0	0	0	0	0	0	0	0	0	0	0	0
07-Sep-98	250	0	0	0	0	0	0	0	0	0	0	0	0
08-Sep-98	251	0	0	0	0	0	0	0	0	0	0	0	0
09-Sep-98	252	0	0	0	0	0	0	0	0	14	0	0	0
10-Sep-98	253	0	5	0	0	0	0	48	0	4	0	0	0
11-Sep-98	254	86	32	56	55	0	56	108	0	2	10	18	0
12-Sep-98	255	185	78	150	76	21	150	20	0	31	0	65	0
13-Sep-98	256	18	18	10	18	0	10	0	0	0	45	7	0
14-Sep-98	257	2	40	0	0	0	0	5	0	0	0	0	0
15-Sep-98	258	11	8	0	8	0	0	72	0	0	0	0	0
16-Sep-98	259	80	15	140	20	0	140	95	0	19	15	4	39
17-Sep-98	260	26	46	168	0	265	168	0	24	43	65	31	0
18-Sep-98	261	0	0	0	0	42	0	0	75	0	15	0	0
19-Sep-98	262	0	0	0	0	5	0	0	0	0	25	0	0
20-Sep-98	263	0	6	0	0	0	0	0	0	0	0	0	0
21-Sep-98	264	0	0	0	0	0	0	0	0	0	0	0	0
22-Sep-98	265	0	0	0	0	0	0	0	0	0	0	0	0
23-Sep-98	266	0	0	0	0	0	0	0	0	0	0	0	0
24-Sep-98	267	0	0	0	0	0	0	0	30	0	0	0	0
25-Sep-98	268	0	0	0	0	0	0	0	0	0	0	0	0
26-Sep-98	269	0	0	0	0	0	0	0	0	2	0	0	0
27-Sep-98	270	0	0	0	0	0	0	0	0	0	0	1	0
28-Sep-98	271	0	0	0	0	0	0	0	0	0	0	0	0
29-Sep-98	272	0	0	0	0	0	0	0	0	0	0	0	0
30-Sep-98	273	0	0	0	0	0	0	0	0	0	0	0	0
01-Oct-98	274	0	0	n/d	0	0	0	0	0	n/d	0	0	62
02-Oct-98	275	0	10	n/d	0	0	0	0	0	n/d	152	96	0
03-Oct-98	276	4	0	n/d	0	0	0	0	0	n/d	0	0	0
04-Oct-98	277	0	0	n/d	0	0	0	0	0	n/d	0	0	0
05-Oct-98	278	0	0	n/d	0	0	0	336	0	n/d	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
06-Oct-98	279	240	253	n/d	277	135	0	0	95	n/d	160	183	130
07-Oct-98	280	2	0	n/d	0	0	0	0	0	n/d	0	0	0
08-Oct-98	281	0	0	n/d	0	0	0	0	0	n/d	0	0	0
09-Oct-98	282	0	0	n/d	0	0	0	0	0	n/d	0	0	0
10-Oct-98	283	0	0	n/d	0	0	0	0	0	n/d	0	0	0
11-Oct-98	284	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
12-Oct-98	285	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
13-Oct-98	286	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
14-Oct-98	287	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
15-Oct-98	288	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
16-Oct-98	289	0	0	n/d	0	0	n/d	376	0	n/d	0	0	0
17-Oct-98	290	363	198	n/d	1150	17	n/d	1405	0	n/d	53	118	0
18-Oct-98	291	325	323	n/d	915	82	n/d	69	0	n/d	0	117	130
19-Oct-98	292	43	38	n/d	47	12	n/d	71	0	n/d	157	11	38
20-Oct-98	293	21	25	n/d	63	6	n/d	5	36	n/d	45	9	0
21-Oct-98	294	8	5	n/d	5	4	n/d	0	0	n/d	23	28	16
22-Oct-98	295	2	0	n/d	0	4	n/d	0	13	n/d	10	4	0
23-Oct-98	296	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
24-Oct-98	297	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
25-Oct-98	298	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
26-Oct-98	299	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
27-Oct-98	300	0	0	n/d	0	0	n/d	0	0	n/d	0	5	0
28-Oct-98	301	8	2	n/d	0	0	n/d	0	0	n/d	0	0	0
29-Oct-98	302	0	0	n/d	0	0	n/d	0	0	n/d	0	0	0
30-Oct-98	303	0	0	n/d	0	0	n/d	129	0	n/d	0	0	0
31-Oct-98	304	0	0	n/d	0	0	n/d	27	0	n/d	0	0	0
01-Nov-98	305	200	138	150	102	183	150	0	182	41	200	179	208
02-Nov-98	306	8	0	0	36	0	0	0	0	0	0	0	0
03-Nov-98	307	0	0	0	0	0	0	0	0	0	0	0	0
04-Nov-98	308	0	0	0	0	0	0	60	0	0	0	0	0
05-Nov-98	309	62	76	47	64	42	47	0	26	47	76	66	87
06-Nov-98	310	0	0	0	0	0	0	40	0	0	0	0	0
07-Nov-98	311	27	56	96	46	0	96	6	0	22	0	13	0
08-Nov-98	312	9	8	9	8	0	9	5	0	1	0	2	0
09-Nov-98	313	2	2	4	0	0	4	12	0	2	0	2	0
10-Nov-98	314	2	0	4	0	0	4	0	0	0	0	0	0
11-Nov-98	315	0	0	0	0	0	0	0	0	0	10	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
12-Nov-98	316	3	0	5	0	0	5	62	0	8	0	2	0
13-Nov-98	317	30	23	75	73	29	75	88	43	9	25	24	150
14-Nov-98	318	67	90	56	50	42	56	20	68	144	0	69	0
15-Nov-98	319	77	59	25	60	0	25	0	0	0	0	29	0
16-Nov-98	320	0	0	3	0	0	3	0	0	0	0	0	0
17-Nov-98	321	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov-98	322	0	0	0	0	0	0	0	0	2	0	0	0
19-Nov-98	323	0	0	0	0	0	0	15	0	0	0	0	0
20-Nov-98	324	0	19	8	22	0	8	0	0	0	0	0	0
21-Nov-98	325	9	0	0	0	59	0	0	0	0	0	5	0
22-Nov-98	326	0	0	0	0	0	0	0	0	0	0	0	0
23-Nov-98	327	0	0	0	0	0	0	0	0	0	0	0	0
24-Nov-98	328	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov-98	329	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov-98	330	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov-98	331	0	0	0	0	0	0	0	0	3	0	0	0
28-Nov-98	332	0	0	8	0	0	8	0	0	0	0	0	0
29-Nov-98	333	0	0	0	0	0	0	7	0	0	0	0	0
30-Nov-98	334	0	0	0	0	0	0	0	0	0	0	0	0
01-Dec-98	335	0	0	0	0	0	0	0	0	0	0	0	0
02-Dec-98	336	0	0	0	22	0	0	0	0	0	0	0	0
03-Dec-98	337	3	0	0	0	0	0	17	0	0	0	0	0
04-Dec-98	338	2	10	8	0	0	8	0	0	0	0	8	0
05-Dec-98	339	0	0	0	0	0	0	0	0	0	0	0	0
06-Dec-98	340	0	0	0	0	0	0	0	0	0	0	0	0
07-Dec-98	341	0	0	0	0	0	0	0	0	0	0	0	0
08-Dec-98	342	0	0	0	0	0	0	0	0	0	0	0	0
09-Dec-98	343	0	0	0	0	0	0	57	0	0	0	0	0
10-Dec-98	344	0	48	48	43	20	48	31	43	34	105	140	59
11-Dec-98	345	83	37	35	22	6	35	0	25	13	25	17	0
12-Dec-98	346	2	0	8	0	0	8	0	0	0	0	0	0
13-Dec-98	347	0	0	0	0	0	0	0	0	0	0	0	0
14-Dec-98	348	0	0	0	0	0	0	0	0	0	0	0	0
15-Dec-98	349	0	0	0	0	0	0	0	0	0	0	0	0
16-Dec-98	350	0	0	0	0	0	0	0	0	0	0	0	0
17-Dec-98	351	0	0	0	0	0	0	0	0	0	0	0	0
18-Dec-98	352	0	0	0	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
19-Dec-98	353	5	0	3	0	0	3	0	0	0	0	3	0
20-Dec-98	354	0	0	0	0	0	0	0	0	0	0	0	0
21-Dec-98	355	2	5	0	0	0	0	0	0	1	0	1	0
22-Dec-98	356	0	0	0	0	0	0	0	0	0	0	0	0
23-Dec-98	357	0	0	0	0	0	0	0	0	0	0	1	0
24-Dec-98	358	6	5	5	0	2	5	0	0	1	0	3	0
25-Dec-98	359	0	0	0	0	0	0	0	0	0	0	0	0
26-Dec-98	360	0	0	0	0	0	0	0	0	0	0	0	0
27-Dec-98	361	0	0	0	0	0	0	0	0	0	0	0	0
28-Dec-98	362	0	0	0	0	0	0	0	0	0	0	0	0
29-Dec-98	363	0	0	0	0	0	0	0	0	0	0	0	0
30-Dec-98	364	0	0	0	0	0	0	0	0	0	0	0	0
31-Dec-98	365	0	0	0	0	0	0	8	0	0	0	0	0
01-Jan-99	1	3	0	0	0	0	n/d	0	0	0	0	0	0
02-Jan-99	2	2	0	0	0	0	n/d	0	0	0	0	0	0
03-Jan-99	3	0	0	0	0	0	n/d	0	0	0	0	0	0
04-Jan-99	4	0	0	0	0	0	n/d	0	0	0	0	0	0
05-Jan-99	5	0	0	0	0	0	n/d	0	0	0	0	0	0
06-Jan-99	6	0	0	0	0	0	n/d	0	0	0	0	0	0
07-Jan-99	7	0	0	0	0	0	n/d	0	0	2	0	0	0
08-Jan-99	8	0	0	0	0	0	n/d	0	0	1	0	0	0
09-Jan-99	9	0	0	0	0	0	n/d	0	0	0	0	0	0
10-Jan-99	10	0	0	0	0	0	n/d	0	0	0	0	0	0
11-Jan-99	11	0	0	0	0	0	n/d	0	0	0	0	0	0
12-Jan-99	12	0	0	0	0	0	n/d	0	0	0	0	0	0
13-Jan-99	13	0	0	0	0	0	n/d	0	0	0	0	0	0
14-Jan-99	14	0	0	0	0	0	n/d	0	0	1	0	0	0
15-Jan-99	15	0	0	0	0	0	n/d	0	0	0	0	0	0
16-Jan-99	16	0	0	0	0	0	n/d	0	0	0	0	0	0
17-Jan-99	17	0	0	0	0	0	n/d	0	0	0	0	0	0
18-Jan-99	18	0	0	0	0	0	n/d	0	0	0	0	0	0
19-Jan-99	19	0	0	0	0	0	n/d	0	0	1	0	0	0
20-Jan-99	20	0	0	0	0	0	n/d	0	0	1	0	1	0
21-Jan-99	21	2	0	0	0	0	n/d	0	0	0	0	0	0
22-Jan-99	22	0	0	0	0	0	n/d	0	0	0	0	0	0
23-Jan-99	23	0	0	0	0	0	n/d	0	0	0	0	0	0
24-Jan-99	24	0	0	0	0	0	n/d	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
25-Jan-99	25	0	0	0	0	0	n/d	0	0	0	0	0	0
26-Jan-99	26	0	0	0	0	0	n/d	0	0	0	0	0	0
27-Jan-99	27	0	0	0	0	0	n/d	0	0	0	0	0	0
28-Jan-99	28	0	0	0	0	0	n/d	0	0	0	0	0	0
29-Jan-99	29	37	6	12	0	0	n/d	0	23	1	15	0	14
30-Jan-99	30	22	0	0	13	0	n/d	0	0	0	5	4	0
31-Jan-99	31	0	0	0	0	0	n/d	0	0	0	0	0	0
01-Feb-99	32	0	0	0	0	0	0	0	0	0	0	0	0
02-Feb-99	33	0	0	0	0	0	0	0	0	0	0	0	0
03-Feb-99	34	0	0	0	0	0	0	0	0	0	0	0	0
04-Feb-99	35	0	0	0	0	0	0	0	0	0	0	0	0
05-Feb-99	36	0	0	0	0	0	0	0	0	0	5	0	0
06-Feb-99	37	0	0	0	0	0	0	0	0	0	0	0	0
07-Feb-99	38	0	0	0	0	0	0	0	0	0	0	0	0
08-Feb-99	39	0	0	0	0	0	0	0	0	0	0	0	0
09-Feb-99	40	0	0	0	0	0	0	0	0	1	0	0	0
10-Feb-99	41	0	0	0	0	0	0	0	0	0	0	0	0
11-Feb-99	42	0	0	0	0	0	0	0	0	0	0	0	0
12-Feb-99	43	6	0	0	0	0	2	0	0	8	0	1	0
13-Feb-99	44	0	0	0	0	0	0	0	0	0	0	0	0
14-Feb-99	45	0	0	0	0	0	0	0	0	0	0	0	0
15-Feb-99	46	0	0	0	0	0	0	0	0	0	0	0	0
16-Feb-99	47	0	0	0	0	0	0	0	0	0	0	0	0
17-Feb-99	48	0	0	0	0	0	0	0	0	0	0	0	0
18-Feb-99	49	0	0	0	0	0	0	0	0	0	0	0	0
19-Feb-99	50	0	0	0	0	0	0	0	0	0	0	0	0
20-Feb-99	51	0	0	0	0	0	0	0	0	0	0	0	0
21-Feb-99	52	2	0	0	0	0	0	0	0	0	0	0	0
22-Feb-99	53	0	0	0	0	0	0	0	0	0	0	0	0
23-Feb-99	54	0	0	0	0	0	0	0	0	0	0	0	0
24-Feb-99	55	0	0	0	0	0	0	0	0	0	0	0	0
25-Feb-99	56	0	0	0	0	0	0	0	0	0	0	0	0
26-Feb-99	57	2	0	0	0	0	0	0	0	0	0	0	0
27-Feb-99	58	0	3	0	0	0	2	0	0	2	0	2	0
28-Feb-99	59	0	0	0	0	0	0	0	0	0	0	0	0
01-Mar-99	60	0	0	0	0	0	0	0	0	0	0	0	0
02-Mar-99	61	0	0	0	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
03-Mar-99	62	0	0	0	0	0	0	0	0	0	0	0	0
04-Mar-99	63	0	0	0	0	0	0	0	0	0	0	0	0
05-Mar-99	64	0	0	0	0	0	0	0	0	0	0	0	0
06-Mar-99	65	0	0	0	0	0	3	0	0	0	0	0	0
07-Mar-99	66	0	0	0	0	0	0	0	0	0	25	0	0
08-Mar-99	67	2	9	0	0	20	0	0	12	4	23	6	20
09-Mar-99	68	12	0	0	0	0	0	0	0	0	0	0	0
10-Mar-99	69	0	0	0	0	0	0	0	0	0	0	0	0
11-Mar-99	70	0	0	0	0	0	0	16	0	0	0	0	0
12-Mar-99	71	5	14	0	0	0	7	23	0	0	0	1	0
13-Mar-99	72	62	45	102	30	35	18	0	20	35	0	20	0
14-Mar-99	73	0	0	0	0	0	0	0	0	0	0	0	0
15-Mar-99	74	0	0	30	0	0	0	0	0	0	0	0	0
16-Mar-99	75	0	0	0	0	0	0	0	0	0	0	0	0
17-Mar-99	76	0	0	0	0	0	0	3	0	0	0	0	0
18-Mar-99	77	3	7	17	143	32	0	100	176	3	115	17	60
19-Mar-99	78	150	118	0	0	0	110	0	0	91	0	130	0
20-Mar-99	79	0	0	0	0	0	13	0	0	4	0	0	0
21-Mar-99	80	0	0	0	0	0	0	0	0	0	0	0	0
22-Mar-99	81	0	0	0	0	0	0	0	0	0	0	0	0
23-Mar-99	82	0	0	0	0	0	0	0	0	0	0	0	0
24-Mar-99	83	3	0	0	0	0	2	0	0	0	0	0	0
25-Mar-99	84	2	0	0	0	0	0	0	5	0	0	0	0
26-Mar-99	85	0	0	0	0	6	0	0	0	0	0	0	0
27-Mar-99	86	0	0	13	0	0	0	126	10	0	0	2	193
28-Mar-99	87	98	140	170	134	143	127	0	178	207	165	143	0
29-Mar-99	88	0	0	0	0	0	0	0	0	0	0	0	0
30-Mar-99	89	0	0	0	0	0	0	0	0	0	0	0	0
31-Mar-99	90	0	0	0	0	0	0	0	0	0	0	0	0
01-Apr-99	91	0	0	0	0	0	0	0	0	2	0	0	0
02-Apr-99	92	3	0	0	0	0	4	0	0	1	0	0	0
03-Apr-99	93	4	0	0	0	0	0	0	0	0	0	0	0
04-Apr-99	94	1	0	0	0	0	0	5	0	0	0	0	0
05-Apr-99	95	2	0	0	0	0	0	0	0	0	0	0	0
06-Apr-99	96	0	0	0	0	0	0	0	0	0	0	0	0
07-Apr-99	97	0	0	0	0	0	0	0	0	0	0	0	0
08-Apr-99	98	0	0	0	0	0	0	0	6	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

Date	Julian Date	1 410832	2 410902	3 411007	4 411215	5 411398	6 411429	7 411431	8 411492	9 414254	10 414374	11 414782	12 415113
09-Apr-99	99	0	0	0	0	0	0	0	0	0	0	0	0
10-Apr-99	100	0	0	0	0	0	0	0	0	0	0	0	0
11-Apr-99	101	0	0	0	0	0	0	0	0	0	0	0	0
12-Apr-99	102	0	0	0	0	0	0	0	0	0	0	0	0
13-Apr-99	103	0	0	0	0	0	0	25	0	0	0	0	0
14-Apr-99	104	14	22	0	0	46	25	0	7	5	65	67	56
15-Apr-99	105	0	0	0	0	0	0	0	0	0	0	0	0
16-Apr-99	106	0	0	0	0	0	0	0	0	0	0	0	0
17-Apr-99	107	0	0	0	0	0	0	0	0	0	0	0	0
18-Apr-99	108	0	0	0	0	0	0	0	0	0	0	0	0
19-Apr-99	109	0	0	0	0	0	0	0	0	0	0	0	0
20-Apr-99	110	0	0	0	0	0	0	0	0	0	0	0	0
21-Apr-99	111	0	0	0	0	0	0	0	0	0	0	0	0
22-Apr-99	112	0	0	0	0	0	0	0	0	0	0	0	0
23-Apr-99	113	0	0	0	0	0	0	0	0	0	0	0	0
24-Apr-99	114	0	0	0	33	0	0	37	0	0	0	0	0
25-Apr-99	115	15	38	63	0	83	40	0	145	160	60	18	300
26-Apr-99	116	23	9	28	23	201	6	35	305	2	70	51	40
27-Apr-99	117	45	82	0	0	10	48	0	25	6	0	0	0
28-Apr-99	118	0	0	0	0	0	0	0	0	0	0	0	25
29-Apr-99	119	0	0	0	0	0	0	0	0	0	0	0	0
30-Apr-99	120	0	0	0	0	0	0	0	3	3	0	0	0
01-May-99	121	0	0	0	0	0	0	0	0	0	0	0	0
02-May-99	122	1	0	80	0	0	1	15	0	0	0	1	0
03-May-99	123	9	27	0	55	10	13	5	0	4	23	7	0
04-May-99	124	5	7	0	33	7	2	0	43	3	0	5	0
05-May-99	125	0	0	0	0	0	0	0	0	0	0	0	0
06-May-99	126	0	0	0	0	0	0	0	0	0	0	0	0
07-May-99	127	0	0	0	0	0	0	0	0	0	0	0	0
08-May-99	128	0	0	0	0	0	0	0	0	0	0	0	0
09-May-99	129	0	0	0	0	0	0	134	0	0	0	0	0
10-May-99	130	128	128	0	0	25	108	12	0	20	145	133	102
11-May-99	131	14	14	0	0	0	13	0	0	0	33	8	0
12-May-99	132	0	0	95	0	90	0	0	0	5	55	34	0
13-May-99	133	0	0	0	0	0	0	0	0	0	0	0	0
14-May-99	134	0	0	0	0	0	0	0	0	0	0	0	0
15-May-99	135	0	0	0	0	0	0	0	0	0	0	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
16-May-99	136	0	0	0	0	0	0	0	0	0	0	0	0
17-May-99	137	0	0	0	0	0	0	9	0	0	0	0	0
18-May-99	138	33	35	80	0	48	55	0	31	134	35	11	34
19-May-99	139	0	0	0	0	0	0	0	0	0	0	0	0
20-May-99	140	0	0	0	0	0	0	0	0	0	0	0	0
21-May-99	141	0	0	0	0	0	0	0	0	0	0	0	0
22-May-99	142	0	0	0	0	0	0	0	0	0	0	0	0
23-May-99	143	0	0	0	0	0	0	0	0	0	0	0	0
24-May-99	144	0	0	0	0	0	0	0	0	0	0	0	0
25-May-99	145	0	0	30	0	0	0	0	0	0	0	0	0
26-May-99	146	0	0	0	7	0	0	0	0	0	0	0	0
27-May-99	147	4	15	0	3	0	1	0	0	0	0	94	0
28-May-99	148	0	0	0	0	0	0	33	0	0	0	0	0
29-May-99	149	27	11	0	0	6	40	0	172	14	0	23	0
30-May-99	150	9	0	0	0	0	41	0	0	0	67	7	0
31-May-99	151	0	0	0	0	0	0	0	0	0	0	0	0
01-Jun-99	152	0	0	n/d	0	0	0	0	10	0	n/d	0	0
02-Jun-99	153	0	0	n/d	0	0	0	0	0	0	n/d	0	0
03-Jun-99	154	0	0	n/d	0	0	0	0	0	0	n/d	0	0
04-Jun-99	155	0	0	n/d	0	0	0	0	0	0	n/d	0	0
05-Jun-99	156	0	0	n/d	0	0	0	0	0	0	n/d	0	0
06-Jun-99	157	0	0	n/d	0	0	0	0	0	0	n/d	0	0
07-Jun-99	158	0	0	n/d	0	0	0	0	0	0	n/d	0	0
08-Jun-99	159	0	2	n/d	0	0	0	0	0	0	n/d	0	0
09-Jun-99	160	0	0	n/d	0	0	0	0	0	0	n/d	0	0
10-Jun-99	161	0	0	n/d	0	0	0	0	0	0	n/d	0	0
11-Jun-99	162	0	0	n/d	0	0	0	0	0	0	n/d	0	0
12-Jun-99	163	0	0	n/d	0	0	0	85	0	0	n/d	0	0
13-Jun-99	164	0	119	n/d	5	5	57	101	0	135	n/d	28	116
14-Jun-99	165	13	0	n/d	15	3	144	0	0	0	n/d	0	0
15-Jun-99	166	0	0	n/d	0	0	20	86	45	208	n/d	0	78
16-Jun-99	167	0	14	n/d	11	0	32	0	33	4	n/d	17	12
17-Jun-99	168	0	0	n/d	0	0	0	0	0	0	n/d	0	0
18-Jun-99	169	0	0	n/d	0	0	0	0	0	0	n/d	0	0
19-Jun-99	170	0	0	n/d	0	0	0	23	0	0	n/d	0	0
20-Jun-99	171	20	0	n/d	0	10	1	203	0	2	n/d	35	0
21-Jun-99	172	283	226	n/d	76	248	200	49	247	89	n/d	172	550

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
22-Jun-99	173	47	115	n/d	44	276	181	51	180	64	n/d	29	0
23-Jun-99	174	4	6	n/d	12	0	9	0	0	17	n/d	11	0
24-Jun-99	175	0	0	n/d	0	0	0	0	0	0	n/d	0	0
25-Jun-99	176	0	0	n/d	0	0	1	0	0	0	n/d	0	43
26-Jun-99	177	13	0	n/d	75	0	2	0	0	0	n/d	6	0
27-Jun-99	178	0	0	n/d	0	0	0	0	0	0	n/d	0	0
28-Jun-99	179	0	0	n/d	0	0	0	0	0	0	n/d	0	0
29-Jun-99	180	0	0	n/d	0	0	0	0	0	0	n/d	0	0
30-Jun-99	181	0	0	n/d	0	0	0	0	0	0	n/d	0	0
01-Jul-99	182	0	0	0	0	0	0	0	0	0	n/d	0	0
02-Jul-99	183	0	0	0	0	0	1	13	0	0	n/d	0	0
03-Jul-99	184	3	4	0	0	0	0	0	0	0	n/d	0	0
04-Jul-99	185	8	15	0	18	8	14	12	13	0	n/d	0	0
05-Jul-99	186	7	0	83	230	0	84	0	0	3	n/d	5	0
06-Jul-99	187	0	0	0	0	0	1	0	0	0	n/d	0	0
07-Jul-99	188	25	56	0	0	30	5	6	0	0	n/d	0	100
08-Jul-99	189	0	0	0	0	0	0	0	116	0	n/d	0	0
09-Jul-99	190	2	0	0	0	0	0	0	35	0	n/d	0	0
10-Jul-99	191	0	0	0	0	0	0	10	0	0	n/d	0	115
11-Jul-99	192	45	230	120	0	60	0	33	42	31	n/d	290	0
12-Jul-99	193	4	21	35	98	25	12	0	22	10	n/d	1	0
13-Jul-99	194	0	0	0	0	0	0	0	0	0	n/d	0	0
14-Jul-99	195	0	0	0	0	0	0	0	0	0	n/d	0	0
15-Jul-99	196	0	0	0	0	0	0	0	0	0	n/d	0	0
16-Jul-99	197	0	0	0	0	0	0	0	0	0	n/d	0	0
17-Jul-99	198	0	0	0	0	0	0	0	0	0	n/d	0	0
18-Jul-99	199	29	0	0	18	20	10	0	0	0	n/d	0	0
19-Jul-99	200	0	0	0	7	0	1	0	0	0	n/d	0	0
20-Jul-99	201	10	0	0	0	0	0	0	0	0	n/d	0	0
21-Jul-99	202	0	9	0	0	0	0	4	0	0	n/d	0	0
22-Jul-99	203	0	0	0	26	0	35	0	0	0	n/d	0	0
23-Jul-99	204	0	0	0	0	0	0	0	0	0	n/d	0	0
24-Jul-99	205	0	0	0	0	0	0	0	0	0	n/d	0	0
25-Jul-99	206	0	0	0	0	0	0	0	0	0	n/d	0	0
26-Jul-99	207	0	0	0	0	0	0	0	0	0	n/d	0	0
27-Jul-99	208	0	0	0	0	0	0	0	0	0	n/d	0	0
28-Jul-99	209	0	0	0	0	0	0	0	0	0	n/d	0	0

B-1. Daily Precipitation Data (1998-1999)

Date	Julian Date	1 410832	2 410902	3 411007	4 411215	5 411398	6 411429	7 411431	8 411492	9 414254	10 414374	11 414782	12 415113
29-Jul-99	210	0	0	0	0	0	0	0	0	0	n/d	0	0
30-Jul-99	211	0	0	0	0	0	0	0	0	0	n/d	0	0
31-Jul-99	212	0	0	0	0	0	0	0	0	0	n/d	0	0
01-Aug-99	213	0	0	0	0	0	0	0	0	0	n/d	0	0
02-Aug-99	214	0	0	0	0	0	0	0	0	0	n/d	0	0
03-Aug-99	215	0	0	0	0	0	0	0	0	0	n/d	0	0
04-Aug-99	216	0	0	0	0	0	0	10	0	0	n/d	0	0
05-Aug-99	217	4	12	0	0	0	5	0	0	0	n/d	0	0
06-Aug-99	218	0	0	0	0	0	0	0	0	0	n/d	0	0
07-Aug-99	219	0	0	0	0	0	0	0	0	0	n/d	0	0
08-Aug-99	220	0	0	0	0	0	0	0	0	0	n/d	0	0
09-Aug-99	221	0	0	0	0	0	0	0	0	0	n/d	0	0
10-Aug-99	222	0	0	0	0	0	0	0	0	0	n/d	0	0
11-Aug-99	223	0	0	0	0	0	0	0	0	0	n/d	0	0
12-Aug-99	224	0	0	0	0	0	0	0	0	0	n/d	0	0
13-Aug-99	225	0	0	0	0	0	0	0	0	0	n/d	0	0
14-Aug-99	226	0	0	0	0	0	0	0	0	0	n/d	0	0
15-Aug-99	227	0	0	0	0	0	0	0	0	0	n/d	0	0
16-Aug-99	228	0	0	0	0	0	0	0	0	0	n/d	0	0
17-Aug-99	229	0	0	0	0	0	0	7	0	0	n/d	0	0
18-Aug-99	230	0	0	0	0	0	2	0	0	0	n/d	0	0
19-Aug-99	231	0	0	0	0	0	0	0	0	0	n/d	0	0
20-Aug-99	232	0	0	0	0	0	0	0	0	105	n/d	0	0
21-Aug-99	233	0	0	0	0	0	0	0	0	0	n/d	0	0
22-Aug-99	234	0	0	0	0	0	0	0	0	0	n/d	0	0
23-Aug-99	235	0	0	0	0	0	0	39	0	50	n/d	0	22
24-Aug-99	236	0	57	40	0	8	8	0	0	0	n/d	24	0
25-Aug-99	237	0	0	45	0	0	30	0	0	0	n/d	0	0
26-Aug-99	238	0	0	0	0	0	0	0	0	0	n/d	0	0
27-Aug-99	239	0	0	0	0	0	0	0	0	0	n/d	0	0
28-Aug-99	240	0	0	0	0	0	0	0	0	0	n/d	0	0
29-Aug-99	241	0	0	0	0	0	0	0	0	15	n/d	0	0
30-Aug-99	242	6	0	0	26	0	10	0	30	0	n/d	0	0
31-Aug-99	243	0	0	0	0	0	0	0	0	0	n/d	0	0
01-Sep-99	244	0	0	0	0	0	0	0	0	0	n/d	0	0
02-Sep-99	245	0	0	0	0	0	0	0	0	0	n/d	0	0
03-Sep-99	246	0	0	0	0	0	0	0	0	0	n/d	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
04-Sep-99	247	0	0	0	0	0	0	0	0	0	n/d	0	0
05-Sep-99	248	0	0	0	0	0	0	0	0	0	n/d	0	0
06-Sep-99	249	0	0	0	0	0	0	0	0	0	n/d	0	0
07-Sep-99	250	0	0	0	0	20	0	0	0	0	n/d	0	0
08-Sep-99	251	0	0	0	0	0	0	0	0	4	n/d	0	0
09-Sep-99	252	0	15	0	2	0	0	0	0	0	n/d	0	0
10-Sep-99	253	0	7	50	0	11	0	0	86	0	n/d	89	0
11-Sep-99	254	0	0	0	0	0	0	0	0	0	n/d	0	0
12-Sep-99	255	0	0	0	0	0	0	0	0	0	n/d	0	0
13-Sep-99	256	0	0	0	0	0	0	0	0	0	n/d	0	0
14-Sep-99	257	0	0	35	0	0	0	0	0	23	n/d	0	0
15-Sep-99	258	0	0	0	0	0	0	0	0	0	n/d	0	0
16-Sep-99	259	0	0	0	0	0	0	0	0	0	n/d	0	0
17-Sep-99	260	0	0	0	0	0	0	0	0	0	n/d	0	0
18-Sep-99	261	0	0	0	0	0	0	0	0	0	n/d	0	0
19-Sep-99	262	0	0	0	0	0	0	0	0	0	n/d	0	0
20-Sep-99	263	0	0	0	0	0	0	0	0	0	n/d	0	0
21-Sep-99	264	0	0	0	0	0	0	0	0	0	n/d	7	0
22-Sep-99	265	0	0	0	0	0	0	0	0	0	n/d	1	0
23-Sep-99	266	0	0	0	0	0	0	0	0	0	n/d	0	0
24-Sep-99	267	0	0	0	0	0	0	0	0	0	n/d	0	0
25-Sep-99	268	0	0	0	0	0	0	0	0	0	n/d	0	0
26-Sep-99	269	0	0	0	0	0	0	0	0	2	n/d	0	0
27-Sep-99	270	0	0	0	0	0	0	0	0	0	n/d	0	0
28-Sep-99	271	0	0	0	0	0	0	0	0	0	n/d	0	0
29-Sep-99	272	0	0	0	0	0	9	0	0	0	n/d	0	0
30-Sep-99	273	0	0	0	0	0	0	0	0	0	n/d	0	0
01-Oct-99	274	0	0	n/d	0	0	0	0	0	0	n/d	0	0
02-Oct-99	275	0	0	n/d	0	0	0	0	0	0	n/d	0	0
03-Oct-99	276	0	0	n/d	0	0	0	0	0	0	n/d	0	0
04-Oct-99	277	0	0	n/d	0	0	0	0	0	0	n/d	0	0
05-Oct-99	278	0	0	n/d	0	0	0	0	0	0	n/d	0	0
06-Oct-99	279	0	0	n/d	0	0	0	0	0	0	n/d	0	0
07-Oct-99	280	0	0	n/d	0	0	0	0	0	0	n/d	0	0
08-Oct-99	281	0	0	n/d	0	0	0	0	0	0	n/d	0	0
09-Oct-99	282	0	0	n/d	0	0	0	0	0	0	n/d	0	0
10-Oct-99	283	0	0	n/d	0	0	0	0	0	0	n/d	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
11-Oct-99	284	0	0	n/d	0	0	0	0	0	0	n/d	0	0
12-Oct-99	285	0	0	n/d	0	0	0	0	0	0	n/d	0	0
13-Oct-99	286	0	0	n/d	0	0	0	0	0	0	n/d	0	0
14-Oct-99	287	0	0	n/d	0	0	0	0	0	0	n/d	0	0
15-Oct-99	288	0	0	n/d	0	0	0	0	0	0	n/d	0	0
16-Oct-99	289	0	0	n/d	0	0	0	89	0	0	n/d	0	0
17-Oct-99	290	50	86	n/d	135	144	50	11	0	184	n/d	148	70
18-Oct-99	291	18	30	n/d	9	46	7	34	82	15	n/d	17	115
19-Oct-99	292	43	31	n/d	47	0	63	0	0	62	n/d	4	0
20-Oct-99	293	0	0	n/d	0	0	0	0	0	0	n/d	0	0
21-Oct-99	294	0	0	n/d	0	0	0	0	0	0	n/d	0	0
22-Oct-99	295	0	0	n/d	0	0	0	0	0	0	n/d	0	0
23-Oct-99	296	0	0	n/d	0	0	0	0	0	0	n/d	0	0
24-Oct-99	297	0	0	n/d	0	0	0	0	0	0	n/d	0	0
25-Oct-99	298	0	0	n/d	0	0	0	0	0	0	n/d	0	0
26-Oct-99	299	0	0	n/d	0	0	0	0	0	0	n/d	0	0
27-Oct-99	300	0	0	n/d	0	0	0	0	0	0	n/d	0	0
28-Oct-99	301	0	0	n/d	0	0	0	0	0	0	n/d	0	0
29-Oct-99	302	0	0	n/d	0	0	0	0	0	0	n/d	0	0
30-Oct-99	303	59	0	n/d	0	14	0	76	n/d	17	n/d	56	0
31-Oct-99	304	0	40	n/d	54	0	71	0	n/d	0	n/d	8	0
01-Nov-99	305	0	0	0	0	0	0	0	0	0	n/d	0	0
02-Nov-99	306	0	0	0	0	0	0	0	0	0	n/d	0	0
03-Nov-99	307	0	0	0	0	0	0	0	0	0	n/d	0	0
04-Nov-99	308	0	0	0	0	0	0	0	0	0	n/d	0	0
05-Nov-99	309	0	0	0	0	0	0	0	0	0	n/d	0	0
06-Nov-99	310	0	0	0	0	0	0	0	0	0	n/d	0	0
07-Nov-99	311	0	0	0	0	0	0	0	0	0	n/d	0	0
08-Nov-99	312	0	0	0	0	0	0	0	0	0	n/d	0	0
09-Nov-99	313	0	0	0	0	0	0	0	0	0	n/d	0	0
10-Nov-99	314	0	0	0	0	0	0	0	0	0	n/d	0	0
11-Nov-99	315	0	0	0	0	0	0	0	0	0	n/d	0	0
12-Nov-99	316	0	0	0	0	0	0	0	0	0	n/d	0	0
13-Nov-99	317	0	0	0	0	0	0	0	0	0	n/d	0	0
14-Nov-99	318	0	0	0	0	0	0	0	0	0	n/d	0	0
15-Nov-99	319	0	0	0	0	0	0	0	0	0	n/d	0	0
16-Nov-99	320	0	0	0	0	0	0	0	0	0	n/d	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
17-Nov-99	321	0	0	0	0	0	0	0	0	0	n/d	0	0
18-Nov-99	322	0	0	0	0	0	0	0	0	0	n/d	0	0
19-Nov-99	323	0	0	0	0	0	0	0	0	0	n/d	0	0
20-Nov-99	324	0	0	0	0	0	0	0	0	0	n/d	0	0
21-Nov-99	325	0	0	0	0	0	0	0	0	0	n/d	0	0
22-Nov-99	326	0	0	0	0	0	0	3	0	0	n/d	0	0
23-Nov-99	327	0	37	0	0	0	0	0	0	0	n/d	0	0
24-Nov-99	328	0	0	0	20	0	0	16	0	0	n/d	0	0
25-Nov-99	329	7	5	0	0	0	4	0	0	4	n/d	0	0
26-Nov-99	330	0	0	0	0	0	0	0	0	0	n/d	0	0
27-Nov-99	331	0	0	0	0	0	0	0	0	0	n/d	0	0
28-Nov-99	332	0	0	0	0	0	0	0	0	0	n/d	0	0
29-Nov-99	333	0	0	0	0	0	0	0	0	0	n/d	0	0
30-Nov-99	334	0	0	0	0	0	0	0	0	0	n/d	0	0
01-Dec-99	335	0	0	0	0	0	0	0	0	0	n/d	0	0
02-Dec-99	336	0	0	0	0	0	0	0	0	0	n/d	0	0
03-Dec-99	337	0	0	0	0	0	0	0	0	0	n/d	0	0
04-Dec-99	338	0	0	0	0	0	0	0	0	0	n/d	0	0
05-Dec-99	339	0	0	0	0	0	0	0	0	0	n/d	0	0
06-Dec-99	340	0	0	0	0	0	0	0	0	0	n/d	0	0
07-Dec-99	341	0	0	0	0	0	0	0	0	0	n/d	0	0
08-Dec-99	342	0	0	0	0	0	0	5	0	0	n/d	0	0
09-Dec-99	343	0	0	0	0	0	2	0	0	3	n/d	2	0
10-Dec-99	344	0	0	0	0	0	0	0	0	0	n/d	0	0
11-Dec-99	345	0	0	0	0	0	9	49	0	0	n/d	0	0
12-Dec-99	346	70	0	0	45	0	13	0	0	9	n/d	40	0
13-Dec-99	347	0	0	0	0	0	0	0	0	0	n/d	0	0
14-Dec-99	348	0	0	0	0	0	0	0	0	0	n/d	0	0
15-Dec-99	349	0	0	0	0	0	0	0	0	0	n/d	0	0
16-Dec-99	350	0	0	0	0	0	0	0	0	0	n/d	0	0
17-Dec-99	351	0	0	0	0	0	0	0	0	0	n/d	0	0
18-Dec-99	352	0	0	0	0	0	0	0	0	0	n/d	0	0
19-Dec-99	353	0	0	0	0	0	0	0	0	0	n/d	0	0
20-Dec-99	354	0	0	0	0	0	2	19	0	0	n/d	0	0
21-Dec-99	355	8	0	0	0	0	20	0	0	4	n/d	0	0
22-Dec-99	356	0	0	0	12	0	0	0	0	9	n/d	0	0
23-Dec-99	357	0	0	0	0	0	0	0	0	4	n/d	0	0

B-1. Daily Precipitation Data (1998-1999)

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**410832**	**410902**	**411007**	**411215**	**411398**	**411429**	**411431**	**411492**	**414254**	**414374**	**414782**	**415113**
24-Dec-99	358	0	0	0	0	0	0	0	0	0	n/d	0	0
25-Dec-99	359	0	0	0	0	0	0	0	0	0	n/d	0	0
26-Dec-99	360	0	0	0	0	0	0	0	0	0	n/d	0	0
27-Dec-99	361	0	0	0	0	0	0	0	0	0	n/d	0	0
28-Dec-99	362	0	0	0	0	0	0	0	0	0	n/d	0	0
29-Dec-99	363	0	0	0	0	0	0	0	0	0	n/d	0	0
30-Dec-99	364	0	0	0	0	0	0	0	0	0	n/d	0	0
31-Dec-99	365	0	0	0	0	0	0	0	0	0	n/d	0	0

B-2. Daily Stream Gage Data (15 Oct. - 15 Nov., 1998)

Index of Stream Gages

1	**Blanco River At Wimberley**	8171000	13	**Hondo Creek near Tarpley**	8200000
2	**Blanco River near Kyle**	8171300	14	**Medina River at Bandera**	8178880
3	**Cibolo Creek at IH-10 above Bourne**	8183850	15	**Nueces River at Laguna**	8190000
4	**Cibolo Creek at Selma**	8185000	16	**Nueces River below Uvalde**	8192000
5	**Frio River at Concan**	8195000	17	**West Nueces River near Bracketville**	8190500
6	**Frio River below Dry Frio River near Uvalde**	8197500	18	**Seco Creek at Miller Ranch near Utopia**	8201500
7	**Dry Frio River near Reagan Wells**	8196000	19	**Seco Creek at Rowe Ranch near D'Hanis**	8202700
8	**Guadalupe River at Comfort**	8167000	20	**Sabinal River near Sabinal**	8198000
9	**Guadalupe River near Spring Branch**	8167500	21	**Sabinal River at Sabinal**	8198500
10	**Guadalupe River at Sattler**	8167800	22	**Plum Creek at Lockhart**	8172400
11	**Guadalupe R. at Comal R. at New Braunfels**	8168500	23	**Salado Creek (upper Station) at San Antonio**	8178700
12	**Hondo Creek at King Waterhole near Hondo**	8200700			

		1	2	3	4	5	6	7	8	9	10	11	12
Date	**Julian Date**	**8167000**	**8167500**	**8167800**	**8168500**	**8171000**	**8171300**	**8172400**	**8178700**	**8178880**	**8183850**	**8185000**	**8190000**
15-Oct-98	288	155	198	120	178	74	51	4.2	0	146	3.2	0	369
16-Oct-98	289	150	188	120	174	73	50	3	0.01	138	3.1	0	366
17-Oct-98	290	182	15600	1230	37400	20800	26000	8840	11600	150	21	32000	361
18-Oct-98	291	346	5520	319	13500	6770	8500	19400	6860	316	97	18000	2970
19-Oct-98	292	339	1590	94	1470	2680	3110	5050	1640	335	83	1300	665
20-Oct-98	293	272	920	64	1020	1990	2680	3900	1190	287	57	806	536
21-Oct-98	294	251	720	44	795	1450	1960	1470	925	253	43	445	502
22-Oct-98	295	227	595	35	628	1100	1480	1110	571	224	35	280	475
23-Oct-98	296	205	515	30	532	884	1180	1020	326	203	31	190	448
24-Oct-98	297	192	470	29	469	737	980	953	235	189	28	132	424
25-Oct-98	298	185	440	30	432	636	830	860	146	181	24	91	405
26-Oct-98	299	181	410	28	405	559	720	809	106	174	23	61	388
27-Oct-98	300	180	400	27	378	500	640	787	80	169	22	40	378
28-Oct-98	301	183	390	39	362	458	580	749	59	165	20	26	366
29-Oct-98	302	182	385	58	360	419	520	660	37	160	18	15	358
30-Oct-98	303	180	370	359	493	376	460	596	8	156	17	6.7	348
31-Oct-98	304	175	367	549	946	344	420	557	2.7	152	16	1.6	341
1-Nov-98	305	577	880	557	1030	1830	2190	1090	48	415	95	3.1	433
2-Nov-98	306	605	1200	736	1050	928	1120	714	14	469	73	0.66	510
3-Nov-98	307	424	867	967	1450	640	760	537	2.8	348	51	0.02	482
4-Nov-98	308	349	690	1230	1600	554	660	464	1.2	305	43	0	446
5-Nov-98	309	387	688	1690	1910	590	700	435	18	419	56	0	431
6-Nov-98	310	361	721	1880	2010	580	690	404	3.4	375	47	0	427
7-Nov-98	311	339	705	1870	2020	580	680	369	7.3	362	51	0	424
8-Nov-98	312	319	698	1870	2010	580	680	331	2.2	342	48	0	412

B-2. Daily Stream Gage Data (15 Oct. - 15 Nov., 1998)

9-Nov-98	313	310	668	2210	2180	560	660	282	1.3	324	46	0	398
10-Nov-98	314	292	641	2770	2710	537	630	235	0.85	304	43	0	387
11-Nov-98	315	264	586	2950	3030	484	560	196	0.57	278	38	0	375
12-Nov-98	316	257	554	2020	2550	488	570	181	0.61	269	39	0	365
13-Nov-98	317	277	552	267	808	621	720	532	3.9	280	44	0	367
14-Nov-98	318	373	787	54	353	1030	1200	611	72	369	76	0	386
15-Nov-98	319	409	1210	55	359	1470	1690	665	17	416	76	0	386

		13	14	15	16	17	18	19	20	21	22	23
Date	**Julian Date**	**8190500**	**8192000**	**8195000**	**8196000**	**8197500**	**8198000**	**8198500**	**8200000**	**8200700**	**8201500**	**8202700**
15-Oct-98	288	29	331	137	44	0	81	5.8	97	0	40	0
16-Oct-98	289	26	322	137	43	0	80	5.6	95	0	38	0
17-Oct-98	290	25	320	137	43	0	82	5.6	132	0	50	0
18-Oct-98	291	24	3630	957	2010	5170	1770	1470	1520	2450	990	3450
19-Oct-98	292	22	1410	276	298	242	313	283	347	58	195	136
20-Oct-98	293	21	743	241	208	23	273	185	281	9.6	166	69
21-Oct-98	294	19	603	227	175	4.7	254	152	240	0.28	146	55
22-Oct-98	295	18	529	213	155	1.6	237	129	213	0	131	44
23-Oct-98	296	17	476	203	137	1.3	225	111	192	0	119	34
24-Oct-98	297	16	447	196	123	1.1	213	98	174	0	110	23
25-Oct-98	298	15	421	188	114	1	203	87	163	0	103	12
26-Oct-98	299	14	404	181	107	0.85	193	79	152	0	96	5.3
27-Oct-98	300	14	392	176	98	0.65	184	69	143	0	86	1.1
28-Oct-98	301	13	379	171	96	0.57	178	60	134	0	81	0
29-Oct-98	302	13	369	167	89	0.45	171	53	125	0	77	0
30-Oct-98	303	12	358	163	83	0.37	164	46	117	0	73	0
31-Oct-98	304	12	348	158	78	0.3	160	40	112	0	70	0
1-Nov-98	305	13	361	283	188	0.27	367	92	186	0	122	0
2-Nov-98	306	13	436	317	182	0.23	283	225	142	0	94	0
3-Nov-98	307	13	477	289	151	0.2	237	126	131	0	85	0
4-Nov-98	308	12	455	266	135	0.14	225	99	131	0	81	0
5-Nov-98	309	11	445	267	130	0.1	233	101	151	0	90	0
6-Nov-98	310	11	423	276	121	0.08	229	112	136	0	82	0
7-Nov-98	311	11	428	272	117	0.07	229	106	139	0	83	0
8-Nov-98	312	11	420	257	110	0.05	217	99	134	0	78	0
9-Nov-98	313	11	412	249	106	0.03	213	88	132	0	77	0
10-Nov-98	314	9.8	400	235	98	0.01	209	80	127	0	72	0
11-Nov-98	315	10	388	228	89	0	193	69	122	0	68	0
12-Nov-98	316	10	384	222	86	0	196	66	123	0	68	0
13-Nov-98	317	10	384	222	87	0	203	69	127	0	67	0
14-Nov-98	318	9.8	419	247	105	0	231	98	166	0	87	0
15-Nov-98	319	9.4	403	247	103	0	216	101	161	0	84	0

B-3. Daily well elevation data (October 11, 1998 through January 31, 1999)

Index of wells

1	**Ehler**	51405	8	**Trio**	36402
2	**City of Uvalde**	50302	9	**City of Castroville***	41301
3	**City of Hondo**	47306	10	**Quihi***	40102
4	**City of Sabinal****	45401	11	**Kyle North**	01303
5	**Knippa****	43607	12	**Landa Park**	23302
6	**North Uvalde**	43409	13	**Hill Country**	29103
7	**J-17**	37203	14	**La Escondida***	19806

* Missing data for these wells estimated with cubic spline, indicated in bold.

** Data from these wells not used. Missing data too erratic to use cubic spline data fitting technique.

	Julian	1	2	3	4	5	6	7
Date	**Date**	**51406**	**50302**	**47306**	**45401****	**43607****	**43409**	**37203**
11-Oct-98	284	845.68	877.16	716.78	780.65	790.61	879.29	664.43
12-Oct-98	285	845.72	877.19	716.88	780.63	790.42	879.27	664.07
13-Oct-98	286	845.72	877.24	716.88	780.45	790.25	879.33	663.88
14-Oct-98	287	845.66	877.28	716.92	780.49	790.12	879.34	663.88
15-Oct-98	288	845.62	877.33	716.95	780.59	789.93	879.38	663.84
16-Oct-98	289	845.67	877.36	717.03	780.58	789.64	879.38	663.76
17-Oct-98	290	845.70	877.43	716.99	780.59	789.34	879.37	666.29
18-Oct-98	291	845.78	877.57	717.83	782.76	789.29	879.75	673.43
19-Oct-98	292	845.86	877.63	722.99	784.95	792.37	880.56	678.38
20-Oct-98	293	845.95	877.69	726.62	786.41	795.60	881.03	681.22
21-Oct-98	294	846.00	877.73	729.18	787.55	797.33	881.22	682.52
22-Oct-98	295	846.08	877.78	731.09	788.63		881.45	683.32
23-Oct-98	296	846.18	877.84	732.57	789.62		881.67	683.96
24-Oct-98	297	846.29	877.91	733.82	790.53		881.83	684.79
25-Oct-98	298	846.35	877.98	734.77	791.28		881.99	685.37
26-Oct-98	299	846.40	878.02	735.48	791.83		882.11	685.63
27-Oct-98	300	846.45	878.10	736.01	792.38		882.24	685.90
28-Oct-98	301	846.51	878.15	736.43	792.91		882.40	686.19
29-Oct-98	302	846.55	878.21	736.88	793.27		882.51	686.33
30-Oct-98	303	846.54	878.26	737.17	793.71		882.61	686.37
31-Oct-98	304	846.51	878.34	737.36	794.12		882.71	686.51
1-Nov-98	305	846.49	878.38	737.68	794.43		882.74	686.84
2-Nov-98	306	846.40	878.44	737.99	794.85		882.83	687.05
3-Nov-98	307	846.02	878.46	738.23	795.23		882.83	687.17
4-Nov-98	308	845.98	878.41	738.27	795.38		882.87	687.23
5-Nov-98	309	845.96	878.47	738.57	785.96		882.97	687.46
6-Nov-98	310	846.02	878.54	738.83	786.48		883.11	687.59
7-Nov-98	311	846.07	878.63	739.23	786.93		883.24	687.84
8-Nov-98	312	846.13	878.70	739.55	787.47		883.44	687.94
9-Nov-98	313	846.21	878.78	739.79	788.05		883.73	687.96
10-Nov-98	314	846.21	878.79	740.27	788.06		883.70	687.87
11-Nov-98	315	846.17	878.82	740.26	788.35		883.74	687.76
12-Nov-98	316	846.19	878.90	740.15	788.84		883.95	687.78
13-Nov-98	317	846.24	878.95	740.50	789.34		884.12	687.86
14-Nov-98	318	846.28	879.06	740.72	789.71		884.25	688.12
15-Nov-98	319	846.31	879.14	741.04	790.08		884.40	688.35
16-Nov-98	320	846.35	879.18	741.41	790.52	790.61	884.55	688.35
17-Nov-98	321	846.35	879.20	741.77	790.83	790.46	884.62	688.40
18-Nov-98	322	846.35	879.24	741.97	791.20	790.36	884.78	688.38
19-Nov-98	323	846.04	879.33	742.30	791.59	790.30	884.87	688.40
20-Nov-98	324	846.05	879.36	742.40	791.77	790.09	884.89	688.36
21-Nov-98	325	846.21	879.42	742.47	792.11	790.06	885.03	688.46
22-Nov-98	326	846.25	879.48	742.61	792.47	790.07	885.16	688.50

B-3. Daily well elevation data (October 11, 1998 through January 31, 1999)

23-Nov-98	327	846.28	879.51	742.75	792.66	790.18	885.19	688.22
24-Nov-98	328	846.32	879.53	742.76	793.06	790.22	885.36	688.12
25-Nov-98	329	846.32	879.56	742.92	793.26	790.19	885.44	687.92
26-Nov-98	330	846.29	879.61	743.00	793.46	790.13	885.48	687.86
27-Nov-98	331	846.26	879.64	743.00	793.69	790.02	885.58	687.96
28-Nov-98	332	846.24	879.71	743.17	793.97	790.00	885.70	687.93
29-Nov-98	333	846.22	879.77	743.33	794.29	790.04	885.86	687.90
30-Nov-98	334	846.19	879.75	743.51	794.25	790.06	885.75	687.62
1-Dec-98	335	846.22	879.78	743.42	794.29		885.82	687.51
2-Dec-98	336	846.28	879.84	743.18	794.48		885.96	687.54
3-Dec-98	337	846.76	879.89	743.30			886.06	687.50
4-Dec-98	338	846.76	879.90	743.39		812.95	886.03	687.43
5-Dec-98	339	846.78	879.96	743.39		812.94	886.11	687.43
6-Dec-98	340	846.78	880.02	743.45		812.98	886.15	687.42
7-Dec-98	341	846.77	880.05	743.54		812.79	886.07	687.18
8-Dec-98	342	846.69	880.00	743.37		812.64	885.97	687.07
9-Dec-98	343	846.67	880.05	743.08		812.58	886.07	687.12
10-Dec-98	344	846.59	880.10	743.15		812.49	886.07	687.04
11-Dec-98	345	846.65	880.11	743.21		812.49	886.08	686.93
12-Dec-98	346	846.68	880.15	743.25		812.66	886.15	687.21
13-Dec-98	347	846.71	880.18	743.22		812.90	886.18	687.22
14-Dec-98	348	846.74	880.24	743.24		813.01	886.23	687.02
15-Dec-98	349	846.73	880.29	743.36		813.03	886.24	686.91
16-Dec-98	350	846.70	880.27	743.44		813.07	886.30	686.91
17-Dec-98	351	846.47	880.31	743.48		813.02	886.36	686.84
18-Dec-98	352	846.48	880.35	743.48		813.14	886.55	686.89
19-Dec-98	353	846.42	880.35	743.82		813.14	886.42	686.87
20-Dec-98	354	846.43	880.35	743.73		813.12	886.42	686.91
21-Dec-98	355	846.47	880.39	743.51		812.97	886.47	686.74
22-Dec-98	356	846.42	880.36	743.57		812.82	886.33	686.57
23-Dec-98	357	846.44	880.39	743.12		812.86	886.37	686.53
24-Dec-98	358	846.40	880.39	743.25		812.75	886.31	686.48
25-Dec-98	359	846.41	880.45	743.11		812.75	886.43	686.67
26-Dec-98	360	846.47	880.50	743.28		812.77	886.53	686.68
27-Dec-98	361	846.51	880.57	743.32		812.76	886.57	686.63
28-Dec-98	362	846.50	880.55	743.41		812.74	886.57	686.38
29-Dec-98	363	846.49	880.56	743.10		812.64	886.56	686.08
30-Dec-98	364	846.43	880.57	743.12		812.59	886.59	685.93
31-Dec-98	365	846.35	880.57	742.76		812.41	886.58	685.86
1-Jan-99	1	846.29	880.63	742.68		812.38	886.75	686.08
2-Jan-99	2	846.25	880.64	742.59		812.02	886.56	685.97
3-Jan-99	3	846.23	880.58	742.54		811.78	886.44	685.79
4-Jan-99	4	846.26	880.55	742.19		811.68	886.43	685.57
5-Jan-99	5	846.25	880.62	742.13		811.69	886.62	685.52
6-Jan-99	6	846.21	880.62	742.30		811.57	886.59	685.48
7-Jan-99	7	846.04	880.64	742.27		811.54	886.66	685.44
8-Jan-99	8	845.89	880.66	741.93		811.47	886.71	685.38
9-Jan-99	9	845.78	880.65	741.80		811.24	886.58	685.39
10-Jan-99	10	845.77	880.64	741.41		811.20	886.56	685.20
11-Jan-99	11	845.68	880.69	741.63		811.20	886.61	685.03
12-Jan-99	12	845.70	880.72	741.68		811.21	886.72	684.96
13-Jan-99	13	845.66	880.72	741.65		810.99	886.65	684.85
14-Jan-99	14	845.54	880.67	741.74		810.86	886.54	684.72
15-Jan-99	15	844.80	880.69	741.36		810.86	886.67	684.64
16-Jan-99	16	844.47	880.69	741.06		810.90	886.70	684.66
17-Jan-99	17	844.45	880.72	741.14		810.74	886.64	684.54
18-Jan-99	18	844.27	880.66	740.98		810.63	886.53	684.27
19-Jan-99	19	844.00	880.59	740.87		810.56	886.56	684.08

B-3. Daily well elevation data (October 11, 1998 through January 31, 1999)

20-Jan-99	20	843.95	880.61	740.61		810.50	886.65	684.10
21-Jan-99	21	844.05	880.65	740.40		810.52	886.79	684.14
22-Jan-99	22	844.72	880.66	740.11		810.19	886.68	683.94
23-Jan-99	23	845.15	880.57	739.84		809.97	886.30	683.76
24-Jan-99	24	845.20	880.56	739.18		809.87	886.26	683.62
25-Jan-99	25	844.45	880.60	739.07		809.80	886.16	683.38
26-Jan-99	26	844.46	880.54	739.10		809.80	886.21	683.28
27-Jan-99	27	844.49	880.50	738.41		809.79	886.23	683.13
28-Jan-99	28	844.53	880.47	738.17		809.77	886.24	683.20
29-Jan-99	29	844.45	880.45	737.95		809.59	886.24	683.24
30-Jan-99	30	844.50	880.32	738.30		809.45	885.96	683.15
31-Jan-99	31	843.90	880.26	737.52		809.35	885.90	682.93

	Julian	8	9	10	11	12	13	14
Date	**Date**	**36402**	**41301***	**40102***	**1303**	**23302**	**29103**	**19806***
11-Oct-98	284	789.42	688.26	833.62	554.83	625.29	685.30	1044.20
12-Oct-98	285	789.57	688.34	833.58	553.81	625.31	685.17	1043.68
13-Oct-98	286	789.76	688.40	833.65	553.89	625.31	685.17	1043.60
14-Oct-98	287	789.96	688.53	833.72	554.03	625.29	685.27	1043.35
15-Oct-98	288	790.13	688.58	833.76	554.21	625.29	685.25	1043.25
16-Oct-98	289	790.28	688.57	833.78	554.33	625.32	685.27	1049.80
17-Oct-98	290	790.43	690.97	833.85	558.81	629.34	688.27	1054.75
18-Oct-98	291	790.57	693.27	837.11	558.81	628.64	691.12	1054.70
19-Oct-98	292	791.02	696.78	837.96	555.11	628.24	692.31	**1053.89**
20-Oct-98	293	791.63	699.42	838.67	556.11	628.11	693.05	**1053.47**
21-Oct-98	294	792.20	701.32	838.84	557.09	628.14	693.23	**1053.37**
22-Oct-98	295	792.75	702.85	838.99	557.90	628.19	693.38	**1053.52**
23-Oct-98	296	793.28	703.96	839.13	558.72	628.24	693.83	**1053.87**
24-Oct-98	297	793.77	704.93	839.22	559.64	628.28	694.37	**1054.35**
25-Oct-98	298	794.28	705.65	839.31	560.29	628.36	694.87	**1054.9**
26-Oct-98	299	794.75	706.11	839.36	559.82	628.41	695.27	**1055.46**
27-Oct-98	300	795.26	706.58	839.42	558.36	628.48	695.73	**1055.96**
28-Oct-98	301	795.79	707.01	839.53	558.63	628.51	696.26	1056.34
29-Oct-98	302	796.27	707.25	839.59	558.52	628.54	696.64	1056.53
30-Oct-98	303	796.74	707.54	839.63	558.50	628.54	697.00	1056.55
31-Oct-98	304	797.27	707.89	839.72	559.00	628.56	697.52	1056.77
1-Nov-98	305	797.68	**708.25**	839.77	559.06	628.62	697.87	1057.10
2-Nov-98	306	798.14	**708.6**	839.78	558.69	628.64	698.30	1057.48
3-Nov-98	307	798.59	**708.95**	839.80	558.85	628.64	698.63	1057.65
4-Nov-98	308	799.21	**709.29**	839.77	559.19	628.63	698.90	1057.73
5-Nov-98	309	799.66	**709.63**	839.73	559.95	628.66	699.27	1057.80
6-Nov-98	310	800.15	**709.97**	839.80	560.71	628.66	699.80	1058.15
7-Nov-98	311	800.60	**710.3**	839.87	562.04	628.66	700.22	1058.35
8-Nov-98	312	801.14	**710.63**	839.96	563.16	628.69	700.75	1058.63
9-Nov-98	313	801.69	**710.95**	840.20	563.84	628.72	701.42	1058.98
10-Nov-98	314	801.96	**711.27**	840.17	564.16	628.71	701.42	1058.88
11-Nov-98	315	802.43	**711.59**	839.97	564.52	628.69	701.63	1059.15
12-Nov-98	316	802.92	**711.9**	840.14	565.03	628.68	702.16	1059.10
13-Nov-98	317	803.45	**712.2**	840.26	565.66	628.71	702.64	1059.95
14-Nov-98	318	803.86	**712.5**	840.31	566.48	628.92	703.11	1060.40
15-Nov-98	319	804.33	**712.79**	840.37	566.39	628.82	703.65	1060.90
16-Nov-98	320	804.78	**713.08**	840.47	565.96	628.84	704.08	1061.40
17-Nov-98	321	805.20	**713.37**	840.46	565.56	628.84	704.35	1061.62
18-Nov-98	322	805.69	**713.65**	840.55	566.12	628.85	704.76	1061.88
19-Nov-98	323	806.12	**713.92**	840.60	566.47	628.85	705.06	1062.03
20-Nov-98	324	806.50	**714.19**	840.54	566.53	628.84	705.19	1062.21
21-Nov-98	325	806.95	**714.45**	840.60	567.22	628.83	705.49	1062.20
22-Nov-98	326	807.41	**714.71**	840.70	567.01	628.85	705.88	1062.30

B-3. Daily well elevation data (October 11, 1998 through January 31, 1999)

23-Nov-98	327	807.81	**714.96**	840.69	566.45	628.88	706.09	1062.45
24-Nov-98	328	808.30	**715.21**	840.81	566.77	628.86	706.46	1062.77
25-Nov-98	329	808.69	**715.45**	840.87	567.07	628.87	706.64	1062.89
26-Nov-98	330	809.08	**715.68**	840.87	566.80	628.84	706.89	1062.91
27-Nov-98	331	809.50	**715.91**	840.94	567.11	628.86	707.20	1063.14
28-Nov-98	332	809.94	**716.13**	840.77	567.51	628.87	707.53	1063.25
29-Nov-98	333	810.34	**716.34**	840.72	567.71	628.88	707.90	1063.49
30-Nov-98	334	810.58	**716.55**	**840.83**	566.85	628.88	707.87	1063.50
1-Dec-98	335	810.97	**716.75**	**841.02**	566.82	628.85	707.95	1063.20
2-Dec-98	336	811.30	716.95	841.23	566.91	628.84	708.40	1063.41
3-Dec-98	337	811.42	717.11	841.38	567.25	628.85	708.78	1063.84
4-Dec-98	338	811.72	717.14	841.38	567.86	628.85	708.85	1063.82
5-Dec-98	339	812.08	717.12	841.47	568.03	628.84	709.14	1063.94
6-Dec-98	340	812.39	717.14	841.54	567.83	628.83	709.35	1064.08
7-Dec-98	341	812.53	717.03	841.52	567.02	628.84	709.42	1064.07
8-Dec-98	342	812.79	716.75	841.39	567.18	628.82	709.36	1063.87
9-Dec-98	343	813.11	716.72	841.54	567.49	628.79	709.76	1063.92
10-Dec-98	344	813.34	716.78	841.57	567.64	628.79	710.09	1064.02
11-Dec-98	345	813.59	716.74	841.60	567.86	628.79	710.13	1064.07
12-Dec-98	346	813.85	716.77	841.67	568.20	628.79	710.32	1064.09
13-Dec-98	347	814.09	716.72	841.71	567.85	628.79	710.47	1064.08
14-Dec-98	348	814.33	716.72	841.77	566.76	628.80	710.64	1064.17
15-Dec-98	349	814.57	716.69	841.80	566.80	628.80	710.92	1064.17
16-Dec-98	350	814.81	716.72	841.89	566.84	628.77	711.15	1064.26
17-Dec-98	351	815.16	716.72	841.99	567.31	628.77	711.42	1064.30
18-Dec-98	352	815.47	717.04	842.27	568.37	629.60	711.93	1064.74
19-Dec-98	353	815.61	716.90	842.16	568.41	628.79	711.91	1064.73
20-Dec-98	354	815.85	716.77	842.19	568.31	628.79	711.93	1064.73
21-Dec-98	355	816.05	716.78	842.29	568.37	628.79	712.14	1064.83
22-Dec-98	356	816.16	716.51	842.14	567.81	628.76	711.98	1064.65
23-Dec-98	357	816.34	716.48	842.23	567.50	628.75	712.17	1064.62
24-Dec-98	358	816.53	716.41	842.20	566.70	628.74	712.25	1064.51
25-Dec-98	359	816.76	716.43	842.34	566.56	628.73	712.54	1064.58
26-Dec-98	360	817.02	716.61	842.50	567.30	628.73	712.82	1064.85
27-Dec-98	361	817.20	716.74	842.63	567.05	628.73	713.02	1065.05
28-Dec-98	362	817.40	716.65	842.68	566.75	628.73	713.10	1065.13
29-Dec-98	363	817.48	716.56	842.68	566.47	628.68	713.17	1065.27
30-Dec-98	364	817.72	716.33	842.77	566.73	628.67	713.22	1065.07
31-Dec-98	365	817.87	716.25	842.77	566.85	628.66	713.28	1065.09
1-Jan-99	1	818.11	716.36	843.03	567.50	628.71	713.74	1065.50
2-Jan-99	2	818.11	716.21	842.92	567.40	628.71	713.64	1065.40
3-Jan-99	3	818.07	715.84	842.69	567.04	628.67	713.22	1064.92
4-Jan-99	4	818.18	715.65	842.72	566.42	628.65	713.25	1064.69
5-Jan-99	5	818.42	715.84	843.00	566.45	628.65	713.77	1065.05
6-Jan-99	6	818.53	715.83	843.05	566.60	628.64	713.86	1065.08
7-Jan-99	7	818.71	715.78	843.17	567.00	628.62	714.05	1065.27
8-Jan-99	8	818.83	715.80	843.26	567.44	628.62	714.18	1065.40
9-Jan-99	9	818.83	715.62	843.11	567.53	628.59	713.97	1065.27
10-Jan-99	10	818.89	715.39	843.14	567.28	628.59	713.88	1065.03
11-Jan-99	11	819.08	715.37	843.31	566.61	628.59	714.25	1065.15
12-Jan-99	12	819.24	715.49	843.48	566.80	628.59	714.44	1065.42
13-Jan-99	13	819.27	715.40	843.43	566.80	628.57	714.35	1065.43
14-Jan-99	14	819.27	715.09	843.31	566.99	628.54	714.11	1065.05
15-Jan-99	15	819.39	715.06	843.53	567.15	628.51	714.35	1065.22
16-Jan-99	16	819.52	715.09	843.65	567.41	628.51	714.77	1065.39
17-Jan-99	17	819.55	714.98	843.63	566.97	628.51	714.95	1065.42
18-Jan-99	18	819.55	714.76	843.54	565.90	628.49	714.52	1065.09
19-Jan-99	19	819.63	714.61	843.67	565.79	628.48	714.66	1065.18

B-3. Daily well elevation data (October 11, 1998 through January 31, 1999)

20-Jan-99	20	819.76	714.56	843.83	566.26	628.47	714.68	1065.34
21-Jan-99	21	819.97	714.61	844.07	565.14	628.47	714.93	1065.64
22-Jan-99	22	819.97	714.58	844.00	564.75	628.47	714.88	1065.68
23-Jan-99	23	819.81	714.00	843.71	565.45	628.46	714.31	1065.11
24-Jan-99	24	819.75	713.71	843.70	565.50	628.43	714.15	1064.84
25-Jan-99	25	819.75	713.55	843.75	564.69	628.41	714.11	1064.78
26-Jan-99	26	819.87	713.42	843.93	565.19	628.40	714.35	1064.90
27-Jan-99	27	819.93	713.32	844.04	565.78	628.38	714.47	1064.94
28-Jan-99	28	820.01	713.18	844.15	566.36	628.37	714.62	1065.15
29-Jan-99	29	820.03	713.13	844.16	566.72	628.36	714.66	1065.24
30-Jan-99	30	819.95	712.79	844.02	567.05	628.35	714.38	1064.91
31-Jan-99	31	819.90	712.47	844.07	566.75	628.32	714.31	1064.73