

# **FINAL REPORT**

*Los Molinos Subbasin*

**Sustainable Groundwater  
Management Act**

## **Groundwater Sustainability Plan (Chapter 2C - Water Budget)**

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## LIST OF ACRONYMS & ABBREVIATIONS

af	Acre-feet
AN	Above normal Sacramento Valley water year type
AWMP	Agricultural Water Management Plan
BMP	Best Management Practice
BN	Below normal Sacramento Valley water year type
C	Critical (dry) Sacramento Valley water year type
CCR	California Code of Regulations
CVP	Central Valley Project
D	Dry Sacramento Valley water year type
DCID	Deer Creek Irrigation District
DWR	Department of Water Resources
ET	Evapotranspiration
GMP	Groundwater Management Plan
GSP	Groundwater Sustainability Plan
GWS	Groundwater System
LMMWC	Los Molinos Mutual Water Company
SVRIC	Stanford Vina Ranch Irrigation Company
SWS	Surface Water System
taf	Thousand acre-feet
Tehama IHM	Tehama Integrated Hydrologic Model
TNC	The Nature Conservancy
UWMP	Urban Water Management Plan
W	Wet Sacramento Valley water year type
WMP	Water Management Plan

## 2 SUBBASIN PLAN AREA AND BASIN SETTING (REG. § 354.8)

### 2.1 Description of Plan Area

### 2.2 Basin Setting

### 2.3 Water Budget (Reg. § 354.18)

An integral component of the GSP is the quantification of the water budget, which is an accounting of water movement and storage between the different systems of the hydrologic cycle (**Figure 2-66**). The Subbasin water budget includes an accounting of all inflows and outflows to the Subbasin. The difference between the volume of inflow and outflow to the Subbasin is equal to the change in storage as illustrated in **Equation 2-1**.

$$\text{Inflows} - \text{Outflows} = \text{Change in Storage}$$

#### *Equation 2-1. Water Budget Equation*

DWR has published guidance and Best Management Practice (BMP) documents related to the development of GSPs, including Water Budget BMPs (DWR, 2016a). The Water Budget BMPs recommend a water budget accounting structure, or conceptual model, that distinguishes the subbasin surface water system (SWS) and groundwater system (GWS). The SWS represents the land surface down to the bottom of plant root zone<sup>1</sup>, within the lateral boundaries of the Subbasin. The GWS extends from the bottom of the root zone to the definable bottom of the Subbasin, within the lateral boundaries of the Subbasin. The complete Subbasin water budget is a product of the interconnected SWS and GWS water budgets. The lateral and vertical boundaries of the Subbasin are described in **Section 2.2** of the GSP.

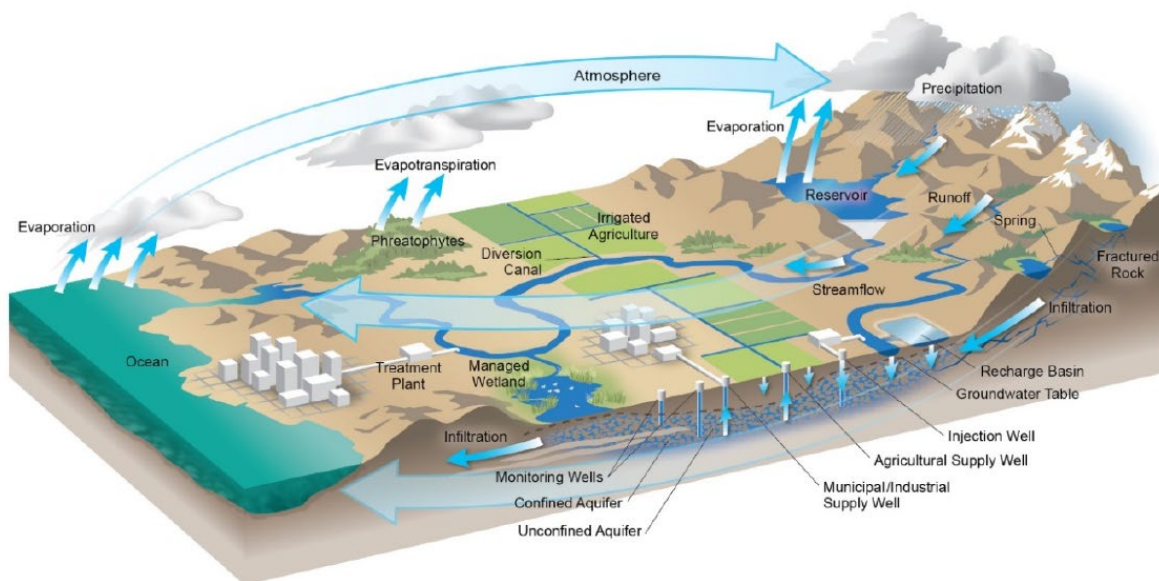
Consistent with these BMPs, this section presents the methodology and results for the historical, current, and projected water budgets of the Los Molinos Subbasin. The water budgets were developed through application of the Tehama Integrated Hydrologic Model (Tehama IHM), a numerical groundwater flow model developed for the Subbasin area that characterizes surface water and groundwater movement and storage across the entire Subbasin, including extending into areas extending outside of the Subbasin. The Tehama IHM is an integrated groundwater and surface water model developed for the purpose of conducting sustainability analyses within Tehama County, including for the Los Molinos Subbasin. The model utilized foundational elements of DWR's SVSim regional model for the Sacramento Valley (DWR, 2021) and was refined locally for improved application in the Subbasin area. Key model refinements made during development of the Tehama IHM include, but are not limited to, extending of the simulation period through water year 2019, refinement of land use conditions based on recent land use mapping information, review and modification to land use crop coefficients based on local remote sensing energy balance data, refinement of surface water supplies and diversions, and enhancements to the sediment textural model used for aquifer parameter. After conducting refinements, the Tehama IHM was calibrated using local groundwater level and streamflow data. The Tehama IHM has a historical simulation period

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<sup>1</sup> The root zone is defined as "the upper portion of the soil where water extraction by plant roots occurs." The depth to the bottom of the root zone varies by crop, but typically ranges from 2-7 feet (ASCE, 2016).

spanning from water year 1985 through 2019, although the calibration period is 1990-2019. Detailed documentation associated with the development of the Tehama IHM is included in **Appendix 2-J**.

This section presents the historical, current, and projected water budget results for the Los Molinos Subbasin. Water budget results for the SWS and GWS are presented individually and as part of a complete water budget for the Subbasin. This section describes the different water budget components and the results of water budget estimates derived from the Tehama IHM. The section includes discussion of the estimated uncertainties associated with the water budget analysis, data sources, and results with additional details related to these topics also described in the model documentation included as **Appendix 2-J**. The water budget results presented in this section are rounded to two significant digits consistent with the typical uncertainty associated with the methods and sources used in the analysis. Water budget component results may not sum to the totals presented because of rounding.



### 2.3.1 Water Budget Conceptual Model

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume<sup>2</sup> over a specified period of time. When the water budget is computed for a subbasin, the water budget facilitates assessment of the total volume of groundwater and surface water entering and leaving the subbasin over time, along with the change in volume of water stored within the subbasin.

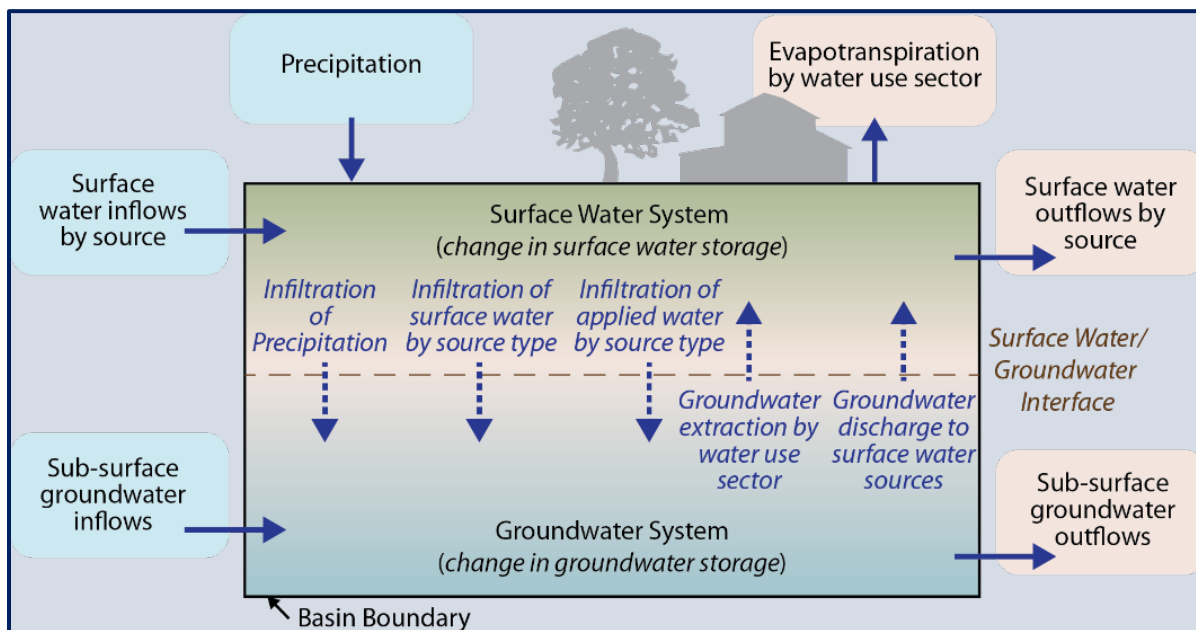
<sup>2</sup> Where 'volume' refers to a space with length, width and depth properties, which for purposes of the GSP means the defined aquifer and associated surface water system.

### 2.3.1.1 Water Budget Structure

For accounting purposes, the Subbasin’s water budget is divided into the surface water system (SWS) and groundwater system (GWS), described above. These systems are referred to as *accounting centers*. Flows between accounting centers and storage within each accounting center are water budget *components*. A schematic of the general water budget accounting structure is provided in **Figure 2-67**.

The conceptual model (or structure) for the Subbasin water budget is presented in **Figure 2-68**, including presentation of terms used in the following section to describe individual aspects of the water budget. The required components for each accounting center are listed in **Table 2-10**, along with the corresponding section of the GSP Regulations (California Code of Regulations Title 23<sup>3</sup> (23 CCR) §354). Separate but related water budgets were prepared for each accounting center that together represent the overall water budget for the Subbasin.

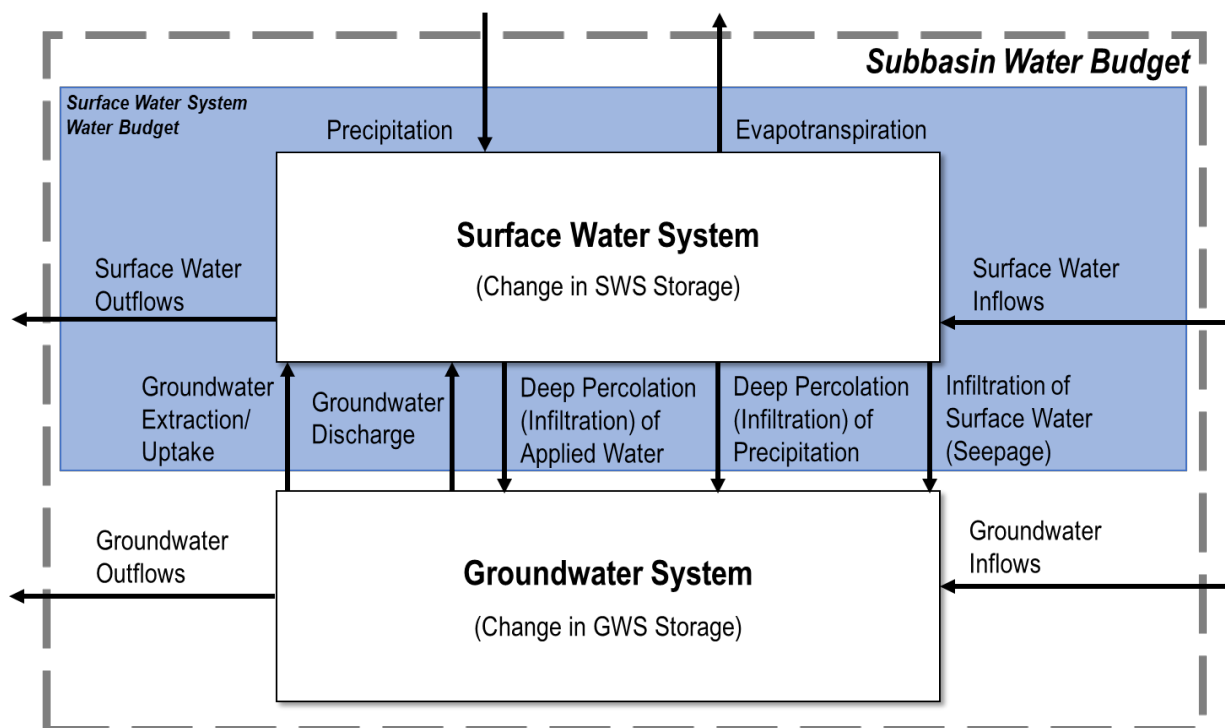
This section discusses the inflows and outflows from each of the SWS and GWS parts of the Subbasin. The water budgets are calculated using the Tehama IHM, which integrates flows between the SWS and GWS. The GWS water budget incorporates all inflows and outflows from the SWS into an accounting of the net effect of the hydrology and water use on groundwater storage in the Subbasin.



**Figure 2-67. Water Budget Accounting Structure (Source: DWR, 2016a)**

<sup>3</sup> California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2 Groundwater Sustainability Plans, Article 5 Plan Contents





Net Recharge from the SWS =  
(Deep Percolation of Applied Water + Deep Percolation of Precipitation +  
Infiltration of Surface Water) – Groundwater Extraction/Uptake

**Figure 2-68. Subbasin Water Budget Conceptual Model**

**Table 2-10. Water Budget Components by Accounting Center and Associated GSP Regulations**

ACCOUNTING CENTER	WATER BUDGET COMPONENT (FLOW DIRECTION)	GSP REGULATION SECTION1
<b>Basin</b>	Surface Water Inflow <sup>2</sup> (+)	§354.18(b)(1)
	Precipitation (+)	Implied
	Subsurface Groundwater Inflow (+)	§354.18(b)(2)
	Evapotranspiration <sup>3</sup> (-)	§354.18(b)(3)
	Surface Water Outflow <sup>2</sup> (-)	§354.18(b)(1)
	Subsurface Groundwater Outflow (-)	§354.18(b)(3)
	Change in Storage	§354.18(b)(4)
<b>Surface Water System</b>	Surface Water Inflow <sup>2</sup> (+)	§354.18(b)(1)
	Precipitation (+)	Implied
	Groundwater Extraction (+)	§354.18(b)(3)
	Groundwater Discharge (+)	§354.18(b)(3)
	Evapotranspiration <sup>3</sup> (-)	§354.18(b)(3)
	Surface Water Outflow <sup>2</sup> (-)	§354.18(b)(1)
	Infiltration of Applied Water <sup>4,5</sup> (-)	§354.18(b)(2)
	Infiltration of Precipitation <sup>4</sup> (-)	§354.18(b)(2)
	Infiltration of Surface Water <sup>6</sup> (-)	§354.18(b)(2)
	Change in SWS Storage <sup>7</sup>	§354.18(a)
<b>Groundwater System</b>	Subsurface Groundwater Inflow (+)	§354.18(b)(2)
	Infiltration of Applied Water <sup>4,5</sup> (+)	§354.18(b)(2)
	Infiltration of Precipitation <sup>4</sup> (+)	§354.18(b)(2)
	Infiltration of Surface Water <sup>6</sup> (+)	§354.18(b)(2)
	Subsurface Groundwater Outflow (-)	§354.18(b)(3)
	Groundwater Extraction (-)	§354.18(b)(3)
	Groundwater Discharge (-)	§354.18(b)(3)
	Change in GWS Storage	§354.18(b)(4)

1. California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2 Groundwater Sustainability Plans, Article 5 Plan Contents
2. By water source type.
3. Evapotranspiration includes total evapotranspiration and evaporation, by water use sector. Total evapotranspiration includes the combined evaporation from the soil and transpiration from plants, resulting from both applied water and precipitation. In this context, evaporation is the direct evaporation from open water surfaces.
4. Synonymous with deep percolation.
5. Includes infiltration of applied surface water, groundwater, and reused water
6. Synonymous with seepage. Includes infiltration of lakes, streams, canals, drains, and springs.
7. Change in storage of root zone soil moisture, not groundwater.

## 2.3.2 Water Budget Analysis Periods

Per 23 CCR §354.18, each GSP must quantify the historical, current, and projected water budget conditions for the Subbasin.

### 2.3.2.1 Historical and Current Water Budget Periods

The historical water budget for the Subbasin must quantify all required water budget components starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the water budget (23 CCR § 354.18(c)(2)(B)). The historical water budget period effectively represents long-term average historical hydrologic conditions. The current water budget must include the most recent hydrology, water supply, water demand, and land use information (23 CCR § 354.18(c)(1)). The historical water budget enables evaluation of the effects of historical hydrologic conditions and water demands on the water budget and groundwater conditions within the Subbasin over a period representative of long-term hydrologic conditions. The current water budget presents information on the effects of recent hydrologic and water demand conditions on the groundwater system.

The historical and current water budget periods were selected to evaluate conditions over discrete representative periods considering the following criteria: Sacramento Valley water year type; long-term mean annual water supply; inclusion of both wet and dry periods, antecedent dry conditions, adequate data availability; and inclusion of current hydrologic, cultural, and water management conditions in the Subbasin. Water years, as opposed to calendar years, are used as the time unit for defining analysis, following the DWR standard water year period (October 1 through September 30). Unless otherwise noted, all years referenced in this section are water years.

Based on these criteria, the following periods were identified for presentation of historical and current water budgets:

- **Historical Water Budget Period:** Water years 1990-2018 (29 years) using historical hydrologic, climate, water supply, and land use data.
- **Current Water Budget Periods:** Consideration of five different recent water year periods (listed below) using the historical hydrologic, climate, water supply, and land use data over each period.
  - Recent 10 years (2009-2018)
  - Recent 5 years (2014-2018)
  - Recent 3 years (2016-2018)
  - Recent 1 year (2018)
  - Recent 1 year (2019)

For the historical water budget, the period from 1990-2018 was selected to represent long-term average hydrologic conditions following evaluation of precipitation records and DWR Sacramento Valley water year type classification (**Table 2-11**). Further information and discussion of the historical water budget period, including discussion of historical hydrology and the base period selection process, are presented in **Section 2.2** of this GSP. Discussion of the historical water budget water results is included in **Section 2.3.5**

**Table 2-11. Sacramento Valley Water Year Type Classification during the Historical Water Budget Period (1990-2018)**

SACRAMENTO VALLEY WATER YEAR TYPE	ABBREVIATION	NUMBER OF YEARS, 1990-2018	PERCENT TOTAL YEARS, 1990-2018
Wet	W	8	28%
Above Normal	AN	4	14%
Below Normal	BN	5	17%
Dry	D	5	17%
Critical	C	7	24%
Total		29	100%

For consideration in estimating the current water budget, the results for several recent periods were presented, including recent 1-year, 3-year, 5-year, and 10-year periods. These various periods result in widely varied inflows and outflows, much of which is attributed to varied precipitation and water supplies in individual years (see results in **Section 2.3.6**). Although the model simulations were run for the period 1990-2072, results for 2019 are only shown in the current water budget comparison table for the purpose of considering variability in water budget over different recent time periods. The water budget for year 2019 is not explicitly included in the historical, current, or projected water budgets for the Subbasin although it was simulated in the model to span the years between historical (1990-2018) and projected (2022-2072) water budget periods. Details of model inputs are presented in **Appendix 2-J**. Because of the year-to-year variability in water budget results, the current water budget summarizes results from the various recent periods considered to provide an appropriate and reasonable representation of the current water budget based on recent conditions.

#### 2.3.2.2 Projected 50-Year Hydrology and Water Budget Period (§354.18c3)

The projected water budget is intended to evaluate the effects of anticipated future conditions of hydrology, water supply availability, and water demand over a 50-year GSP planning period on the Subbasin water budget and groundwater conditions. The projected water budget incorporates consideration of potential climate change and water supply availability scenarios and evaluation of the need for and benefit of any projects and management actions to be implemented in the Subbasin to maintain or achieve sustainability. The 50-year projected water budget uses hydrologic conditions representative of the most recent 50 years of hydrology in the Subbasin, with adjustments applied in scenarios for evaluating the water budget under climate change and/or altered water supply and demand conditions.

To evaluate projected water budgets, fifty years of future hydrology inputs to the Tehama IHM were developed through consideration of the historical hydrology from 1968 to 2018. Because of the availability of higher quality data and characterization of conditions in the Subbasin during more recent years spanning the historical base period (1990-2018), the projected water budget analyses used surrogate years from the historical period to construct a future hydrology and water budget period representative and consistent with hydrologic conditions over a historical 50-years period from 1968 to 2018. Surrogate

years from the historical period were assigned to represent 50 years of future hydrology based on 1) the Sacramento Valley water year index from DWR for each year, 2) mimicking variability (wet and dry) in the historical precipitation conditions in the Subbasin and replicating precipitation consistent with the annual average historical precipitation, and (3) replicating regional streamflow conditions based on flows in the Sacramento River. The frequency of water year types used in the projected hydrology is representative of the 50 years of hydrology for the period 1969-2019 and includes approximately equal proportions of water years with above normal (wet and above normal; 48%) and below normal (below normal, dry, critical; 52%) hydrologic conditions (**Table 2-12**).

The approach and inputs used in development of the projected water budget are described in greater detail in the Tehama IHM documentation included as **Appendix 2-J**.

**Table 2-12. Sacramento Valley Water Year Type Classification Over the Projected Water Budget Period (2022-2072)**

SACRAMENTO VALLEY WATER YEAR TYPE	ABBREVIATION	NUMBER OF YEARS, 2022-2072	PERCENT TOTAL YEARS, 2022-2072
Wet	W	18	35%
Above Normal	AN	7	14%
Below Normal	BN	7	14%
Dry	D	9	18%
Critical	C	10	20%
Total		51	100%

### 2.3.3 Surface Water System (SWS) Water Budget Description

Water budgets for the SWS were developed to characterize historical and current conditions in the Subbasin relating to the individual inflows and outflows and overall SWS water budget. The general approach used in the SWS water budget calculations is described in **Section 2.3.4.1**. **Section 2.3.6** presents the results of the historical SWS water budgets within the boundary of the Subbasin and **Section 2.3.7** presents results for current SWS water budget analyses. The analyses and results relating to the projected water budget are presented in **Sections 2.3.7** through **2.3.10**. Additional detailed discussion of the procedures and results of the SWS water budgets is included in documentation of the Tehama IHM development and results presented in **Appendix 2-D**.

#### 2.3.3.1 General SWS Water Budget Components and Calculations

SWS inflows and outflows were quantified on a monthly basis, including accounting for any changes in SWS storage, such as changes in water stored in the root zone (**Equation 2-2**).

$$\text{Total SWS Inflows} - \text{Total SWS Outflows} = \text{Change in SWS Storage (monthly)}$$

*Equation 2-2. Equation for Los Molinos Subbasin SWS Water Budget Analysis*

As shown in **Figure 2-67** and **Table 2-10**, inflows to the SWS include surface water inflows (in various rivers, streams, and canals), precipitation, groundwater extraction (pumping and groundwater uptake), and groundwater discharge to surface water sources (from areas of high groundwater levels). Outflows include evapotranspiration (ET), surface water outflows (in various rivers, streams, and canals), infiltration of applied water (deep percolation from irrigation), infiltration of precipitation (deep percolation from precipitation), and infiltration of surface water (seepage).

The ET outflow component includes the following: ET of applied water (ET from soil and crop surfaces, of water that is derived from applied surface water, groundwater, and reused water); ET of precipitation (ET from soil and crop surfaces, of water that is derived from precipitation); and evaporation from rivers, streams, canals, reservoirs, and other water bodies. ‘ET of applied water’ differs from ‘applied water’ in that applied water is the volume of water that is directly applied to the land surface by irrigators (from all water sources), whereas ET of applied water is the volume of that applied water that is consumptively used by crops, vegetation, and soil surfaces.

Change in SWS storage is also depicted in **Figure 2-68** and **Table 2-10**. This represents the change in root zone soil moisture throughout the year. This is not the same as change in groundwater storage. Net recharge from the SWS is defined as the total groundwater recharge (total infiltration from all sources) minus groundwater outflows to the surface water system, including both groundwater extraction and groundwater uptake by crops and vegetation.<sup>4</sup> Groundwater discharge to the SWS is not included in the net recharge term but is summarized separately as an exchange between the SWS and GWS. Net recharge from the SWS is a useful metric that equates only the impacts of the SWS on recharge and extraction from the GWS, providing valuable insight to the combined effects of land surface processes on the underlying GWS. More information about the net exchanges of surface water and groundwater in the Subbasin is provided in **Appendix 2-K**.

### 2.3.3.2 Detailed SWS Water Budget Accounting Centers and Components

To estimate the water budget components required by the GSP Regulations (**Table 2-10**), the SWS water budget accounting center is subdivided into detailed accounting centers representing the Land Surface System, the Canal System, and the Rivers, Streams, and Small Watersheds System (waterways conveying natural flow and surface water supplies into the Subbasin).

The Land Surface System represents inflows and outflows from irrigated and non-irrigated land. The Canals System represents flows through the canals and conveyance systems of diverters with access to surface water. The Rivers, Streams, and Small Watershed Systems represent inflows and outflows through waterways that convey natural flow, upgradient runoff, and drainage.

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<sup>4</sup> Groundwater discharge to surface water is not included in the calculation of net recharge from the SWS, as groundwater discharge is more dependent on shallow groundwater and soil characteristics along waterways and is much less dependent on the management of the surface layer. Net recharge from the SWS is intended to describe the impacts of the SWS on the GWS, but groundwater discharge is more reflective of the GWS effects on the SWS.

The Land Surface System is further subdivided into water use sectors, defined in the GSP Regulations as “categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation” (23 CCR Section 351(al)). Principal water use sectors in the Subbasin include Agricultural (irrigated crop land and idle agricultural land), Native Vegetation (native and riparian vegetation), and Urban (urban, residential, industrial, and semi-agricultural<sup>5</sup>).

#### 2.3.3.2.1 SWS Inflows

##### 2.3.3.2.1.1 Surface Water Inflow by Water Source Type

Per the GSP Regulations, surface inflows must be reported by water source type. According to the Regulations (23 CCR § 351(ak)):

*“Water source type” represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.*

Major surface water inflows to the Los Molinos Subbasin are summarized below according to water source type. Additionally, runoff of precipitation from upgradient areas adjacent to the Subbasin represents a potential source of SWS inflow.

##### Local Supplies

Local supply inflows to the Los Molinos Subbasin predominantly include runoff from upgradient small watersheds adjacent to the Subbasin and surface inflows along Sacramento River, Antelope Creek, little Antelope Creek, Dye Creek, Mill Creek and Deer Creek. A portion of these local supplies are diverted by local water rights users for beneficial use within the Subbasin.

##### Central Valley Project

There are no significant Central Valley Project (CVP) inflows to the Los Molinos Subbasin.

##### 2.3.3.2.1.2 Precipitation

Precipitation falling on the landscape within the Subbasin is an inflow to the SWS. Precipitation inflows are accounted for by the land use (water use sector) on which they occur.

##### 2.3.3.2.1.3 Groundwater Extraction and Uptake

Groundwater extraction is an inflow to the SWS (an outflow from the GWS). Groundwater extraction is accounted for by agricultural and urban (urban, residential, semi-agricultural, industrial) water use

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<sup>5</sup> As defined in the DWR crop mapping metadata, semi-agricultural land includes farmsteads and miscellaneous land use incidental to agriculture (small roads, ditches, etc.) (DWR, 2016b).

sectors. Urban groundwater pumping includes domestic well pumping. Groundwater uptake is water taken up by plant roots directly from the GWS.

#### *2.3.3.2.1.4 Groundwater Discharge to Surface Water*

Groundwater discharging to surface water features can occur where groundwater is very shallow and where groundwater levels are higher than the stage in surface water bodies. Groundwater discharge to surface water represents an inflow to the SWS (an outflow from the GWS).

### *2.3.3.2.2 SWS Outflows*

#### *2.3.3.2.2.1 Evapotranspiration*

Evapotranspiration (ET) is accounted for by water use sector (urban, agriculture, native) and according to the source water (applied water or precipitation). ET from land includes from applied water and precipitation sources. Evaporation also occurs from rivers, streams, canals, and drains throughout the Subbasin.

#### *2.3.3.2.2.2 Infiltration*

Infiltration (deep percolation) is water that infiltrates below the root zone and recharges the GWS. Infiltration can occur from applied water (e.g., irrigation) or precipitation occurring on the landscape within the Subbasin. Alternatively, infiltration of surface water (stream seepage) can occur from surface water that seeps through the bottom of surface water features and recharges the GWS.

#### *2.3.3.2.2.3 Surface Water Outflow*

In the Los Molinos Subbasin, surface water outflows consist entirely of local supplies that traverse the Subbasin, or that drain from lands within the Subbasin or runoff into the Subbasin from upland areas outside the Subbasin. As described above, substantial local supply volumes enter the Los Molinos Subbasin along Sacramento River and tributary waterways, although much of this water passes through the Subbasin.

### *2.3.3.3 SWS Water Budget Overview*

Water budget components are defined for each detailed accounting center in **Table 2-13 through Table 2-16**. Within the Land Surface System accounting center, water budget components are also defined for each water use sector. These detailed water budget accounting centers and components are quantified based on the best available data and science, including information from water management plans (WMPs), groundwater management plans (GMPs), agricultural water management plans (AWMPs), urban water management plans (UWMPs), and other sources.

Each detailed accounting center was computed for the Subbasin. The Subbasin boundary SWS water budget components are identified in **Table 2-16**. The water budget includes the crop demands, available water supplies, and other characteristics specific to the Subbasin, including diversions, evaporation, and infiltration of surface water within the Subbasin.



**Table 2-13. Land Surface System Water Budget Components**

DETAILED ACCOUNTING CENTER	DETAILED COMPONENT	FLOW DIRECTION	DESCRIPTION
Land Surface System  <i>Water Use Sectors: Agricultural, Native Vegetation, Urban</i>	Deliveries	Inflow	Deliveries of surface water supply for use within the Subbasin.
	Groundwater Extraction	Inflow	Groundwater pumping to meet water demands, and groundwater uptake by crops and vegetation.
	Precipitation	Inflow	Direct precipitation on the land surface.
	Reuse	Inflow	Reuse of percolated water from the unsaturated zone <sup>1</sup> .
	ET of Applied Water	Outflow	Consumptive use of applied irrigation water.
	ET of Groundwater Uptake	Outflow	Consumptive use of shallow groundwater uptake.
	ET of Precipitation	Outflow	Consumptive use of infiltrated precipitation.
	Net Return Flow	Outflow	Net runoff of applied irrigation water, accounting for reuse <sup>2</sup> .
	Runoff of Precipitation	Outflow	Direct runoff of precipitation.
	Infiltration of Applied Water	Outflow	Deep percolation of applied water below the root zone.
	Infiltration of Precipitation	Outflow	Deep percolation of precipitation below the root zone.
	Change in SWS Storage	Storage	Change in root zone soil moisture throughout the year; does not represent change in groundwater storage.

<sup>1</sup> “The unsaturated zone is below the land surface system and represents the portion of the basin that receives percolated water from the root zone and either transmits it as deep percolation to the GWS or to reuse within the land surface system, or both.” (DWR, 2016a).

<sup>2</sup> Includes tailwater and pond drainage for ponded crops.

**Table 2-14. Canal System Water Budget Components**

DETAILED ACCOUNTING CENTER	DETAILED COMPONENT	FLOW DIRECTION	DESCRIPTION
Canal System	Diversions	Inflow	Diversions of surface water supply from waterways, a portion of which is delivered and used within the Subbasin.
	Deliveries	Outflow	Deliveries of surface water supply for use within the Subbasin.
	Infiltration of Surface Water (Seepage)	Outflow	Seepage from canals to the GWS.
	Evaporation	Outflow	Direct evaporation from canal water surfaces.
	Spillage	Outflow	Spillage from canals used for conveyance.

**Table 2-15. Rivers, Streams, and Small Watersheds System Water Budget Components**

DETAILED ACCOUNTING CENTER	DETAILED COMPONENT	FLOW DIRECTION	DESCRIPTION
Rivers, Streams, and Small Watersheds System	Stream Inflows	Inflow	Surface water inflows at the upstream boundary of waterways that traverse the Subbasin; includes natural flow and spillage, drainage, and runoff from canals and land surfaces upgradient of the Subbasin.
	Small Watershed Inflows	Inflow	Surface water inflows of drainage from upgradient small watersheds.
	Groundwater Discharge	Inflow	Discharge from shallow groundwater into rivers and streams.
	Spillage	Inflow	Spillage from canals used for conveyance.
	Stream Outflows	Outflow	Surface water outflows at the downstream boundary of waterways that traverse the Subbasin; includes natural flow and spillage, drainage, and runoff from canals and land surfaces.
	Small Watershed Outflows	Outflow	Surface water outflows of drainage from upgradient small watersheds at the downgradient boundary of the Subbasin.
	Diversions	Outflow	Diversions of surface water supply from waterways, a portion of which is delivered and used within the Subbasin.
	Infiltration of Surface Water (Seepage)	Outflow	Seepage from rivers, streams, and small watershed inflows to the GWS.
	Evaporation	Outflow	Direct evaporation from river and stream water surfaces.

**Table 2-16. Subbasin Boundary Surface Water System Water Budget Components**

DETAILED ACCOUNTING CENTER	DETAILED COMPONENT	FLOW DIRECTION	DESCRIPTION
Rivers, Streams, and Small Watersheds System	Stream Inflows	Inflow	Surface water inflows at the upstream boundary of waterways that traverse the Subbasin; includes natural flow and spillage, drainage, and runoff from canals and land surfaces upgradient of the Subbasin.
	Small Watershed Inflows	Inflow	Surface water inflows of drainage from upgradient small watersheds.
	Groundwater Discharge	Inflow	Discharge from shallow groundwater into rivers and streams.
Canal System	Diversions ( <i>in select cases</i> )	Inflow	Diversions of surface water supply from waterways <i>at a point outside or along the boundary of the Subbasin</i> , a portion of which is delivered and used within the Subbasin
Land Surface System <i>Water Use Sectors: Agricultural, Native Vegetation, Urban</i>	Groundwater Extraction	Inflow	Groundwater pumping to meet water demands, and groundwater uptake by crops and vegetation.
	Precipitation	Inflow	Direct precipitation on the land surface.
	ET of Applied Water	Outflow	Consumptive use of applied irrigation water.
	ET of Groundwater Uptake	Outflow	Consumptive use of shallow groundwater uptake.
	ET of Precipitation	Outflow	Consumptive use of infiltrated precipitation.
	Runoff of Applied Water	Outflow	Direct runoff of applied irrigation water <sup>2</sup> .
	Runoff of Precipitation	Outflow	Direct runoff of precipitation.
	Infiltration of Applied Water	Outflow	Deep percolation of applied water below the root zone.
	Infiltration of Precipitation	Outflow	Deep percolation of precipitation below the root zone.
	Change in SWS Storage	Storage	Change in root zone soil moisture throughout the year; (not change in groundwater storage)
Canal System; and Rivers, Streams, and Small Watersheds System	Infiltration of Surface Water (Seepage)	Outflow	Seepage from canals, streams, and small watershed inflows to the GWS.
	Evaporation	Outflow	Direct evaporation from canals, rivers, and streams.
Canal System	Spillage	Outflow	Spillage from canals used for interior conveyance.
Rivers, Streams, and Small Watersheds System	Stream Outflows	Outflow	Surface water outflows at the downstream boundary of waterways that traverse the Subbasin; includes natural flow and spillage, drainage, and runoff from canals and land surfaces.
	Small Watershed Outflows	Outflow	Surface water outflows of drainage from upgradient small watersheds at the downgradient boundary of the Subbasin.

## 2.3.4 Groundwater System Water Budget Description

Water budgets for the GWS were developed to characterize historical and current conditions in the Subbasin utilizing the Tehama IHM for different historical and current time periods described above. **Sections 2.3.6** and **2.3.7** present the results of the historical and current GWS water budgets within the lateral and vertical boundaries of the Subbasin. Discussion of the general approach used in developing model scenarios to evaluate projected GWS water budgets for the Subbasin with the Tehama IHM and the results from these projected water budget analyses is included in **Sections 2.3.8** through **2.3.8**. More detail related to the procedures and results of the GWS water budgets are also included in documentation of the Tehama IHM development presented in **Appendices 2-J and 2-K**.

### 2.3.4.1 GWS Water Budget Components and Calculations

Inflows and outflows of the GWS were quantified on a monthly basis, including accounting for any changes in GWS storage (**Equation 2-3**).

$$\text{Total GWS Inflows} - \text{Total GWS Outflows} = \text{Change in GWS Storage (monthly)}$$

#### *Equation 2-3. Equation for Los Molinos Subbasin GWS Water Budget Analysis*

As shown in **Figure 2-67** and **Table 2-10**, inflows to the GWS include some of the outflow components from the SWS including infiltration (deep percolation) of precipitation and applied water and infiltration (seepage) of surface water. Additional GWS inflows include lateral subsurface groundwater inflows from adjacent subbasins and from adjacent upland or foothill areas outside the Subbasin (small watersheds). GWS outflows include exchanges with the SWS including groundwater discharge to surface waterways, groundwater extraction through pumping, and root water uptake by plants occurring directly from shallow groundwater. Lateral subsurface groundwater flows to adjacent subbasins represent additional GWS outflows. Water budget components representing exchanges between the GWS and the SWS are also included in discussions and presentations of the SWS conceptual water budget and results.

#### 2.3.4.1.1 Lateral Subsurface Flows

Subsurface groundwater flows to and from the Los Molinos Subbasin occur between the Antelope, Red Bluff, Corning Subbasins to the west and the Vina Subbasin to the south. Additional subsurface groundwater inflows occur from the upland (small watershed) areas adjoining the Los Molinos Subbasin.

#### 2.3.4.1.2 Deep Percolation From the SWS

Deep percolation from the SWS includes infiltration of water below the root zone (deep percolation) from precipitation and applied water. These two water budget components represent inflows to the GWS and are also included in the SWS water budget as outflows from the SWS.

#### 2.3.4.1.3 Net Stream Seepage/Groundwater Discharge to Surface Water

The flow of water between the GWS and SWS through seepage of water from streams and canals and groundwater discharging into streams is discussed as part of the SWS water budget. These components are combined in the GWS water budget as a net volume of stream seepage. Positive total net seepage values represent a net inflow of water from the SWS to the GWS via stream and canal seepage indicating that the overall volume of stream seepage is greater than the volume of any groundwater discharging into surface waterways. Negative net seepage values represent a net outflow of groundwater from the GWS to the SWS through groundwater discharge to surface water. When net seepage is negative, it means that more groundwater is discharging into the surface waterways than is seeping from surface waterways into the GWS.

#### 2.3.4.1.4 Groundwater Extraction and Uptake

Groundwater extractions and groundwater uptake are exchanges that occur between the GWS and the SWS and represent an outflow from the GWS. Groundwater extraction from the GWS occurs through groundwater pumping to meet water demands for urban and agricultural needs whereas groundwater uptake occurs through uptake of water by plants directly from the GWS.

#### 2.3.4.2 GWS Water Budget Overview

Change in GWS storage as represented by change in groundwater storage is also depicted in **Figure 2-68** and **Table 2-10**. The change in groundwater storage represents the total change in the volume of water in storage in the groundwater system as a result of exchanges between the GWS and the SWS and the balance of all inflows and outflows of the GWS. The change in groundwater storage is directly related to changes in water levels in the groundwater system, both of which are sustainability indicators to be considered during development of a sustainable yield for the Subbasin. Each of the detailed components of the Subbasin boundary GWS water budget are identified in **Table 2-17** and were computed for the Subbasin to develop a complete GWS water budget. The HCM discussed in **Section 2.2** identifies two principal aquifers within the GWS: an Upper Aquifer and Lower Aquifer. Vertical groundwater flow does occur between these aquifers and change in storage of the entire GWS and also within each principal aquifer zone are considerations for sustainable groundwater management.

**Table 2-17. Subbasin Boundary Groundwater System Water Budget Components**

ACCOUNTING CENTER	DETAILED COMPONENT	FLOW DIRECTION	DESCRIPTION
Groundwater System	Lateral Subsurface Groundwater Flows Between Adjacent Subbasins	Inflow	Lateral subsurface groundwater inflow from adjacent subbasins.
	Lateral Subsurface Groundwater Flows Between Adjacent Upland or Foothill Areas	Inflow	Lateral subsurface groundwater inflow from adjacent upland or foothill areas.
	Infiltration of Surface Water (Seepage)	Inflow	Seepage from canal, streams, and small watershed inflows from the SWS.
	Infiltration (Deep Percolation) of Applied Water	Inflow	Deep percolation of applied water below the root zone from the SWS.
	Infiltration (Deep Percolation) of Precipitation	Inflow	Deep percolation of precipitation below the root zone from the SWS.
	Lateral Subsurface Groundwater Flows Between Adjacent Subbasins	Outflow	Lateral subsurface groundwater outflow to adjacent subbasins.
	Groundwater Extraction	Outflow	Groundwater pumping to meet water demands, and groundwater uptake by crops and vegetation.
	Groundwater Discharge	Outflow	Discharge from shallow groundwater into rivers and streams.
	Vertical Subsurface Groundwater Flows within the GWS	Storage	Vertical subsurface groundwater flows between the Upper and Lower Aquifers within the GWS
	Change in GWS Storage	Storage	Change in volume of water stored within the groundwater system, representative of total accrual or depletion of groundwater storage.

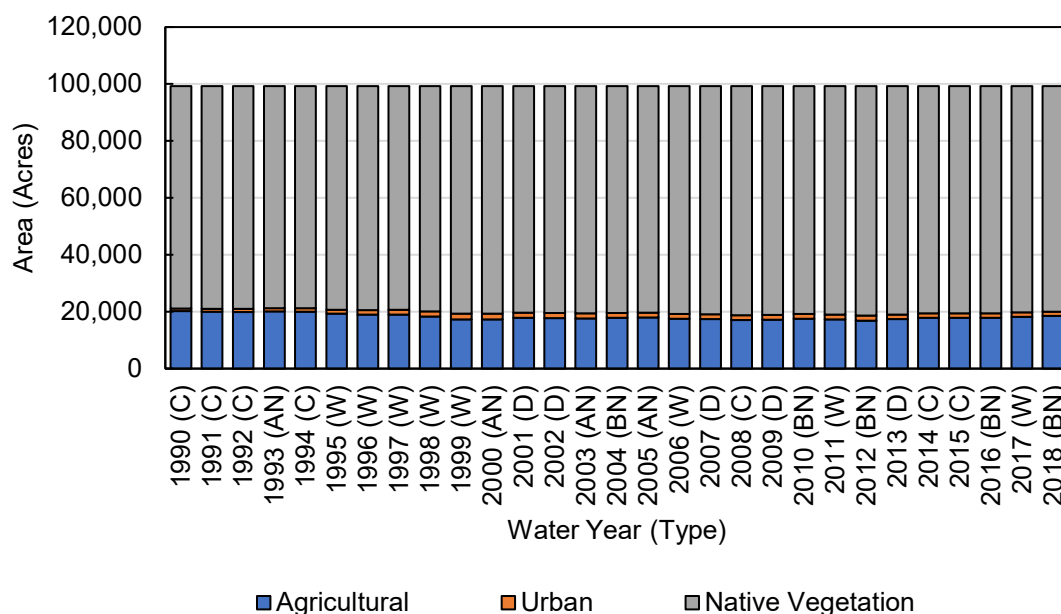
### 2.3.5 Historical Water Budget

The following section summarizes the analyses and results relating to the historical SWS water budget for the Subbasin. Detailed descriptions and presentation of results for each of the individual water budget components, and the processes and data sources used in their development are included in **Appendices 2-J and 2-K**.

#### 2.3.5.1 Land Use

Characterizing historical land use is foundational for accurately quantifying how and where water is beneficially used. Land use areas are also used to distinguish the water use sector in which water is consumed, as required by the GSP Regulations. **Figure 2-69** and **Table 2-18** summarize the annual land use areas over the historical period (1990-2018) in the Los Molinos Subbasin by water use sector, as defined by the GSP Regulations (23 CCR § 351(al)). In the Los Molinos Subbasin, water use sectors include agricultural, urban, and native vegetation land uses. The urban water use sector covers all urban, residential, industrial, and semi-agricultural<sup>6</sup> land uses. See Plan Area section 2.1.1.2, Land Use.

On average, agricultural, urban, and native vegetation land uses covered approximately 18,200 acres, 1,600 acres, and 79,500 acres, respectively, between 1990 and 2018. The total area of each water use sector has remained relatively constant over time, though slight expansion of urban land uses in the 1990s coincided with a similar decrease in agricultural acreage.



**Figure 2-69. Los Molinos Subbasin Land Use Areas, by Water Use Sector**

<sup>6</sup> As defined in the DWR crop mapping metadata, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2016b)).

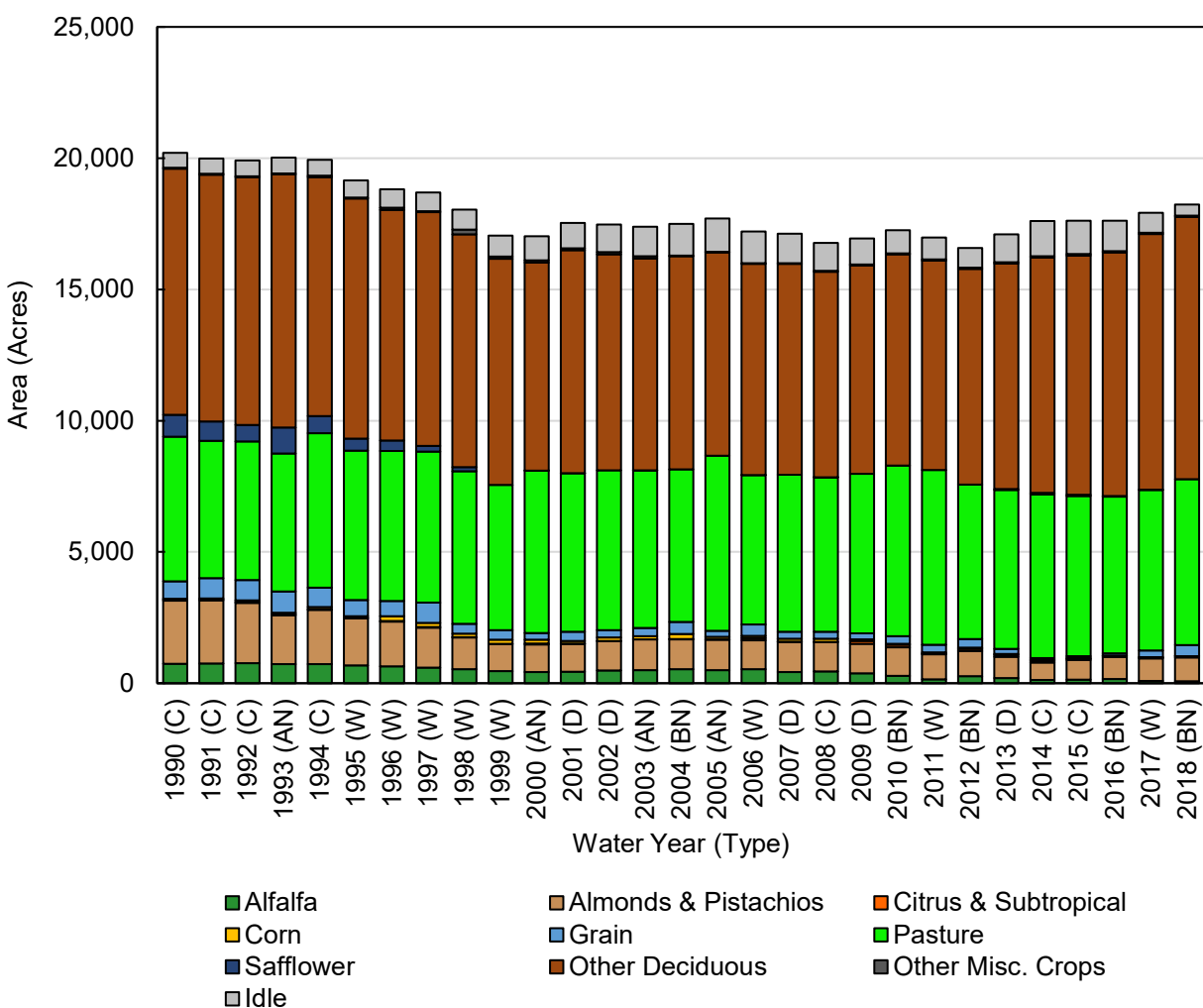
**Table 2-18. Los Molinos Subbasin Land Use Areas, by Water Use Sector**

WATER YEAR (TYPE)	AGRICULTURAL	URBAN <sup>1</sup>	NATIVE VEGETATION	TOTAL
1990 (C)	20,212	951	78,123	99,286
1991 (C)	20,008	1,020	78,259	99,286
1992 (C)	19,932	1,101	78,253	99,286
1993 (AN)	20,050	1,173	78,063	99,286
1994 (C)	20,032	1,244	78,010	99,286
1995 (W)	19,281	1,396	78,609	99,286
1996 (W)	18,980	1,563	78,744	99,286
1997 (W)	18,986	1,692	78,608	99,286
1998 (W)	18,272	1,842	79,172	99,286
1999 (W)	17,315	2,000	79,971	99,286
2000 (AN)	17,300	1,965	80,022	99,286
2001 (D)	17,803	1,875	79,608	99,286
2002 (D)	17,743	1,819	79,724	99,286
2003 (AN)	17,670	1,782	79,835	99,286
2004 (BN)	17,855	1,733	79,698	99,286
2005 (AN)	17,979	1,644	79,663	99,286
2006 (W)	17,494	1,696	80,096	99,286
2007 (D)	17,409	1,679	80,198	99,286
2008 (C)	17,066	1,713	80,507	99,286
2009 (D)	17,220	1,692	80,375	99,286
2010 (BN)	17,539	1,693	80,055	99,286
2011 (W)	17,257	1,696	80,333	99,286
2012 (BN)	16,865	1,727	80,694	99,286
2013 (D)	17,360	1,657	80,269	99,286
2014 (C)	17,854	1,590	79,842	99,286
2015 (C)	17,873	1,575	79,838	99,286
2016 (BN)	17,877	1,557	79,852	99,286
2017 (W)	18,175	1,541	79,570	99,286
2018 (BN)	18,483	1,559	79,245	99,286
Average (1990- 2018)	18,203	1,592	79,491	99,286

<sup>1</sup> Area includes land classified as urban, residential, industrial, and semi-agricultural.



Agricultural land uses are further detailed in **Figure 2-70** and **Table 2-19**. Historically, a majority of the agricultural area in the Los Molinos Subbasin has been comprised of pasture and various orchard crops, especially walnuts and prunes. The total area used to cultivate these primary crops has remained relatively constant over time, though the composition of orchard crops has shifted in recent years, with decreased acreage of prunes and increased acreage of walnuts. Slight decreases in agricultural land use have instead resulted from loss of other irrigated crop areas, such as alfalfa, grain, and safflower.



**Figure 2-70. Los Molinos Subbasin Agricultural Land Use Areas**

**Table 2-19. Los Molinos Subbasin Agricultural Land Use Areas (acres)**

WATER YEAR (TYPE)	ALFALFA	ALMONDS & PISTACHIOS	CITRUS & SUBTROPICAL	CORN	GRAIN	PASTURE	PONDED (RICE)	SAFFLOWER	OTHER DECIDUOUS <sup>1</sup>	OTHER MISC. CROPS <sup>2</sup>	IDLE	TOTAL
1990 (C)	737	2,409	36	37	661	5,515	14	833	9,367	37	566	20,212
1991 (C)	758	2,397	34	44	773	5,229	18	738	9,399	36	583	20,008
1992 (C)	767	2,292	32	63	777	5,275	22	632	9,435	36	600	19,932
1993 (AN)	725	1,867	30	67	800	5,265	27	988	9,635	37	609	20,050
1994 (C)	735	2,060	25	79	736	5,893	95	646	9,102	53	608	20,032
1995 (W)	685	1,781	21	68	615	5,685	132	460	9,147	38	649	19,281
1996 (W)	645	1,705	28	181	574	5,721	164	390	8,782	93	697	18,980
1997 (W)	590	1,528	19	158	779	5,747	288	220	8,900	38	721	18,986
1998 (W)	539	1,209	12	133	373	5,808	233	162	8,864	184	754	18,272
1999 (W)	461	1,023	12	165	354	5,540	268	0	8,617	84	789	17,315
2000 (AN)	424	1,056	40	138	254	6,185	277	1	7,928	89	910	17,300
2001 (D)	436	1,072	7	101	340	6,045	274	1	8,500	71	958	17,803
2002 (D)	482	1,122	7	134	277	6,093	274	0	8,222	92	1,041	17,743
2003 (AN)	504	1,162	7	118	322	5,995	278	1	8,078	81	1,124	17,670
2004 (BN)	539	1,133	14	195	450	5,819	363	0	8,110	24	1,208	17,855
2005 (AN)	499	1,160	12	95	235	6,662	281	0	7,751	26	1,260	17,979
2006 (W)	534	1,107	81	85	430	5,688	290	0	8,051	19	1,210	17,494
2007 (D)	426	1,147	8	115	265	5,979	290	0	8,039	24	1,117	17,409
2008 (C)	456	1,110	8	122	262	5,886	290	0	7,834	33	1,065	17,066
2009 (D)	382	1,118	113	60	228	6,075	283	0	7,943	36	983	17,220
2010 (BN)	284	1,090	95	34	290	6,498	280	0	8,047	36	885	17,539
2011 (W)	149	959	15	53	296	6,658	280	0	7,971	48	829	17,257
2012 (BN)	267	958	88	49	322	5,879	282	0	8,222	41	758	16,865
2013 (D)	191	821	71	37	191	6,048	267	34	8,597	40	1,063	17,360
2014 (C)	122	664	63	32	74	6,234	253	68	8,962	46	1,338	17,854
2015 (C)	138	748	47	19	83	6,094	253	46	9,121	49	1,276	17,873
2016 (BN)	159	835	47	10	88	5,966	253	24	9,283	51	1,160	17,877
2017 (W)	83	863	40	5	254	6,122	256	12	9,737	49	755	18,175
2018 (BN)	77	909	48	2	422	6,321	252	0	9,990	49	414	18,483
Average (1990- 2018)	441	1,286	37	83	397	5,928	226	181	8,677	53	894	18,203

<sup>1</sup> Includes primarily walnuts and prunes.

<sup>2</sup> Area includes land classified as cotton, cucurbits, dry beans, onions & garlic, potatoes, sugar beets, tomatoes, vineyards, other field crops, and other truck crops.

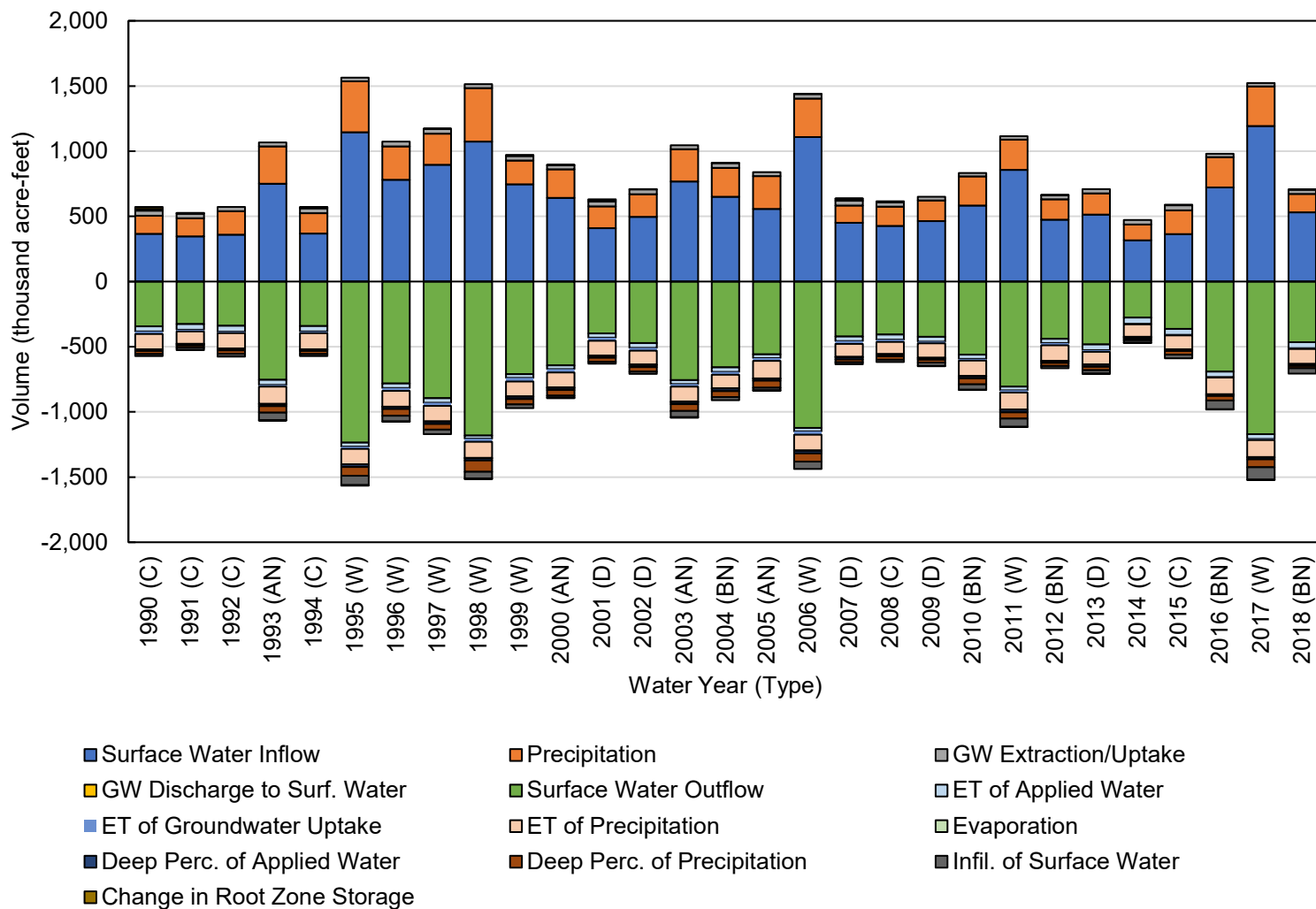
### 2.3.5.2 Historical Surface Water System Water Budget Summary

Annual inflows, outflows, and change in SWS root zone storage during the historical water budget period (1990-2018) are summarized in **Figure 2-71** and **Table 2-20**. Inflows in **Figure 2-71** are shown as positive values, while outflows and change in SWS root zone storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the SWS water budget.

Of particular note in the historical SWS water budget results are the volumes of surface water inflows that make up a large part of the Subbasin SWS inflows. Over the historical period, surface water inflows to surface water averaged about 630 taf per year. Precipitation also represents a large SWS inflow component averaging about 210 taf per year. Groundwater extraction and uptake represent a small SWS inflow in the Subbasin averaging about 33 taf per year over the historical water budget period. Groundwater discharge to surface water represents a smaller SWS inflow averaging about 2 taf per year.

Among the outflows from the Subbasin SWS, surface water outflow makes up a large fraction of the total Subbasin SWS outflows. The surface water outflows total about 620 taf per year on average, a value that corresponds with the large volumes of surface water inflow (about 630 taf per year). By comparison, other SWS outflows in the Subbasin are relatively smaller, with values for ET of precipitation about 120 taf per year and ET of applied water totaling about 36 taf per year on average. The outflow of deep percolation of precipitation, infiltration (seepage) of surface water, and deep percolation of applied water are about 39, 35 and 15 taf per year on average, respectively. Together, the outflows from the SWS to the GWS total about 89 taf per year over the historic water budget period. The outflows of ET of groundwater uptake and evaporation from surface water are about 17 and 2.1 taf per year, respectively.

Detailed results for the historical SWS water budget are presented in **Appendix 2-K**.



**Figure 2-71. Los Molinos Subbasin Surface Water System Historical Water Budget, 1990-2018**

**Table 2-20. Los Molinos Subbasin Surface Water System Historical Water Budget, 1990-2018 (acre-feet)**

WATER YEAR (TYPE)	INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
	SURFACE WATER INFLOW	PRECIPI- TATION	GROUND- WATER EXTRACTION / UPTAKE	GROUND- WATER DISCHARGE	SURFACE WATER OUTFLOW	ET OF APPLIED WATER	ET OF GROUND -WATER UPTAKE	ET OF PRECIPI TATION	EVAPO- RATION	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
1990 (C)	370,000	140,000	38,000	14,000	340,000	38,000	20,000	120,000	910	13,000	24,000	16,000	-16,000
1991 (C)	350,000	140,000	35,000	2,900	330,000	43,000	13,000	96,000	940	13,000	18,000	15,000	-1,400
1992 (C)	360,000	180,000	34,000	0	340,000	46,000	10,000	120,000	920	13,000	25,000	19,000	100
1993 (AN)	750,000	290,000	30,000	0	750,000	37,000	13,000	130,000	870	15,000	52,000	58,000	2,700
1994 (C)	370,000	160,000	35,000	8,100	340,000	41,000	14,000	120,000	850	13,000	24,000	15,000	-3,600
1995 (W)	1,100,000	390,000	30,000	0	1,200,000	31,000	17,000	120,000	1,100	18,000	68,000	71,000	4,000
1996 (W)	780,000	260,000	37,000	0	780,000	33,000	23,000	120,000	1,700	17,000	52,000	43,000	400
1997 (W)	900,000	240,000	38,000	0	890,000	34,000	24,000	120,000	2,300	17,000	44,000	35,000	-420
1998 (W)	1,100,000	410,000	32,000	0	1,200,000	23,000	24,000	120,000	1,600	19,000	86,000	52,000	3,900
1999 (W)	750,000	180,000	36,000	0	710,000	29,000	27,000	110,000	3,000	17,000	41,000	28,000	-7,100
2000 (AN)	640,000	220,000	34,000	820	640,000	29,000	25,000	120,000	2,700	17,000	42,000	16,000	3,300
2001 (D)	410,000	170,000	37,000	15,000	400,000	33,000	23,000	120,000	2,900	13,000	29,000	16,000	-2,800
2002 (D)	500,000	170,000	36,000	0	470,000	37,000	21,000	110,000	3,000	16,000	34,000	18,000	-3,100
2003 (AN)	770,000	250,000	31,000	0	760,000	31,000	21,000	120,000	2,400	17,000	52,000	48,000	4,300
2004 (BN)	650,000	220,000	36,000	0	660,000	35,000	23,000	100,000	2,800	19,000	45,000	26,000	-3,600
2005 (AN)	560,000	250,000	30,000	0	560,000	27,000	21,000	140,000	1,800	15,000	53,000	21,000	4,300
2006 (W)	1,100,000	300,000	34,000	0	1,100,000	27,000	25,000	120,000	2,100	18,000	64,000	56,000	-890
2007 (D)	450,000	130,000	36,000	16,000	420,000	34,000	23,000	99,000	2,700	16,000	21,000	17,000	-310
2008 (C)	430,000	150,000	35,000	2,200	410,000	39,000	18,000	94,000	2,900	15,000	26,000	16,000	-4,600
2009 (D)	460,000	160,000	29,000	0	420,000	37,000	13,000	110,000	2,500	12,000	22,000	26,000	2,100

WATER YEAR (TYPE)		INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
		SURFACE WATER INFLOW	PRECIPI- TATION	GROUND- WATER EXTRACTION / UPTAKE	GROUND- WATER DISCHARGE	SURFACE WATER OUTFLOW	ET OF APPLIED WATER	ET OF GROUND -WATER UPTAKE	ET OF PRECIPI TATION	EVAPO- RATION	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2010 (BN)		580,000	220,000	26,000	0	560,000	32,000	13,000	120,000	2,100	16,000	46,000	42,000	1,800
2011 (W)		860,000	230,000	26,000	0	810,000	29,000	17,000	130,000	2,000	19,000	48,000	62,000	1,900
2012 (BN)		470,000	160,000	31,000	0	440,000	34,000	17,000	120,000	2,400	13,000	23,000	19,000	-4,400
2013 (D)		510,000	160,000	33,000	0	480,000	43,000	12,000	98,000	2,800	15,000	26,000	27,000	2,300
2014 (C)		320,000	120,000	34,000	0	280,000	46,000	6,400	94,000	2,800	10,000	13,000	19,000	2,200
2015 (C)		360,000	180,000	39,000	0	360,000	45,000	4,200	110,000	2,500	11,000	26,000	30,000	-4,900
2016 (BN)		720,000	230,000	27,000	0	690,000	42,000	4,100	130,000	2,300	11,000	35,000	67,000	1,400
2017 (W)		1,200,000	300,000	26,000	0	1,200,000	36,000	8,700	130,000	2,100	14,000	61,000	96,000	2,200
2018 (BN)		530,000	140,000	32,000	0	470,000	44,000	7,800	110,000	2,500	12,000	19,000	42,000	-2,300
Average (1990-2018)		630,000	210,000	33,000	2,000	620,000	36,000	17,000	120,000	2,100	15,000	39,000	35,000	-630
1990- 2018	W	970,000	290,000	32,000	0	990,000	30,000	21,000	120,000	2,000	17,000	58,000	55,000	490
	AN	680,000	250,000	31,000	210	680,000	31,000	20,000	130,000	2,000	16,000	50,000	36,000	3,600
	BN	590,000	200,000	30,000	0	560,000	37,000	13,000	120,000	2,400	14,000	34,000	39,000	-1,400
	D	470,000	160,000	34,000	6,200	440,000	37,000	18,000	110,000	2,800	15,000	27,000	21,000	-360
	C	360,000	150,000	36,000	3,900	340,000	43,000	12,000	110,000	1,700	13,000	22,000	19,000	-4,000

### 2.3.5.3 Historical Groundwater System Water Budget Summary

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Figure 2-72** and **Table 2-21**. The positive net seepage values (on average 29 taf per year) and deep percolation values (on average 54 taf per year) represent the major inflows to the GWS. The net subsurface flows average about -56 taf per year represent the combined net subsurface outflows from the Subbasin to adjacent subbasins. Groundwater (root water) uptake directly from shallow groundwater (on average -17 taf per year) and groundwater pumping (on average -16 taf per year) are somewhat smaller outflows from the GWS. Overall, the water budget results for the 29-year historic period indicate a cumulative change in groundwater storage of about -74 taf, which equals an average annual decrease in groundwater storage of approximately -2.5 taf per year. This change in storage estimates equate to total decreases in storage in the Subbasin of about -0.74 acre-feet per acre over the 29 years and an annual decrease of about -0.03 acre-feet per acre across the entire Subbasin (approximately 99,000 acres). **Figure 2-72** provides a conceptual illustration of the historical water budget. **Figure 2-73** highlights the cumulative change in groundwater storage that has occurred over the 1990-2018 period, with a notable decline in storage over the generally dry period since the mid-2000s. The decrease of groundwater storage during relatively dry years is not an indication of overdraft, but likely due to removal of temporary surplus of groundwater. Temporary surplus removal is the extraction of a volume of aquifer storage to enable the capture of recharge and reduction in subsurface outflow from the subbasin without impacting beneficial users of groundwater creating unreasonable results. In contrast, overdraft is defined as “the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts” (DWR, 2003).

Additional details on the historical GWS water budget are presented in **Appendix 2-K**.

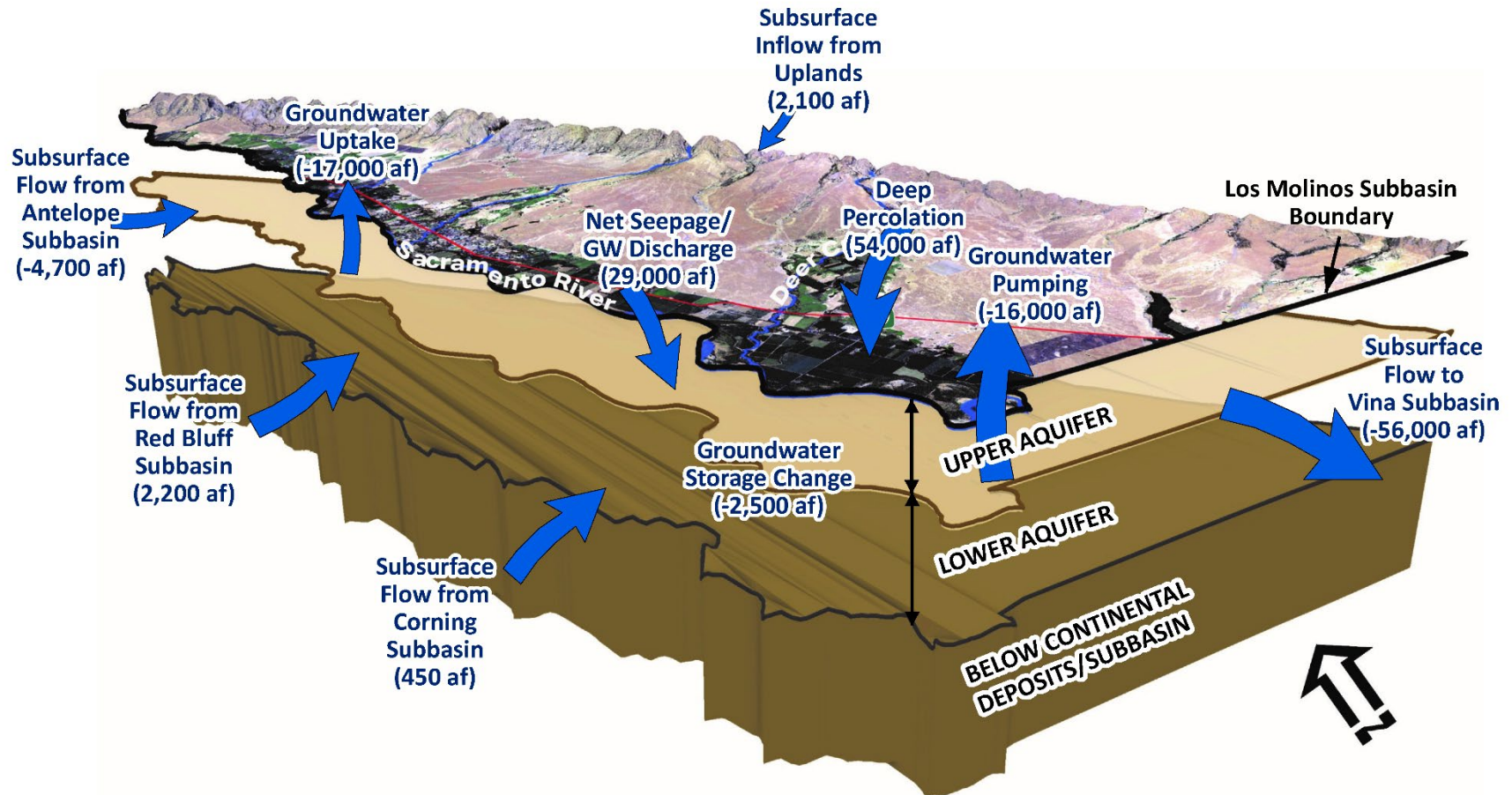


Figure 2-72. Diagram of the Los Molinos Subbasin Historical Average Annual Water Budget (1990-2018)



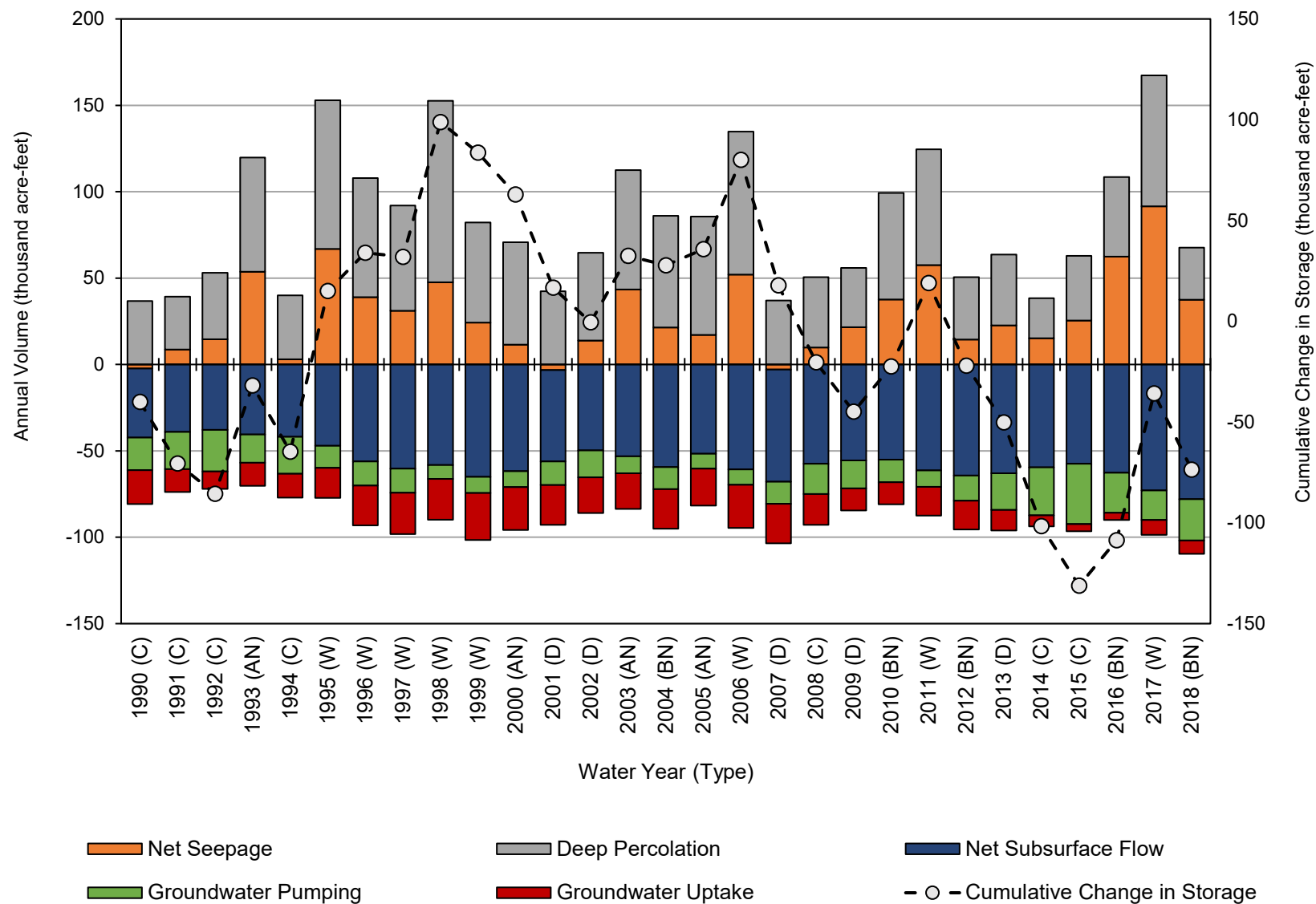


Figure 2-73. Los Molinos Subbasin Historical Groundwater Budget Summary

**Table 2-21. Los Molinos Subbasin Historical Groundwater Budget Summary (acre-feet)**

WATER YEAR (TYPE)	NET SEEPAGE	DEEP PERCOLATION	NET SUBSURFACE FLOWS	GROUND- WATER PUMPING	GROUND- WATER UPTAKE	ANNUAL GROUNDWATER STORAGE CHANGE	CUMULATIVE GROUNDWATER STORAGE CHANGE
1990 (C)	-2,300	37,000	-40,000	-19,000	-20,000	-40,000	-40,000
1991 (C)	8,600	31,000	-39,000	-22,000	-13,000	-31,000	-71,000
1992 (C)	15,000	39,000	-38,000	-24,000	-10,000	-15,000	-86,000
1993 (AN)	54,000	66,000	-41,000	-16,000	-13,000	54,000	-32,000
1994 (C)	3,000	37,000	-42,000	-21,000	-14,000	-33,000	-65,000
1995 (W)	67,000	86,000	-47,000	-13,000	-17,000	80,000	15,000
1996 (W)	39,000	69,000	-56,000	-14,000	-23,000	19,000	34,000
1997 (W)	31,000	61,000	-60,000	-14,000	-24,000	-2,000	32,000
1998 (W)	48,000	110,000	-58,000	-8,000	-24,000	67,000	99,000
1999 (W)	24,000	58,000	-65,000	-9,400	-27,000	-15,000	84,000
2000 (AN)	11,000	59,000	-62,000	-9,100	-25,000	-21,000	63,000
2001 (D)	-3,300	42,000	-53,000	-14,000	-23,000	-46,000	17,000
2002 (D)	14,000	51,000	-50,000	-16,000	-21,000	-17,000	-530
2003 (AN)	43,000	69,000	-53,000	-9,900	-21,000	33,000	32,000
2004 (BN)	21,000	65,000	-59,000	-13,000	-23,000	-4,700	28,000
2005 (AN)	17,000	68,000	-52,000	-8,600	-21,000	8,100	36,000
2006 (W)	52,000	83,000	-61,000	-9,000	-25,000	44,000	80,000
2007 (D)	-3,000	37,000	-65,000	-13,000	-23,000	-62,000	18,000
2008 (C)	9,800	41,000	-57,000	-17,000	-18,000	-38,000	-20,000
2009 (D)	22,000	34,000	-55,000	-16,000	-13,000	-24,000	-45,000
2010 (BN)	38,000	62,000	-55,000	-13,000	-13,000	22,000	-22,000
2011 (W)	58,000	67,000	-61,000	-9,500	-17,000	41,000	19,000
2012 (BN)	14,000	36,000	-64,000	-15,000	-17,000	-41,000	-22,000
2013 (D)	23,000	41,000	-63,000	-21,000	-12,000	-28,000	-50,000
2014 (C)	15,000	23,000	-60,000	-28,000	-6,400	-51,000	-100,000
2015 (C)	25,000	37,000	-57,000	-35,000	-4,200	-30,000	-130,000
2016 (BN)	62,000	46,000	-63,000	-23,000	-4,100	23,000	-110,000
2017 (W)	92,000	76,000	-73,000	-17,000	-8,700	73,000	-36,000
2018 (BN)	37,000	30,000	-78,000	-24,000	-7,800	-38,000	-74,000
Average (1990-2018)	29,000	54,000	-56,000	-16,000	-17,000	-2,500	
1990- 2018	W	51,000	76,000	-62,000	-12,000	-21,000	38,000
	AN	31,000	66,000	-54,000	-11,000	-20,000	18,000
	BN	35,000	48,000	-66,000	-18,000	-13,000	-7,700
	D	10,000	41,000	-59,000	-16,000	-18,000	-36,000
	C	11,000	35,000	-50,000	-24,000	-12,000	-34,000

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.

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### 2.3.6 Current Water Budget

As described above in **Section 2.3.2**, several recent water budget periods have been considered for use in representing the current water budget. Because the hydrology and land use conditions can vary year to year, estimating the current water budget can be challenging. To evaluate the current water budget, water budget results from the historical model run were summarized for five different recent time periods to evaluate variability and trends. The five different recent water budget periods evaluated include the following:

- Most recent 10 years (2009-2018)
- Most recent 5 year (2014-2018)
- Most recent 3 years (2016-2018)
- Recent single year 2018
- Recent single year 2019

Comparison of these recent water budget periods provides a representation of how water use varies with precipitation and water supply conditions from year to year. Based on these comparisons and consideration of the hydrologic conditions over these recent periods, the recent three-year period from 2016 through 2018 is believed to provide a reasonable representation of the recent water budget conditions. For reporting a current water budget in the GSP, the average water budget for the three-year period between 2016 and 2018 is considered to be representative of the current water budget and representative of current hydrologic and land use conditions. This period incorporates recent land use conditions and spans three years (two below normal years and one wet year) that collectively have precipitation and hydrology similar to the long-term average. Although the 2016 through 2018 period provides a summary of the water budget for recent years that appear to be reasonably representative of recent typical conditions, it is not necessarily representative of any longer-term average conditions. Understanding the recent water budget years is helpful in anticipating longer-term conditions under a scenario where current land uses are maintained in the Subbasin (see section 2.3.7). The results from comparisons of the recent water budget periods evaluated are presented below, including the results and discussion of the selected current water budget period of 2016-2018. The projected water budget with a current land use condition, as described in **Section 2.3.7** also is insightful on the current water budget conditions.

#### 2.3.6.1 Surface Water System Water Budget Summary

The comparison of the different recent SWS water budget periods provides a representation of how individual SWS water budget components vary from year to year depending on water demands, precipitation, and water supply conditions. The SWS water budget results for these different recent time periods are presented in **Table 2-22**. The single year SWS water budget results highlight the high variability between these two years, which included a below normal year in 2018 and a wet year in 2019. The water budget inflows and outflows from the SWS vary by about 500 taf between these two single years. Most of the variability in the total SWS inflows and outflows is a result of variability in precipitation, surface water inflow and surface water outflow. When comparing the average annual water budget results for recent

multi-year periods, the variability is considerably reduced with a maximum difference in both inflows and outflows of about 280 taf per year between the three different recent multi-year periods evaluated.

The selected current water budget period of 2016-2018 (highlighted blue in **Table 2-22**) has total SWS inflows and outflows of about 1,100 taf per year, with the largest SWS inflows being surface water inflow (820 taf per year) and the largest SWS outflow being surface water outflow (780 taf per year). Current SWS water budget inflows also include 230 taf per year of precipitation, and nearly 28 taf per year of groundwater extraction and uptake. Other SWS outflows in the current SWS water budget include 120 taf per year ET of precipitation, 68 taf per year infiltration of surface water, 41 taf per year ET of applied water, 38 taf per year deep percolation of precipitation, 12 taf per year of deep percolation of applied water, and additional smaller outflows for ET of groundwater uptake, evaporation from surface water, and change in root zone storage.

**Table 2-22. Comparison of Recent SWS Water Budget Periods (acre-feet)**

FLOW PATH		RECENT WATER BUDGET PERIOD				
		RECENT <u>10</u> YEARS	RECENT <u>5</u> YEARS	RECENT <u>3</u> YEARS	RECENT <u>1</u> YEAR	RECENT <u>1</u> YEAR
		(2009-2018)	(2014-2018)	(2016-2018)	2018	2019
<b>Inflow</b>	Surface Water Inflow	600,000	630,000	820,000	530,000	890,000
	Precipitation	190,000	200,000	230,000	140,000	330,000
	Groundwater Extraction/Uptake	30,000	32,000	28,000	32,000	25,000
	Groundwater Discharge to Surface Water	0	0	0	0	0
	<b>Total Inflows<sup>1</sup></b>	<b>820,000</b>	<b>850,000</b>	<b>1,100,000</b>	<b>700,000</b>	<b>1,200,000</b>
<b>Outflow</b>	Surface Water Outflow	570,000	590,000	780,000	470,000	910,000
	ET of Applied Water	39,000	43,000	41,000	44,000	37,000
	ET of Groundwater Uptake	10,000	6,200	6,800	7,800	9,300
	ET of Precipitation	120,000	120,000	120,000	110,000	140,000
	Evaporation	2,400	2,400	2,300	2,500	1,900
	Deep Percolation of Applied Water	13,000	12,000	12,000	12,000	16,000
	Deep Percolation of Precipitation	32,000	31,000	38,000	19,000	57,000
	Infiltration of Surface Water (Seepage)	43,000	51,000	68,000	42,000	74,000
	Change in Root Zone Storage	240	-280	430	-2,300	6,100
	<b>Total Outflows</b>	<b>820,000</b>	<b>850,000</b>	<b>1,100,000</b>	<b>700,000</b>	<b>1,200,000</b>

### 2.3.6.2 Groundwater System Water Budget Summary

Comparing the different recent water budget periods provides a representation of how the overall GWS water budget components vary from year to year depending on conditions including inflows/outflows between the SWS and subsurface flows. The GWS water budget results for these different recent time periods are presented in **Table 2-23**. As with the results for the current SWS water budget summaries, the single year results for the GWS water budget highlight the high variability between the two individual years of 2018 and 2019, which included a below normal year (2018) and a wet year (2019). Although some of the individual water budget components are relatively stable between the two different recent water budget years, the total change in groundwater storage varied by over 85 taf ranging from a decrease in storage of about -38 taf in 2018 (a below normal year) to an increase in storage of 47 taf in 2019 (a wet year). There is considerably less variability in most of the different water budget components when comparing between the three different recent multi-year periods, although the net seepage and net subsurface flows do show relatively higher differences between the three recent periods. Average annual change in storage varies between -5.3 and -4.7 taf per year for the recent 10-year and 5-year periods, respectively, and indicates an average increase in storage of about 19 taf per year for the recent three-year period. This difference is likely attributable to the drought years consisting of dry and critical years that occurred between 2013 and 2015, which are included in the recent five- and ten-year periods, but not included in the most recent three-year period from 2016-2018.

The selected current water budget period of 2016-2018 (highlighted blue in **Table 2-23**) has total net seepage of about 64 taf per year, indicating net seepage of surface water into the GWS. Deep percolation represents an additional 51 taf per year of inflow to the GWS. Net subsurface flows total -71 taf per year of outflow on average over the current water budget period and groundwater pumping and groundwater uptake account for outflows from the GWS averaging about -21 and -6.8 taf per year, respectively, during the current water budget period.

**Table 2-23. Comparison of Recent GWS Water Budget Periods (acre-feet)**

GWS WATER BUDGET COMPONENT	RECENT WATER BUDGET PERIODS				
	RECENT 10 YEARS	RECENT 5 YEARS	RECENT 3 YEARS	RECENT 1 YEAR	RECENT 1 YEAR
	(2009-2018)	(2014-2018)	(2016-2018)	2018	2019
Net Seepage	39,000	46,000	64,000	37,000	70,000
Deep Percolation	45,000	43,000	51,000	30,000	73,000
Net Subsurface Flows	-63,000	-66,000	-71,000	-78,000	-75,000
Groundwater Pumping	-20,000	-25,000	-21,000	-24,000	-16,000
Groundwater Uptake	-10,000	-6,200	-6,800	-7,800	-9,300
<b>Annual Groundwater Storage Change</b>	<b>-5,300</b>	<b>-4,700</b>	<b>19,000</b>	<b>-38,000</b>	<b>47,000</b>

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.

### 2.3.7 Projected Water Budgets

To evaluate projected water budgets in the future, projected model runs were developed using Tehama IHM. The projected model runs are intended to evaluate the effects of anticipated future conditions of hydrology, water supply availability, and water demand on the Los Molinos Subbasin water budget and groundwater conditions over a 50-year GSP planning period. The projected model runs also incorporate consideration of potential climate change and water supply availability scenarios and evaluation of the need for and benefit of any projects and management actions to be implemented in the Subbasin to maintain or achieve sustainability. The projected model runs use hydrologic conditions representative of the most recent 50 years of hydrology in the Subbasin, with adjustments applied in scenarios for evaluating the water budget under climate change and/or altered water supply and demand conditions. A number of projected future scenarios were simulated in Tehama IHM to compare possible outcomes, including different projected land uses and potential climate change impacts. Additional information about the development of the projected model scenarios is provided in **Appendix 2-J**.

#### 2.3.7.1 Projected (Current Land Use) Water Budget

This section presents the results of the Projected (Current Land Use) scenario. The Current Land Use scenario assumes constant land use conditions based on 2018 conditions.

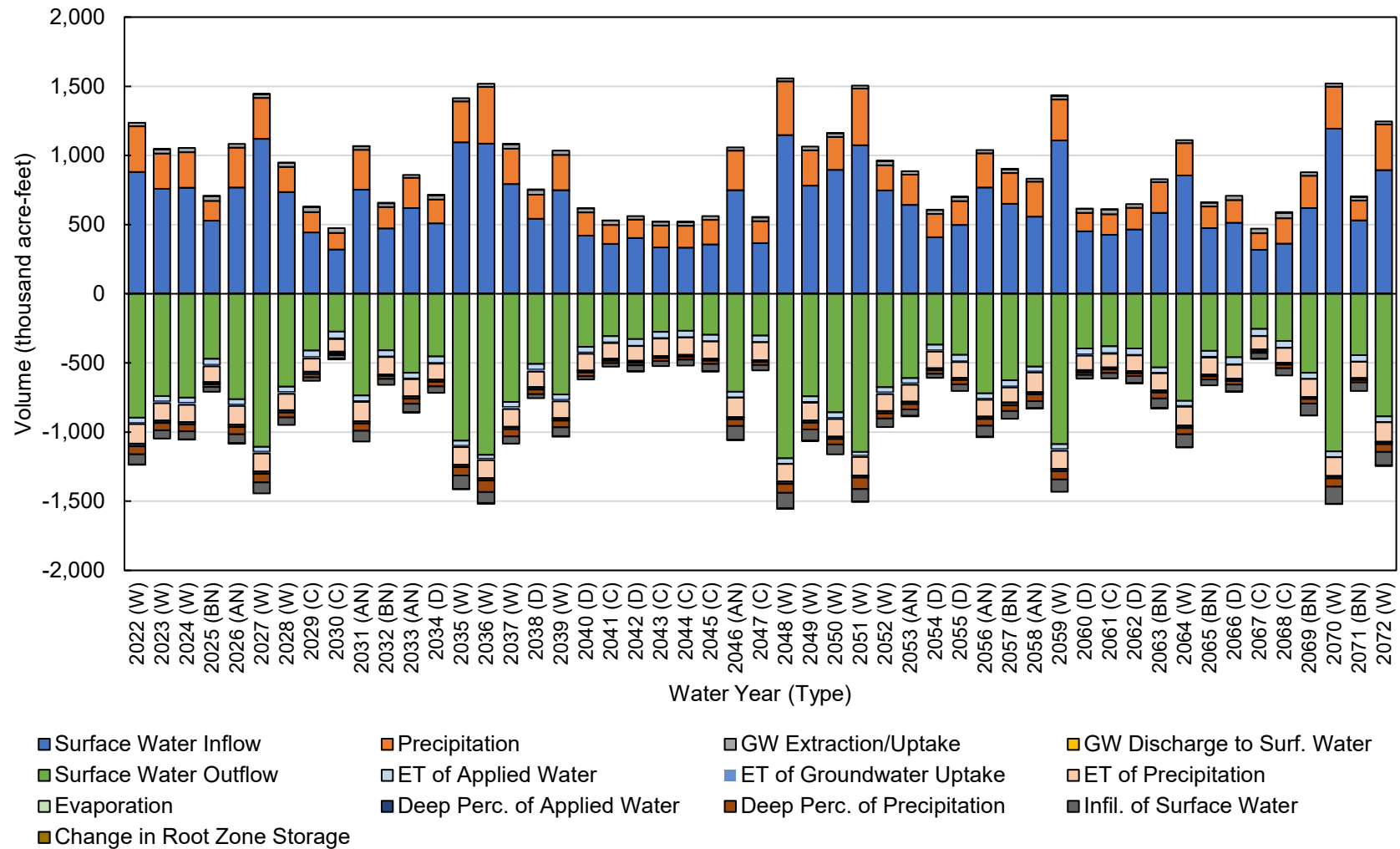
##### 2.3.7.1.1 Projected (Current Land Use) Surface Water System Water Budget Summary

Annual inflows, outflows, and change in SWS root zone storage during the projected (current land use) water budget period (2022-2072) are summarized in **Figure 2-74** and **Table 2-24**. Inflows in **Figure 2-74** are shown as positive values, while outflows are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the SWS water budget.

Of particular note in the projected (current land use) SWS water budget results are the volumes of surface water inflows that make up a large part of the Subbasin SWS inflows. Over the projected (current land use) period, surface water inflows to surface water averaged about 650 taf per year. Precipitation also represents a large SWS inflow component averaging about 220 taf per year. Groundwater extraction and uptake represent a small SWS inflow in the Subbasin averaging about 27 taf per year over the projected (current land use) water budget period. Groundwater discharge to surface water is negligible throughout the projected (current land use) period.

Among the outflows from the Subbasin SWS, surface water outflow makes up a large fraction of the total Subbasin SWS outflows. The surface water outflows total about 610 taf per year on average, a value that corresponds with the large volumes of surface water inflow (about 650 taf per year). By comparison, other SWS outflows in the Subbasin are relatively smaller, with values for ET of precipitation about 120 taf per year and ET of applied water totaling about 41 taf per year on average.

The outflow of infiltration (seepage) of surface water, deep percolation of precipitation, and deep percolation of applied water are about 59, 38 and 14 taf per year on average, respectively. Together, the outflows from the SWS to the GWS total about 110 taf per year over the historic water budget period. The outflows of ET of groundwater uptake and evaporation from surface water are about 7.3 and 2.2 taf per year, respectively. Detailed results for the projected (current land use) SWS water budget are presented in **Appendix 2-K**.



**Figure 2-74. Los Molinos Subbasin Surface Water System Projected (Current Land Use) Water Budget, 2022-2072**

**Table 2-24. Los Molinos Subbasin Surface Water System Projected (Current Land Use) Water Budget, 2022-2072 (acre-feet)**

WATER YEAR (TYPE)	INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
	SURFACE WATER INFLOW	PRECIPI- TATION	GROUNDWA- TER EXTRACTION / UPTAKE	GROUND WATER DISCHARGE	SURFACE WATER OUTFLO W	ET OF APPLIED WATER	ET OF GROUND- WATER UPTAKE	ET OF PRECIPI- TATION	EVAPO- RATION <sup>1</sup>	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2022 (W)	880,000	330,000	27,000	0	900,000	37,000	9,500	140,000	1,900	16,000	58,000	75,000	1,500
2023 (W)	760,000	260,000	31,000	0	740,000	38,000	13,000	130,000	2,200	15,000	50,000	61,000	-1,700
2024 (W)	770,000	260,000	31,000	0	750,000	38,000	14,000	120,000	2,200	16,000	50,000	58,000	190
2025 (BN)	530,000	140,000	32,000	0	470,000	42,000	11,000	120,000	2,400	12,000	19,000	36,000	-4,700
2026 (AN)	770,000	290,000	27,000	0	760,000	38,000	11,000	140,000	2,100	15,000	52,000	64,000	3,800
2027 (W)	1,100,000	300,000	28,000	0	1,100,00	35,000	14,000	130,000	1,900	17,000	60,000	80,000	-760
2028 (W)	740,000	180,000	30,000	0	670,000	37,000	15,000	120,000	2,200	15,000	35,000	55,000	-1,500
2029 (C)	440,000	150,000	35,000	0	410,000	45,000	11,000	96,000	2,700	14,000	24,000	25,000	-2,800
2030 (C)	320,000	120,000	34,000	0	270,000	50,000	5,200	90,000	2,800	10,000	12,000	24,000	6,000
2031 (AN)	750,000	290,000	25,000	0	740,000	40,000	5,300	140,000	2,100	15,000	52,000	77,000	-1,000
2032 (BN)	470,000	160,000	27,000	0	410,000	43,000	5,300	120,000	2,300	10,000	20,000	43,000	-3,800
2033 (AN)	620,000	220,000	23,000	0	570,000	41,000	5,100	120,000	2,200	14,000	37,000	60,000	5,000
2034 (D)	510,000	170,000	29,000	0	450,000	46,000	5,700	120,000	2,500	14,000	32,000	47,000	-5,400
2035 (W)	1,100,000	300,000	23,000	0	1,100,00	37,000	8,100	130,000	2,000	16,000	58,000	98,000	3,100
2036 (W)	1,100,000	410,000	23,000	0	1,200,00	26,000	13,000	130,000	1,400	16,000	82,000	79,000	5,700
2037 (W)	790,000	260,000	33,000	0	780,000	36,000	16,000	130,000	2,200	16,000	51,000	53,000	-3,200
2038 (D)	540,000	170,000	34,000	0	510,000	41,000	14,000	110,000	2,500	15,000	33,000	29,000	-5,400
2039 (W)	750,000	260,000	30,000	0	730,000	39,000	12,000	120,000	2,200	15,000	49,000	63,000	4,900
2040 (D)	420,000	170,000	29,000	0	380,000	40,000	10,000	120,000	2,300	12,000	26,000	25,000	-2,700
2041 (C)	360,000	140,000	30,000	0	310,000	45,000	5,700	110,000	2,500	11,000	17,000	26,000	-30



WATER YEAR (TYPE)	INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
	SURFACE WATER INFLOW	PRECIPI- TATION	GROUNDWA- TER EXTRACTION / UPTAKE	GROUND WATER DISCHARGE	SURFACE WATER OUTFLO W	ET OF APPLIED WATER	ET OF GROUND- WATER UPTAKE	ET OF PRECIPI- TATION	EVAPORATION <sup>1</sup>	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2042 (D)	400,000	130,000	25,000	0	330,000	47,000	3,200	110,000	2,600	13,000	17,000	43,000	680
2043 (C)	340,000	160,000	28,000	0	280,000	46,000	2,300	130,000	2,200	12,000	21,000	36,000	-2,100
2044 (C)	330,000	160,000	26,000	0	270,000	46,000	1,400	130,000	2,200	12,000	20,000	42,000	-60
2045 (C)	360,000	180,000	26,000	0	300,000	48,000	1,000	130,000	2,300	12,000	23,000	52,000	150
2046 (AN)	750,000	290,000	22,000	0	710,000	41,000	1,900	140,000	2,200	14,000	50,000	98,000	3,200
2047 (C)	370,000	160,000	27,000	0	300,000	45,000	2,100	130,000	2,200	12,000	21,000	40,000	-3,300
2048 (W)	1,100,000	390,000	21,000	0	1,200,00	37,000	3,200	130,000	1,900	16,000	65,000	110,000	3,600
2049 (W)	780,000	260,000	26,000	0	740,000	41,000	6,000	130,000	2,200	14,000	49,000	81,000	230
2050 (W)	900,000	240,000	26,000	0	860,000	41,000	7,600	130,000	2,400	14,000	40,000	70,000	-110
2051 (W)	1,100,000	410,000	21,000	0	1,100,00	27,000	11,000	130,000	1,400	15,000	82,000	90,000	3,700
2052 (W)	750,000	180,000	29,000	0	680,000	37,000	13,000	120,000	2,300	15,000	37,000	63,000	-6,500
2053 (AN)	640,000	220,000	26,000	0	610,000	37,000	12,000	120,000	2,200	15,000	38,000	47,000	3,700
2054 (D)	410,000	170,000	29,000	0	370,000	41,000	8,600	120,000	2,300	12,000	26,000	29,000	-3,200
2055 (D)	500,000	170,000	29,000	0	440,000	46,000	6,200	110,000	2,500	14,000	31,000	47,000	-2,500
2056 (AN)	770,000	250,000	23,000	0	720,000	39,000	6,800	120,000	2,100	15,000	48,000	80,000	4,200
2057 (BN)	650,000	220,000	28,000	0	630,000	44,000	8,600	110,000	2,500	18,000	42,000	56,000	-3,600
2058 (AN)	560,000	250,000	21,000	0	530,000	34,000	8,600	140,000	1,800	13,000	49,000	51,000	3,800
2059 (W)	1,100,000	300,000	27,000	0	1,100,00	35,000	12,000	130,000	1,900	16,000	60,000	89,000	-860
2060 (D)	450,000	130,000	29,000	0	390,000	43,000	9,900	100,000	2,600	14,000	18,000	26,000	-480
2061 (C)	430,000	150,000	33,000	0	380,000	49,000	5,800	99,000	2,800	14,000	23,000	39,000	-3,700
2062 (D)	460,000	160,000	26,000	0	400,000	46,000	3,600	110,000	2,500	12,000	20,000	51,000	2,200

WATER YEAR (TYPE)		INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
		SURFACE WATER INFLOW	PRECIPI- TATION	GROUNDWA- TER EXTRACTION / UPTAKE	GROUND WATER DISCHARGE	SURFACE WATER OUTFLO W	ET OF APPLIED WATER	ET OF GROUND- WATER UPTAKE	ET OF PRECIPI- TATION	EVAPO- RATION <sup>1</sup>	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2063 (BN)		580,000	220,000	21,000	0	530,000	38,000	3,800	120,000	2,100	14,000	43,000	69,000	1,900
2064 (W)		860,000	230,000	20,000	0	770,000	36,000	6,100	140,000	1,900	17,000	45,000	91,000	1,900
2065 (BN)		470,000	160,000	27,000	0	410,000	43,000	6,100	120,000	2,300	11,000	20,000	43,000	-4,700
2066 (D)		510,000	160,000	32,000	0	460,000	51,000	3,800	100,000	2,700	14,000	25,000	50,000	2,600
2067 (C)		320,000	120,000	33,000	0	250,000	51,000	1,800	96,000	2,800	11,000	12,000	40,000	2,100
2068 (C)		360,000	180,000	40,000	0	340,000	49,000	940	110,000	2,500	11,000	25,000	51,000	-5,000
2069 (BN)		620,000	230,000	27,000	0	570,000	44,000	860	130,000	2,300	11,000	34,000	84,000	980
2070 (W)		1,200,000	300,000	23,000	0	1,100,000	40,000	2,700	130,000	2,100	14,000	60,000	120,000	2,000
2071 (BN)		530,000	140,000	28,000	0	440,000	46,000	2,500	120,000	2,500	11,000	17,000	63,000	-2,500
2072 (W)		890,000	330,000	22,000	0	890,000	40,000	3,500	140,000	2,000	16,000	56,000	96,000	6,000
Average (2022-2072)		650,000	220,000	27,000	0	610,000	41,000	7,300	120,000	2,200	14,000	38,000	59,000	20
2022- 2072	W	930,000	290,000	26,000	0	910,000	36,000	10,000	130,000	2,000	15,000	55,000	80,000	1,000
	AN	690,000	260,000	24,000	0	660,000	39,000	7,100	130,000	2,100	14,000	46,000	68,000	3,200
	BN	550,000	180,000	27,000	0	500,000	43,000	5,400	120,000	2,400	12,000	28,000	56,000	-2,400
	D	470,000	160,000	29,000	0	410,000	45,000	7,200	110,000	2,500	13,000	25,000	39,000	-1,600
	C	360,000	150,000	31,000	0	310,000	47,000	3,800	110,000	2,500	12,000	20,000	38,000	-880

1 Diversions for some years were estimated based on average monthly data, resulting in a generally constant evaporation volume for some years.

### 2.3.7.2 Projected (Current Land Use) Groundwater System Water Budget Summary

Summarized results for major components of the projected (current land use) water budget as they relate to the GWS are presented in **Figure 2-75** and **Table 2-25**. The positive net seepage values (on average 55 taf per year) and deep percolation values (on average 52 taf per year) represent the major inflows to the GWS. The net subsurface flows average about -86 taf per year represent the combined net subsurface outflows from the Subbasin to adjacent subbasins.

Groundwater pumping (on average -20 taf per year) and groundwater (root water) uptake directly from shallow groundwater (on average -7.3 taf per year) are somewhat smaller outflows from the GWS. Overall, the water budget results for the 51-year projected (current land use) period indicate a cumulative change in groundwater storage of about -93 taf, which equals an average annual decrease in groundwater storage of approximately -1.8 taf per year. This change in storage estimates equate to total decreases in storage in the Subbasin of about -0.94 acre-feet per acre over the 51 years and an annual decrease of about -0.02 acre-feet per acre across the entire Subbasin (approximately 99,000 acres). **Figure 2-75** provides a conceptual illustration of the projected (current land use) water budget. **Figure 2-76** highlights the cumulative change in groundwater storage that would occur during anticipated multi-year wet and dry periods within the projected period.

Detailed results for the projected (future land use) period GWS water budget are presented in **Appendix 2-K**.

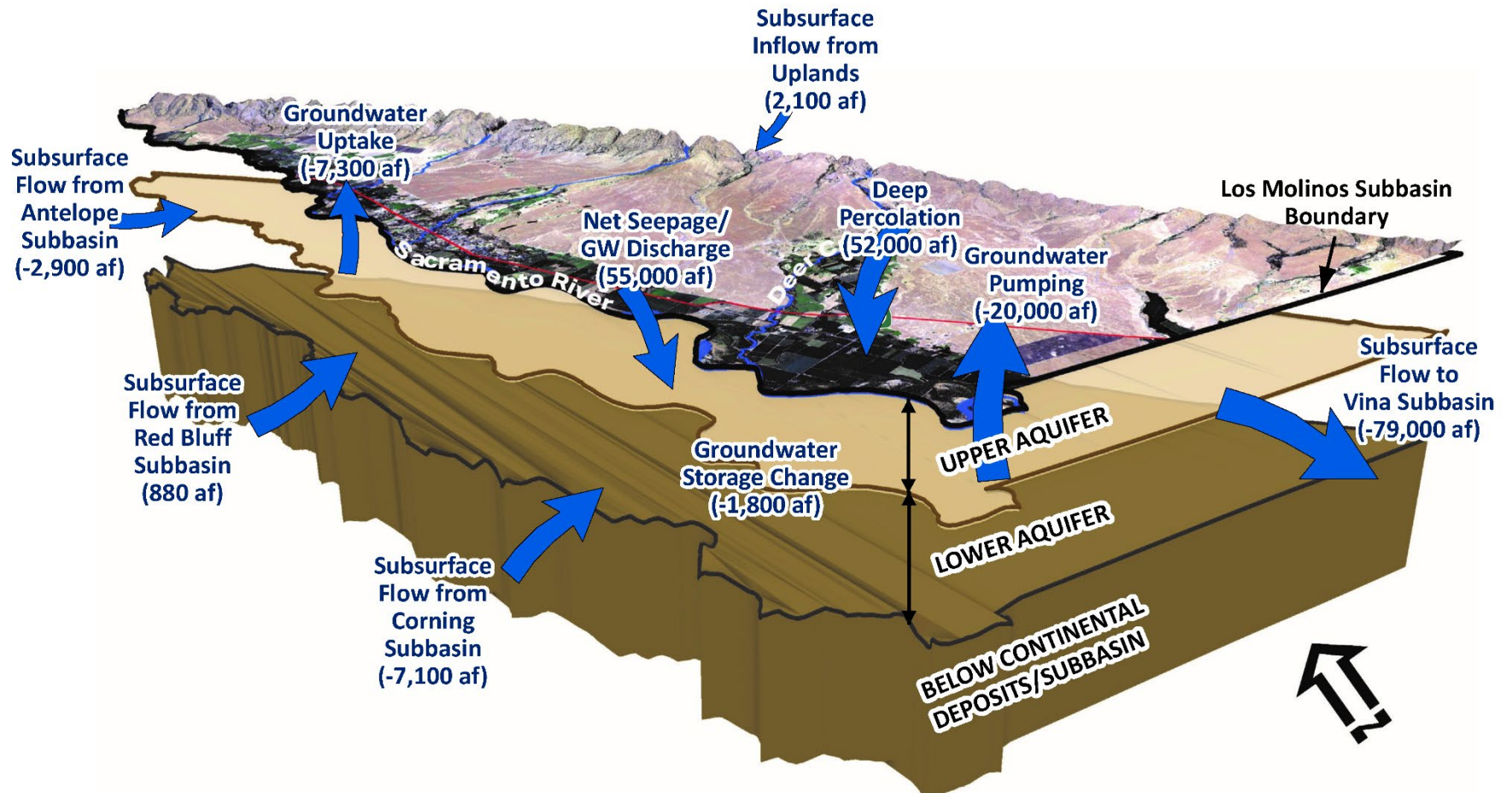
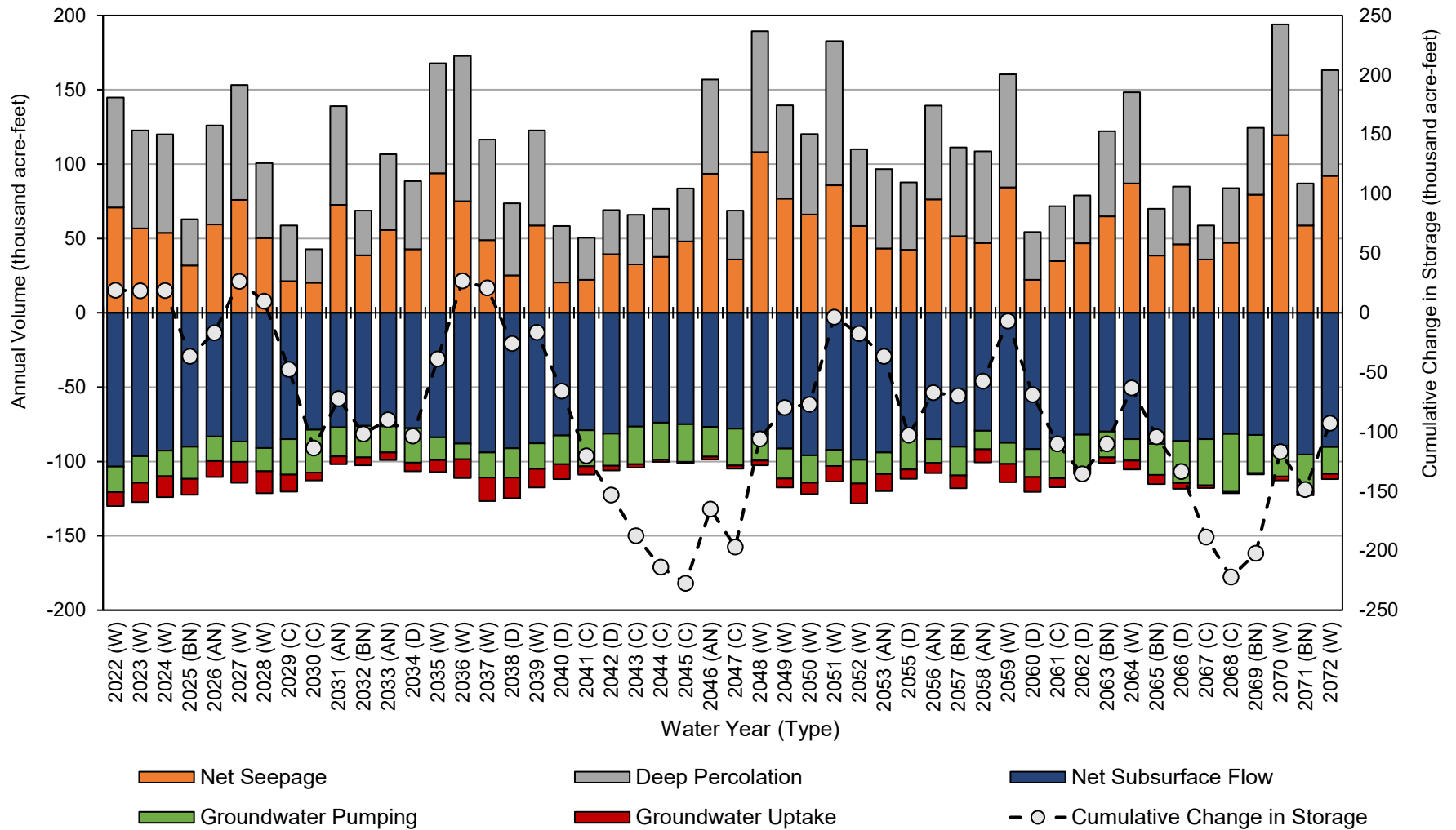


Figure 2-75. Diagram of the Los Molinos Subbasin Projected (Current Land Use) Average Annual Water Budget, 2022-2072



**Figure 2-76 Los Molinos Subbasin Projected (Current Land Use) Water Budget Summary**

**Table 2-25. Los Molinos Subbasin Projected (Current Land Use)  
Water Budget Summary (acre-feet)**

WATER YEAR (TYPE)	NET SEEPAGE	DEEP PERCOLATION	NET SUBSURFACE FLOWS	GROUND- WATER PUMPING	GROUND- WATER UPTAKE	ANNUAL GROUNDWATER STORAGE CHANGE	CUMULATIVE GROUNDWATER STORAGE CHANGE
2022 (W)	71,000	74,000	-100,000	-17,000	-12,000	19,000	19,000
2023 (W)	57,000	66,000	-96,000	-18,000	-9,000	-310	19,000
2024 (W)	54,000	66,000	-93,000	-17,000	-9,500	180	19,000
2025 (BN)	32,000	31,000	-90,000	-22,000	-13,000	-55,000	-37,000
2026 (AN)	60,000	67,000	-83,000	-17,000	-14,000	20,000	-17,000
2027 (W)	76,000	77,000	-87,000	-14,000	-11,000	43,000	26,000
2028 (W)	50,000	50,000	-91,000	-16,000	-11,000	-17,000	9,800
2029 (C)	21,000	37,000	-85,000	-24,000	-14,000	-57,000	-48,000
2030 (C)	20,000	23,000	-79,000	-29,000	-15,000	-66,000	-110,000
2031 (AN)	73,000	67,000	-77,000	-19,000	-11,000	41,000	-72,000
2032 (BN)	39,000	30,000	-76,000	-21,000	-5,200	-30,000	-100,000
2033 (AN)	56,000	51,000	-76,000	-17,000	-5,300	12,000	-90,000
2034 (D)	43,000	46,000	-78,000	-23,000	-5,300	-14,000	-100,000
2035 (W)	94,000	74,000	-84,000	-15,000	-5,100	65,000	-39,000
2036 (W)	75,000	98,000	-88,000	-10,000	-5,700	66,000	27,000
2037 (W)	49,000	68,000	-94,000	-17,000	-8,100	-5,900	21,000
2038 (D)	25,000	48,000	-91,000	-20,000	-13,000	-47,000	-26,000
2039 (W)	59,000	64,000	-88,000	-17,000	-16,000	9,400	-16,000
2040 (D)	20,000	38,000	-82,000	-19,000	-14,000	-49,000	-66,000
2041 (C)	22,000	28,000	-79,000	-24,000	-12,000	-54,000	-120,000
2042 (D)	39,000	30,000	-81,000	-22,000	-10,000	-33,000	-150,000
2043 (C)	33,000	33,000	-77,000	-25,000	-5,700	-34,000	-190,000
2044 (C)	38,000	32,000	-74,000	-25,000	-3,200	-26,000	-210,000
2045 (C)	48,000	36,000	-75,000	-25,000	-2,300	-14,000	-230,000
2046 (AN)	93,000	63,000	-77,000	-20,000	-1,400	62,000	-160,000
2047 (C)	36,000	33,000	-78,000	-25,000	-1,000	-32,000	-200,000
2048 (W)	110,000	81,000	-82,000	-18,000	-1,900	91,000	-110,000
2049 (W)	77,000	63,000	-91,000	-20,000	-2,100	26,000	-80,000
2050 (W)	66,000	54,000	-96,000	-18,000	-3,200	2,600	-77,000
2051 (W)	86,000	97,000	-92,000	-11,000	-6,000	73,000	-3,600
2052 (W)	58,000	52,000	-99,000	-16,000	-7,600	-14,000	-18,000
2053 (AN)	43,000	53,000	-94,000	-14,000	-11,000	-19,000	-37,000
2054 (D)	25,000	38,000	-85,000	-20,000	-13,000	-46,000	-83,000
2055 (D)	42,000	45,000	-82,000	-23,000	-12,000	-20,000	-100,000
2056 (AN)	76,000	63,000	-85,000	-16,000	-8,600	36,000	-67,000
2057 (BN)	51,000	60,000	-90,000	-19,000	-6,200	-2,700	-70,000
2058 (AN)	47,000	62,000	-79,000	-13,000	-6,800	12,000	-57,000

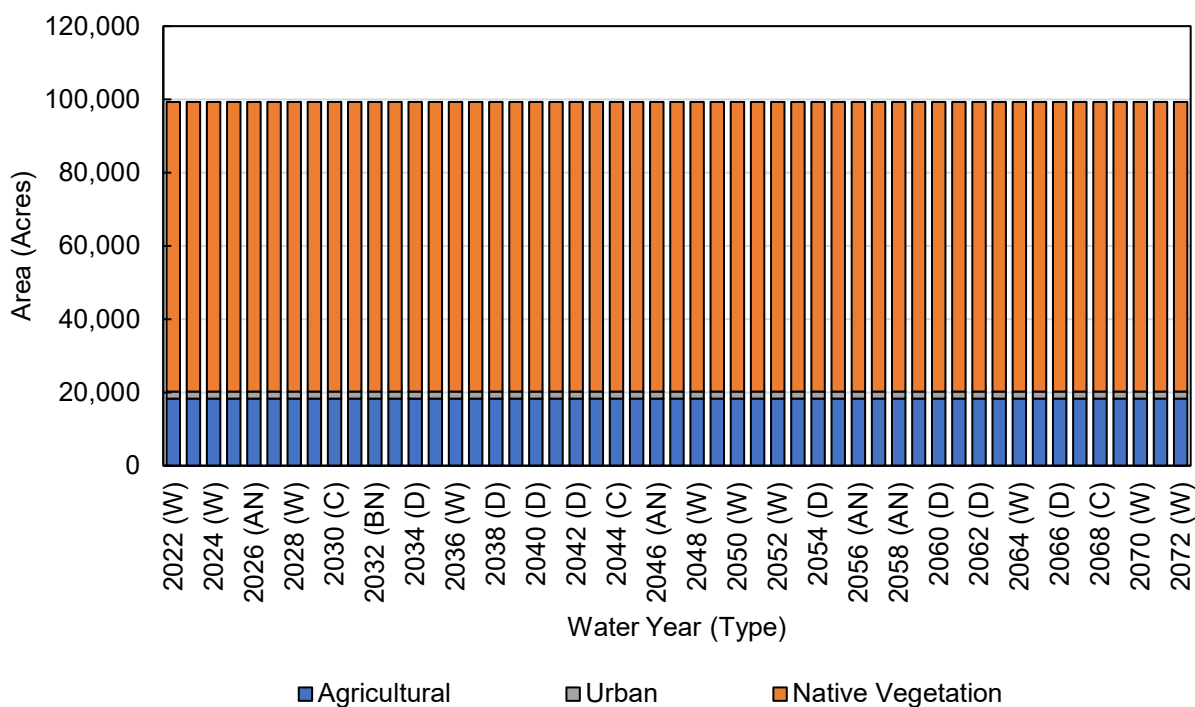
WATER YEAR (TYPE)	NET SEEPAGE	DEEP PERCOLATION	NET SUBSURFACE FLOWS	GROUND- WATER PUMPING	GROUND- WATER UPTAKE	ANNUAL GROUNDWATER STORAGE CHANGE	CUMULATIVE GROUNDWATER STORAGE CHANGE
2059 (W)	84,000	76,000	-87,000	-14,000	-8,600	51,000	-6,900
2060 (D)	22,000	32,000	-92,000	-19,000	-8,600	-62,000	-69,000
2061 (C)	35,000	37,000	-84,000	-27,000	-12,000	-41,000	-110,000
2062 (D)	47,000	32,000	-82,000	-23,000	-9,900	-25,000	-140,000
2063 (BN)	65,000	57,000	-80,000	-17,000	-5,800	25,000	-110,000
2064 (W)	87,000	61,000	-85,000	-14,000	-3,600	47,000	-63,000
2065 (BN)	39,000	31,000	-88,000	-21,000	-3,800	-41,000	-100,000
2066 (D)	46,000	39,000	-86,000	-28,000	-6,100	-29,000	-130,000
2067 (C)	36,000	23,000	-85,000	-31,000	-6,100	-55,000	-190,000
2068 (C)	47,000	37,000	-82,000	-39,000	-3,800	-33,000	-220,000
2069 (BN)	80,000	45,000	-82,000	-26,000	-1,800	20,000	-200,000
2070 (W)	120,000	74,000	-90,000	-20,000	-940	85,000	-120,000
2071 (BN)	59,000	28,000	-95,000	-25,000	-870	-32,000	-150,000
2072 (W)	92,000	71,000	-90,000	-18,000	-2,700	56,000	-93,000
Average (2022-2072)	55,000	52,000	-86,000	-20,000	-7,300	-1,800	
2022- 2072	W	76,000	70,000	-91,000	-16,000	-10,000	33,000
	AN	64,000	61,000	-82,000	-17,000	-7,100	24,000
	BN	52,000	40,000	-86,000	-22,000	-5,400	-16,000
	D	34,000	39,000	-84,000	-22,000	-7,200	-36,000
	C	34,000	32,000	-80,000	-27,000	-3,800	-41,000

### 2.3.8 Projected (Future Land Use) Water Budget Summary

This section presents the results of the Projected (Future Land Use) scenario. The Future Land Use scenario assumes a static (held constant over the entire projected period) land use condition reflecting an anticipated future development or land use condition that is expected to exist at the end of the 50-year GSP planning horizon. The future land use condition was developed through discussion with local stakeholders and consultation with the Tehama County Planning Department. The future land use condition includes an increase in urban area reflective of the recent rate of urban increase experienced for the County.

Land use areas are used to distinguish the water use sector in which water is consumed, as required by the GSP Regulations. **Figure 2-77** and **Table 2-26** summarize the annual land use areas over the projected (future land use) period (2022-2072) in the Los Molinos Subbasin by water use sector, as defined by the GSP Regulations (23 CCR § 351(al)). In the Los Molinos Subbasin, water use sectors include agricultural, urban, and native vegetation land uses. The urban water use sector covers all urban, residential, industrial, and semi-agricultural<sup>7</sup> land uses.

Agricultural, urban, and native vegetation land uses covered approximately 18,000 acres, 1,900 acres, and 79,000 acres, respectively, between 2022 and 2072.



**Figure 2-77. Los Molinos Subbasin Future Land Use Areas, by Water Use Sector**

**Table 2-26. Los Molinos Subbasin Future Land Use Areas, by Water Use Sector (acres)**

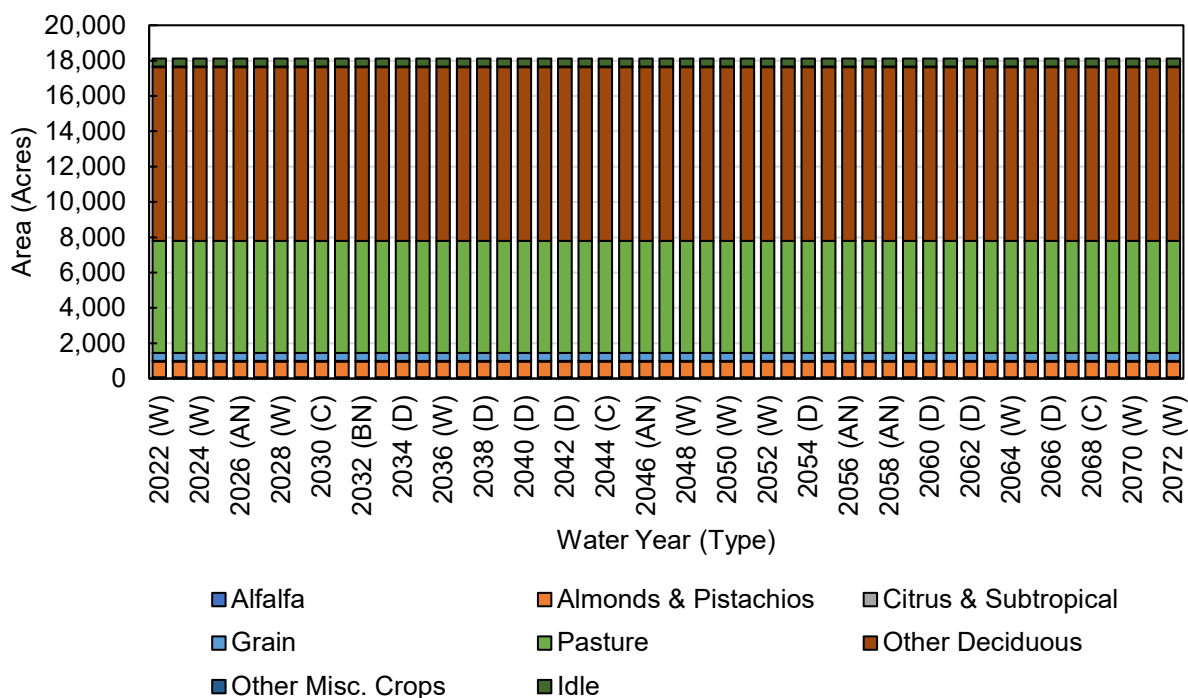
PROJECTED PERIOD (FUTURE LAND USE)	AGRICULTURAL	URBAN <sup>1</sup>	NATIVE VEGETATION	TOTAL
2022 -2072	18,360	1,860	79,070	99,290

<sup>1</sup> Area includes land classified as urban, residential, industrial, and semi-agricultural.

<sup>7</sup> As defined in the DWR crop mapping metadata, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2016b)).



Agricultural land uses are further detailed in **Figure 2-78** and **Table 2-27**. In the future, a majority of the agricultural area in the Los Molinos Subbasin is projected to consist of deciduous crops and pasture. Irrigated agricultural areas within the Los Molinos Subbasin are projected to remain relatively constant at these acreages during the entire projected period.



**Figure 2-78. Los Molinos Subbasin Projected Agricultural Land Use Areas**

**Table 2-27. Los Molinos Subbasin Projected Agricultural Land Use Areas (acres)**

PROJECTED PERIOD (FUTURE LAND USE)	ALFALFA	ALMONDS & PISTACHIOS	CITRUS & SUB TROPICAL	GRAIN	PASTURE	PONDED (RICE, REFUGE)	OTHER DECIDUOUS	OTHER MISC. CROPS	IDLE	TOTAL
2022 - 2072	70	890	40	460	6,330	250	9,840	40	440	18,360

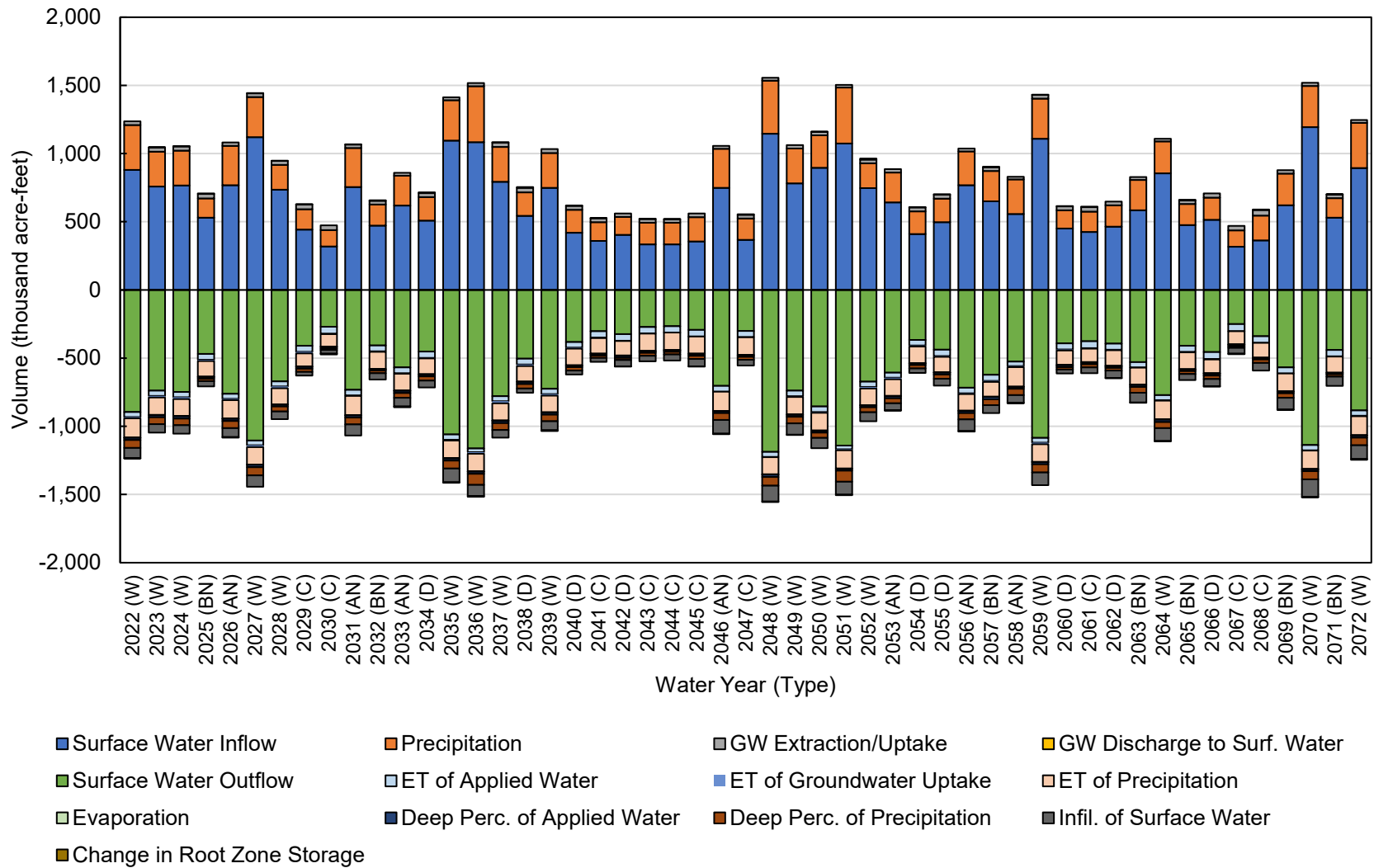
### 2.3.8.1 Projected (Future Land Use) Surface Water System Water Budget Summary

Annual inflows, outflows, and change in SWS root zone storage during the projected (future land use) water budget period (2022-2072) are summarized in **Figure 2-79** and Table **2-28**. Inflows in **Figure 2-79** are shown as positive values, while outflows are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the SWS water budget.

Of particular note in the projected (future land use) SWS water budget results are the volumes of surface water inflows that make up a large part of the Subbasin SWS inflows. Over the projected (future land use) period, surface water inflows to surface water averaged about 650 taf per year. Precipitation also represents a large SWS inflow component averaging about 220 taf per year. Groundwater extraction and uptake represent a small SWS inflow in the Subbasin averaging about 27 taf per year over the projected (current land use) water budget period. Groundwater discharge to surface water is negligible throughout the projected (current land use) period.

Among the outflows from the Subbasin SWS, surface water outflow makes up a large fraction of the total Subbasin SWS outflows. The surface water outflows total about 610 taf per year on average, a value that corresponds with the large volumes of surface water inflow (about 650 taf per year). By comparison, other SWS outflows in the Subbasin are relatively smaller, with values for ET of precipitation about 120 taf per year and ET of applied water totaling about 42 taf per year on average. The outflow of infiltration (seepage) of surface water, deep percolation of precipitation, and deep percolation of applied water are about 63, 38 and 14 taf per year on average, respectively. Together, the outflows from the SWS to the GWS total about 110 taf per year over the historic water budget period. The outflows of ET of groundwater uptake and evaporation from surface water are about 6.1 and 2.3 taf per year, respectively.

Detailed results for the projected (future land use) SWS water budget are presented in **Appendix 2-K**.



**Figure 2-79. Los Molinos Subbasin Surface Water System Projected (Future Land Use) Water Budget, 2022-2072**

**Table 2-28. Los Molinos Subbasin Surface Water System Projected (Future Land Use) Water Budget, 2022-2072 (acre-feet)**

WATER YEAR (TYPE)	INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
	SURFACE WATER INFLOW	PRECIPI- TATION	GROUND- WATER EXTRACTION/ UPTAKE	GROUNDWATER DISCHARGE TO SURFACE WATER	SURFACE WATER OUTFLOW	ET OF APPLIED WATER	ET OF GROUND- WATER UPTAKE	ET OF PRECIPI- TATION	EVAPO- RATION	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2022 (W)	880,000	330,000	26,000	0	890,000	38,000	8,300	140,000	1,900	16,000	58,000	77,000	1,600
2023 (W)	760,000	260,000	30,000	0	740,000	38,000	12,000	130,000	2,200	15,000	50,000	63,000	-2,000
2024 (W)	770,000	260,000	31,000	0	750,000	38,000	13,000	130,000	2,200	16,000	50,000	61,000	-40
2025 (BN)	530,000	140,000	32,000	0	470,000	42,000	9,500	120,000	2,400	12,000	19,000	39,000	-4,000
2026 (AN)	770,000	290,000	26,000	0	760,000	39,000	8,900	140,000	2,100	15,000	51,000	67,000	3,400
2027 (W)	1,100,000	300,000	27,000	0	1,100,000	35,000	13,000	130,000	1,900	17,000	60,000	83,000	-770
2028 (W)	740,000	180,000	30,000	0	670,000	38,000	14,000	120,000	2,200	15,000	35,000	58,000	-1,700
2029 (C)	440,000	150,000	35,000	0	410,000	46,000	10,000	96,000	2,700	14,000	24,000	28,000	-2,600
2030 (C)	320,000	120,000	33,000	0	270,000	50,000	4,100	90,000	2,800	10,000	12,000	27,000	5,900
2031 (AN)	750,000	290,000	24,000	0	730,000	41,000	4,100	140,000	2,100	15,000	51,000	80,000	-990
2032 (BN)	470,000	160,000	26,000	0	410,000	43,000	4,200	130,000	2,300	10,000	19,000	46,000	-3,800
2033 (AN)	620,000	220,000	22,000	0	570,000	41,000	4,000	120,000	2,200	14,000	36,000	63,000	5,000
2034 (D)	510,000	170,000	29,000	0	450,000	46,000	4,400	120,000	2,500	14,000	32,000	50,000	-5,400
2035 (W)	1,100,000	300,000	23,000	0	1,100,000	38,000	6,500	130,000	2,000	15,000	58,000	100,000	3,100
2036 (W)	1,100,000	410,000	22,000	0	1,200,000	27,000	12,000	130,000	1,400	16,000	81,000	83,000	5,400
2037 (W)	790,000	260,000	32,000	0	780,000	37,000	15,000	130,000	2,200	16,000	51,000	57,000	-3,100
2038 (D)	540,000	170,000	33,000	0	500,000	42,000	12,000	110,000	2,500	15,000	33,000	32,000	-5,300
2039 (W)	750,000	260,000	29,000	0	720,000	39,000	11,000	120,000	2,200	15,000	48,000	66,000	4,800
2040 (D)	420,000	170,000	29,000	0	380,000	41,000	8,600	120,000	2,300	12,000	25,000	28,000	-2,400
2041 (C)	360,000	140,000	29,000	0	300,000	46,000	4,400	110,000	2,500	11,000	17,000	29,000	-80

WATER YEAR (TYPE)	INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
	SURFACE WATER INFLOW	PRECIPI- TATION	GROUND- WATER EXTRACTION/ UPTAKE	GROUNDWATER DISCHARGE TO SURFACE WATER	SURFACE WATER OUTFLOW	ET OF APPLIED WATER	ET OF GROUND- WATER UPTAKE	ET OF PRECIPI- TATION	EVAPO- RATION	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2042 (D)	400,000	130,000	24,000	0	320,000	48,000	2,400	110,000	2,600	13,000	16,000	47,000	680
2043 (C)	340,000	160,000	27,000	0	270,000	46,000	1,600	130,000	2,200	12,000	21,000	40,000	-2,100
2044 (C)	330,000	160,000	26,000	0	270,000	46,000	920	130,000	2,200	12,000	20,000	45,000	-50
2045 (C)	360,000	180,000	26,000	0	290,000	48,000	670	130,000	2,300	12,000	23,000	55,000	160
2046 (AN)	750,000	290,000	22,000	0	700,000	41,000	1,300	140,000	2,200	14,000	49,000	100,000	3,100
2047 (C)	370,000	160,000	26,000	0	300,000	45,000	1,400	130,000	2,200	12,000	21,000	43,000	-3,300
2048 (W)	1,100,000	390,000	20,000	0	1,200,000	37,000	2,500	130,000	1,900	16,000	65,000	120,000	3,600
2049 (W)	780,000	260,000	26,000	0	740,000	42,000	4,600	130,000	2,200	14,000	48,000	85,000	220
2050 (W)	900,000	240,000	25,000	0	850,000	42,000	6,000	130,000	2,400	14,000	40,000	74,000	-120
2051 (W)	1,100,000	410,000	20,000	0	1,100,000	28,000	9,200	130,000	1,400	15,000	81,000	94,000	3,400
2052 (W)	750,000	180,000	29,000	0	670,000	37,000	12,000	120,000	2,300	14,000	37,000	66,000	-6,200
2053 (AN)	640,000	220,000	25,000	0	610,000	38,000	10,000	120,000	2,200	15,000	38,000	51,000	3,600
2054 (D)	410,000	170,000	28,000	0	370,000	42,000	7,200	120,000	2,300	12,000	25,000	32,000	-3,100
2055 (D)	500,000	170,000	29,000	0	440,000	46,000	4,900	110,000	2,500	14,000	31,000	50,000	-2,400
2056 (AN)	770,000	250,000	22,000	0	720,000	40,000	5,300	120,000	2,100	15,000	48,000	84,000	4,100
2057 (BN)	650,000	220,000	27,000	0	620,000	45,000	7,000	110,000	2,500	17,000	42,000	59,000	-3,500
2058 (AN)	560,000	250,000	21,000	0	520,000	35,000	6,900	140,000	1,800	13,000	48,000	54,000	4,100
2059 (W)	1,100,000	300,000	25,000	0	1,100,000	35,000	11,000	130,000	2,000	16,000	60,000	92,000	-1,200
2060 (D)	450,000	130,000	28,000	0	390,000	44,000	8,500	110,000	2,600	14,000	18,000	29,000	-290
2061 (C)	430,000	150,000	32,000	0	380,000	50,000	4,500	99,000	2,800	13,000	23,000	42,000	-3,700
2062 (D)	460,000	160,000	26,000	0	390,000	46,000	2,800	110,000	2,500	12,000	20,000	54,000	2,200

WATER YEAR (TYPE)		INFLOWS				OUTFLOWS								CHANGE IN ROOT ZONE STORAGE
		SURFACE WATER INFLOW	PRECIPI- TATION	GROUND- WATER EXTRACTION/ UPTAKE	GROUNDWATER DISCHARGE TO SURFACE WATER	SURFACE WATER OUTFLOW	ET OF APPLIED WATER	ET OF GROUND- WATER UPTAKE	ET OF PRECIPI- TATION	EVAPO- RATION	DEEP PERC. OF APPLIED WATER	DEEP PERC. OF PRECIPI- TATION	INFIL. OF SURFACE WATER	
2063 (BN)		580,000	220,000	21,000	0	530,000	38,000	3,000	120,000	2,100	14,000	43,000	73,000	1,800
2064 (W)		860,000	230,000	20,000	0	770,000	36,000	4,800	140,000	1,900	16,000	44,000	95,000	1,800
2065 (BN)		470,000	160,000	26,000	0	410,000	44,000	4,800	120,000	2,300	11,000	20,000	46,000	-4,700
2066 (D)		510,000	160,000	32,000	0	460,000	51,000	3,000	100,000	2,700	14,000	25,000	53,000	2,600
2067 (C)		320,000	120,000	33,000	0	250,000	51,000	1,200	96,000	2,800	11,000	12,000	43,000	2,100
2068 (C)		360,000	180,000	40,000	0	340,000	49,000	610	110,000	2,500	11,000	25,000	54,000	-5,000
2069 (BN)		620,000	230,000	27,000	0	570,000	44,000	580	130,000	2,300	11,000	34,000	87,000	970
2070 (W)		1,200,000	300,000	23,000	0	1,100,000	40,000	2,000	130,000	2,100	14,000	60,000	130,000	2,000
2071 (BN)		530,000	140,000	27,000	0	440,000	46,000	1,700	120,000	2,500	11,000	17,000	66,000	-2,500
2072 (W)		890,000	330,000	21,000	0	880,000	40,000	2,700	140,000	2,000	15,000	55,000	100,000	6,000
Average (2022-2072)		650,000	220,000	27,000	0	610,000	42,000	6,100	120,000	2,300	14,000	38,000	63,000	30
2022- 2072	W	930,000	290,000	26,000	0	910,000	37,000	8,800	130,000	2,000	15,000	55,000	83,000	940
	AN	690,000	260,000	23,000	0	660,000	39,000	5,800	130,000	2,100	14,000	46,000	71,000	3,200
	BN	550,000	180,000	27,000	0	490,000	43,000	4,400	120,000	2,400	12,000	28,000	59,000	-2,300
	D	470,000	160,000	29,000	0	410,000	45,000	6,000	110,000	2,500	13,000	25,000	42,000	-1,500
	C	360,000	150,000	31,000	0	310,000	48,000	2,900	110,000	2,500	12,000	20,000	41,000	-860

### 2.3.8.2 Projected (Future Land Use) Groundwater System Water Budget Summary

Summarized results for major components of the projected (future land use) water budget as they relate to the GWS are presented in **Figure 2-80** and **Table 2-29**. The positive net seepage values (on average 59 taf per year) and deep percolation values (on average 51 taf per year) represent the major inflows to the GWS. The net subsurface flows average about -89 taf per year represent the combined net subsurface outflows from the Subbasin to adjacent subbasins.

Groundwater pumping (on average -21 taf per year) and groundwater (root water) uptake directly from shallow groundwater (on average -6.1 taf per year) are somewhat smaller outflows from the GWS. Overall, the water budget results for the 51-year projected (future land use) period indicate a cumulative change in groundwater storage of about -100 taf, which equals an average annual decrease in groundwater storage of approximately -2.0 taf per year. This change in storage estimates equate to total decreases in storage in the Subbasin of about 1.0 acre-feet per acre over the 51 years and an annual decrease of about -0.02 acre-feet per acre across the entire Subbasin (approximately 99,000 acres). **Figure 2-80** provides a conceptual illustration of the projected (future land use) water budget. **Figure 2-81** highlights the cumulative change in groundwater storage that would occur during anticipated multi-year wet and dry periods and over the entire projected period.

Detailed results for the projected (current land use) period GWS water budget are presented in **Appendix 2-K**.

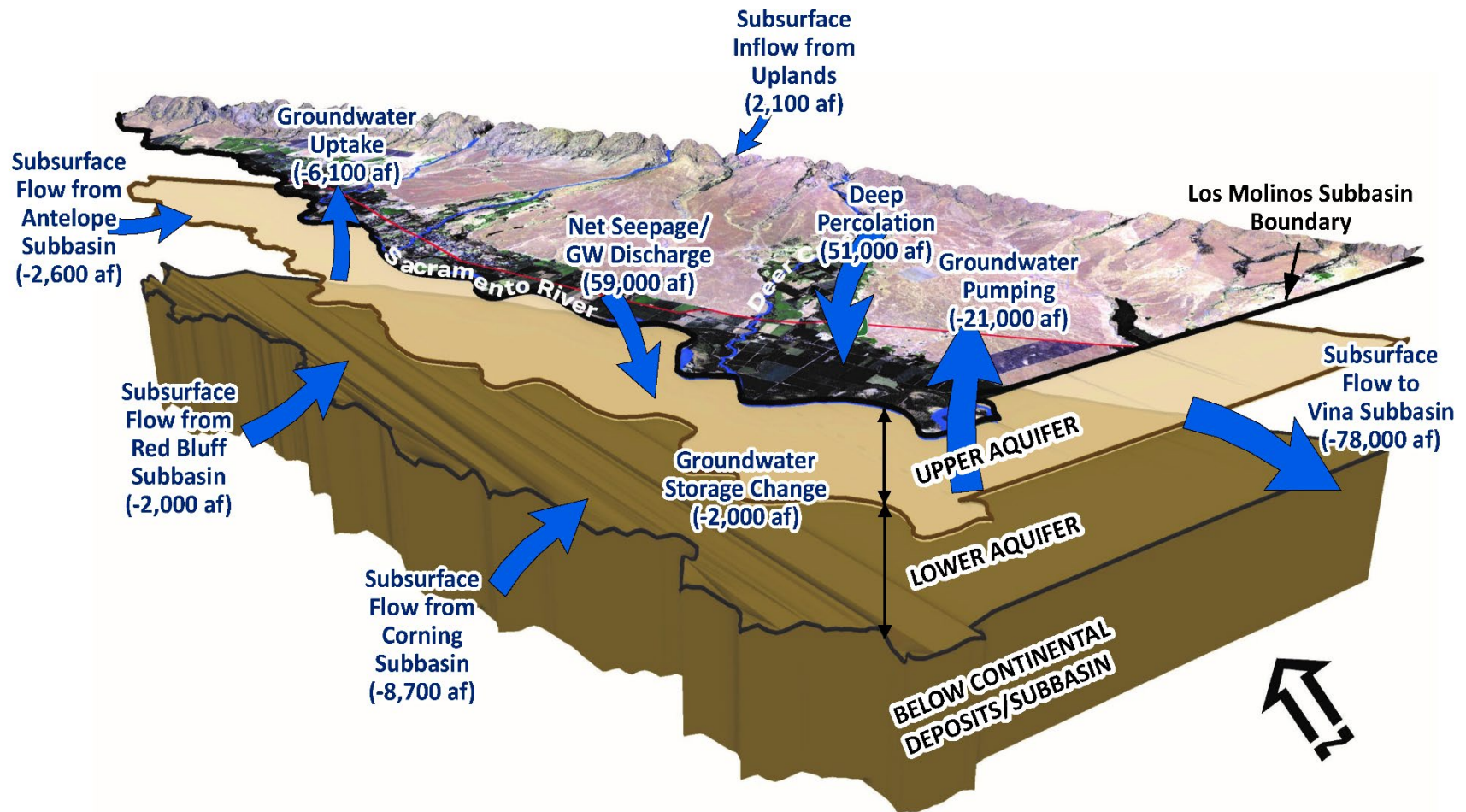
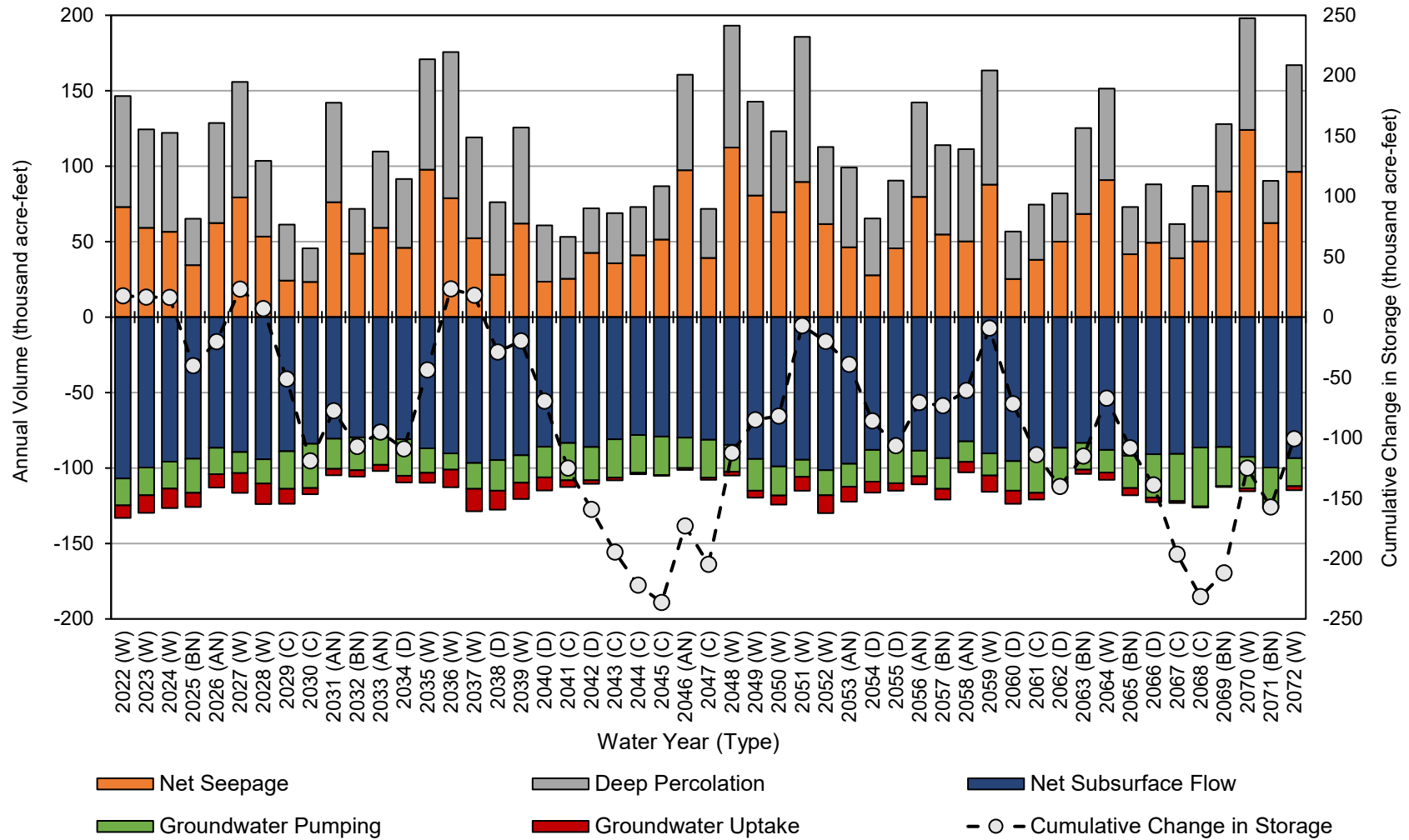


Figure 2-80. Diagram of the Los Molinos Subbasin Projected (Future Land Use) Average Annual Water Budget, 2022-2072





**Figure 2-81. Los Molinos Subbasin Projected (Future Land Use) Water Budget Summary**

**Table 2-29. Los Molinos Subbasin Projected (Future Land Use) Water Budget Summary (acre-feet)**

Water Year (Type)	Net Seepage	Deep Percolation	Net Subsurface Flows	Ground-water Pumping	Groundwater Uptake	Annual Groundwater Storage Change	Cumulative Groundwater Storage Change
2022 (W)	73,000	74,000	-110,000	-18,000	-8,300	18,000	18,000
2023 (W)	59,000	65,000	-100,000	-19,000	-12,000	-1,100	16,000
2024 (W)	57,000	66,000	-96,000	-18,000	-13,000	-200	16,000
2025 (BN)	34,000	31,000	-94,000	-23,000	-9,500	-56,000	-40,000
2026 (AN)	62,000	66,000	-87,000	-17,000	-8,900	20,000	-20,000
2027 (W)	79,000	77,000	-89,000	-14,000	-13,000	44,000	23,000
2028 (W)	53,000	50,000	-94,000	-16,000	-14,000	-16,000	7,000
2029 (C)	24,000	37,000	-89,000	-25,000	-10,000	-58,000	-51,000
2030 (C)	23,000	22,000	-84,000	-29,000	-4,100	-68,000	-120,000
2031 (AN)	76,000	66,000	-81,000	-20,000	-4,100	42,000	-77,000
2032 (BN)	42,000	30,000	-80,000	-22,000	-4,200	-30,000	-110,000
2033 (AN)	59,000	51,000	-80,000	-18,000	-4,000	12,000	-95,000
2034 (D)	46,000	46,000	-81,000	-24,000	-4,400	-14,000	-110,000
2035 (W)	98,000	73,000	-87,000	-16,000	-6,500	65,000	-44,000
2036 (W)	79,000	97,000	-90,000	-11,000	-12,000	67,000	23,000
2037 (W)	52,000	67,000	-97,000	-17,000	-15,000	-5,200	18,000
2038 (D)	28,000	48,000	-95,000	-20,000	-12,000	-47,000	-29,000
2039 (W)	62,000	64,000	-92,000	-18,000	-11,000	9,300	-20,000
2040 (D)	23,000	37,000	-86,000	-20,000	-8,600	-50,000	-70,000
2041 (C)	25,000	28,000	-83,000	-25,000	-4,400	-55,000	-120,000
2042 (D)	43,000	29,000	-86,000	-22,000	-2,400	-34,000	-160,000
2043 (C)	36,000	33,000	-81,000	-26,000	-1,600	-35,000	-190,000
2044 (C)	41,000	32,000	-78,000	-25,000	-920	-27,000	-220,000
2045 (C)	51,000	35,000	-79,000	-25,000	-670	-14,000	-240,000
2046 (AN)	97,000	63,000	-80,000	-20,000	-1,300	63,000	-170,000
2047 (C)	39,000	33,000	-81,000	-25,000	-1,400	-32,000	-200,000
2048 (W)	110,000	81,000	-85,000	-18,000	-2,500	92,000	-110,000
2049 (W)	81,000	62,000	-94,000	-21,000	-4,600	27,000	-85,000
2050 (W)	70,000	53,000	-99,000	-19,000	-6,000	3,100	-82,000
2051 (W)	90,000	96,000	-95,000	-11,000	-9,200	75,000	-7,000
2052 (W)	62,000	51,000	-100,000	-17,000	-12,000	-13,000	-20,000
2053 (AN)	46,000	53,000	-97,000	-15,000	-10,000	-19,000	-39,000
2054 (D)	28,000	38,000	-88,000	-21,000	-7,200	-47,000	-86,000
2055 (D)	46,000	45,000	-86,000	-24,000	-4,900	-21,000	-110,000
2056 (AN)	80,000	63,000	-89,000	-17,000	-5,300	36,000	-71,000
2057 (BN)	55,000	59,000	-94,000	-20,000	-7,000	-2,700	-73,000
2058 (AN)	50,000	61,000	-82,000	-14,000	-6,900	13,000	-61,000

Water Year (Type)	Net Seepage	Deep Percolation	Net Subsurface Flows	Ground-water Pumping	Groundwater Uptake	Annual Groundwater Storage Change	Cumulative Groundwater Storage Change
2059 (W)	88,000	76,000	-90,000	-15,000	-11,000	52,000	-9,100
2060 (D)	25,000	32,000	-95,000	-20,000	-8,500	-63,000	-72,000
2061 (C)	38,000	37,000	-88,000	-28,000	-4,500	-42,000	-110,000
2062 (D)	50,000	32,000	-87,000	-23,000	-2,800	-26,000	-140,000
2063 (BN)	68,000	57,000	-83,000	-18,000	-3,000	25,000	-110,000
2064 (W)	91,000	61,000	-88,000	-15,000	-4,800	48,000	-67,000
2065 (BN)	42,000	31,000	-92,000	-22,000	-4,800	-41,000	-110,000
2066 (D)	49,000	39,000	-91,000	-29,000	-3,000	-31,000	-140,000
2067 (C)	39,000	23,000	-91,000	-31,000	-1,200	-57,000	-200,000
2068 (C)	50,000	37,000	-86,000	-39,000	-620	-35,000	-230,000
2069 (BN)	83,000	45,000	-86,000	-26,000	-570	20,000	-210,000
2070 (W)	120,000	74,000	-93,000	-21,000	-2,000	87,000	-130,000
2071 (BN)	62,000	28,000	-100,000	-25,000	-1,700	-32,000	-160,000
2072 (W)	96,000	71,000	-93,000	-19,000	-2,600	57,000	-100,000
Average (2022-2072)	59,000	51,000	-89,000	-21,000	-6,100	-2,000	
2022-2072	W	79,000	70,000	-94,000	-17,000	-8,800	34,000
	AN	67,000	60,000	-85,000	-17,000	-5,800	24,000
	BN	55,000	40,000	-90,000	-22,000	-4,400	-17,000
	D	38,000	38,000	-88,000	-23,000	-6,000	-37,000
	C	37,000	32,000	-84,000	-28,000	-2,900	-42,000

### 2.3.9 Projected Water Budgets with Climate Change

Additional projected scenarios were developed to model potential climate change scenarios. Climate change scenarios were developed using the DWR guidance for the 2030 and 2070 central tendencies. Additional detail about the development and results of these scenarios can be found in **Appendices 2-J and 2-K**. The climate change scenarios were implemented following DWR's guidance related to the 2030 and 2070 central tendency climate change scenarios and associated adjustment factors applied to model inputs such as precipitation, ET, and surface water inflows. In the Tehama IHM area, the DWR climate change guidance and adjustment factors tend to result in increases in precipitation, ET, and stream flows.

#### 2.3.9.1 Projected (Current Land Use) Water Budget

A comparison of the major components of the projected (current land use) water budget as they relate to the GWS are presented in **Table 2-30**. Net seepage increases under climate change scenarios, indicating greater stream seepage to groundwater. Greater streamflow volumes entering the Subbasin under the climate change scenarios likely results in greater stream seepage although deep percolation and net subsurface flows change little under climate change scenarios. Groundwater pumping increases slightly under climate change scenarios, but the overall water budget results suggest that annual change in storage is only very slightly more negative under the climate change scenarios.

**Table 2-30. Comparison of Annual Projected (Current Land Use)  
GWS Water Budgets with Climate Change Adjustments (acre-feet)**

GWS WATER BUDGET COMPONENT	PROJECTED (CURRENT LAND USE)		
	NO CLIMATE CHANGE ADJUSTMENT	CLIMATE CHANGE (2030)	CLIMATE CHANGE (2070)
Net Seepage	55,000	62,000	67,000
Deep Percolation	52,000	52,000	50,000
Net Subsurface Flows	-86,000	-87,000	-88,000
Groundwater Extractions (Pumping and Uptake)	-27,000	-29,000	-31,000
<b>Annual Groundwater Storage</b>	<b>-1,800</b>	<b>-1,900</b>	<b>-2,100</b>

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.

### 2.3.9.2 Projected (Future Land Use) Water Budget

A comparison of the major components of the projected (future land use) water budget as they relate to the GWS are presented in **Table 2-31**. Overall, the climate change scenarios do not appear to change the overall Subbasin GWS water budget in a considerable way, at similar magnitudes as in the projected (current land use) conditions. Net seepage increases by about 11 taf per year under climate change scenarios, indicating greater stream seepage to groundwater. Deep percolation and net subsurface flows change little under climate change scenarios. Groundwater pumping increases by about 3.0 taf per year under climate change scenarios; however, overall change in storage is only slightly more negative under the climate change scenarios.

**Table 2-31. Comparison of Annual Projected (Future Land Use)  
GWS Water Budgets with Climate Change Adjustments (acre-feet)**

GWS Water Budget Component	Projected (Future Land Use)		
	No Climate Change Adjustment	Climate Change (2030)	Climate Change (2070)
Net Seepage	59,000	66,000	70,000
Deep Percolation	51,000	51,000	49,000
Net Subsurface Flows	-89,000	-91,000	-92,000
Groundwater Extractions (Pumping and Uptake)	-27,000	-28,000	-30,000
<b>Annual Groundwater Storage Change</b>	<b>-2,000</b>	<b>-2,100</b>	<b>-2,300</b>

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.

### 2.3.10 Projected Groundwater Storage Change by Aquifer

This section presents the projected groundwater storage change in the Upper Aquifer and Lower Aquifer under Current Land Use and Future Land Use conditions with and without the climate change conditions. Note that the total water budget numbers presented below by aquifer may differ from the sum of the average annual values because of rounding. Additional detail about the development and results of these scenarios can be found in **Appendices 2-J and 2-K**.

#### 2.3.10.1 Projected (Current Land Use) Storage Change

A comparison of the groundwater storage change under the projected (current land use) conditions with different climate change assumptions is presented in **Table 2-32**. The results suggest reduction of storage is only slightly greater under climate change scenarios, with more of the storage change occurring in the Upper Aquifer. Overall projected storage change in the Subbasin is relatively small and differs little between the various climate change conditions evaluated. The projected average annual storage change decreases range from -1.8 to -2.1 taf per year and are equivalent to very minimal change on a per-acre basis over the 51-year projected period. Projected annual storage changes in the Upper Aquifer range from annual storage decreases of -1.1 to -1.3 taf per year with and without climate change conditions. Storage changes in the Lower Aquifer range from an increase of about -0.73 taf (-730 acre-feet) per year without climate change to -0.9 taf (-900 acre-feet) per year on average with 2070 climate change. The small amounts of change in the entire Subbasin, including individual aquifers, is small and is likely within the range of uncertainty of the water budget results, considering the magnitude of many of the other water budget components. For the projected (current land use) conditions with 2070 climate change factors, storage changes in the Upper and Lower Aquifers equate to annual basin wide storage changes of about -0.02 acre-feet per acre per year on average over the 51 years.

**Table 2-32. Comparison of Projected (Current Land Use) Aquifer-Specific GWS Water Budgets with Climate Change Adjustments**

PROJECTED (CURRENT LAND USE)		AVERAGE ANNUAL CHANGE IN STORAGE			CUMULATIVE CHANGE IN STORAGE		
		UPPER AQUIFER	LOWER AQUIFER	TOTAL	UPPER AQUIFER	LOWER AQUIFER	TOTAL
No Climate Change Adjustment	acre-feet	-1,100	-730	-1,800	-56,000	-37,000	-93,000
	<i>acre-feet per acre</i>	-0.01	-0.01	-0.02	-0.56	-0.37	-0.94
Climate Change 2030	acre-feet	-1,100	-760	-1,900	-58,000	-39,000	-97,000
	<i>acre-feet per acre</i>	-0.01	-0.01	-0.02	-0.58	-0.39	-0.98
Climate Change 2070	acre-feet	-1,300	-900	-2,100	-66,000	-44,000	-110,000
	<i>acre-feet per acre</i>	-0.01	-0.01	-0.02	-0.66	-0.44	-1.1

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.

### 2.3.10.2 Projected (Future Land Use) Water Budget

A comparison of the groundwater storage change under the projected (future land use) conditions with different climate change assumptions is presented in **Table 2-33**. As with the projected (current land use) water budget results, the results suggest reduction of storage is only slightly greater under climate change scenarios, with more of the storage change occurring in the Upper Aquifer. Overall projected storage change in the Subbasin is relatively small and differs little between the various climate change conditions evaluated. The projected average annual storage change decreases range from -2.0 to -2.3 taf per year and are equivalent to very minimal change on a per-acre basis over the 51-year projected period. Projected annual storage changes in the Upper Aquifer range from annual storage decreases of -1.2 to -1.4 taf per year with and without climate change conditions. Storage changes in the Lower Aquifer range from an increase of about -0.81 taf (-810 acre-feet) per year without climate change to -0.96 taf (-960 acre-feet) per year on average with 2070 climate change. The small amounts of change in the entire Subbasin, including individual aquifers, is small and is likely within the range of uncertainty of the water budget results, considering the magnitude of many of the other water budget components. For the projected (future land use) conditions with 2070 climate change factors, storage changes in the Upper and Lower Aquifers equate to annual basin wide storage changes of about -0.02 acre-feet per acre per year on average over the 51 years.

**Table 2-33. Comparison of Projected (Future Land Use)  
Aquifer-Specific GWS Water Budgets with Climate Change Adjustments**

PROJECTED (CURRENT LAND USE)		AVERAGE ANNUAL CHANGE IN STORAGE			CUMULATIVE CHANGE IN STORAGE		
		UPPER AQUIFER	LOWER AQUIFER	TOTAL	UPPER AQUIFER	LOWER AQUIFER	TOTAL
No Climate Change Adjustment	acre-feet	-1,200	-810	-2,000	-59,000	-41,000	-100,000
	<i>acre-feet per acre</i>	-0.01	-0.01	-0.02	-0.59	-0.41	-1.0
Climate Change 2030	acre-feet	-1,200	-850	-2,100	-62,000	-43,000	-105,000
	<i>acre-feet per acre</i>	-0.01	-0.01	-0.02	-0.62	-0.43	-1.1
Climate Change 2070	acre-feet	-1,400	-960	-2,300	-70,000	-49,000	-120,000
	<i>acre-feet per acre</i>	-0.01	-0.01	-0.02	-0.71	-0.49	-1.2

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.

## 2.3.11 Uncertainty in Water Budget Estimates

### 2.3.11.1 Uncertainty in SWS Water Budget

Uncertainties associated with each SWS water budget component have been computed or estimated following the process described by Clemmens and Burt (1997). In summary:

1. The uncertainty of each independently-estimated water budget component (excluding the closure term) is calculated or estimated as a percentage that approximately represents a 95 percent confidence interval for the average annual component volume of the component. Uncertainty percentages are based on the accuracy of measurement devices, the uncertainty of supporting calculations and estimation procedures, and professional judgement.
2. Assuming random, normally-distributed error, the standard deviation is calculated for each independently-estimated component as the average uncertainty on a volumetric basis (uncertainty percentage multiplied by the average annual component volume) divided by two.
3. The variance is calculated for each independently-estimated component as the square of the standard deviation.
4. The variance of the closure term is estimated as the sum of variances of all independently-estimated components.
5. The standard deviation of the closure term is estimated as the square root of the sum of variances.
6. The 95 percent confidence interval of the closure term is estimated as twice the estimated standard deviation.

Estimated uncertainties were calculated following the above procedure for the Subbasin water budget and all GSA water budgets. **Table 2-34** provides a summary of typical uncertainty values associated with major SWS inflows and outflows, along with the sources of these uncertainty values. For surface water flows, deliveries, and diversions, the uncertainty is estimated based on typical accuracy of streamflow gages and measurement devices. For IDC root zone water budget inflows and outflows, the uncertainty is based on typical accuracies given in technical literature and the cumulative estimated accuracy of all inputs used to calculate the components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

**Table 2-34. Estimated Uncertainty of Major Water Budget Components**

FLOWPATH DIRECTION (RELATIVE TO SWS)	WATER BUDGET COMPONENT	DATA SOURCE	ESTIMATED UNCERTAINTY (%)	SOURCE
Inflows	Surface Water Inflows	Measurement	5% <sup>1</sup>	Accuracy of USGS streamflow gages, with adjustment for infiltration and evaporation of inflows upstream/downstream of nearest measurement site.
	Deliveries	Measurement	6%	Required delivery measurement accuracy for Reclamation contractors, per the USGS 2017 Standard Criteria for Agricultural Water Management Plans)
	Water Rights Diversions	Measurement/ Estimate	10%	Required diversion measurement accuracy, per California Senate Bill 88.
	Precipitation	Calculation	20% <sup>2</sup>	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Calculation	20%	Typical uncertainty when calculated for Land Surface System water budget closure. The uncertainty of the accounting center closure is a product of the combined uncertainty of all other inflows and outflows, and the relative magnitude of each component.
Outflows	Surface Water Outflows	Measurement	15%	Estimated streamflow measurement accuracy with adjustment for infiltration and evaporation.
	Evaporation	Calculation	20%	Clemmens and Burt, 1997; typical accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Clemmens and Burt, 1997; typical accuracy of total irrigation water consumption on irrigated land, parsed into ET of Applied Water and ET of Precipitation by daily root zone water budget component based on reference ET, precipitation, surface energy balance crop coefficients, and annual land use.



FLOWPATH DIRECTION (RELATIVE TO SWS)	WATER BUDGET COMPONENT	DATA SOURCE	ESTIMATED UNCERTAINTY (%)	SOURCE
	ET of Precipitation	Calculation	10% <sup>2</sup>	Clemmens and Burt, 1997; accuracy of total water consumption on irrigated land, parsed into ET of Applied Water and ET of Precipitation by daily root zone water budget component based on reference ET, precipitation, surface energy balance crop coefficients, and annual land use.
	Infiltration of Applied Water	Calculation	20% <sup>2</sup>	Estimated accuracy of daily IDC root zone water budget based on annual land use and NRCS soils characteristics. Similar accuracy anticipated for monthly results.
	Infiltration of Precipitation	Calculation	20% <sup>2</sup>	Estimated accuracy of daily IDC root zone water budget based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Typical accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data compared to field measurements.

<sup>1</sup> Higher uncertainty of 10-20 percent is typical for estimated surface water inflows, including ungaged inflows from small watersheds into creeks that enter the Subbasin.

<sup>2</sup> IDC root zone water budget inflows and outflows. The uncertainty of these water budget components is based on typical accuracies given in technical literature and the cumulative estimated accuracy of all inputs used to calculate the components.

### 2.3.11.2 [GWS Water Budget Uncertainty](#)

Uncertainty associated with the GWS water budget results estimated using the Tehama IHM depends in part on the model inputs relating to the SWS with additional sources of uncertainty associated with model inputs relating to the GWS, including aquifer and streambed properties, specification of boundary conditions, and other factors. The uncertainty estimates associated with SWS water budget components that are also inputs or outputs of the GWS water budget are noted above. The overall uncertainty of other water budget components simulated for the GWS, including subsurface flows, groundwater discharging to surface water, and change in groundwater storage are estimated to be slightly higher, in the range of 15 to 30 percent. These GWS water budget components are subject to higher uncertainty as a result of limitations in available input data and simplification required in modeling of the subsurface heterogeneity. However, the uncertainty in GWS water budget results derived from a numerical model such as the Tehama IHM depends to a considerable degree on the calibration of the model and can vary by location and depth within the Subbasin. The Tehama IHM is a product of local refinement and improvements made to the SVSim model and calibration at a more local scale. The Tehama IHM simulates the integrated groundwater and surface water system and metrics relating to the calibration of the model indicate the model is reasonably well calibrated in accordance with generally accepted professional guidelines and is

sufficient for GSP-related applications. The calibration and sensitivity of the model and different model parameters are presented in **Appendix 2-J**.

### 2.3.12 Estimate of Sustainable Yield

GSP Regulations require the GSP quantify the sustainable yield for the Subbasin. Sustainable yield is defined as “the maximum quantity of water, calculated over a base period representative of long term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result” (CWC Section 10721(w)). Historical and projected model results show that the conditions in the Subbasin under the historical and anticipated future land use conditions and hydrology, including with potential climate change conditions (2030 and 2070), will not cause the occurrence of undesirable results in the Subbasin over the 50-year GSP planning period based on sustainability indicator Minimum Thresholds (MTs) developed for the Subbasin.

Over the historical base period, the average annual volume of groundwater pumping in the Los Molinos Subbasin is estimated to be about 16,000 acre-feet per year. An additional 17,000 acre-feet of groundwater is estimated to be taken up and consumed directly by plants reflecting a total historical groundwater extraction volume of about 33,000 acre-feet per year on average. Observed groundwater level conditions and simulated water budget results suggest there has been little or no historical long-term change in groundwater storage in the Subbasin. Under the projected scenarios (current land use and future land use conditions) without climate change, total groundwater extraction (combination of groundwater pumping and uptake) within the Subbasin decreases overall, although the groundwater pumping component increases by about 4,000 acre-feet per year to about 20,000 acre-feet per year while direct groundwater uptake decreases to between 6,000 and 7,000 acre-feet per year. Under the projected climate change scenarios groundwater pumping ranges from about 22,000 to 25,000 acre-feet per year with groundwater uptake between 5,000 and 7,000 acre-feet per year. The groundwater extraction water budget component is a relatively smaller water budget component in comparison to the net seepage, deep percolation, and subsurface flow water budget components. Notably, projected groundwater extractions are considerably less than the projected GWS inflows of stream seepage and deep percolation which total to between 107,000 and 119,000 acre-feet per year, depending on the water budget land use and climate scenario. Considerable net subsurface outflows to adjacent subbasin of about 76,000 to 92,000 acre-feet per year are also projected to occur. Under all of the projected scenarios, the change in storage is simulated to be very small or practically zero, recognizing typical uncertainty associated with water budget estimates and the magnitude of other water budget components

Accordingly, for the purpose of the GSP, the sustainable yield is estimated to be 28,000 acre-feet per year, which is equal to the volume of groundwater extracted annually in the Subbasin (by pumping and by uptake) minus the simulated annual decrease in storage under the projected model scenario with future land use and 2070 climate change conditions and considering the level of uncertainty associated with water budget estimates. This volume is well below the annual volume of vertical inflows (stream seepage and deep percolation) occurring within the Subbasin as a result of water infiltrating from the SWS into the GWS. Assuming potential uncertainty of 25 percent associated with the water budget estimates, an associated range of values for the estimated sustainable yield would be 21,000 to 35,000 acre-feet per

year. It is possible that the true sustainable yield is higher as no model scenarios were developed to test the maximum possible volume of groundwater extraction. The sustainable yield estimate provided here is consistent with the sustainability goal for the Subbasin and will be reviewed as the Subbasin implements the GSP, including through periodic review and updates to the Tehama IHM and water budget results and ongoing monitoring of Subbasin conditions as required by GSP Regulations.

## 2.4 References

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