REVISED Draft

Paso Robles Subbasin
Groundwater Sustainability Plan
Chapter 6

Prepared for the Paso Robles Subbasin Cooperative Committee and the Groundwater Sustainability Agencies

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6 WATER BUDGETS

This chapter summarizes the estimated water budgets for the Paso Robles Subbasin, including information required by the SGMA Regulations and information that is important for developing an effective plan to achieve sustainability. In accordance with the SGMA Regulations §354.18, the GSP should include a water budget for the basin that provides an accounting and assessment of the total annual volume of surface water and groundwater entering and leaving the basin, including historical, current, and projected water budget conditions, and the change in the volume of water stored. Water budgets should be reported in graphical and tabular formats, where applicable.

6.1 Overview of Water Budget Development

This chapter is subdivided into three sections: (1) historical water budgets, (2) current water budgets, and (3) future water budgets. Within each section, a surface water budget and groundwater budget are presented. Water budgets were developed using the computer model of the Subbasin hydrogeologic conditions. Before presenting the water budgets, a brief overview of the models is presented. This chapter includes one appendix. The appendix provides additional information about the models and compares previously reported water budgets to water budgets developed for the GSP.

The water budgets reported herein are for the Subbasin defined in Section 1.2 and depicted on Figure 1-1. Previous water budgets reported for the Paso Robles groundwater Subbasin were for a larger area that included area within Monterey County and the Atascadero Subbasin. Because the Subbasin boundary was redefined by DWR, the area within Monterey County and the Atascadero Subbasin are no longer part of the Subbasin and therefore are not considered in water budgets reported in this section of the GSP. The revised Subbasin area results in water budget inflow components, outflow components, and estimates of sustainable yield that are different from previously reported water budgets.

In accordance with Section 354.18 of the SGMA Regulations, one integrated groundwater budget was developed for the combined inflows and outflows for the two principal aquifers - Alluvial Aquifer and Paso Robles Formation Aquifer – for each water budget period. Groundwater is pumped from both aquifers for beneficial use. Available groundwater elevation data suggest that most of the historic reduction in groundwater storage has occurred in the Paso Robles Formation Aquifer. Due to limitations in available groundwater elevation data for the Alluvial Aquifer, water budgets for this aquifer are more uncertain. Monitoring of hydrologic conditions in both aquifers will be conducted in the future to ensure that aquifer-specific sustainable management criteria are being achieved and undesirable results are being avoided.

Figure 6-1 presents a general schematic diagram of the hydrologic cycle. The water budgets include the components of the hydrologic cycle.

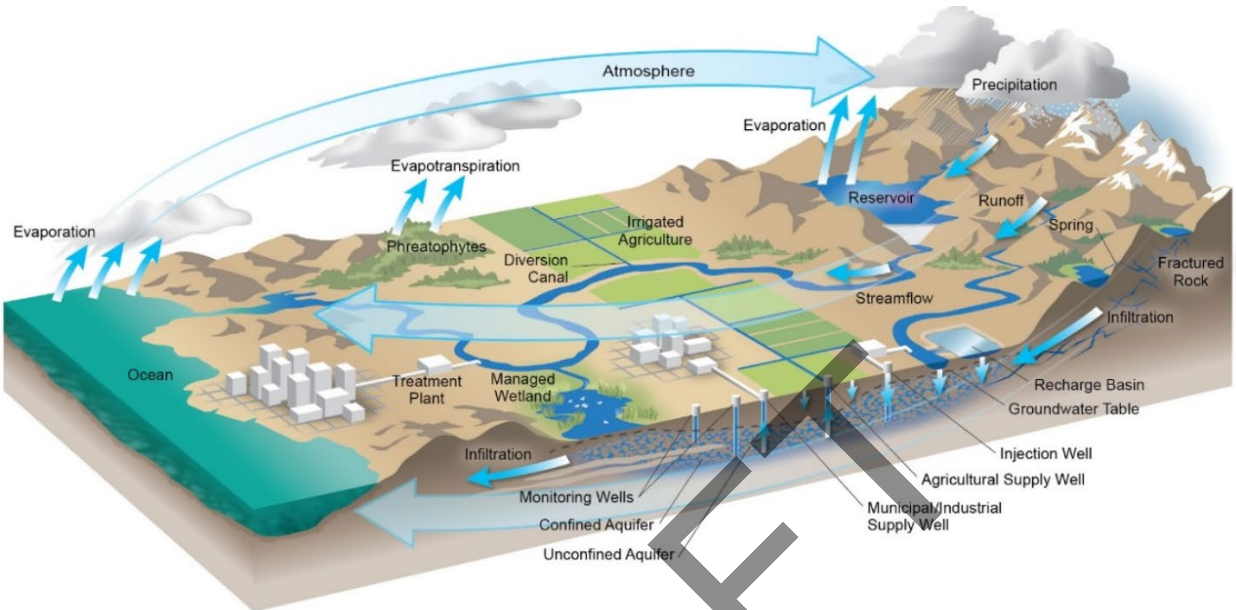

Figure 6-1. Hydrologic Cycle

A few components of the water budget can be measured, like streamflow at a gaging station or groundwater pumping from a metered well. Other components of the water budget are estimated, like recharge from precipitation or unmetered groundwater pumping. The water budget is an inventory of surface water and groundwater inflows (supplies) and outflows (demands) from the Subbasin, including:

Surface Water Inflows:

- Runoff of precipitation and reservoir releases into streams and rivers that enter the Subbasin from the surrounding watershed and that occurs inside the Subbasin
- Groundwater discharge to streams and rivers

Surface Water Outflows:

- River flows exiting the Subbasin
- Percolation of streamflow to the groundwater system
- Evaporation (negligible compared to other surface water outflows)

Groundwater Inflows:

- Recharge from precipitation
- Subsurface inflow (including percolation of irrigation return flow, precipitation, and streamflow outside the Subbasin)
- Irrigation return flow (water not consumed by crops)
- Percolation of surface water from streams
- Infiltration of treated wastewater from disposal ponds

Groundwater Outflows:

- Evapotranspiration
- Groundwater pumping
- Discharge to streams and rivers
- Subsurface outflow to the next downgradient groundwater basin

The difference between inflows and outflows is equal to the change in storage.

6.2 Water Budget Data Sources and Basin Model

Water budgets for the Paso Robles Subbasin were estimated using an integrated system of three hydrologic models (collectively designated herein as the "basin model"), including:

1. A watershed model
2. A soil water balance model
3. A groundwater flow model

The groundwater model was originally developed by Fugro (2005). The watershed and soil water balance models were developed and integrated with an updated version of the groundwater model by Geoscience Support Services, Inc. (GSSI) (GSSI, 2014 and 2016). These models were developed for San Luis Obispo Flood Control and Water Conservation District (SLOFCWCD). The original models are documented in the following reports:

- *Final Report, Paso Robles Groundwater Basin Study Phase II, Numerical Model Development, Calibration, and Application*: Fugro, February 2005
- *Paso Robles Groundwater Basin Model Update: Geoscience Support Services, Inc.*, December 2014

- *Refinement of the Paso Robles Groundwater Basin Model and Results of Supplemental Water Supply Options Predictive Analysis: Geoscience Support Services, Inc.*, December 2016

The 2016 version of the basin model was updated for the GSP. The update included incorporating hydrologic data for the period 2012 through 2016 into the models. Appendix D includes a brief summary of the model update process, including:

- A summary of data sources used for the update (Table D-1)
- A summary of modifications made to the basin model to address computational refinements, data processing issues, and conceptual application of the model codes
- A comparison of the water budgets from the updated model and the original 2016 GSSI model.

The updated versions of the basin models are referred to herein collectively as the "GSP model".

Numerous sources of raw data were used to update the basin models for the GSP. Examples of raw data include reported pumping rates from the City of Paso Robles, precipitation data obtained from weather stations in the Subbasin, and crop acreage from the office of the San Luis Obispo County Agricultural Commissioner, among many others. Data sources are listed in Table D-1. Raw data were compiled, processed, and used to develop model input files. Model results were used to develop estimates of the individual inflow and outflow components of the surface water and groundwater budgets. Thus, all of the estimated flow components herein were extracted from the GSP model.

6.2.1 Model Assumptions and Uncertainty

The GSP model is based on available hydrogeologic and land use data from the past several decades, previous studies of Subbasin hydrogeologic conditions, and earlier versions of the basin models. The GSP models give insight into how the complex hydrologic processes are operating in the Subbasin. During previous studies, available data and a peer-review process were used to calibrate the basin model to Subbasin hydrogeologic conditions. Results of the previous calibration process demonstrated that the model-simulated groundwater and surface water flow conditions were similar to observed conditions. After updating for the GSP, the calibration of the GSP model was reviewed. Results of the review indicated that the GSP model was sufficiently calibrated for use in the GSP.

Projections made with the GSP model have uncertainty due to limitations in available data and limitations from assumptions made to develop the models. This uncertainty is typical of all models, and its effect on projections made with the models is well understood. Model uncertainty has been considered when developing and using the reported GSP water budgets for developing sustainability management actions and projects (Chapter 9).

During early implementation of the GSP, additional data will be collected to refine Subbasin understanding and recalibrate the GSP model. New hydrologic data and the recalibrated model will be used to adaptively implement sustainability management actions and projects to ensure that progress toward sustainability goals is being achieved.

6.3 Historical Water Budget

The SGMA Regulations require that the historical surface water and groundwater budget be based on at least the most recent 10 years of data. For the Paso Robles Subbasin GSP, the period 1981 to 2011 was selected as the time period for the historical water budget (referred to as the historical base period) because it is long enough to capture typical climate variations, it corresponds to the period simulated in the basin model, and it ends at about the time the recent drought period began. Estimates of the surface water and groundwater inflow and outflow, and changes in storage for the historical base period are provided below.

6.3.1 Historical Surface Water Budget

The SGMA Regulations (§354.18) require development of a surface water budget for the GSP. The surface water budget quantifies important sources of surface water and evaluates their historical and future reliability. The water budget Best Management Practice (BMP) document states that surface water sources should be identified as one of the following (DWR, 2016):

- Central Valley Project
- State Water Project
- Colorado River Project
- Local imported supplies
- Local supplies

The Paso Robles Subbasin relies on two of these surface water source types: local imported supplies and local supplies.

6.3.1.1 Historical Local Imported Supplies

During the historical base period, local imported water supplies were not used in the Subbasin. Use of local imported supplies began in 2014; information about these supplies is presented in Section 6.4 – Future Water Budget.

6.3.1.2 Historical Local Supplies

Local surface water supplies include surface water flows that enter the Subbasin from precipitation runoff within the watershed, Salinas River inflow to the Subbasin (including releases from the Salinas Reservoir), Nacimiento River inflow to the Subbasin (including releases from Nacimiento Reservoir), and discharge of groundwater to streams from the Alluvial Aquifer. Table 6-1 summarizes the annual average, minimum, and maximum values for these inflows.

Table 6-1. Estimated Historical (1981-2011) Annual Surface Water Inflows to Subbasin

Surface Water Inflow Component	Average	Minimum	Maximum
Nacimiento River Inflow to Subbasin	214,400	5,500	734,100
Precipitation Runoff within Watershed	96,900	400	606,900
Salinas River Inflow to Subbasin	41,800	1,600	179,900
Groundwater Discharge to Rivers and Streams from Alluvial Aquifer	7,300	4,300	11,800
Total [1]	360,400	13,700	1,198,600

Note: All values in AF

(1) The total minimum and maximum inflow rates are not equal to the sum of the minimum and maximum rates for the inflow components, because the water year corresponding to the minimum and maximum inflow rates differs across the different inflow components.

The estimated annual average total inflow from these sources over the historical base period is about 360,400 AF. The largest component of this average inflow is releases and flow in the Nacimiento River. While average inflows are large from the Nacimiento River, nearly all of this inflow leaves the Subbasin as surface water outflow because the length of the Nacimiento River within the Subbasin is short. The large difference between the minimum and maximum inflows reflects the difference between dry and wet years in the Subbasin. The sum of the minimum and maximum inflows will not necessarily equal the tally of individual inflows because the minimums and maximums of the individual inflows do not always occur in the same year.

6.3.1.3 Historical Surface Water Outflows

The estimated annual average total surface water outflow leaving the Subbasin as flow in the Salinas River, flow in the Nacimiento River, and percolation into the groundwater system over the historical base period is summarized in Table 6-2.

Table 6-2. Estimated Historical (1981-2011) Annual Surface Water Outflows from Subbasin

Surface Water Outflow Component	Average	Minimum	Maximum
Salinas River Outflow from Subbasin	119,100	5,300	646,300
Nacimiento River Outflow from Subbasin	214,400	5,500	734,000
Percolation of Surface Water to Groundwater	26,900	2,000	126,000
Total [1]	360,400	13,700	1,198,600

Note: All values in acre-feet (AF)

(1) The total minimum and maximum outflow rates are not equal to the sum of the minimum and maximum rates for the outflow components, because the water year corresponding to the minimum and maximum inflow rates differs across the different inflow components.

The estimated annual average total outflow from these sources over the historical base period is about 360,400 AF. Of this 360,400 AFY, approximately 26,900 AFY of the outflow is percolation from streams into the groundwater system. Of this 26,900 AFY of percolation, 7,300 AFY returns to streamflow as groundwater discharge.

6.3.1.4 Historical Surface Water Budget

Figure 6-2 summarizes the historical water budget for the Subbasin.

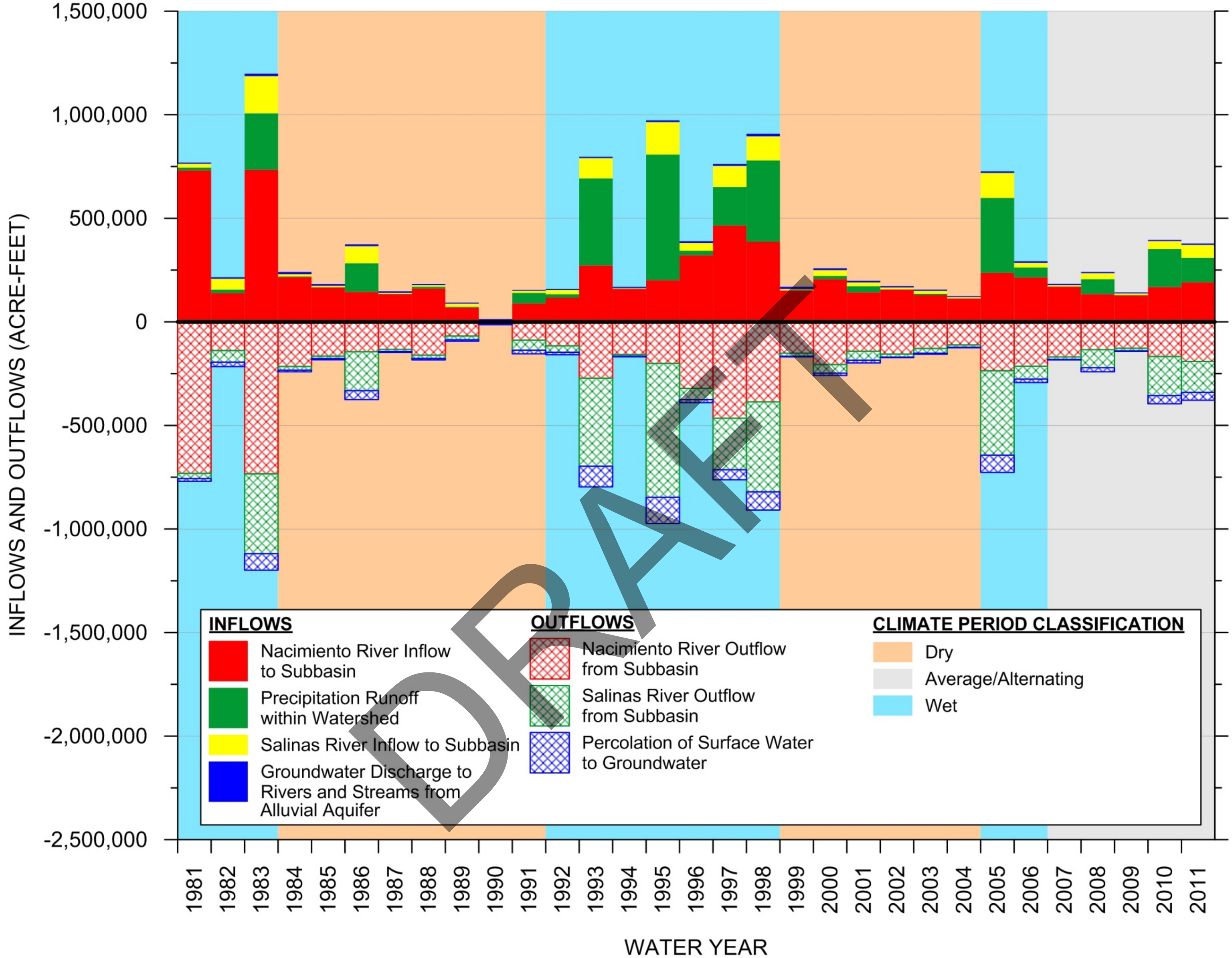

Figure 6-2. Historical (1981-2011) Surface Water Inflows and Outflows

This graph shows the strong correlation between precipitation and streamflow in the Subbasin. In wet periods, shown with a blue background, surface water inflows and outflows are large. In contrast, in dry periods that are shown with an orange background, surface water inflows and outflows are small. As shown on the graph, several years during the historical base period had total surface water inflows greater than 500,000 AFY. Assuming diversion permits could be obtained, future high flow years may provide opportunities to capture and use excess storm water as a new water supply in the Subbasin. This concept is discussed in more detail in Chapter 9 – Projects and Management Actions.

6.3.2 Historical Groundwater Budget

Groundwater supplied most of the water used in the Subbasin over the historical base period. The historical groundwater budget includes a summary of the estimated groundwater inflows, groundwater outflows, and change in groundwater in storage.

6.3.2.1 Historical Groundwater Inflows

Groundwater inflow components include streamflow percolation, agricultural irrigation return flows, deep percolation of direct precipitation, subsurface inflow into the Subbasin, wastewater pond leakage, and urban irrigation return flow. Estimated annual groundwater inflows for the historical base period are summarized in Table 6-3. Values reported in the table were estimated or derived from the basin models using data sources reported in Table D-1 in Appendix D.

Table 6-3. Estimated Historical (1981-2011) Annual Groundwater Inflows to Subbasin

Groundwater Inflow Component [1]	Average	Minimum	Maximum
Streamflow Percolation	26,900	2,000	126,000
Agricultural Irrigation Return Flow	17,800	10,700	29,100
Deep Percolation of Direct Precipitation	12,000	300	45,400
Subsurface Inflow into Subbasin	10,100	4,900	14,300
Wastewater Pond Leakage	3,400	2,400	4,400
Urban Irrigation Return Flow	1,200	300	2,200
Total [2]	71,400	25,700	201,700

Note: All values in acre-feet (AF)

(1) – Percolation from septic systems is not directly accounted for because it is subtracted from the total estimated rural-domestic pumping to simulate a net rural-domestic pumping amount.

(2) - The total minimum and maximum inflow rates are not equal to the sum of the minimum and maximum rates for the inflow components, because the water year corresponding to the minimum and maximum inflow rates differs across the different inflow components.

For the historical base period, estimated total average groundwater inflow ranged from 25,700 AFY to 201,700 AFY, with an average inflow of 71,400 AFY. The largest groundwater inflow component is streamflow percolation, which accounts for approximately 38% of the total average inflow. Streamflow percolation, agricultural irrigation return flow, and deep percolation of direct precipitation account for approximately 79% of the estimated total annual average inflow to the Subbasin. The large difference between the minimum and maximum inflows from streamflow percolation and direct precipitation reflect the variations in precipitation over the historical base period.

6.3.2.2 Historical Groundwater Outflows

Groundwater outflow components include total groundwater pumping from all water use sectors, groundwater discharge to streams and rivers from the Alluvial Aquifer, subsurface flow out of the Subbasin, and riparian evapotranspiration. Estimated annual groundwater outflows for the historical base period are summarized in Table 6-4.

Table 6-4. Estimated Historical (1981-2011) Annual Groundwater Outflow from Subbasin

Groundwater Outflow Component	Average	Minimum	Maximum
Total Groundwater Pumping	72,400	48,200	102,900
Groundwater Discharge to Streams and Rivers from Alluvial Aquifer	7,300	4,300	11,800
Subsurface Flow Out of Subbasin	2,600	2,300	3,000
Riparian Evapotranspiration	1,700	1,700	1,700
Total [1]	84,000	62,300	112,700

Note: All values in acre-feet (AF)

(1) - The total minimum and maximum outflow rates are not equal to the sum of the minimum and maximum rates for the outflow components, because the water year corresponding to the minimum and maximum outflow rates differs across the different outflow components.

The largest groundwater outflow component from the Subbasin is groundwater pumping. Estimated annual groundwater pumping by water use sector for the historical base period is summarized in Table 6-5.

Table 6-5. Estimated Historical (1981-2011) Annual Groundwater Pumping by Water Use Sector from Subbasin

Water Use Sector	Average	Minimum	Maximum
Agricultural	65,300	40,600	95,800
Municipal	3,200	1,700	6,000
Rural-Domestic [1]	2,500	1,700	3,400
Small Commercial	1,400	1,200	1,700
Total [2]	72,400	48,200	102,900

Notes: All values in acre-feet (AF)

(1) Assumed to be net amount of pumping based on an analysis conducted by GSSI (2016). Net pumping was computed as total pumping amount minus septic return flow.

(2) The total minimum and maximum pumping rates are not equal to the sum of the minimum and maximum rates for the water use sectors, because the water year corresponding to the minimum and maximum pumping rates differs across the different water use sectors.

Agricultural pumping was the largest component of total groundwater pumping, accounting for about 90% of total pumping over the historical base period. Municipal, rural-domestic, and small commercial pumping account for 4%, 4%, and 2%, respectively, of total average annual pumping over the historical base period.

6.3.2.3 Historical Groundwater Budget and Changes in Groundwater Storage

Groundwater inflows and outflows for the historical base period are summarized on Figure 6-3. This graph shows groundwater inflow and outflow components for every year of the historical period. Inflow components are graphed above the zero line and outflow components are graphed below the zero line. Groundwater outflow by pumping (green bars) includes pumping from all water use sectors (Table 6-5).

Figure 6-4 shows annual and cumulative change in groundwater storage during the historical base period. Annual increases in groundwater storage are graphed above the zero line and annual decreases in groundwater storage are graphed below the zero line. The red line shows the cumulative change in groundwater storage over the historical base period.

The GSP uses the best available information to quantify the water budget for the Subbasin while recognizing the limitations inherent from existing data gaps. The water budget identifies and tracks changing inflows and outflows to the Subbasin and therefore is an important tool for local water resources management. The GSP contains a plan to gather more and better data in the future, which will be used to further refine the water budget. The GSP is designed to adapt to an increasing data set and expanding understanding of basin conditions and water budget.

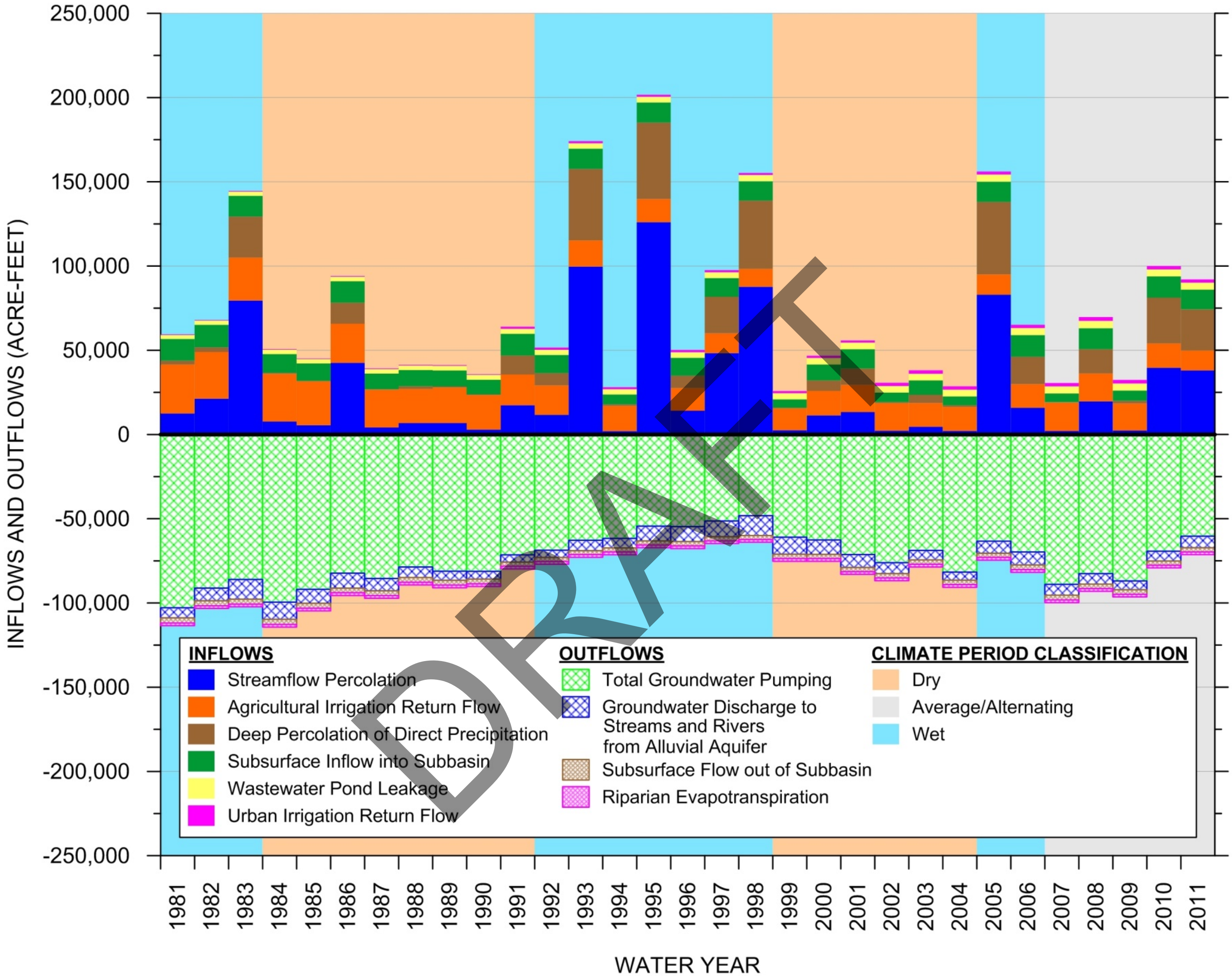

Figure 6-3. Historical (1981-2011) Groundwater Inflows and Outflows

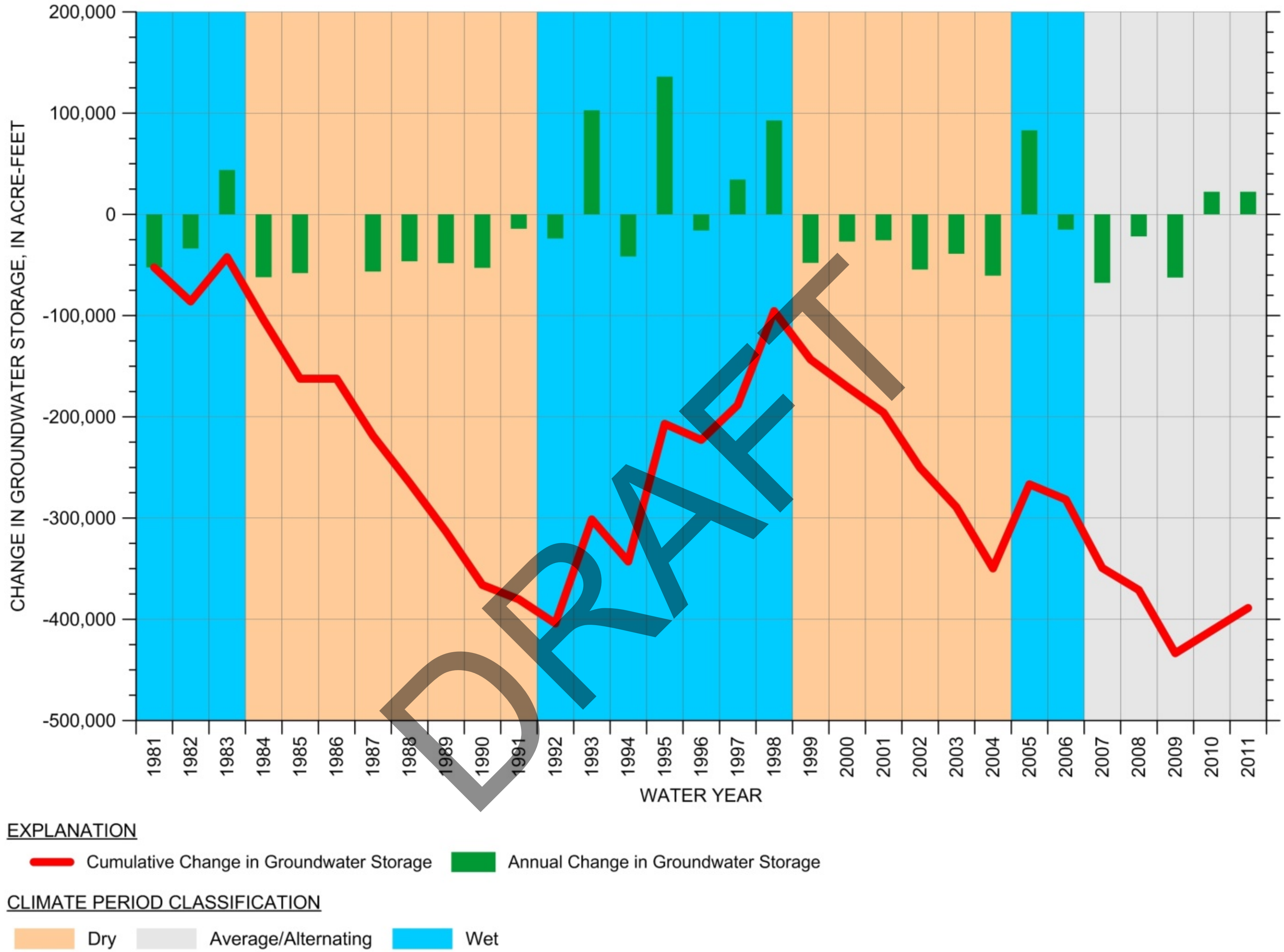

Figure 6-4. Historical (1981-2011) Annual and Cumulative Change in Groundwater Storage

The historical groundwater budget is strongly influenced by the amount of precipitation. During the historical base period, dry conditions prevailed from 1984 through 1991 and 1999 through 2004, as depicted by the orange areas on Figure 6-3 and Figure 6-4. During these dry periods, the amounts of recharge and streamflow percolation were relatively low and the amount of pumping was relatively high. The net result was a loss of groundwater from storage. In contrast, wet conditions prevailed in the early 1980s, 1992 through 1998, and 2005 and 2006, as shown by blue areas on Figure 6-3 and Figure 6-4. During these wet periods, the amounts of recharge and streamflow percolation were relatively high and the amount of pumping was relatively low. The net result was a gain of groundwater in storage. The period from 2007 through 2011 had generally alternative years of average precipitation. During this period, the amounts of recharge and streamflow percolation were average and the amount of groundwater pumping was relatively high. The net result was a loss of groundwater from storage.

The historical groundwater budget is also influenced by the amount of groundwater pumping. Over the historical base period, the total amount of groundwater pumping showed two distinct trends (Figure 6-3). From the early 1980s through the late 1990s, groundwater pumping declined from about 100,000 AFY to about 50,000 AFY. In general, this decline in groundwater pumping corresponded to a period when irrigation of alfalfa and pasture acreage declined and irrigated vineyard acreage increased (Fugro, 2002). The transition from alfalfa and pasture to vineyard resulted in a net decrease in groundwater pumping because the irrigation demand of vineyards is less than alfalfa and pasture. This decrease in pumping contributed to the increase in groundwater in storage during the 1990s. After the late 1990s, groundwater pumping increased to about 100,000 AFY in 2007, largely due to continued expansion of irrigated vineyard acreage. The increase in groundwater pumping during this period contributed to the reductions in groundwater in storage that occurred after the late 1990s.

Over the 31 year historical base period, a net loss of groundwater storage of about 390,000 AF occurred. The annual average groundwater storage loss was approximately 12,500 AF. The average groundwater storage loss of 12,500 AFY is about 18% of the average total groundwater inflow of 71,400 AFY (Table 6-3) and about 15% of the average total groundwater outflow of 84,000 AFY (Table 6-4).

6.3.2.4 Historical Sustainable Yield of the subbasin

The computed long-term depletion of groundwater in storage indicates that total groundwater pumping from all water use sectors exceeded the total amount of recharge in the Subbasin from 1981 through 2011; this depletion is consistent with observed groundwater elevation declines (for example, see groundwater elevation change maps and hydrographs in Chapter 5). As summarized in Table 6-5, total groundwater pumping averaged approximately 72,400 AFY during the historical base period. In accordance with Section 354.18(b)(7) of the SGMA Regulations, a sustainable yield for the Subbasin for the historical base period was estimated. Sustainable yield of the Subbasin was computed by subtracting the average groundwater storage deficit of 12,500 AFY from the total average amount of groundwater pumping. In this case, the historical sustainable yield of the Subbasin for the historical base period is about 59,900 AFY. This estimate of sustainable yield reflects historical climate, hydrologic and water resource conditions and provides insight into the amount of groundwater pumping that could be sustained to maintain a balance between groundwater inflows and outflows. However, it differs from estimates of future sustainable yield, which will be developed for representative average future climate and hydrologic conditions and will be used to plan management actions and projects needed to avoid undesirable results under SGMA.

6.4 Current Water Budget

The SGMA Regulations require that the current surface water and groundwater budget be based on the most recent hydrology, water supply, water demand, and land use information. For the Paso Robles Subbasin GSP, the period 2012 to 2016 was selected as the time period for the current water budget. The current water budget period corresponds to a drought period when the average annual precipitation averaged about 62% of the historical average annual precipitation and the average streamflow percolation was 10% of the historical average percolation. As a result, the current water budget period represents a more extreme condition in the basin and is not appropriate for sustainability planning in the Subbasin. Estimates of the surface water and groundwater inflow and outflow, and changes in storage for the current water budget period are provided below.

6.4.1 Current Surface Water Budget

The current surface water budget quantifies important sources of surface water. Similar to the historical surface water budget, the current surface water budget includes two surface water source types: local imported supplies and local supplies.

6.4.1.1 Current Local Imported Supplies

As reported in the City of Paso Robles' 2016 Urban Water Management Plan, the most significant source of imported surface water in the Paso Robles Subbasin is the City's entitlement for Nacimiento water through a SLOFCWCD contract (Todd Groundwater, 2016). The total Nacimiento entitlement is about 6,500 AFY. Use of the Nacimiento water by the City began in 2014. Recently the Subbasin has begun to receive relatively small deliveries of up to 100 AFY of State Water Project water to Shandon CSA 16 for residential use. Currently, the City can treat up to about 2,700 AFY of Nacimiento water and deliver it for potable use (Todd Groundwater, 2016). Approximately another 270 AFY of Nacimiento water can be discharged to the Salinas River and recovered by a dedicated recovery well. In times of drought, Nacimiento water can be discharged to the Salinas River to improve reliability of the City's river recovery wells.

Only a small portion of the total water demand in the Subbasin during the current water budget period was met by the City's entitlement of imported surface water from Nacimiento Reservoir. According to records provided by the City, the amounts of Nacimiento water used in 2014, 2015, and 2016 were 227, 622, and 799 AF, respectively. The limited use is not an indication of the reliability of Nacimiento water, but rather a choice by the City regarding how to operate its water supply portfolio. Nacimiento water is expected to be a stable water supply given the favorable contractual priority of SLOFCWCD for the reservoir supply (Todd Groundwater, 2016).

Given the limited amount of imported Nacimiento water used compared to the amount of other local surface water supplies, the Nacimiento water supply is not aggregated into the surface water budget discussed below.

6.4.1.2 Current Local Supplies

Local surface water supplies include surface water flows that enter the Subbasin from precipitation runoff within the watershed, Salinas River inflow to the Subbasin (including releases from the Salinas Reservoir), Nacimiento River inflow to the Subbasin (including releases from Nacimiento Reservoir), and discharge of groundwater to streams from the Alluvial Aquifer. Table 6-6 summarizes the annual average, minimum, and maximum values for these inflows.

Table 6-6. Estimated Current (2012-2016) Annual Surface Water Inflows to Subbasin

Surface Water Inflow Component	Average	Minimum	Maximum
Precipitation Runoff	2,900	1,300	7,500
Salinas Reservoir Releases to Salinas River	6,600	5,200	8,500
Nacimiento Reservoir Releases	73,200	29,400	163,600
Groundwater Discharge to Rivers and Streams	4,300	3,000	6,100
Total [1]	87,000	45,600	180,200

Note: All values in acre-feet (AF)

(1) The total minimum and maximum inflow rates are not equal to the sum of the minimum and maximum rates for the inflow components, because the water year corresponding to the minimum and maximum inflow rates differs across the different inflow components.

The estimated average total inflow from both precipitation runoff and reservoir releases over the current water budget period was approximately 87,000 AFY, or 25% of the 360,400 AFY over the historical base period. Approximately 84% of the local surface water supply was from Nacimiento Reservoir releases, most of which flows out of the Subbasin as surface flow. As a result, Nacimiento River flows do not result in appreciable amounts of surface water percolation to groundwater. If Nacimiento releases are not considered in the surface water inflows, surface water inflows during the current water budget period were less than 10% of the surface water inflows for the historical base period. The substantial reduction in surface water inflows reflects the drought conditions that prevailed during the current water budget period.

6.4.1.3 Current Surface Water Outflows

The estimated annual average, minimum, and maximum surface water outflow leaving the Subbasin as flow in the Salinas River, flow in the Nacimiento River, and percolation into the groundwater system over the current base period is summarized in Table 6-7.

Table 6-7. Estimated Current (2012-2016) Annual Surface Water Outflows from Subbasin

Surface Water Outflow Component	Average	Minimum	Maximum
Salinas River Flow	11,100	8,500	14,100
Nacimiento River Flow	73,200	29,400	163,300
Percolation of Surface Water to Groundwater	2,700	2,100	4,100
Total [1]	87,000	45,600	180,200

Note: All values in acre-feet (AF)

(1) The total minimum and maximum outflow rates are not equal to the sum of the minimum and maximum rates for the outflow components, because the water year corresponding to the minimum and maximum outflow rates differs across the different outflow components.

Reductions in surface water outflow for the current water budget period were similar to those reported above for the surface water inflows.

6.4.1.4 Current Surface Water Budget

Figure 6-5 summarizes the current surface water budget for the Subbasin. Figure 6-5 is on the same scale as Figure 6-2 and shows the effects of the drought conditions that prevailed during the period 2012 through 2016. During this period, precipitation was well below average, which resulted in very little surface water flow.

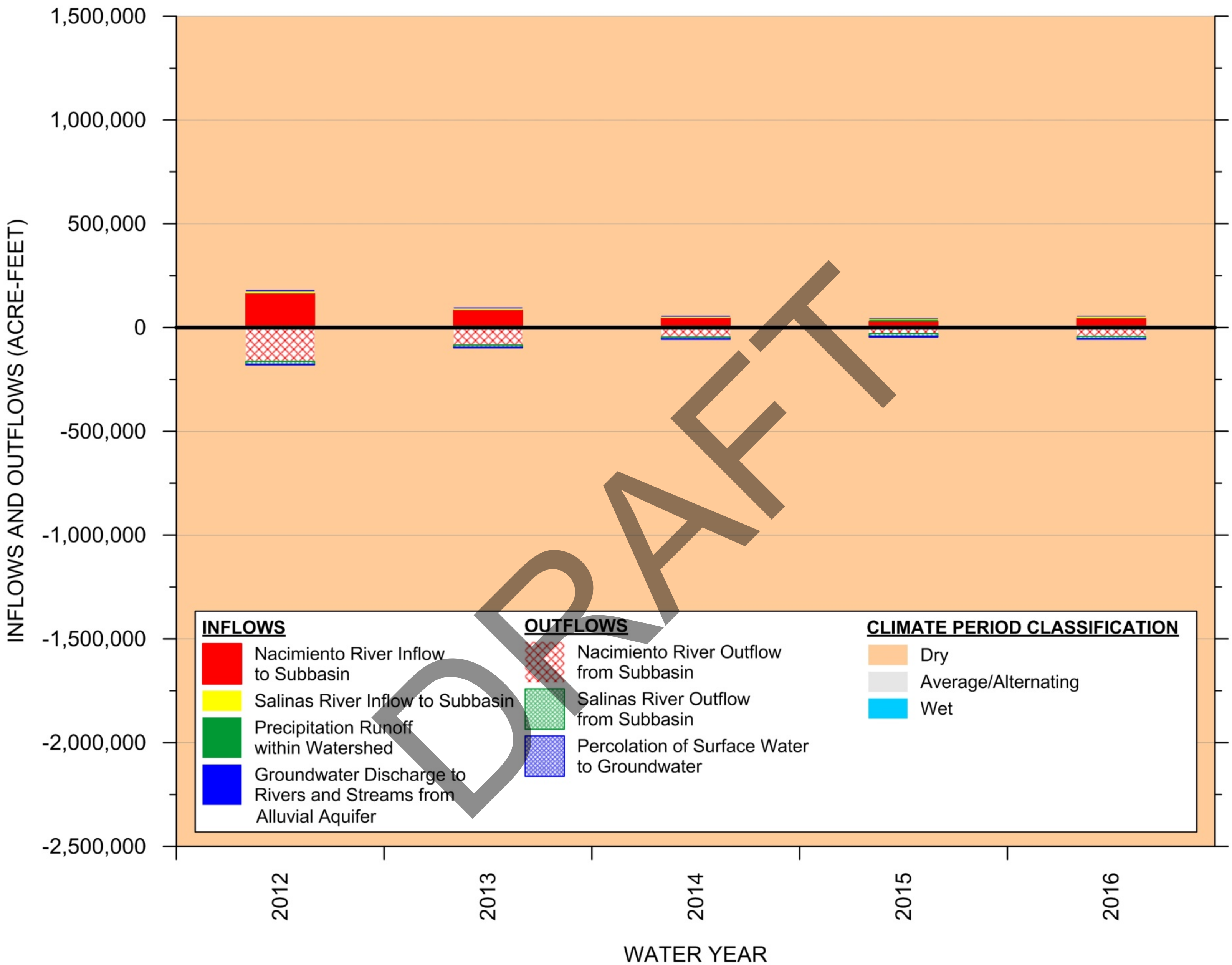

Figure 6-5. Current Surface Water Inflows and Outflows

6.4.2 Current Groundwater Budget

Groundwater supplied most of the water used in the basin during the current water budget period. The current water budget includes a summary of the estimated groundwater inflows, groundwater outflows, and change in groundwater in storage.

6.4.2.1 Current Groundwater Inflows

Groundwater inflow components include streamflow percolation, agricultural irrigation return flows, deep percolation of direct precipitation, subsurface inflow into the Subbasin, wastewater pond leakage, and urban irrigation return flow. Estimated annual groundwater inflows for the current water budget period are summarized in Table 6-8.

Table 6-8. Estimated Current (2012-2016) Annual Groundwater Inflows to Subbasin

Groundwater Inflow Component [1]	Average	Minimum	Maximum
Streamflow Percolation	2,700	2,100	4,100
Agricultural Irrigation Return Flow	13,100	12,400	13,800
Deep Percolation of Direct Precipitation	1,400	500	3,800
Subsurface Inflow into Subbasin	4,900	4,400	6,000
Wastewater Pond Leakage	4,700	4,600	4,900
Urban Irrigation Return Flow	2,100	2,000	2,200
Total [2]	28,900	27,500	33,100

Note: All values in acre-feet (AF)

(1) – Percolation from septic systems is not directly accounted for because it is subtracted from the total estimated rural-domestic pumping to simulate a net rural-domestic pumping amount.

(2) - The total minimum and maximum inflow rates are not equal to the sum of the minimum and maximum rates for the inflow components, because the water year corresponding to the minimum and maximum inflow rates differs across the different inflow components.

For the current water budget period, estimated total average groundwater inflow ranged from 27,500 AFY to 33,100 AFY, with an average inflow of 28,900 AFY. Notable observations from the summary of groundwater inflows for the current water budget period included:

- Average total inflow during the current water budget period was about 40% of the historical base period.
- Unlike the historical base period, when the largest inflow component was streamflow percolation, the largest groundwater inflow component for the current water budget is

agricultural irrigation return flow, which accounts for approximately 45% of the total average inflow.

- The relatively small difference between the minimum and maximum inflows reflects the drought condition that prevailed during the current water budget period, when precipitation and runoff were continuously low.
- Total annual average streamflow percolation in the current water budet period was approximately 10% of the streamflow percolation in the historical base period. This reflects the very low streamflows during the drought. This has a significant impact on the groundwater basin because streamflow percolation was the most significant source of groundwater recharge during the historical period.
- Total annual average recharge from direct precipitation for the current water budget period was about 12% of the recharge from direct precipitation for the historical base period.

6.4.2.2 Current Groundwater Outflows

Groundwater outflow components include total groundwater pumping from all water use sectors, groundwater discharges to streams and rivers from the Alluvial Aquifer, subsurface flow out of the Subbasin, and riparian evapotranspiration. Total groundwater pumping includes all water use sectors. Estimated annual groundwater outflows for the current water budget period are summarized in Table 6-9.

Table 6-9. Estimated Current (2012-2016) Annual Groundwater Outflow from Subbasin

Groundwater Outflow Component	Average	Minimum	Maximum
Total Groundwater Pumping	85,800	73,900	101,200
Discharge to Streams and Rivers from Alluvial Aquifer	4,300	3,000	6,100
Subsurface Flow Out of Subbasin	2,500	2,300	2,600
Riparian Evapotranspiration	1,700	1,700	1,700
Total [1]	94,300	81,200	109,300

Note: All values in acre-feet (AF)

(1) - The total minimum and maximum outflow rates are not equal to the sum of the minimum and maximum rates for the outflow components, because the water year corresponding to the minimum and maximum outflow rates differs across the different outflow components.

For the current water budget period, estimated total average groundwater outflows ranged from 81,200 AFY to 109,300 AFY, with an average annual outflow of 94,300 AF. Notable observations from a comparison of the historical (Table 6-4) and current groundwater outflows include:

- Total annual average groundwater pumping was about 19% higher during the current water budget period.
- Groundwater discharge from the Alluvial Aquifer to streams was about 40% lower during the current water budget period, reflecting lower precipitation and lower groundwater levels.

The largest groundwater outflow component from the Subbasin in the current water budget period is pumping. Estimated annual groundwater pumping by water use sector for the current water budget period is summarized in Table 6-10.

Table 6-10. Estimated Current (2012-2016) Annual Groundwater Pumping by Water Use Sector

Water Use Sector	Average	Minimum	Maximum
Agricultural	77,000	65,600	92,300
Municipal	3,800	3,200	4,300
Rural-Domestic [1]	3,500	3,400	3,600
Small Commercial	1,500	1,500	1,500
Total [2]	85,800	73,900	101,200

Note: All values in acre-feet (AF)

(1) Assumed to be net amount of pumping based on an analysis conducted by GSSI (2016). Net pumping was computed as total pumping amount minus septic return flow.

(2) The total minimum and maximum pumping rates are not equal to the sum of the minimum and maximum rates for the water use sectors, because the water year corresponding to the minimum and maximum pumping rates differs across the different water use sectors.

For the current water budget period, estimated total average groundwater pumping ranged from 73,900 AFY to 101,200 AFY, with an average pumping of 85,800 AFY. Agricultural pumping was the largest component of total groundwater pumping and accounts for about 90% of total pumping during the current water budget period. Municipal, rural-domestic, and small commercial pumping account for 4%, 4%, and 2%, respectively, of total average pumping during the current water budget period.

Notable observations from a comparison of the historical (Table 6-5) and current total annual average groundwater pumping include:

- Total annual average agricultural groundwater pumping was about 18% higher during the current water budget period when compared to the historical period (increase of 11,700 AFY)
- Total annual average rural-domestic groundwater pumping was about 40% higher during the current water budget period (increase of 1,000 AFY)

6.4.2.3 Current Groundwater Budget and Change in Groundwater Storage

Groundwater inflows and outflows for the current base period are summarized on Figure 6-6. This graph shows inflow and outflow components for every year of the current water budget period. Inflow components are graphed above the zero line and outflow components are graphed below the zero line. Groundwater outflow by pumping (green bars) includes pumping from all water use sectors (Table 6-10).

Figure 6-7 shows annual and cumulative change in groundwater storage during the current water budget period. Annual decreases in groundwater storage are graphed below the zero line. The red line shows the cumulative change in groundwater storage over the historical base period.

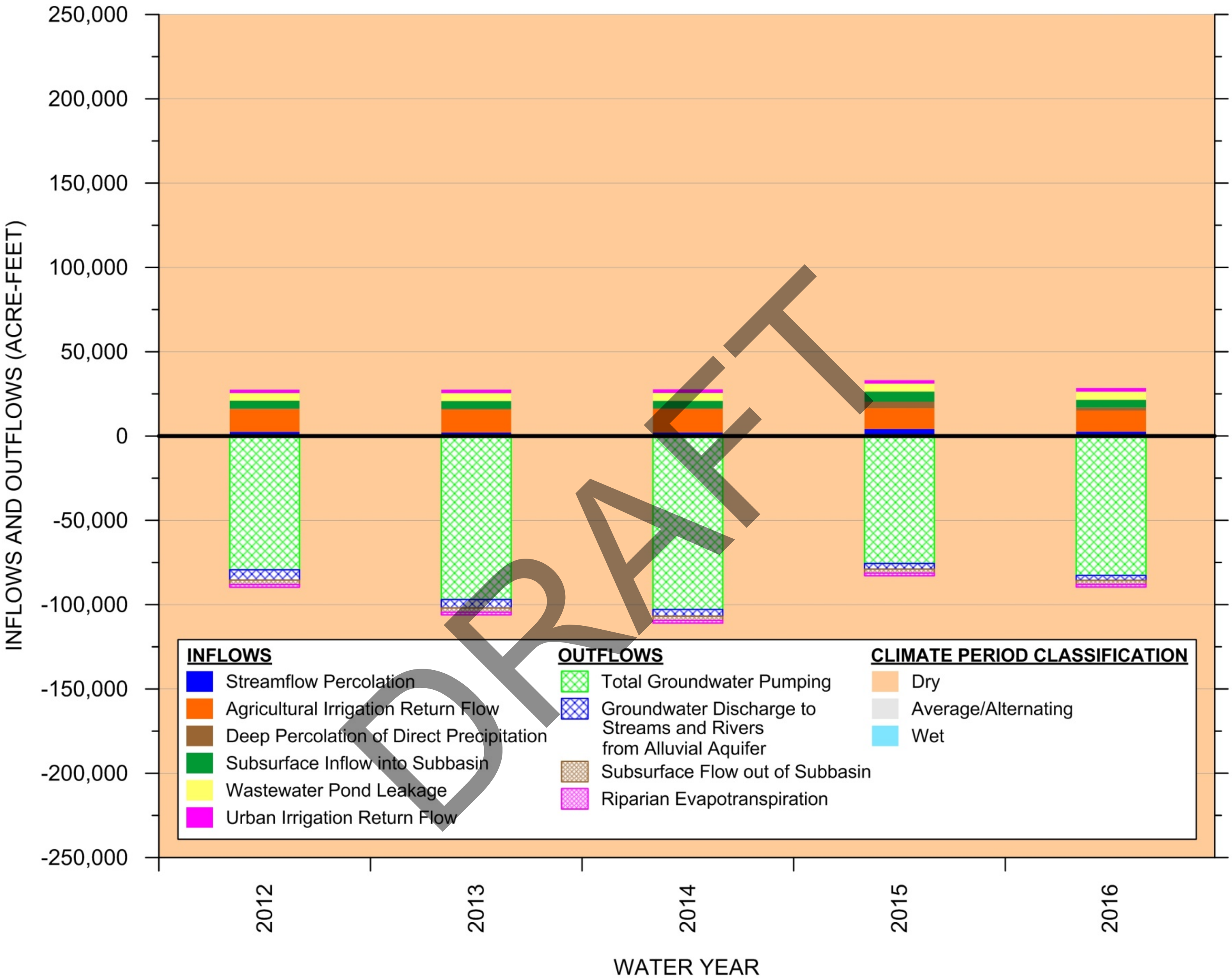

Figure 6-6. Current (2012-2016) Groundwater Inflows and Outflows

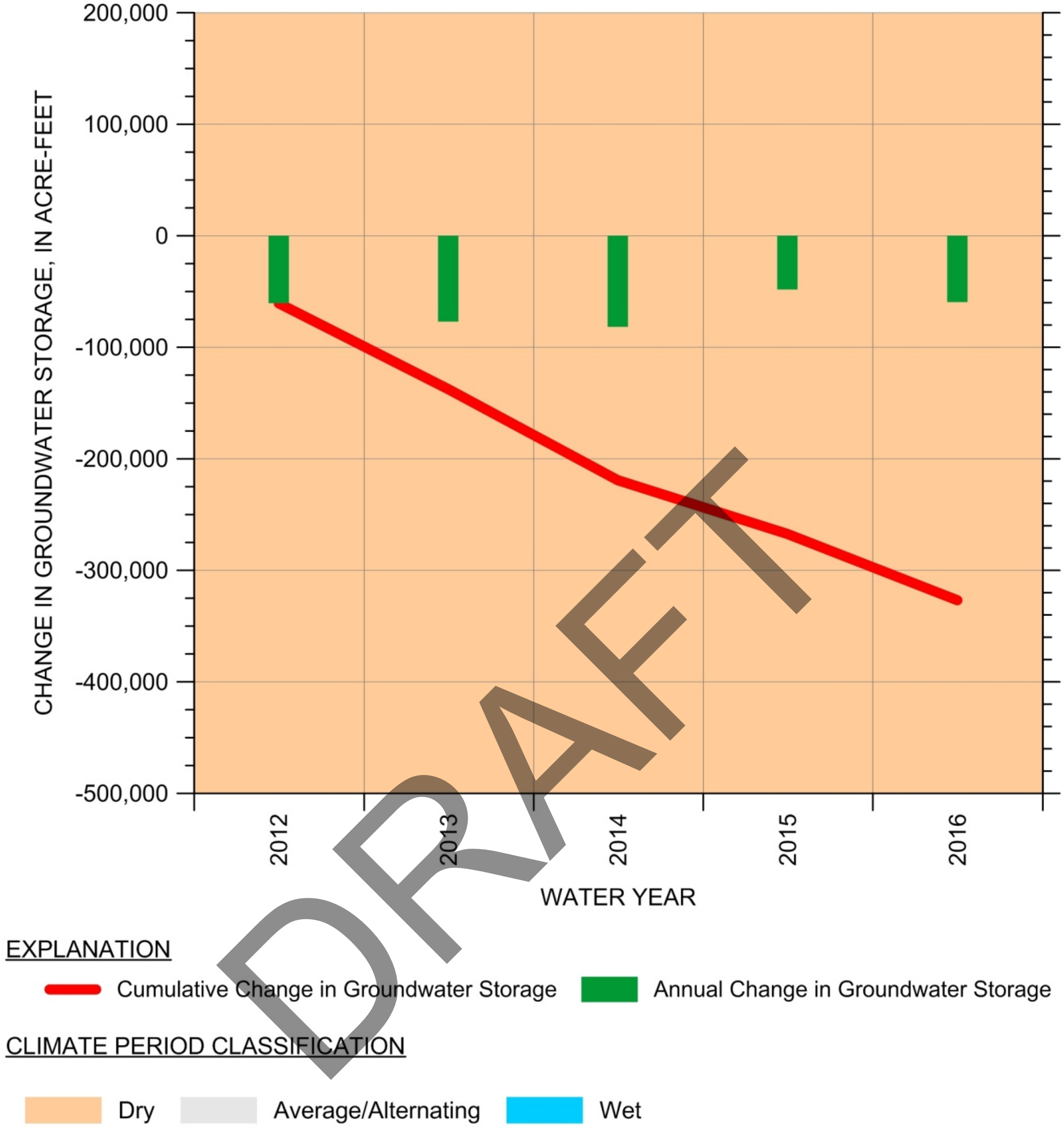

Figure 6-7. Current Annual (2012-2016) and Cumulative Change in Groundwater Storage

The current groundwater budget is strongly influenced by the drought; total groundwater pumping shows no trend over the five years that might be related to any continuing land use change. During the current water budget period, the amounts of recharge and streamflow percolation were very low and the average amount of pumping was slightly greater than the historical water budget period. Over the five-year current water budget period, a net loss of groundwater in storage of about 327,000 AF occurred (Figure 6-7). The annual average groundwater storage loss, or the difference between outflow and inflow to the basin, was approximately 65,400 AF.

6.4.2.4 Current Sustainable Yield

The substantial short-term depletion of groundwater from storage during the current water budget period indicates that total groundwater pumping from all water use sectors exceeded the total amount of recharge in the Subbasin. As summarized in Table 6-9, total groundwater pumping averaged approximately 85,800 AFY during the current period. The sustainable yield of the Subbasin can be estimated by subtracting the average groundwater storage deficit of 65,400 AFY from the total average amount of groundwater pumping. For the current water budget, the sustainable yield for the Subbasin is about 20,400 AFY. Due to the drought conditions, the estimated groundwater storage loss and low sustainable yield for the current water budget period are not appropriate for long-term sustainability planning.

6.5 Future Water Budget

SGMA Regulations require the development of a future surface water and groundwater budget to estimate future baseline conditions of supply, demand, and aquifer response to GSP implementation. The future water budget developed for this plan provides a baseline against which management actions will be evaluated over the GSP implementation period from 2020 to 2040. Future water budgets were developed using the updated basin-wide modeling platform.

In accordance with Section 354.18 (c)(3)(A) of the SGMA Regulations, the future water budget should be based on 50 years of historical precipitation, evapotranspiration, and streamflow information. The GSP model includes only 31 years of historical precipitation, evapotranspiration, and streamflow data. Therefore, the future water budget is based on 31 years of historical data rather than 50 years of historical data. It is believed that this time period is representative and is the best available information and approach for groundwater sustainability planning purposes.

6.5.1 Assumptions Used in Future Water Budget Development

Assumptions about future groundwater supplies and demands are described in the following subsections. An overarching assumption for the GSP is that any future increases in groundwater use within the Subbasin will be offset by equal reductions in groundwater use in other parts of the Subbasin, or in other words, groundwater neutral.

Future water budgets were developed using the GSP model. During the update process for the GSP model, all model components (e.g., groundwater pumping) of the entire original 2016 GSSI model area were updated, including components with Monterey County and the Atascadero Subbasin. However, information provided for the future water budget only pertains to the GSP Subbasin (Figure 1-1), thus do not include areas within Monterey County or the Atascadero Subbasin.

6.5.1.1 Future Non-Agricultural Water Demand Assumptions

Future non-agricultural water demands were estimated for the City of Paso Robles (City) and San Miguel Community Services District (SMCSD) based on the following available planning documents:

- Paso Robles 2015 Urban Water Management Plan (UWMP) (Todd Groundwater, 2016)
- San Miguel Community Services District Water & Wastewater Master Plan Update (Monsoon Consultants, 2017)

Projections of the City's groundwater demand were obtained from the City's UWMP. A portion of the City's future groundwater demand will be offset by imported Nacimiento water. The projected water demand for SMCSD was assumed to be satisfied solely by groundwater. Non-agricultural water demand for entities other than those listed above, such as residential wells and smaller commercial water users, was assumed to remain constant at 2016 rates. This assumption was made to be consistent with the overarching assumption that future growth will be groundwater neutral.

Total non-agricultural groundwater demand in the Subbasin is projected to increase from about 8,500 AFY in 2020 to about 8,700 AFY in 2040.

6.5.1.2 Future Wastewater Discharge Assumptions

Discharge of treated wastewater to the Salinas River provides a source of recharge to the Alluvial Aquifer. Rates of future wastewater discharge were estimated as a percentage of total water demand. Wastewater discharge as a percentage of water demand was calculated separately for each water provider. Projected annual wastewater discharge for San Miguel CSD is about 200 AFY, and projected annual wastewater discharge for the City of Paso Robles increases from about 2,900 AFY in 2020 to about 3,600 AFY by 2040.

6.5.1.3 Future Crop Acreage and Irrigation Efficiency Assumptions

In accordance with Section 354.18 (c)(3)(B) of the SGMA Regulations, the most recently available land use (in this case, crop acreage) and crop coefficient information should be used as the baseline condition for estimating future water demand. In this case, the 2016 crop acreage data obtained from the office of the San Luis Obispo County Agricultural Commissioner were used. These crop acreage data were the most recently available for the GSP. To account for irrigation efficiency in the future water budget, the reported crop coefficient information from GSSI (GSSI, 2016) was used.

In October 2015, the San Luis Obispo County Board of Supervisors adopted Resolution 2015-288, which established the Countywide Water Conservation Program (CWWCP) in response to the declining groundwater levels in County groundwater basins, including the Paso Robles Groundwater Subbasin. A key strategy of the CWWCP was to ensure all new construction and new or expanded agriculture offset its predicted water use by reducing existing water use on other properties within the same groundwater basin. The CWWCP will sunset with the adoption of GSP, however, conservation provisions in the GSP are expected to be similar to the existing program. This expectation supports the approach of using 2016 crop acreage and irrigation efficiencies for the future water budget.

6.5.1.4 Future Climate Assumptions

The SGMA Regulations require incorporating future climate estimates into the future water budget. To facilitate this climate evaluation, DWR developed an approach for incorporating reasonably expected, spatially gridded changes to monthly precipitation and reference evapotranspiration (ETo) into the updated model (DWR, 2018). The changes are presented as separate monthly change factors for both precipitation and ETo, and are intended to be applied to historical time series within the climatological base period through 2011. Specifically, precipitation and ETo change factors were applied to historical climate data for the period 1981 to 2011 for modeling the future water budget.

DWR provides several sets of change factors representing potential climate conditions in 2030 and 2070. DWR recommends using the 2030 change factors to evaluate conditions over the GSP implementation period (DWR, 2018). Consistent with DWR recommendations, datasets of monthly 2030 change factors for the Paso Robles area were applied to precipitation and ETo data from the historical base period to develop monthly time series of precipitation and ETo, which were then used to simulate future hydrology conditions.

6.5.2 Modifications to Modeling Platform to Simulate Future Conditions

The existing modeling platform was modified to simulate future conditions, and the results of these simulations are used to develop the future water budget.

6.5.2.1 Modification to Soil Water Balance Model

The soil water balance model operates on a daily time scale and tracks daily variations in soil water storage for different agricultural areas in the Paso Robles Subbasin. For consistency with the monthly climate change factors provided by DWR, the daily model was used to develop monthly soil water balance calculations. These calculations compute irrigation demand as the residual crop evapotranspiration demand unsatisfied by effective precipitation.

These calculations use monthly precipitation and ETo, rescaled by the monthly climate change factors provided by DWR, and the same monthly crop coefficients used in the historical water budget analysis. Empirical relationships were developed to account for soil moisture carryover from the winter into the spring based on results from the daily soil water balance model.

Monthly applied irrigation water was determined over the future base period from computed monthly crop demand and the crop-specific irrigation efficiencies. Agricultural irrigation return flow is then computed as the difference between the applied irrigation water and the crop demand. Results were then averaged to provide average monthly rates of applied irrigation water and irrigation return flow that would be expected under future climate conditions.

6.5.2.2 Modifications to the Watershed Model

The watershed model operates on a daily time scale and simulates streamflow and infiltration of direct precipitation. The watershed model was modified to account for climate change by rescaling daily precipitation and ETo with the monthly climate change factors provided by DWR. The watershed model was then re-run using the modified precipitation and ETo values.

Results from the modified historical base period simulation were then averaged to provide average monthly rates of infiltration of direct precipitation and streamflow under future climate conditions.

6.5.2.3 Modifications to the Groundwater Model

The groundwater model operates at a semi-annual time scale, with stress periods representing six-month periods. The groundwater model was extended and modified to simulate the period 2020 to 2040. Starting groundwater levels for the future simulation were set to groundwater levels at the end of Water Year (WY) 2016, extracted from the updated groundwater model.

Future groundwater recharge components were computed using the modified soil water balance model and watershed model, as described above. Future streamflow generated both inside and outside the Subbasin was computed using the modified watershed model.

Future agricultural groundwater pumping was computed based on the modified soil water balance model. Future non-agricultural groundwater pumping was determined based on water demand assumptions described in Section 6.4.1.1.

Future groundwater recharge, streamflow, and agricultural pumping are specified in the groundwater model as repeating average time-series, based on average monthly calculation of applied irrigation water, excess irrigation water, recharge of direct precipitation, and streamflow. This approach was adopted to simplify the future water budget and allow reporting of average future conditions accounting for climate change. Future non-agricultural pumping and wastewater return flows are the only inputs to the groundwater model that exhibit a long-term trend over the implementation period.

6.5.3 Projected Future Water Budget

Future surface water and groundwater budgets were projected.

6.5.3.1 Future Surface Water Budget

The future surface water budget includes average inflows from local imported supplies, average inflows from local supplies, average stream outflows, and average stream percolation to groundwater. Average future local imported supplies are estimated to be approximately 1,400 AFY. Table 6-11 summarizes the average local supply components of projected surface water budget.

Table 6-11. Projected Future Annual Average Surface Water Budget

Surface Water Budget Component	Flow Amount
Inflows	
Nacimiento River Inflow to Subbasin	214,300
Precipitation Runoff within Watershed	84,800
Salinas River Inflow to Subbasin	39,300
Groundwater Discharge to Rivers and Streams	4,600
Total	343,000
Outflows	
Nacimiento River Outflow from Subbasin	214,300
Salinas River Outflow from Subbasin	99,900
Percolation of Surface Water to Groundwater	28,800
Total	343,000

Note: All values in AF

6.5.3.2 Future Groundwater Budget

Projected groundwater budget components are computed using the modified groundwater flow model to simulate average conditions over the implementation period.

Table 6-12 summarizes projected annual groundwater inflows. In contrast to the historical groundwater budget which accounted for month-to-month variability, the projected groundwater budget is based on average monthly inflows. Therefore, variability in simulated groundwater budget components is minor, and minimum and maximum values are not included in Table 6-12.

Table 6-12. Projected Future Annual Groundwater Inflow to Subbasin

Groundwater Inflow Component	Average
Streamflow Percolation	28,800
Agricultural Irrigation Return Flow	14,500
Deep Percolation of Direct Precipitation	12,600
Subsurface Inflow into Subbasin	8,300
Wastewater Pond Leakage	3,500
Urban Irrigation Return Flow	1,800
Total	69,500

Note: All values in acre-feet (AF)

The total average annual groundwater inflow is 1,900 AF less during the future period than during the historical base period. Annual agricultural irrigation return flow is the inflow component with the most significant reduction – about 3,300 AF – between the historical base period and future water budget period. Reduction in agricultural irrigation return flow is due partly to changes in historical cropping patterns and partly to improvements in vineyard irrigation efficiency.

Table 6-13 summarizes projected annual groundwater outflows.

Table 6-13. Projected Future Annual Groundwater Outflow from Subbasin

Groundwater Outflow Component	Average
Total Groundwater Pumping	74,800
Discharge to Streams and Rivers from Alluvial Aquifer	4,600
Groundwater Flow Out of Subbasin	2,100
Riparian Evapotranspiration	1,700
Total	83,200

Note: All values in acre-feet (AF)

The total average annual groundwater outflow is estimated to be 800 AF less during the future period than during the historical base period. Future total annual groundwater pumping is projected to increase by about 2,400 AF compared to the historical base period. Concurrently, total annual discharge to streams and rivers and total annual groundwater outflow from the Subbasin are projected to decrease by about 2,700 AF and 500 AF, respectively.

6.5.3.3 Future Sustainable Yield

The projected future groundwater budget shows a long-term imbalance between inflows and outflows, with projected groundwater inflows of about 69,500 AFY and projected groundwater outflows of about 83,200 AFY. The projected future imbalance indicates an average annual decrease in groundwater in storage deficit of 13,700 AFY. The projected future sustainable yield of the Subbasin was estimated by subtracting the average groundwater storage deficit of 13,700 AFY from the total projected future average amount of groundwater pumping of 74,800 AFY. In this case, the future sustainable yield for the Subbasin period is estimated to be approximately 61,100 AFY. The estimated future sustainable yield is similar to the estimated sustainable yield for the historic base period. This similarity indicates that potential future changes in climate are not projected to have a substantial impact on the amount of groundwater that can be sustainably used compared to historical conditions.