# Update
# for the
# Paso Robles Groundwater Basin

Report to Paso Robles Groundwater Basin Committee
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# FOR THE
# PASO ROBLES GROUNDWATER BASIN

DECEMBER 2007

PREPARED FOR

PASO ROBLES GROUNDWATER BASIN COMMITTEE

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# Executive Summary

The purpose of the Paso Robles Groundwater Basin monitoring program and Basin Update is to monitor and evaluate groundwater conditions, recognizing that monitoring and appropriate management of Basin water resources can delay or even avoid basin overdraft. This first Basin Update provides an overview of the current condition of the Paso Robles Groundwater Basin, building on the *Paso Robles Groundwater Basin Study* (Phase I Report) (Fugro, et al., 2002) and the *Paso Robles Groundwater Basin Numerical Model* (Phase II Report) (Fugro, et al., 2005). The Phase I study period was from July 1980 through June 1997; this Basin Update provides an update from 1997 through 2006 on rainfall, groundwater levels and storage, and groundwater management planning.

The study area is located in the Salinas River watershed in northern San Luis Obispo County and southern Monterey County, and includes the Atascadero subbasin and seven subareas. The major water-bearing units in the basin include alluvial deposits and the Paso Robles Formation. Precipitation is the ultimate source of recharge to the groundwater basin. In general, average annual rainfall over the basin varies from 20 inches in the west to 10 inches in the east; this report describes two different maps showing the distribution of rainfall. Since the study period of the Phase I report, rainfall has been slightly higher than average. However, the past water year was one of the driest on record with only 5.48 inches recorded.

Examination of groundwater level data from spring 2006 show that the general direction and pattern of groundwater flow are unchanged from 1997. In addition, historical groundwater level data from over 200 wells were examined to evaluate trends in groundwater levels. Representative hydrographs are presented to characterize the Atascadero subbasin and the seven subareas of the Paso Robles Groundwater Basin. These hydrographs illustrate how groundwater levels change with varying rainfall amounts and changing pumping patterns.

Change in groundwater storage from 1997 to 2006 was calculated using essentially the same method as the Phase I Report. The storage calculations indicate an estimated net groundwater storage decrease of -29,767 acre-feet (AF), equivalent to an average storage decrease of -3,307 acre feet per year (AFY). Between 1997 and 2006, storage decreases were concentrated in the Estrella and Creston subareas, while storage increases are documented in the Atascadero subbasin and Shandon subarea. Storage declines have persisted since 1981 in portions of the Estrella and San Juan subareas.

The San Luis Obispo County Flood Control and Water Conservation District (District), City of Paso Robles, and other local stakeholders have taken the initiative to better manage groundwater Recent project include the ongoing groundwater level monitoring program, Nacimiento Project, Water Banking Study, City of Paso Robles Water Resources Plan Integration, County Resource Capacity and Conservation Element Study and upcoming Water Master Plan Update, and USGS GAMA program.

**Conclusions** of this first Basin Update are summarized as follows:

- A comprehensive water balance accounts for *all* inflows (e.g., deep rainfall percolation, streamflow percolation, subsurface inflow, wastewater discharge, and return flows) and *all* outflows (pumping, subsurface outflow, and phreatophyte use). The most recent water balance completed for the basin covered a study period of 1980 through 1997.

- The Basin Update reviews readily available components of the water balance from 1997 through 2006. It reviews rainfall records, evaluates groundwater level trends, maps regional groundwater elevations, estimates change in storage, and reports on groundwater management activities.

- Changes in recharge are strongly influenced by fluctuations in rainfall, which are considered in the Basin Update's evaluation of groundwater levels and storage. Changes in discharge, particularly groundwater pumping and use, are not documented in this Basin Update.

- A comparison of existing isohyetal (rainfall) maps reveals differences, particularly in the highland areas west and southwest of the basin. Further review of the geographic distribution of rainfall within the basin is important to better understanding of recharge.

- Average annual rainfall for the 1997 through 2006 water years was 15.85 inches, slightly higher than the long term average (14.78 inches). Water year 2007 was one of the driest on record with only 5.3 inches of rainfall. Annual rainfall typically is characterized by long, dry periods and short, intense wet periods. In light of the uneven distribution rainfall over time, it is important to plan for long, dry periods and short, wet periods.

- The direction and pattern of regional groundwater flow within the basin were basically unchanged from 1997 to 2006.

- Groundwater level hydrographs show that declines have persisted in portions of the Estrella and San Juan subareas from 1981 to 2006.

- Change in groundwater storage for 1997 to 2006 was estimated to be a net decrease of -29,767 acre-feet, or -3,307 acre feet per year. Decreases in storage are documented in the Estrella and Creston subareas, while storage increased in the Atascadero subbasin and Shandon subarea.

- Updating groundwater pumping would help explain local groundwater level changes and would also allow assessment of the current amount of pumping relative to buildout.

- Recharge from rainfall and subsurface inflow may not be fully represented, particularly at the close of the 1997-2006 period. As a result, recharge is likely underestimated and groundwater storage decrease may be overestimated.

- The District, City of Paso Robles, and others have undertaken projects and programs to improve groundwater management, including the ongoing monitoring program, Nacimiento Project, Water Banking Study, City of Paso Robles Water Resources Plan Integration, USGS GAMA program, and upcoming County Resource Capacity Study, Conservation Element and Water Master Plan Update.

**Recommendations** of this Basin Update are summarized below:

- In order to better understand changes in water levels and storage, groundwater pumping in the basin should be updated in Spring 2008, including the pumping by agriculture, municipalities, rural and community water systems. The update should be coordinated with the District's Water Master Plan Update. Future groundwater pumping updates should be completed and incorporated into the Basin Update every five to ten years or as land use data are available.

- The next Basin Update should be completed in Spring 2009 and should cover water year 2008 (October 2007 – September 2008). It should include an update of groundwater quality trends and analysis of the geographic distribution of rainfall. Subsequent Basin Updates should be completed annually and should cover a water year to provide timely updates to the District, City, PRIOR and the public regarding the response of the basin to annual changes in rainfall and pumping.

- A water balance accounting for all inflows and all outflows should be updated before 2010 and every 5 years thereafter using a comprehensive methodology similar to that of the Phase I Report. Such a schedule would allow the water balance to incorporate effects of the delivery of Nacimiento water.

- The District, City, and PRIOR landowners group should continue cooperative efforts to improve the efficiency and effectiveness of local monitoring programs, focusing on addition of existing wells to the program and data management.

# Introduction

## *Background*

This first Basin Update has been prepared in accordance with the August 2005 Paso Robles Groundwater Basin Agreement among the San Luis Obispo County Flood Control and Water Conservation District (District), City of Paso Robles (City), and certain private landowners, who have organized as the Paso Robles Imperiled Overlying Rights (PRIOR) group. Key elements of the Agreement are a clear acknowledgment that the basin is not in overdraft now, and that the parties will not take court action to establish any priority of groundwater rights over another party as long as the Agreement is in effect.

The District, City, and PRIOR landowners have designated representatives to participate in a committee, informally termed the Paso Robles Groundwater Basin Committee, to develop a plan or program ("Plan") for monitoring groundwater conditions in the basin. This Committee, which has conducted semi-annual meetings since February 2006, has guided preparation of this Basin Update as a means of reporting on groundwater conditions and developing recommendations for improved monitoring.

This first Basin Update provides an overview of the current condition of the Paso Robles Groundwater Basin, including rainfall, groundwater levels and storage, groundwater quality, and groundwater management planning. The Basin Update builds on the *Paso Robles Groundwater Basin Study* (Phase I Report) (Fugro, et al., 2002) and the *Paso Robles Groundwater Basin Numerical Model* (Phase II Report) (Fugro, et al., 2005). Subsequent Basin Updates should cover a water year to provide timely updates to the District, City, PRIOR and the public regarding the response of the basin to annual changes in rainfall and pumping.

## *Purpose*

The purpose of the Paso Robles Groundwater Basin monitoring program and Basin Update is to monitor and evaluate groundwater conditions, based on readily available information, recognizing that monitoring and appropriate management of basin water resources can delay or even avoid basin overdraft. Groundwater-related plans and projects are summarized to support coordinated management.

## *Study Area*

The study area of the Basin Update is the Paso Robles Groundwater Basin as defined in the Phase I Report. **Figure 1** shows the groundwater basin boundaries and key geographic features. The groundwater basin is also defined by the California Department of Water Resources as the Paso Robles Area Subbasin of the Salinas Valley Groundwater Basin with a designation as basin number 3-4.06.

As shown in **Figure 1**, the study area encompasses about 790 square miles of the Salinas River watershed in northern San Luis Obispo County and southern Monterey County, and includes the Atascadero Subbasin and seven subareas. The major water-bearing units in the basin include alluvial deposits and the Paso Robles Formation. The alluvial deposits are up to about 100 feet in depth and include recent stream-laid sands and gravels along the Salinas River and its tributaries. Wells in the alluvium typically produce in excess of 1,000 gallons per minute (gpm) (Fugro, et al., 2002). The Paso Robles Formation is the most extensive aquifer and consists of typically unconsolidated sedimentary layers extending to depths of more than 2,000 feet. Wells generally produce several hundred gpm (Fugro, et al., 2002).

### *Water Year*

When applicable, the hydrologic data are reported in terms of water year. A water year begins on October 1 and ends on September 30. The year is denoted by the ending year.

## Groundwater Basin Conditions

The most recent studies of the Paso Robles Groundwater Basin, the Phase I and Phase II Reports, were sponsored by the District and supported by local water purveyors and users including the City of Paso Robles. The Phase I Report included basic data compilation and review, definition of the basin and subbasin/areas, aquifer characterization, assessment of water quality conditions, and a water balance study. The Phase II report presents the results of the development, calibration, and application of a numerical groundwater flow model of the Paso Robles Groundwater Basin. This model was applied to a baseline scenario, a buildout scenario with the Nacimiento Water Project, and a buildout scenario without the Nacimiento Water Project. Buildout was defined to include not only municipal buildout but also the maximum reasonable agricultural water demand.

The Phase I Report provides a comprehensive baseline assessment of basin conditions for its study period of July 1980 through June 1997. This study period was selected as representative of then-current land and water use conditions, with overall near-average rainfall. This first Basin Update provides information for the period from June 1997 through September 2006 on groundwater basin conditions, including rainfall, groundwater levels and storage, and groundwater management planning. Groundwater quality information from Phase I is not updated in this Basin Update as data were not readily available. Local beneficial uses of groundwater depend not only on an adequate supply, but also groundwater of high quality. Therefore, water quality trend assessment is recommended for subsequent Basin Updates, with a focus on TDS, nitrate, and chloride.

### *Precipitation*

Viewed from a watershed perspective, precipitation is the ultimate source of recharge to the groundwater basin, directly providing deep percolation and indirectly providing other sources of inflow such as streambed percolation and subsurface inflow. Percolation of precipitation alone accounts for 44 percent of total inflow to the groundwater basin (Fugro, et al., 2002). The remainder comes from streambed percolation (43%), subsurface inflow (8%), wastewater percolation (3%), and irrigation return flow (2%).

**Background.** The Paso Robles Groundwater Basin has a semi-arid, Mediterranean climate characterized by hot sunny summers and cool winters. Most precipitation occurs in the winter, between November and April. Average annual rainfall over the basin varies from 20 inches in the west to 10 inches in the east.

**Geographic Distribution**. The geographic distribution of rainfall is important to understanding where recharge occurs to the groundwater basin and is basic to developing a monitoring program. Several rainfall distribution maps have been prepared by others that encompass the upper Salinas River watershed and Paso Robles Groundwater Basin including maps published by the United States Geological Survey (USGS) (Rantz,1969), San Luis Obispo County (1972), and Oregon State University (PRISM, 2007). The two most recent maps are examined here.

**Figure 2** shows the distribution across the basin of rainfall with isohyets (lines of equal precipitation) based on data compiled by the County between 1937 and 1967 (San Luis Obispo County, 1972). **Figure 3** is a comparable map, showing isohyets developed by Parameter-elevation Regressions on Independent Slopes Model (PRISM, 2007). PRISM maps are produced by Oregon State University using point measurements from 1961-1990 (e.g., precipitation) and a digital elevation model to generate digital maps available as GIS (Geographic Information Systems). The PRISM maps have been prepared for the entire United States and consequently, the isohyets on **Figure 3** extend beyond the San Luis Obispo County lines. The digital elevation model is used to estimate rainfall amounts and patterns where no climate station exists, for example, on mountain tops. A similar process—relying on professional judgment and without the use of computers—was used in preparing the County map.

A comparison of the two isohyetal maps reveals differences, particularly in the highland areas west and southwest of the basin. Specifically, the County map indicates the highest rainfall amounts in the highlands west of Paso Robles (up to 45 inches per year) while the PRISM map indicates highest rainfall amounts in the highlands south of Atascadero (up to 34 inches). Within the basin, the PRISM map indicates average rainfall in the Creston area six inches greater than the County map. In Shandon, the average rainfall is almost 4 inches greater.

Further review of the distribution of rainfall is important to better understanding recharge, particularly along the perimeter of the basin where rainfall is relatively high. Additional investigation could involve analysis of the rainfall station data used in preparing both the County and PRISM maps, comparison of the respective amounts of rainfall on a watershed basis, and examination of measured stream flow relative to rainfall. The different rainfall maps also should be reviewed with respect to the groundwater flow model developed in the Phase II Report, which averaged data from seven rainfall stations.

**Historical Rainfall. Figure 4** illustrates annual rainfall at a representative gage over the past 50 years [Salinas River at Paso Robles Station]. The location of the rainfall gage is shown on **Figure 1**. Average annual rainfall at this gage is 14.78 inches with a median of 13.21 inches for the 1957 through 2007 water years.

As seen on **Figure 4**, annual rainfall is subject to wide variations. Between 1957 and 2006, the lowest annual rainfall was 7.22 inches (1990 water year) and the greatest annual rainfall was 31.50 inches (1969 water year). Water year 2007 was one of the driest on record with only 5.48 inches between October 2006 through September 2007.

The average rainfall at the same gage for the 1981 to 1997 period of study defined in the Phase I Report was 15.00 inches, similar to the long term average of 14.78 inches. This report focuses on the 1997 through 2006 water years, which experienced a slightly higher annual average rainfall (15.85 inches) than the past 50 year annual average (14.78 inches). Median values for the 1981 to 1997 and 1997 to 2006 water years were 13.90 inches and 13.94 inches, respectively, indicating that wet years have skewed the annual average slightly higher. In light of the uneven distribution rainfall over time, it is important to plan for long, dry periods and short, wet periods.

## *Basin Areas*

The Phase I Report defined one subbasin (Atascadero) and seven subareas within the Paso Robles Groundwater Basin (Bradley, Creston, Estrella, North Gabilan, San Juan, Shandon, and South Gabilan). The Atascadero Subbasin lies west of the Rinconada fault, which has been identified as a barrier to groundwater flow. Therefore, the Atascadero Subbasin is considered to be hydrologically distinct. The seven subareas are not identified as formal boundaries, but were informally established in Phase I as a practical approach to subdivide the large basin for discussion purposes.

## *Groundwater Levels*

This first Basin Update describes groundwater conditions at the close of the Phase I base period in spring 1997 through spring 2006. **Figure 5** shows groundwater elevations in spring 1997. These water levels were contoured with data from 119 wells. The data was obtained from the District database as well as on-line records from the USGS and California Department of Water Resources (DWR). In areas where there was little information, contours follow the Phase I Report spring 1997 map (Fugro, 2002). Also, adjustments were made to more closely match the Phase I Report in two locations:  along San Juan Creek southwest of Shandon and along the Estrella River near the community of Estrella.

**Figure 6** shows groundwater elevations in spring 2006 based on 115 wells. As in the 1997 map, the District data were augmented for the 2006 map with data from the USGS and DWR.

Overall the direction and pattern of groundwater flow is unchanged from 1997 to 2006. Groundwater levels in the basin ranged between above 1500 to below 600 feet above mean sea level (msl). Groundwater flows from the southeast in the San Juan, Creston, and Shandon subareas to the northwest into the Estrella subarea. Groundwater flows from the northeast in the South Gabilan and North Gabilan subareas to the southwest into the Estrella and Bradley subareas, respectively. Along the Salinas River near San Miguel, groundwater flow northwesterly from the Estrella into the Bradley subarea.

In order to evaluate trends in groundwater levels, over 200 hydrographs from the Paso Robles Groundwater Basin were examined. Ten hydrographs, described below, were selected to characterize trends in the Atascadero Subbasin and seven subareas of the Paso Robles Groundwater Basin.

**Atascadero.** In the eastern portion of the subbasin, east of Templeton, the Phase I Report found that deeper wells were stable or gradually increasing as of 1997. Well 027/S012E-33F001 (**Figure 7**) was increasing up until 1999, but has been stable since that time. Well 027/S012E-22M001 had an increasing trend from 1994 through 1998, but groundwater levels have dropped over 30 feet since that time (**Figure 7**). Comparison of groundwater levels in **Figure 7** with the annual rainfall amounts in **Figure 4** reveals the influence of varying rainfall; for example, the drought water years of 1987 through 1992 are shown on the hydrographs by decreasing groundwater levels.

**Bradley.** No current water level data from the wells identified in Phase I are available for this subarea. Three existing wells have been proposed by the District for addition to the monitoring program. The Phase I Report indicated that at the confluence of the Nacimiento and San Antonio rivers, water levels in the alluvium are stable due to the influence of stream recharge. Likewise, deeper Paso Robles Formation wells were reportedly stable based on limited available data. In the Hames Valley, the irrigation pumpage resulted in significant water level decreases in the mid 1970's. According to the Phase I Report, this trend had changed and as of 1995, groundwater levels had stabilized.

**Creston.** Groundwater levels in the northern part of the subarea decreased from the 1960's through the 1990's. The Phase I Report noted that water levels increased over 50 feet during their hydrologic base period. Well 27S/13E27P002 (**Figure 8**) illustrates this trend. Since 2000, however, water levels in this well have generally decreased. In the central part of the basin, along Highway 41, well 28S/13E-04K001 (**Figure 8**) was increasing from the 1950's up through 1988. During subsequent years of below average rainfall, water levels decreased. Water levels recovered from 1993 – 1998, when rainfall was at or well above average. Since that time, water levels have decreased to levels below those measured in the late 1950's.

**Estrella.** The Phase I Report documented overall groundwater level decreases in the area along Highway 46 east of Paso Robles and concluded that the decreases were the result of pumping from low permeability sediments and the absence of a nearby recharge source. This decreasing trend continues in well 026S/013E-34B001 (**Figure 9**). In the vicinity of Estrella, water levels were increasing but are now decreasing as seen in well 26S/13E-5D001(**Figure 9**).

**North and South Gabilan.** Well 25S/13E-11E001 is described in the Phase I Report as located on the Gabilan Mesa, near Hog Canyon. As shown in **Figure 10**, water levels increased from the 1950's through the early 1980's. Since that time, water levels have been relatively stable, although fluctuating with wet and dry periods. There are no additional water level data available for this subarea; an additional well is proposed for the monitoring program.

**San Juan.** Monitoring indicated both rising and falling groundwater levels in the San Juan subarea during the Phase I Report study period. The hydrograph for well 27S/14E-

25A001 (**Figure 11**) steadily decreased between 1959 and 1996. This was attributed to localized agricultural pumping. Beginning in 1997, water levels briefly recovered, indicating that significant stream recharge occurs in Shedd Creek. Since 2005, levels are once again decreasing. The hydrograph for well 28S/16E-15D001 (**Figure 11**) is located along the southern reach of San Juan Creek. Water levels gradually decreased between 1977 and 1995. Since that time water levels have decreased over 50 feet.

**Shandon.** The hydrograph for well 26S/15E-18J001 (bottom of **Figure 11**) shows water levels with significant seasonal fluctuations. In addition, groundwater levels in this well have followed rainfall over the past 30 years, with elevations dropping below 1,000 feet msl during years of below average rainfall. Water levels appear to have decreased beginning in 2003, suggesting increased local pumping in the area.

## *Change in Storage*

For the Phase I Report, change in groundwater storage was determined in two ways. The first method is termed the *change in storage* method. This method used maps of groundwater levels (in GIS) to calculate the volume of saturated materials between the groundwater level contour surfaces and the base of the fresh groundwater for each year. Specific yield estimates for the Atascadero Subbasin and other subareas were combined with these volumes to identify the change in groundwater volume. **Table 1** (at the end of this section) shows the specific yield values, which range from 7 to 11%. The change in storage was computed as the difference in groundwater volume from one year to the next. The second method used in the Phase I Reports was a *water balance inventory* of all the inflow and outflow components; the change in storage is equal to the difference between inflow and outflow. Using two such methods allows cross-checking; in addition, the availability of pumping data supports interpretation of groundwater level and storage changes.

This Basin Update used a *change in storage* method similar to that of the Phase I Report. Specifically, spring groundwater measurements were used to document the groundwater level changes from 1997 to 2006. For each subarea, change in storage was calculated by multiplying the area, the average change in groundwater elevation from 1997 to 2006, and an average specific yield value from the Phase I Report. The average groundwater level change was determined digitally in GIS by computing the difference between the raster surfaces representing the groundwater elevation in the Paso Robles Groundwater Basin for spring 1997 and spring 2006.

**Figure 12** illustrates the groundwater storage changes from Spring 1997 – Spring 2006 across the basin with warm colors indicating groundwater level decreases and cool colors indicating groundwater level increases. No color indicates less than one foot of change; note that most of the basin indicates no change. In some areas of minimal groundwater use (for example, in parts of North Gabilan) this may be reasonable. However, the lack of apparent change in other areas may reflect an absence of monitored wells. For example, review of **Figure 12** indicates extensive areas where long-term groundwater level monitoring is lacking, including areas along streams and the perimeter of the basin where recharge from rainfall and subsurface inflow may be taking place but is not tracked. The monitoring network is, by necessity, based largely on active production wells and is likely skewed toward documenting areas of groundwater production and decreases in storage.

As shown in **Figure 12**, areas of groundwater level decrease occur in the Estrella, Creston, and San Juan subareas. Other small areas of decrease also are indicated, often centered on only one or two monitored wells. Groundwater level increases are shown in the Atascadero Subbasin, northern Estrella subarea, and Shandon and San Juan subareas.

The storage calculations (**Table 1**) indicate that from 1997 to 2006, groundwater storage in the basin decreased by -29,767 AF, equivalent to an average annual storage decrease of -3,307 acre feet per year (AFY). Decreases in storage were concentrated in the Estrella and Creston subareas, while storage increased in the Atascadero subbasin and Shandon subarea. By way of comparison, the Phase I report calculated an average storage change from 1981 to 1997 of -2,700 AFY using the *water balance inventory* and 700 AFY using the *change in storage* method.

| Subbasin/Area | Area | | Specific | Ave WL Change | Δ Storage |
|---|---|---|---|---|---|
| | acres | $mi^2$ | Yield | ft | AF |
| North Gabilan | 52,725 | 82.4 | 0.09 | 0.000 | 0 |
| Bradley | 56,570 | 88.4 | 0.07 | 0.000 | 0 |
| South Gabilan | 44,492 | 69.5 | 0.09 | -0.180 | -721 |
| Estrella | 83,595 | 130.6 | 0.08 | -4.506 | -30,133 |
| Shandon | 74,665 | 116.7 | 0.09 | 0.984 | 6,615 |
| Creston | 57,587 | 90.0 | 0.09 | -2.106 | -10,914 |
| Atascadero | 14,708 | 23.0 | 0.11 | 4.724 | 7,642 |
| San Juan | 84,025 | 131.3 | 0.08 | -0.336 | -2,256 |
| **Total** | **468,368** | **732** | | | **-29,767** |

**Table 1. Specific Yield and Change in Storage (Spring 1997 to Spring 2006)[1]**

## *Groundwater Pumping and Comprehensive Water Balance*

Groundwater levels and storage reveal the net effect of changes in the water balance, including changes in inflow (recharge) and outflow (discharge). Changes in recharge are strongly influenced by fluctuations in rainfall, which are accounted for in the evaluation of groundwater levels and storage in this Basin Update. However, changes in discharge, particularly groundwater pumping and use, were not part of this first Basin Update. Groundwater pumping in the basin should be updated in Spring of 2008, including groundwater pumping by agriculture, municipalities, rural users, and small community water systems.

[1] Average water level changes are shown to a fraction of a foot and change in storage values are shown to the nearest acre-foot (AF). As a result, numbers may appear to be accurate to four or five digits, which is not the case. Values for data that are measured directly, such as water levels in a well, are probably accurate to two or possibly three significant digits. Values for data that are estimated, such as groundwater storage change, are probably accurate to only one or two significant digits. All digits are retained in the text and Table 1 for documentation and to preserve correct column totals.

**Table 2** highlights groundwater uses in the Basin as of 1997 (Fugro, et al., 2002). As indicated, agriculture accounted for about two-thirds of groundwater use with the remainder used for urban, rural and small community systems.

| Groundwater Use | Percent of Total |
|---|---|
| Agriculture | 67 % |
| Urban | 18% [1] |
| Rural | 13% |
| Small Community Systems | 2% |

[1] Groundwater extraction by the City of Paso Robles represented 43% of urban demand and 8% of all uses combined.

**Table 2. Groundwater Uses in the Paso Robles Groundwater Basin, 1997**

The recommended update of pumping would reveal changes in the relative proportions of groundwater uses and would allow assessment of the current amount of pumping relative to the buildout scenarios presented in the Phase II Report. The pumping update would use land use mapping recently completed by the District. Also, the District is currently developing strategies to evaluate groundwater pumping for the Water Master Plan Update in 2010. A pumping update would provide useful interim information and should be coordinated for a consistent methodology.

Subsequently, the entire water balance should be updated before 2010 and every five years thereafter. The water balance would be updated using a comprehensive methodology similar to that of the Phase I Report and up-to-date information (for example, recent land use mapping and the latest rainfall distribution maps). Such a water balance would account for *all* inflows (e.g., deep rainfall percolation, streamflow percolation, subsurface inflow, wastewater discharge, and return flows) and *all* outflows (pumping, subsurface outflow, and phreatophyte use). It would also include computation of groundwater storage as the difference between inflow and outflow, providing an independent check on the evaluation of groundwater storage using groundwater level maps.

Scheduling the water balance within the next five years would provide the opportunity to select an optimal study period. The 1981 to 1997 study period for the Phase I Report was selected carefully to represent long-term climatic conditions and to provide the basis for an accurate water balance study, including evaluation of groundwater storage. A selected base period for a water balance study optimally begins and ends after one or more dry years. This minimizes problems accounting for recharge water that is still moving through the unsaturated zone and is not yet represented in a water level rise. In contrast, the period for this Basin Update (water years 1997 through 2006) is not ideal for evaluating storage change. Specifically, the 1997-2006 period ends after two wet years. Accordingly, the estimated storage change probably does not fully account for recharge at the end of the period.

In addition, scheduling of the water balance analysis within the next five years would allow incorporation of the effects of the delivery of Nacimiento water.

## *Groundwater Management Activities*

The local groundwater users—including the District, City, PRIOR and other stakeholders—have taken the initiative to better monitor and manage water resources in the Paso Robles Groundwater Basin. Recent projects and programs relevant to local groundwater management include the ongoing groundwater level monitoring program, Nacimiento Project, Water Banking Study, City of Paso Robles Water Resources Plan Integration, USGS GAMA program, and the upcoming County Resource Capacity Study, Conservation Element, and Water Master Plan Update.

**Groundwater Level Monitoring Program**. The District has monitored groundwater levels in the Paso Robles Groundwater Basin for 40 years; this effort has provided much of the data for this Basin Update. Currently there are nearly 145 wells in the network, 99 monitored by the District and 55 monitored locally and reported to the District; the City of Paso Robles is an active participant in the program. In 2006, an evaluation of the monitoring program (Cleath & Associates, 2006) provided specific recommendations to improve the program's efficiency and effectiveness. These recommendations addressed data management and identified specific wells for addition to or deletion from the program. Other wells were identified for backup status. Most recently, the District has reviewed the wells to be added to the program, identifying well owners in order to request cooperation with the monitoring program. The PRIOR landowners group is actively participating in the process of contacting well owners. The District, City, and PRIOR landowners group should continue these cooperative efforts to improve the efficiency and effectiveness of local monitoring programs, focusing on addition of existing wells to the program and data management.

**Nacimiento Project.** The District has a 17,500 AFY entitlement from Lake Nacimiento based on a 1959 agreement with Monterey County. The Nacimiento Water Project involves construction of a water intake at Lake Nacimiento, water storage tanks, pump stations and a 49-mile water transmission pipeline to provide 15,750 AFY of water supply to water providers in both the north and south County areas. Major water purveyors in the north County to receive Lake Nacimiento water include the City of Paso Robles (4,000 AFY) and Atascadero Mutual Water Company (3,000 AFY). Construction of the project is underway. Provision of Lake Nacimiento water to the municipal water purveyors—slated for 2010—will reduce municipal dependence on groundwater basin supplies. Lake Nacimiento water is high quality relative to groundwater and would provide better water quality to municipal customers and improve wastewater quality. This is important because municipal wastewater is recharged to the groundwater basin and improved quality would yield long-term water quality benefits to the groundwater basin. In addition, Lake Nacimiento supply is independent of local groundwater supplies and the Lake Nacimiento contracts provide the District and participating water purveyors with high priority in droughts.

**City of Paso Robles Water Resources Plan Integration.** Over the past three years, the City of Paso Robles has engaged in intensive water and wastewater resource planning, including preparation of a series of water resource reports, culminating in the *Water Resources Plan Integration* (T.J. Cross, February 2007) adopted by the City in May 2007. Recognizing the challenges of rising water demand, limited groundwater supply, salt loading to wastewater, and increasingly restrictive wastewater treatment and disposal regulations, the *Water Resources Plan Integration* and associated *Capital Improvement Program* provides a sequence of management actions, including acceptance and treatment of Nacimiento Project water, initiation of water conservation and a wastewater source control programs, continued studies for water recycling, installation of recycled water delivery pipelines, design and construction of an upgraded wastewater treatment plant and recycled water delivery system, and updating of the Potable Water Distribution Master Plan. These actions are scheduled over the period 2008 to 2017.

**District Water Banking Feasibility Study.** The Water Banking Feasibility Study for the Paso Robles Groundwater Basin, initiated in October 2006, is being led by the District as part of the District's Integrated Regional Water Management Plan. The goal of the Feasibility Study is to determine the water recharge and banking potential in the Paso Robles Basin, recognizing that the Coastal Branch of the State Water Project (SWP) crosses the basin upon entering the County and that the County has an unused allocation of SWP water. At time of writing (November 2007), the Feasibility Study is approaching completion, with the draft report released in late October and the final report scheduled for completion in December. Thus far the Study has evaluated the availability of surface water from the SWP, defined raw water and treated water options, identified recharge methods, and established evaluation criteria. Three water banking alternatives have been identified and evaluated for hydrogeologic feasibility using the Phase II Report groundwater flow model. The preliminary findings of this analysis indicate that the Shell/Camatta/Lower San Juan alternative and the Salinas River/Hwy 46 alternative appear to have adequate groundwater storage capacity and recharge/recovery capacity to support a water banking project, but the Creston alternative does not. Additional engineering analysis, including feasibility-level design and layout and cost estimates, will be provided in the draft report.

**County Resource Capacity Study, Conservation Element, and County-wide Master Water Plan.** In its June 5, 2007 meeting, the San Luis Obispo County Board of Supervisors recommended a Level of Severity 1 designation for the Paso Robles Groundwater Basin. This designation was made with reference to the 1980-1997 groundwater level decreases in the Estrella subarea and to increases in extent of overlying land uses, including ranchettes, golf courses, and vineyards. As a result of this designation, County staff was directed to prepare a Resource Capacity Study that will focus on the area of groundwater level decrease; the next step is consideration by the Board in February 2008 of a Resource Capacity Study work program. Relevant staff activities to date have included compilation of well and land use data, and review of potential new wells for the District monitoring program. This Basin Update and the Water Banking Feasibility Study will be considered in the Resource Capacity Study.

The County-wide Master Water Plan update, slated for 2009, will update the 1998 document. Incorporating recent documents such as urban water management plans, general plan updates, and water/wastewater master plans, the County-wide update will include current and future water use projections for water planning areas.

The Conservation Element of the County's General Plan is being updated to improve, consolidate and revise the existing policies and programs including those related to water resources. "Cutting edge" policies will be developed related to green building, watershed protection, water conservation, biological resource protection, and conservation-oriented land use patterns such as smart growth that may have an impact on future groundwater basin management efforts.

**GAMA Program.** In 2001, the California Legislature enacted the Ground-Water Monitoring Act. The Act requires the State Water Board to monitor California's groundwater that is used for municipal supply. In response to this mandate, the USGS will complete a Groundwater Ambient Monitoring and Assessment Program (GAMA) by 2010 in over 100 priority groundwater basins in California to identify the status and trends of groundwater quality. In 2005 the USGS addressed the Paso Robles Groundwater Basin and sampled eleven randomly-selected wells located along the major rivers valleys (USGS, 2005). The GAMA study area in the Paso Robles Groundwater Basin and the locations of sampled wells are shown in **Figure 13**. While trace amounts of pesticides, arsenic, and boron were reported, no constituents of concern were detected above regulatory thresholds.

# Conclusions

This first Basin Update provides an overview of the current condition of the Paso Robles Groundwater Basin, building on the *Paso Robles Groundwater Basin Study* and *Paso Robles Groundwater Basin Numerical Model*. The study period for these reports was 1980 through 1997; this report provides an update on rainfall and groundwater levels and storage from 1997 to 2006. Major conclusions include the following:

The Basin Update was designed to evaluate components of the water balance with readily available data. Rainfall, groundwater levels, and change in groundwater storage are documented, and groundwater management activities are summarized. Changes in recharge are strongly influenced by fluctuations in rainfall, which are considered in the evaluation of groundwater levels and storage. Changes in discharge, particularly groundwater pumping and use, were not part of the scope of this Basin Update.

A comprehensive water balance accounts for *all* inflows (e.g., deep rainfall percolation, streamflow percolation, subsurface inflow, wastewater discharge, and return flows) and *all* outflows (pumping, subsurface outflow, and phreatophyte use). The most recent water balance completed for the basin covered a study period of 1980 through 1997.

A comparison of existing historical County and more recent PRISM isohyetal maps reveals differences, particularly in the highland areas west and southwest of the basin. Further review of the geographic distribution of rainfall within the basin is important to better understanding of recharge.

Average annual rainfall for the 1997 through 2006 water years was 15.85 inches, slightly higher than the average rainfall over the 1980 – 1997 study period for the Paso Robles

Groundwater Basin Study was (15.00 inches) and the long term average (14.78 inches). Median values for the 1981 to 1997 and 1997 to 2006 water years were 13.90 inches and 13.94 inches, respectively, indicating that a few wet years have skewed the annual average slightly higher. Water year 2007 was one of the driest on record with only 5.3 inches of rainfall. In light of the uneven distribution rainfall over time, it is important to plan for long, dry periods and short, wet periods.

The direction and pattern of regional groundwater flow within the basin were basically unchanged from 1997 to 2006.

Groundwater level hydrographs show declines in portions of the Estrella and San Juan subareas have persisted from 1981 to 2006.

Change in groundwater storage for the period 1997 to 2006 was estimated to be a net storage decrease of -29,767 acre-feet, or -3,307 acre feet per year. Net decreases in storage were concentrated in the Estrella and Creston subareas, while storage increased in the Atascadero subbasin and Shandon subarea. Updating groundwater pumping would help explain local groundwater level changes and would also allow assessment of the current amount of pumping relative to buildout.

Both the study period for the Basin Update and the distribution of monitoring wells influence the storage calculation. Recharge from rainfall and subsurface inflow may not be fully represented, particularly at the close of the 1997-2006 period. As a result, recharge is likely underestimated and groundwater storage decrease is overestimated.

The District, City of Paso Robles, and other local stakeholders have undertaken projects and programs to improve local groundwater management include the ongoing groundwater level monitoring program, Nacimiento Project, Water Banking Study, City of Paso Robles Water Resources Plan Integration, USGS GAMA program, and the upcoming County Resource Capacity Study, Conservation Element and Water Master Plan Update.

# Recommendations

The Paso Robles Groundwater Basin Agreement among the District, City of Paso Robles, and PRIOR provides for a committee, informally termed the Paso Robles Groundwater Basin Committee, to develop a plan or program (“Plan”) for monitoring and evaluating groundwater conditions in the Basin. The following recommendations support further development of the Plan:

In order to better understand changes in water levels and storage, groundwater pumping in the basin should be updated in Spring 2008, including the pumping by agriculture, municipalities, rural and community water systems. Such an update would make timely use of recent land use mapping in the Basin and should be coordinated with the District’s Water Master Plan Update. Future groundwater pumping updates should be completed and incorporated into the Basin Update every five to ten years, or as land use data are available.

The next Basin Update should be completed in Spring 2009 and should cover water year 2008 (October 2007 – September 2008). It should include an update of groundwater quality trends and analysis of the geographic distribution of rainfall. Subsequent Basin Updates should be completed annually and should cover a water year to provide timely updates to the District, City, PRIOR and the public regarding the response of the basin to annual changes in rainfall and pumping.

A water balance accounting for all inflows and all outflows should be updated before 2010 and every five years thereafter using a comprehensive methodology similar to that of the Phase I Report. Such a schedule would allow the water balance to incorporate effects of the delivery of Nacimiento water.

The District, City, and PRIOR landowners group should continue cooperative efforts to improve the efficiency and effectiveness of local monitoring programs, focusing on addition of existing wells to the program and data management.

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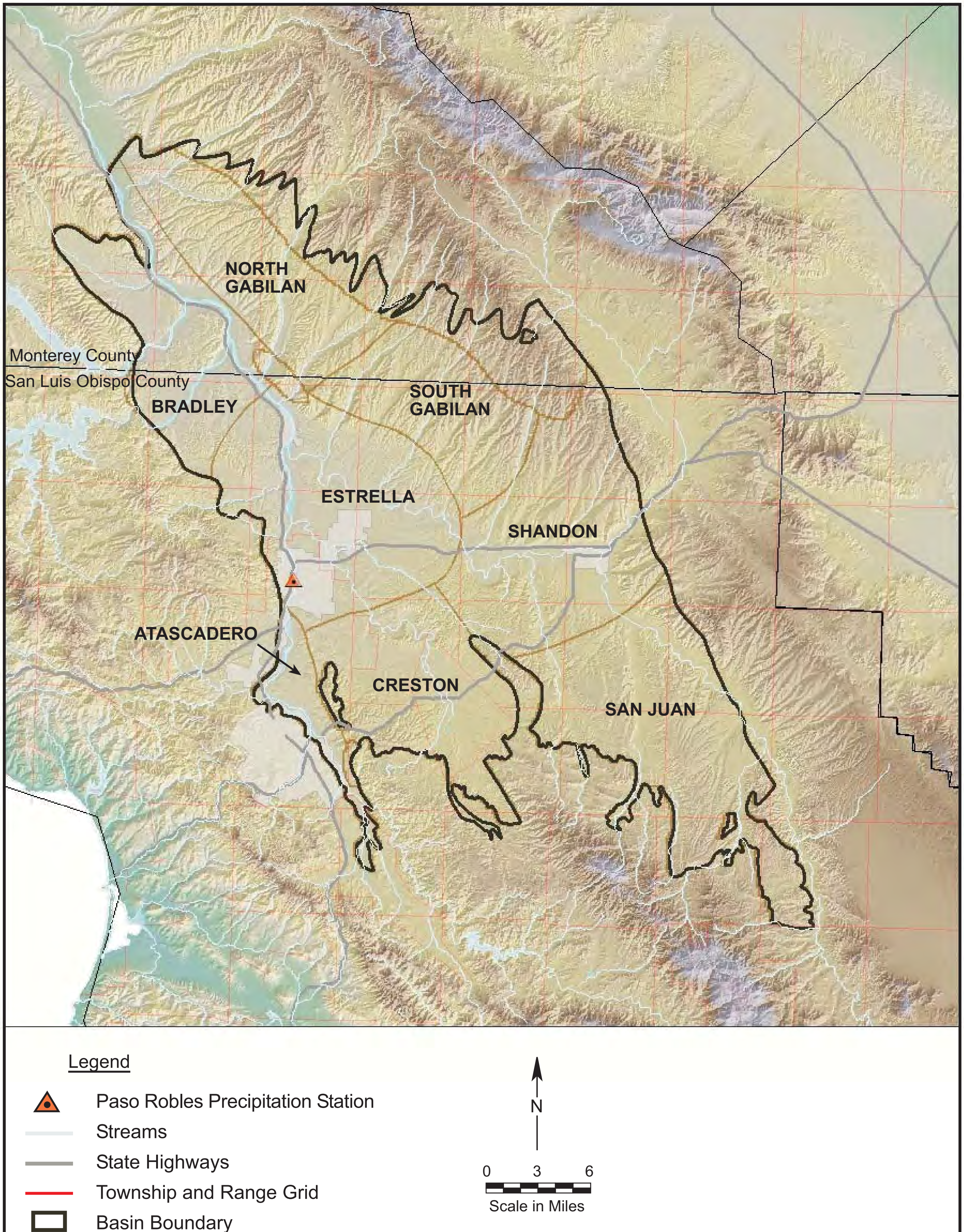
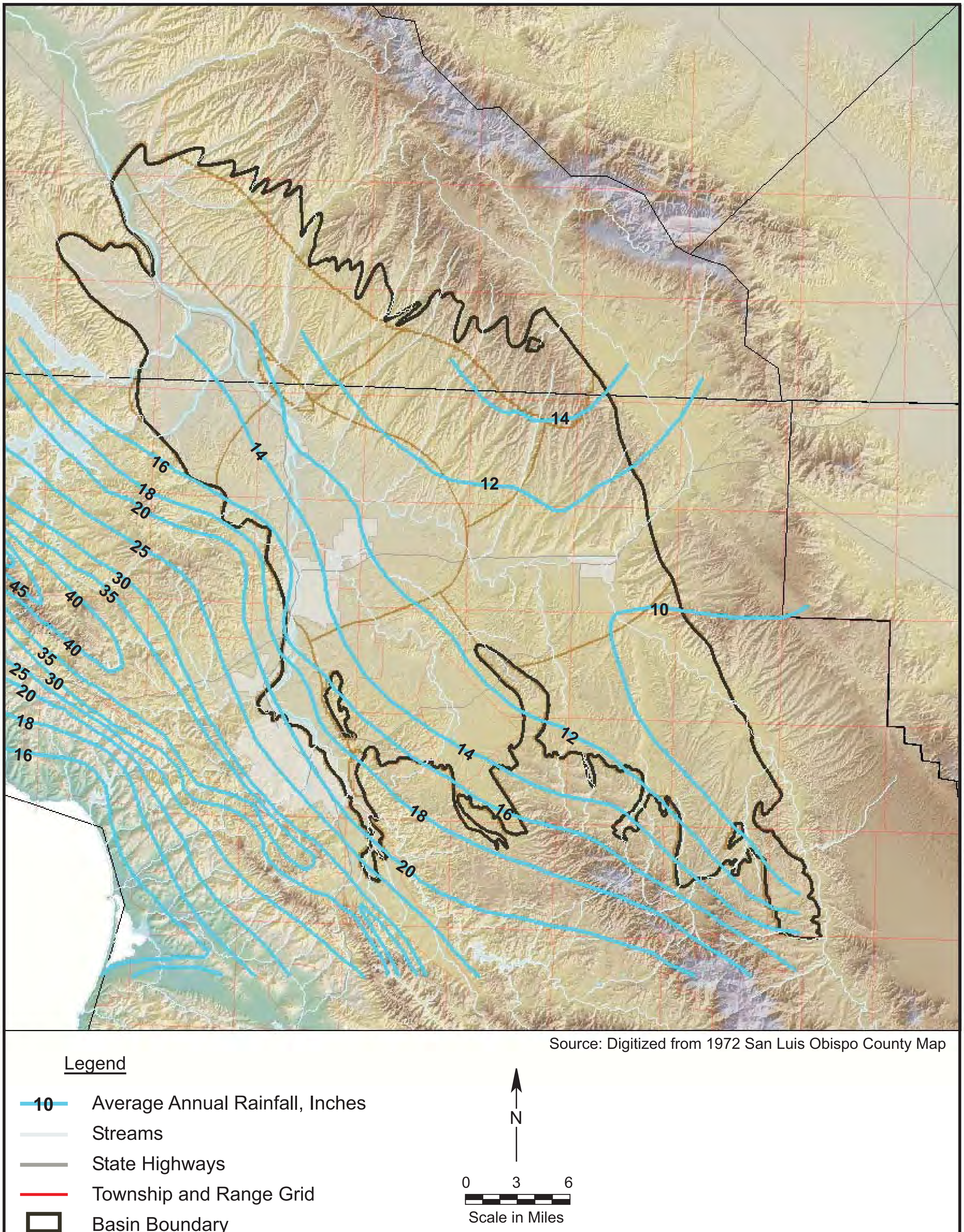



| December 2007 | **Figure 1** |
|---|---|
| TODD ENGINEERS<br>Emeryville, California | **Paso Robles Groundwater Basin** |




December 2007

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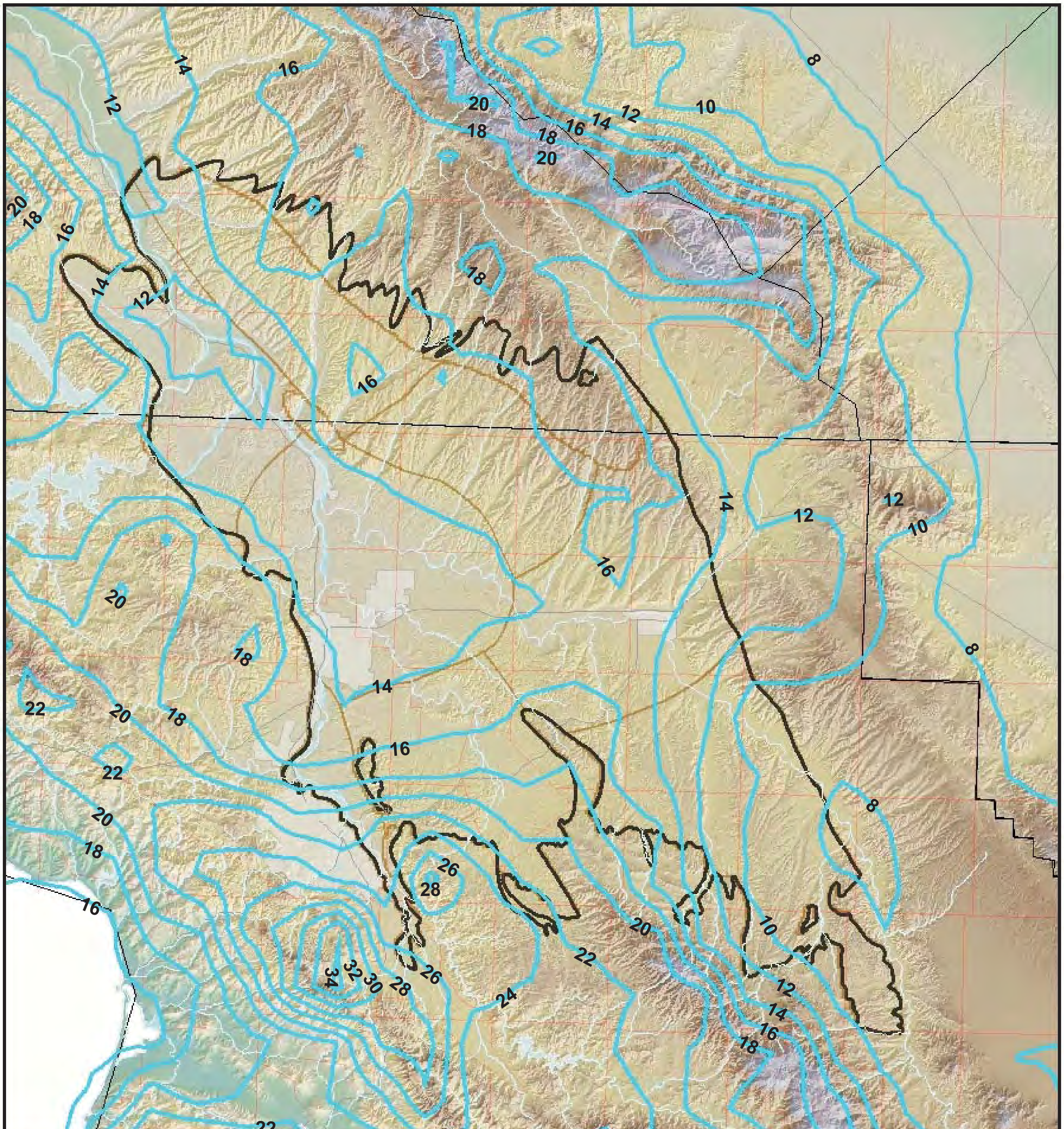
**Figure 2**
**County Map of Average Annual Rainfall 1937 - 1967**




Source: PRISM, 2007

Legend

- 10 Average Annual Rainfall, Inches
- Streams
- State Highways
- Township and Range Grid
- Basin Boundary
- Cities/Communities
- Subareas
- County Line

N

0 3 6

Scale in Miles

December 2007

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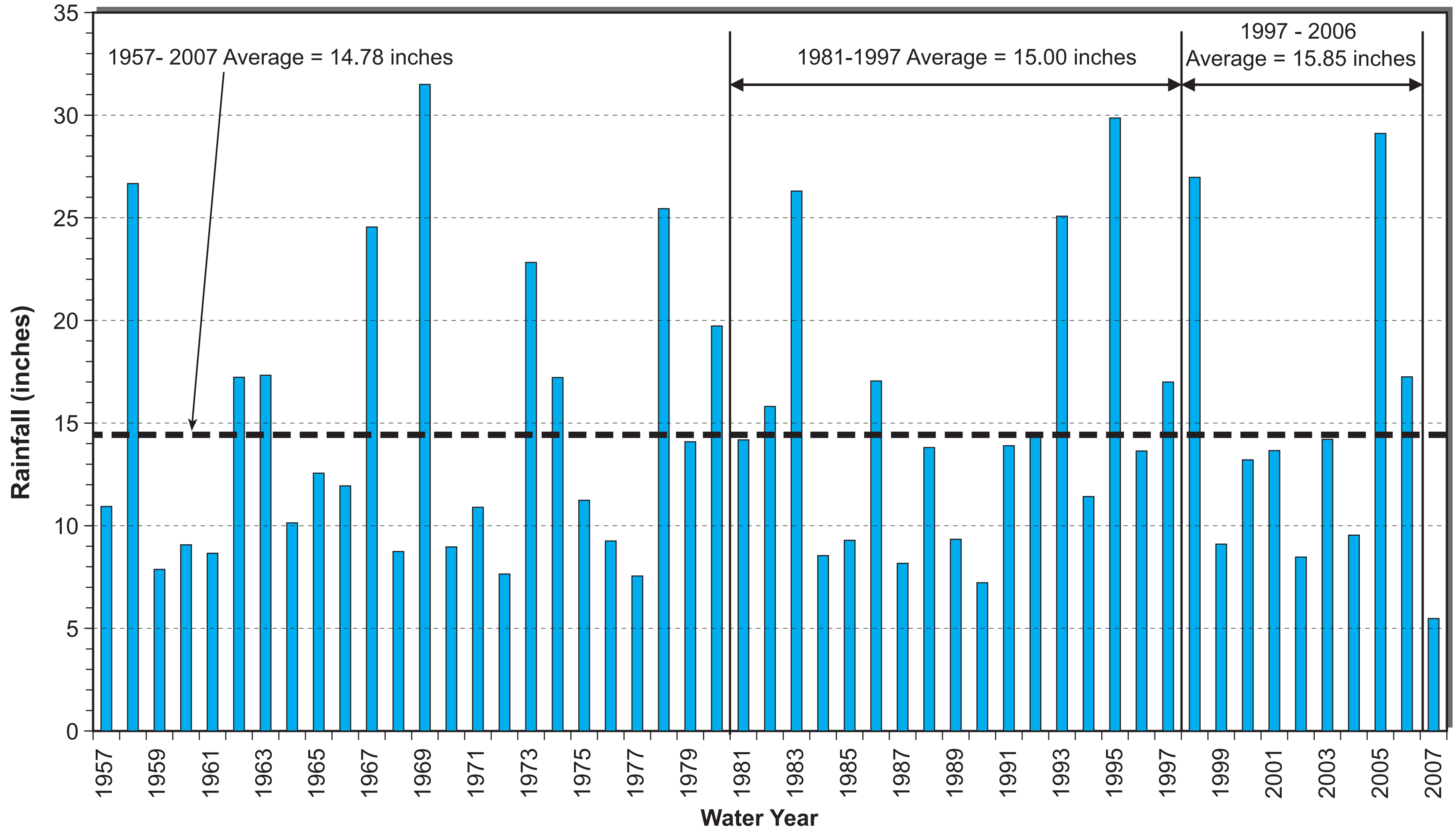
**Figure 3**
**PRISM Map of Average Annual Rainfall, 1961-1990**




December 2007

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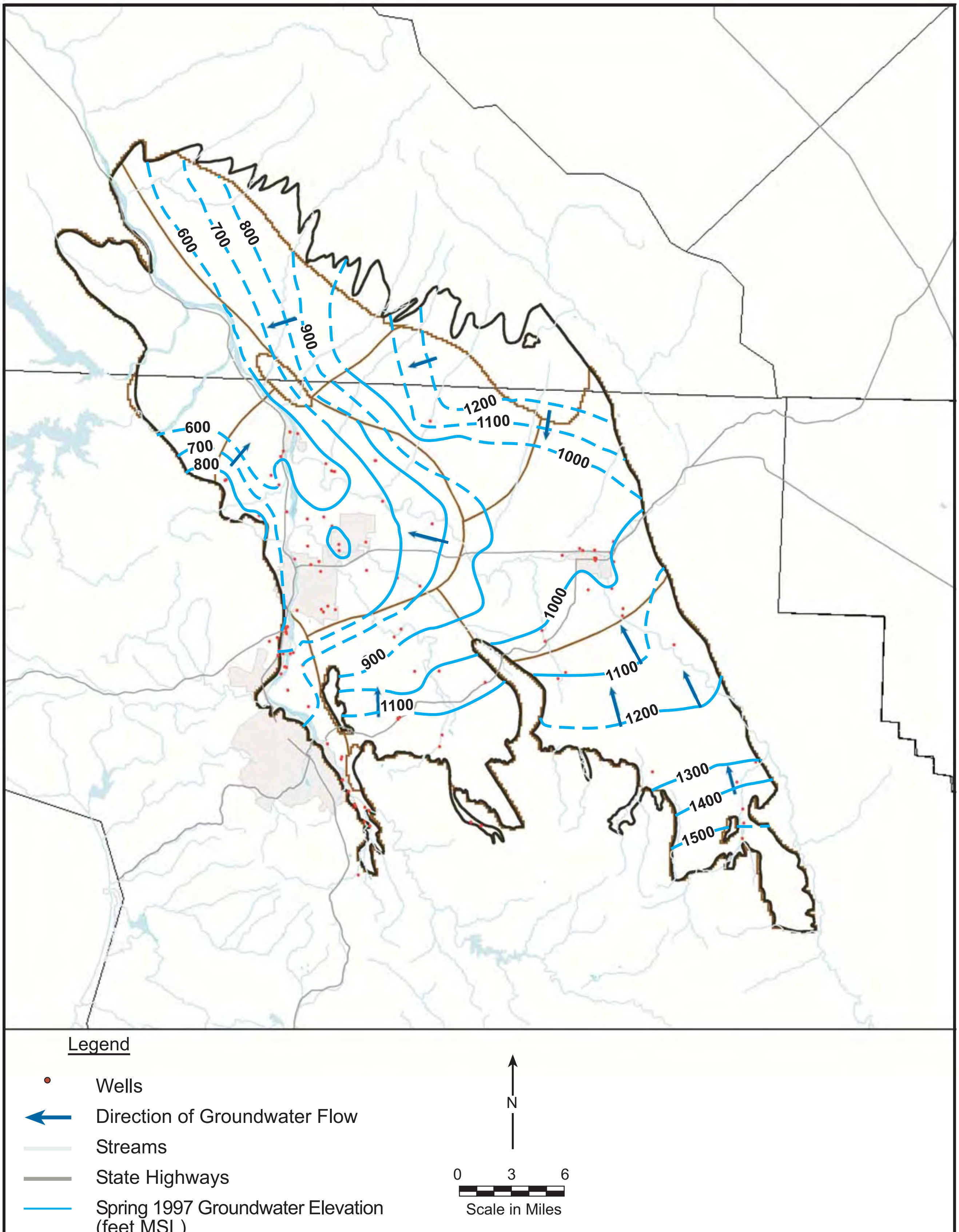
**Figure 4**
**Annual Rainfall at Paso Robles, Water Years 1957 - 2007**




Legend

- Wells
- Direction of Groundwater Flow
- Streams
- State Highways
- Spring 1997 Groundwater Elevation (feet MSL)
- Basin Boundary
- Cities/Communities
- Subareas
- Counties

December 2007

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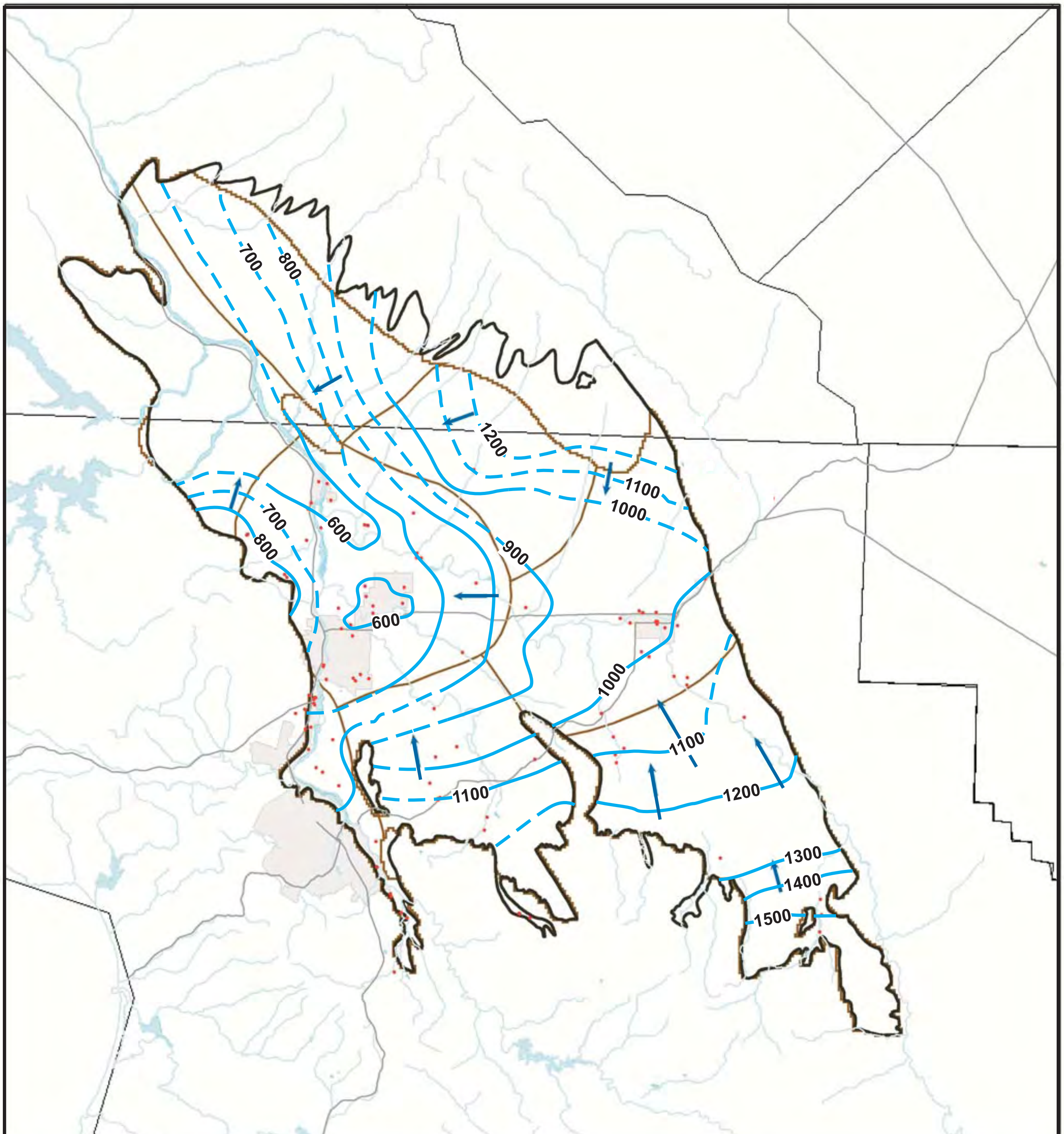
**Figure 5**
**Groundwater Elevation Map**
**(Spring 1997)**




Legend

- Wells
- Direction of Groundwater Flow
- Streams
- State Highways
- Spring 2006 Groundwater Elevation (feet MSL)
- Basin Boundary
- Cities/Communities
- Subareas
- Counties

N

0 3 6

Scale in Miles

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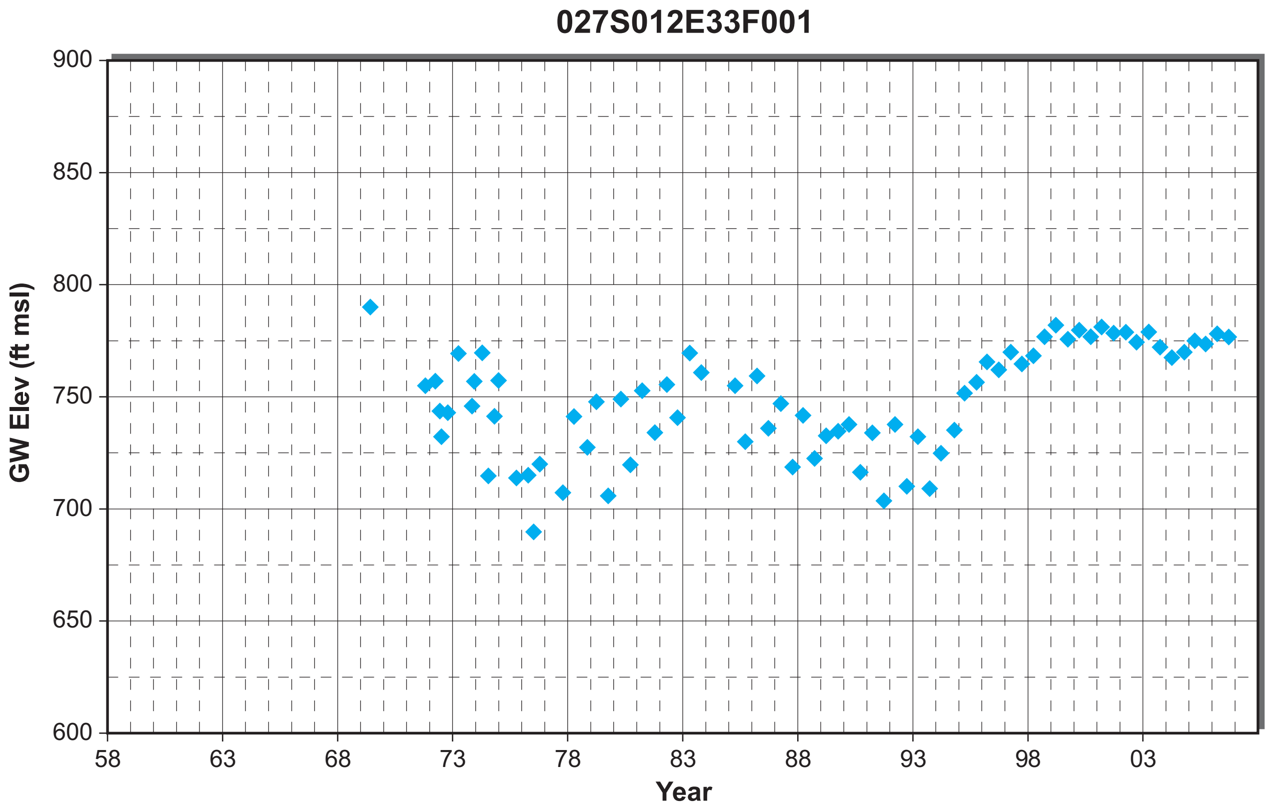
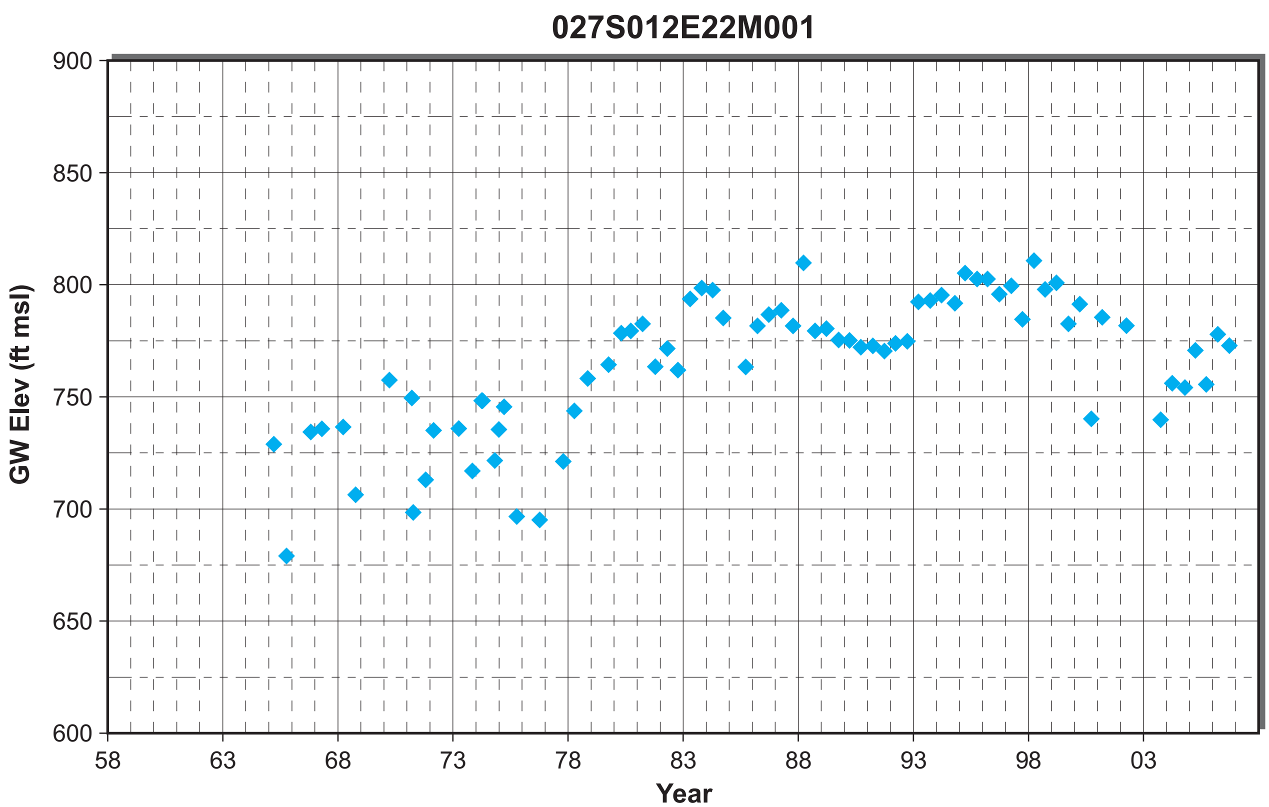
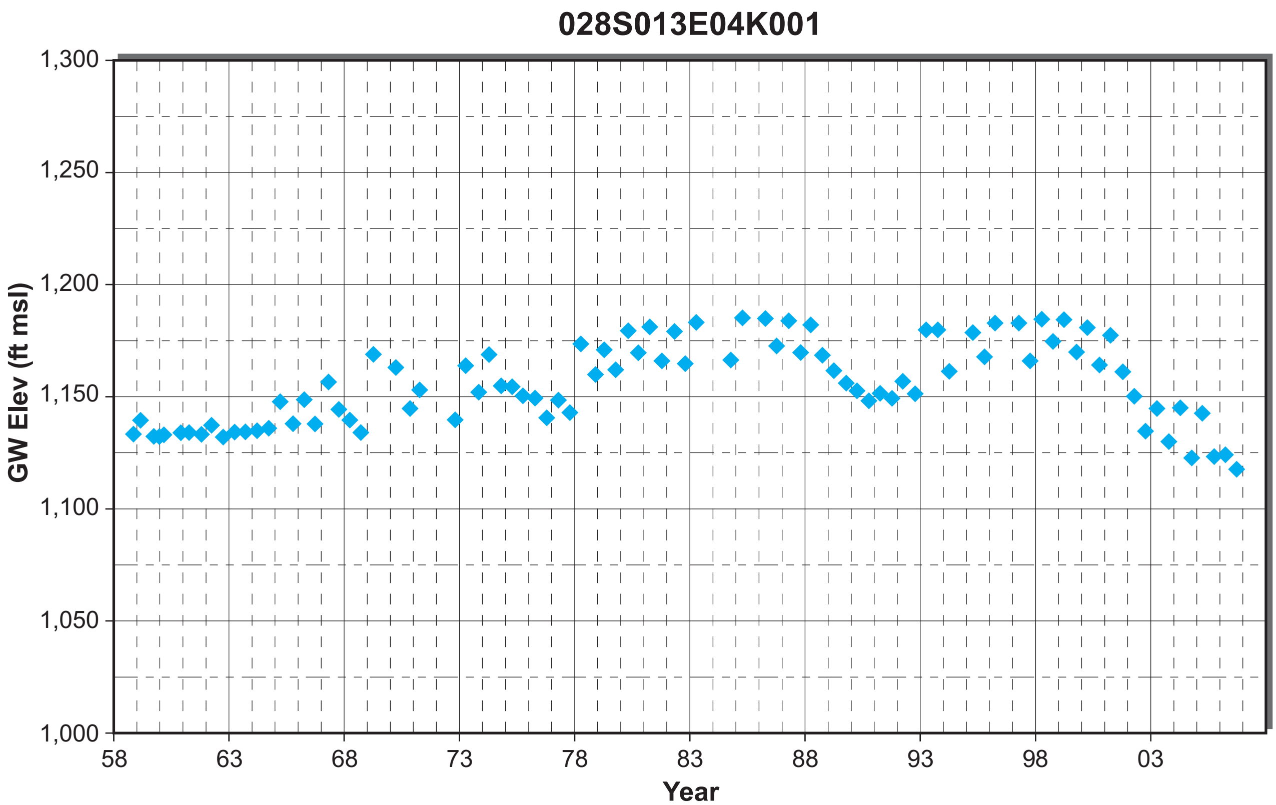
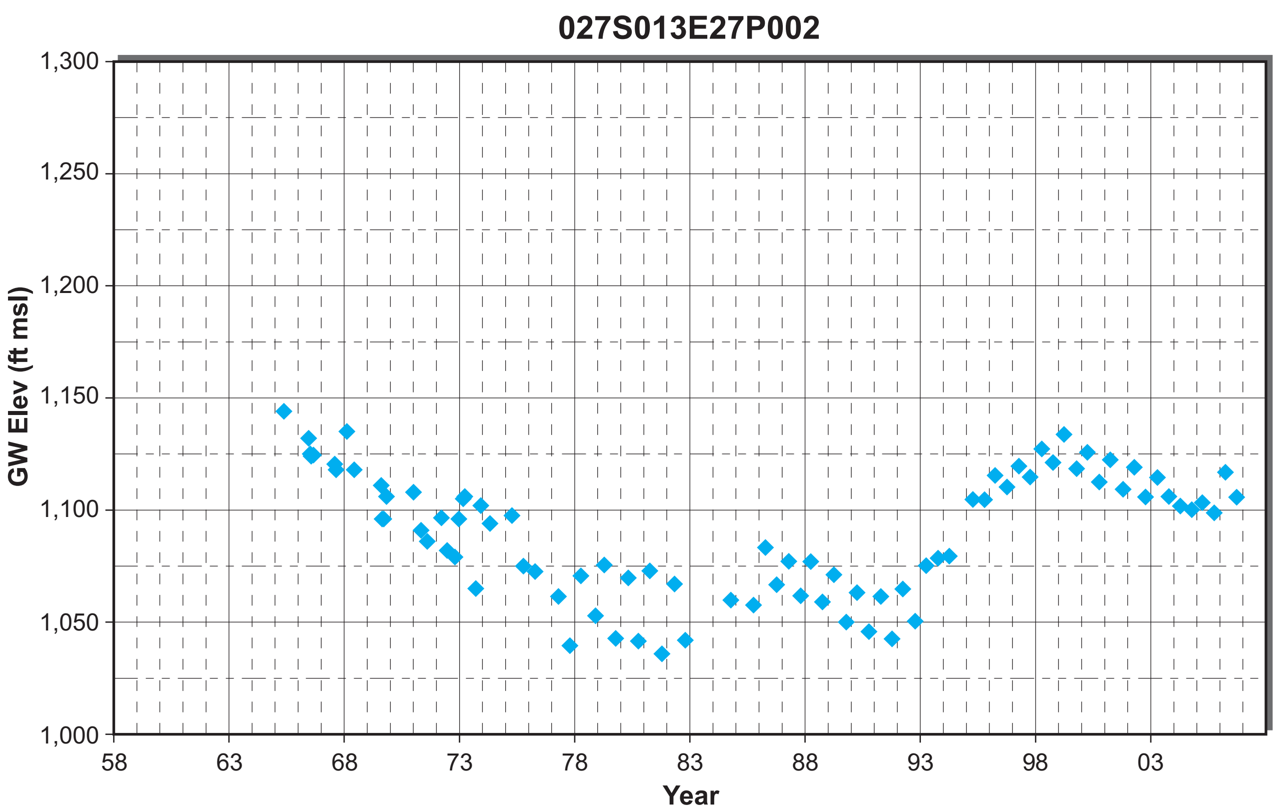
**Figure 6**
**Groundwater Elevation Map (Spring 2006)**



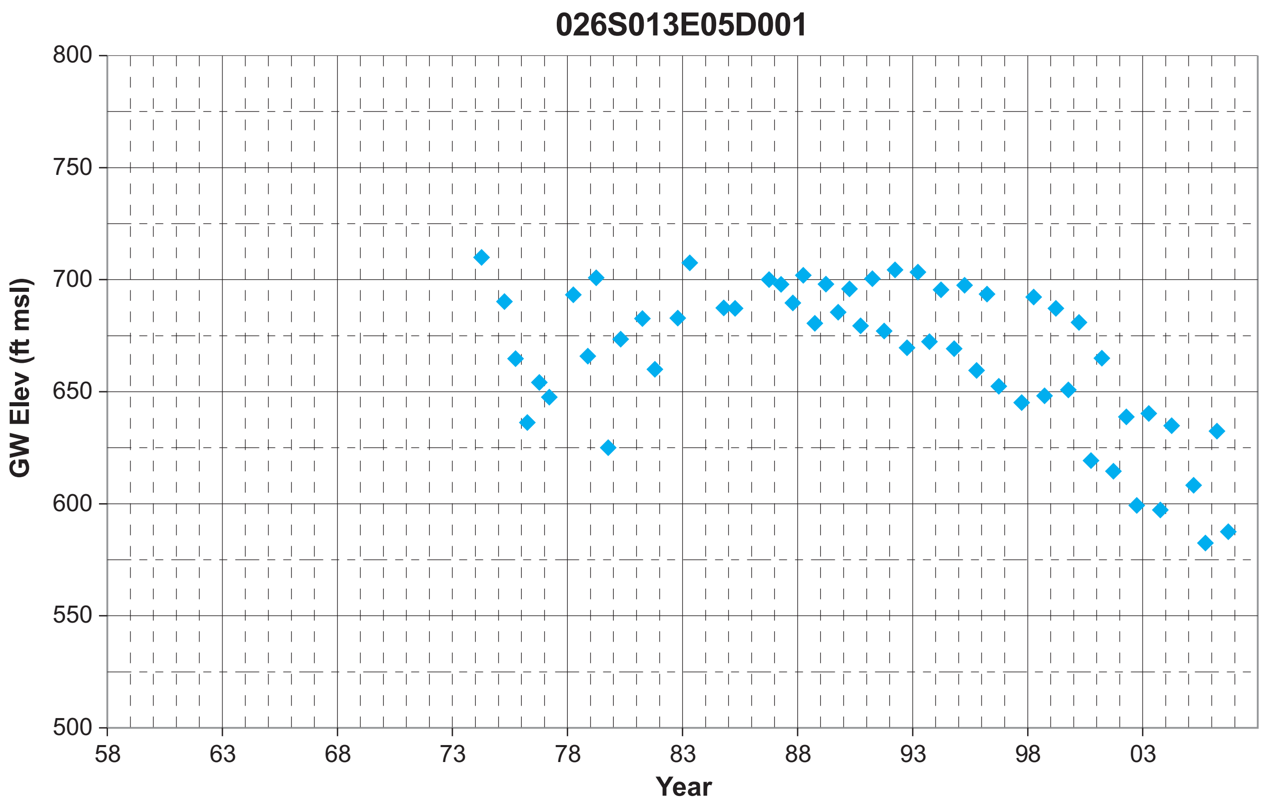




| | |
|---|---|
| December 2007<br>TODD ENGINEERS<br>Emeryville, California | **Figure 7**<br>**Atascadero Subbasin Hydrographs** |




| December 2007 | **Figure 8** |
| --- | --- |
| TODD ENGINEERS<br>Emeryville, California | **Creston Area Hydrographs** |



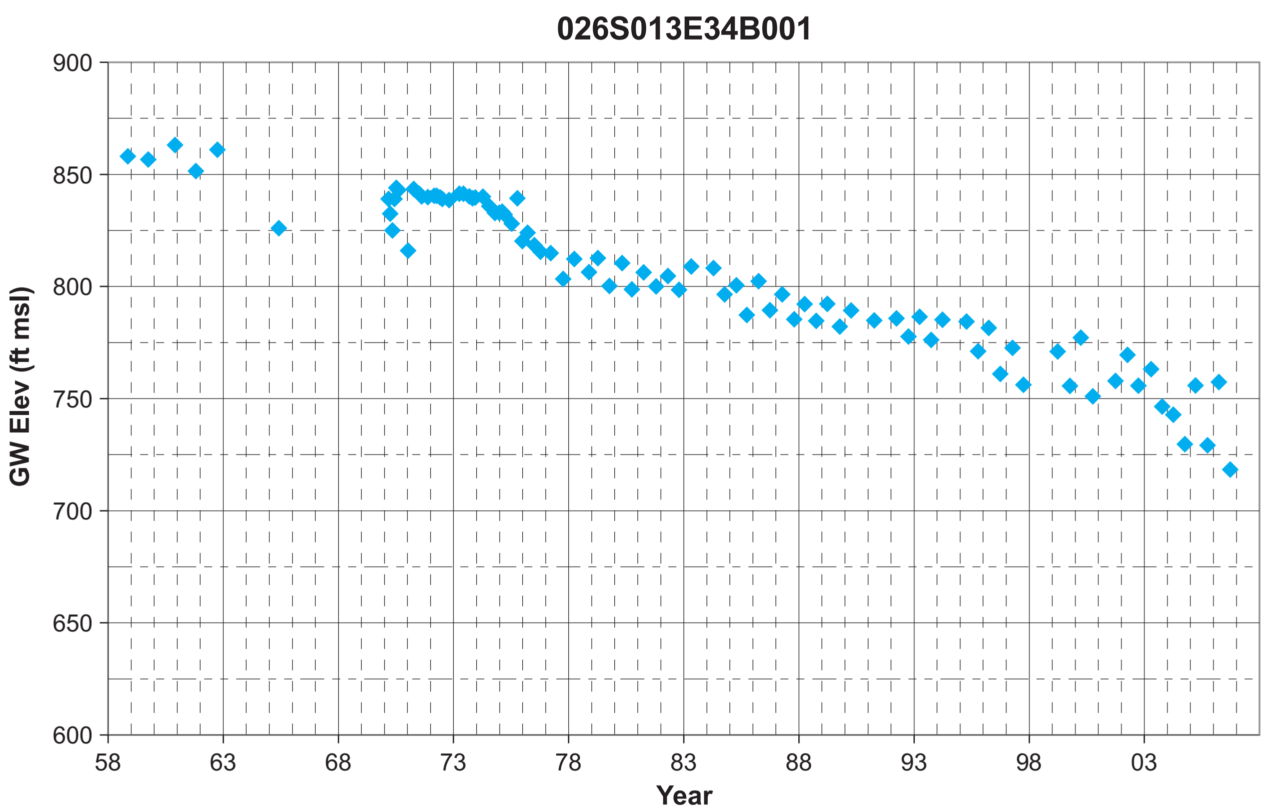




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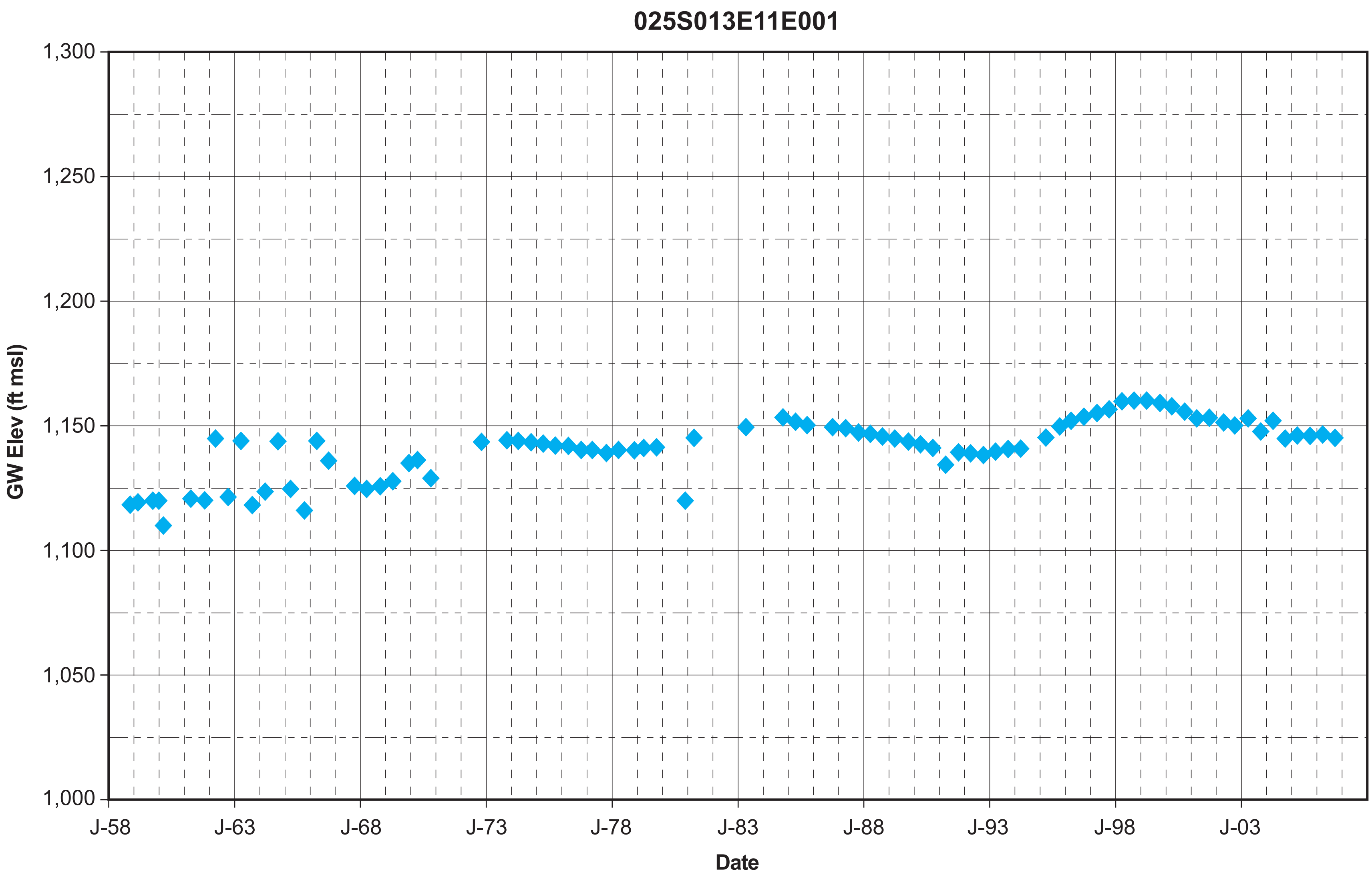
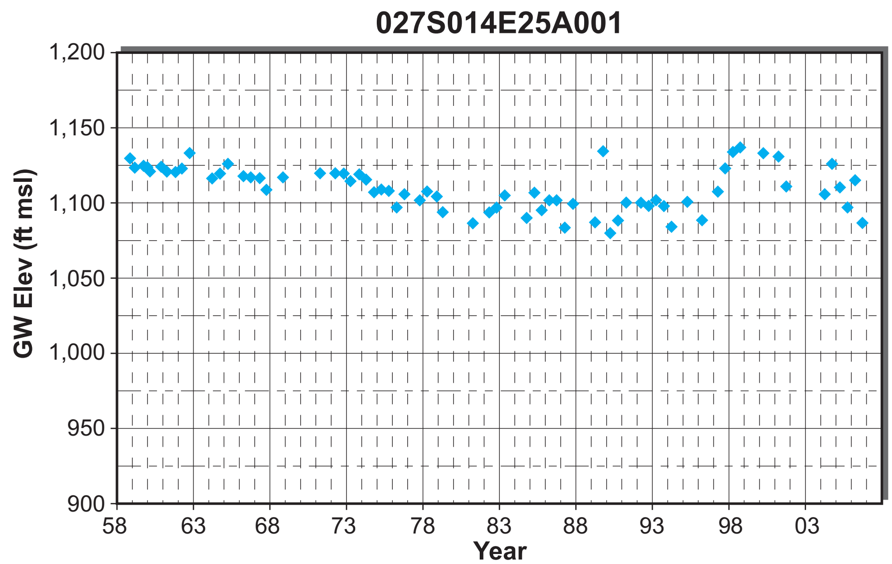
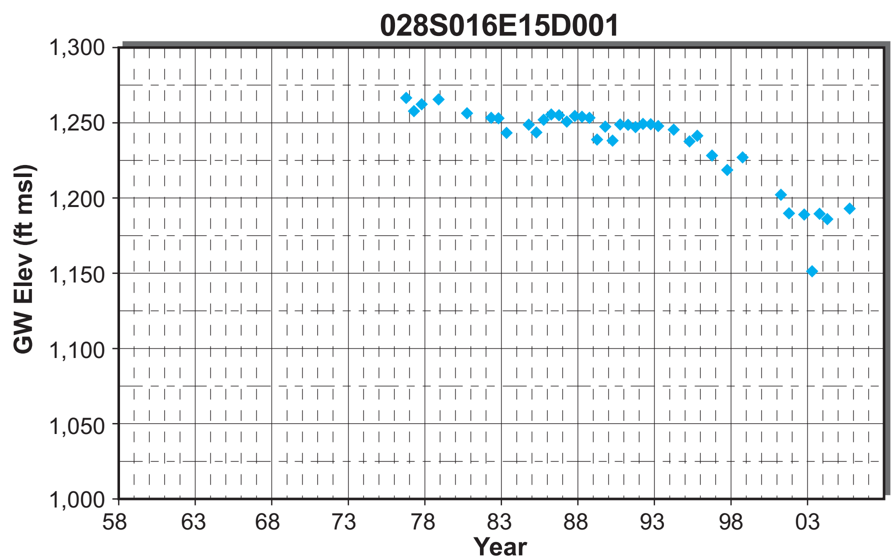
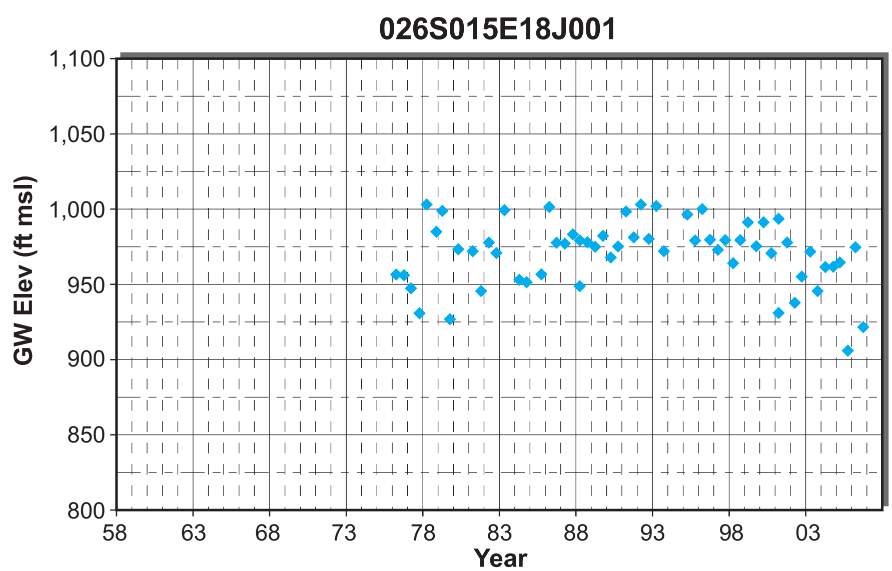
**Figure 9**
**Estrella Area Hydrographs**



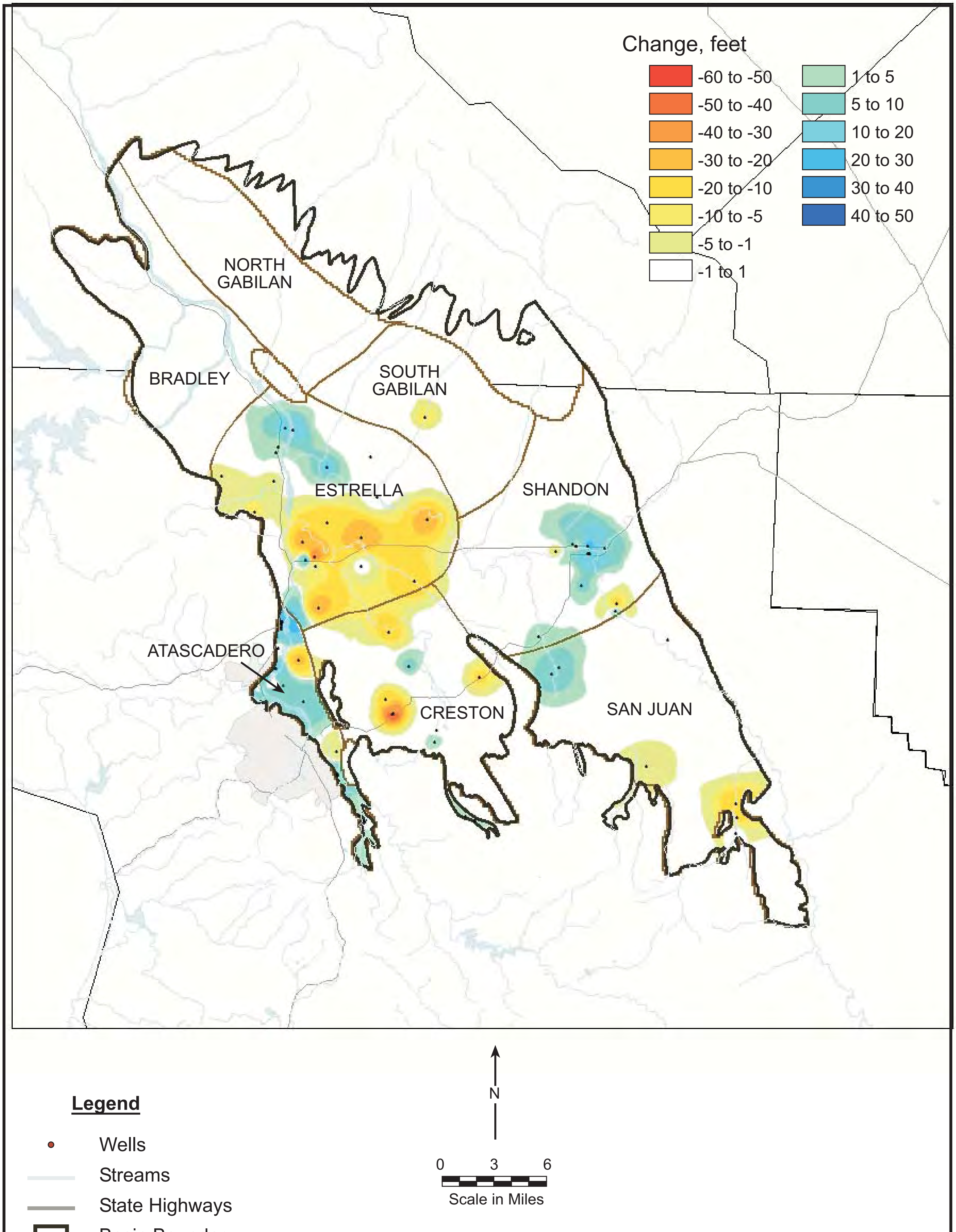

| December 2007 | **Figure 10** |
|---|---|
| TODD ENGINEERS<br>Emeryville, California | **Gabilan Area Hydrographs** |




| December 2007 | **Figure 11** |
|---|---|
| TODD ENGINEERS<br>Emeryville, California | **San Juan and Shandon Area Hydrographs** |




**Legend**

- Wells
- Streams
- State Highways
- Basin Boundary
- Cities/Communities
- Subareas
- Counties

December 2007

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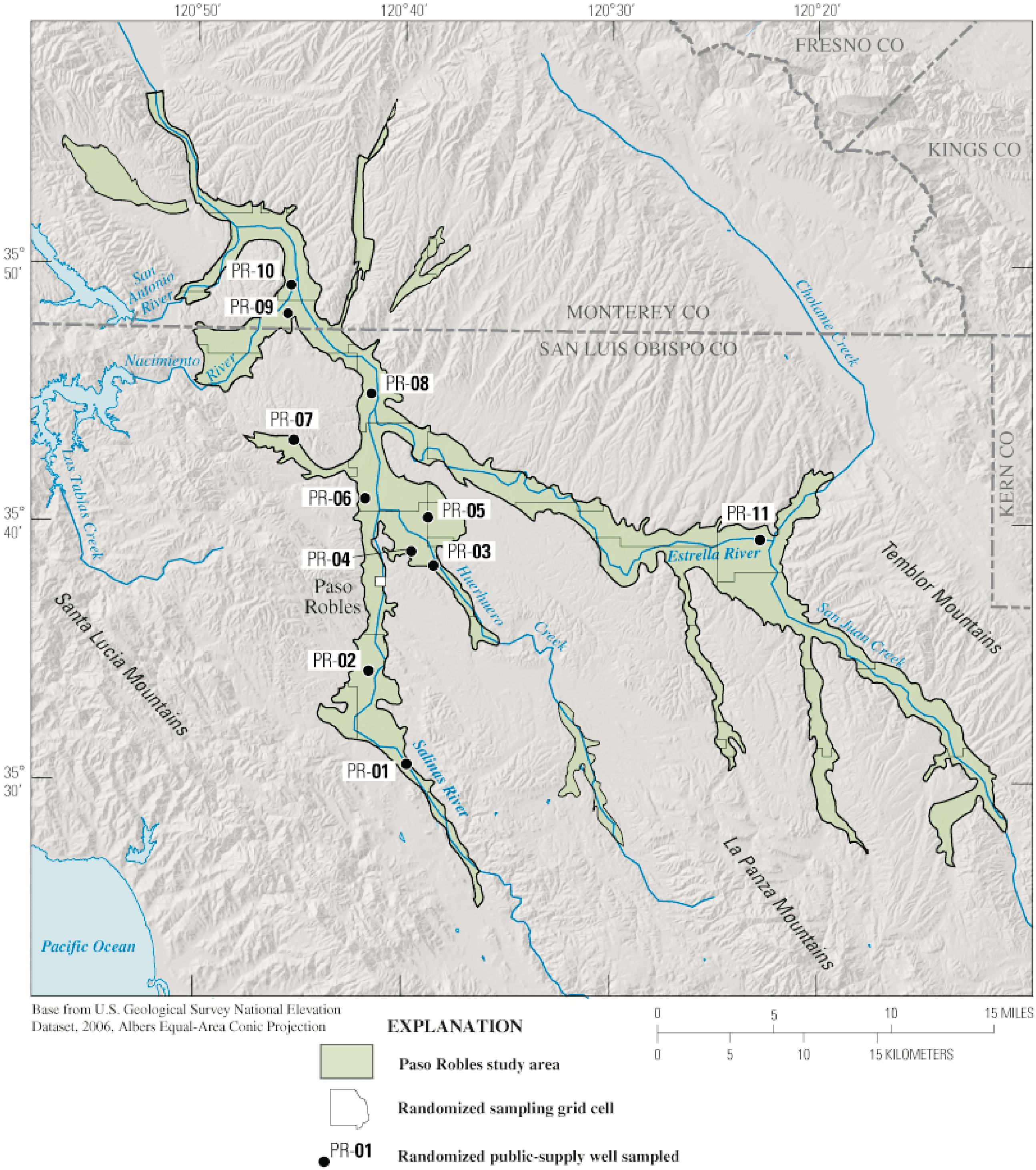
**Figure 12**
**Change in Groundwater Storage (Spring 1997 - Spring 2006)**




| December 2007 | **Figure 13**<br>**USGS**<br>**GAMA Wells** |
|---|---|
| TODD ENGINEERS<br>Emeryville, California | |