water use and/or stream flows to assess implications on the fisheries and wildlife. Monthly water budgets are typically used to demonstrate variability in agricultural water demand during the irrigation season, or monthly and seasonal variability in surface water supply and/or groundwater pumping. The water budget estimates for the Turlock Subbasin GSP have been developed on a monthly time step. However, the water budgets, for purposes of presentation and policy decisions, are presented on annual basis.

DWR's regulations under the SGMA require that annual water budgets be based on three different levels of development: historical, current, and projected conditions. Water budgets are developed to capture long-term conditions, averaging hydrologic conditions over several different timeframes: The historical water budgets reflect the average over a 25-year hydrologic period, an average year from the historical period is selected to represent current conditions, and the average of a 50-year hydrologic period is used to represent projected conditions. This provides opportunities to incorporate dry years and drought conditions, wet periods, and normal periods. By incorporating these varied conditions within the water budgets, analysis of the system under certain hydrologic conditions, such as drought, can be performed along with analysis of long-term averages. The following subsection provides additional detail on identification of hydrologic periods.

5.1.1. Identification of Hydrologic Periods

Hydrologic periods were selected to meet the needs of developing historical, current, and projected water budgets. The regulations require that the projected conditions are assessed based on a 50-year hydrologic period to represent long-term hydrologic conditions. Precipitation for the Turlock Subbasin was used to identify hydrologic periods that would provide a representation of wet and dry periods and long-term average conditions needed for water budget analyses.

Rainfall data for the Subbasin is derived from the detailed dataset provided by the Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) (PRISM, 2010). This data set is commonly used by the State DWR and other organizations for mapping the spatial and temporal distribution of precipitation throughout the state. The DWR uses PRISM for the California Simulation of Evapotranspiration of Applied Water (CALSIMETAW) model, a major source of calculation of ET of applied water (ETAW) throughout the state. Identification of periods with a balance of wet and dry periods was performed by evaluating the cumulative departure from mean precipitation. **Figure 5-2** shows the annual and cumulative departure from mean precipitation for the Turlock Subbasin. While the annual rainfall and precipitation data provides information on annual variability of rainfall over the course of the planning period, the cumulative departure from mean is indicative of the long-term trends in the precipitation conditions in the Subbasin. In this context, the rising limbs of the cumulative departure line is indicative of short-term and long-term wet periods (e.g., 1978-83 and 1991-97), and the falling limbs are indicative of short-term and long-term dry periods (e.g., 1976-77 and 2011-15). For the Turlock Subbasin water budget analysis, rainfall and water supply and demand conditions are available for the period from October 1968 to September 2018 (WY 1969-2018), with an average annual rainfall of 11.6 inches. For historical water budget analysis, the period WY 1991-2015 (average annual precipitation of

11.5 inches) is used, which coincides with the period that the C2VSimTM (described in **Section 5.1.2**) model is calibrated for, and the historical water demand and supplies have been confirmed for the model. This meets the GSP regulatory requirement of at least 10 years of record for historical water budget analysis. For the projected water budget purposes, the full period of WY 1969-2018 is used, which provides a 50-year record as required by the regulations. In addition, a climate change water budget has been developed to evaluate the projected water budget under future climate change conditions.

5.1.2. Usage of C2VSimTM and Associated Data in Water Budget Development

Water budgets were developed utilizing the C2VSimTM, a fully integrated surface and groundwater flow model covering the entire Central Valley. This version of the model is based on the full C2VSimFG BETA2 model released by the DWR. The C2VSimFG is refined for land and water use and operational data for both the Turlock and Modesto Subbasins, with some limited refinements in the Merced Subbasin area to address any boundary condition effects. The C2VSimTM, a quasi-three-dimensional finite element model, was developed using the Integrated Water Flow Model (IWFM) 2015 software package to simulate the relevant hydrologic processes prevailing in the Region. The C2VSimTM integrates the groundwater aquifer with the surface hydrologic system and land surface processes and operations. Using data from federal, state, and local resources, the C2VSimTM was calibrated for the hydrologic period of October 1991 to September 2015 by comparing simulated evapotranspiration, groundwater levels, and streamflow records with historical observed records. Development of the model involved the study and analyses of hydrogeologic conditions, agricultural and urban water demands, agricultural and urban water supplies, and an evaluation of regional water quality conditions. Additional detail on the data used to develop the C2VSimTM, which represents the best available data known at this time, is included in **Appendix D**.

All integrated hydrologic models contain assumptions and some level of uncertainty. They are decision support tools used to better understand complex interactive systems. Sources of model uncertainty include heterogeneity in hydrogeologic properties and stratigraphy, quality of historical data, projections of future land use, hydrology, operational data, and climatic conditions.

The C2VSimTM model has been calibrated and validated. The data and assumptions for Turlock and Modesto Subbasins were developed in a collaborative manner with the respective GSAs and are based on best available data and science. Projections of future land use and water demands were based on the most recent planning documents prepared by agencies in the Subbasin. The model in its current form represents the best available representation of the Subbasin. As additional information is collected during GSP implementation, the model will be updated to reflect the newly available data. Efforts to address Subbasin data gaps will improve information available for the model.

With the C2VSimTM as the underlying framework, model simulations were developed to allow for the estimation of water budgets. Four model simulations were used to develop the water budgets for historical, current, and projected conditions, which are discussed in detail below:

- The **historical water budget** is based on a simulation of historical conditions in the Turlock Subbasin.
- The **current water budget** is based on an average year of the historical simulation that incorporates current irrigation and operational practices.
- The **projected water budget** is based on a simulation of future land and water use over the historical hydrologic conditions.
- The **climate change water budget** is based on the projected water budget under 2070 climate conditions. The development of this water budget is described in **Section 5.2** below.

5.1.3. Water Budget Definitions and Assumptions

Definitions and assumptions for the historical, current, and projected water budgets are provided below.

5.1.3.1. Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to WY type. The historical calibration of the C2VSimTM was last updated to reflect the historical conditions in the Turlock Subbasin through WY 2015. The hydrologic period of WY 1991 through 2015 is selected for the GSP historical water budget based on input from the Technical Advisory Committee (TAC) because it provides a period of representative hydrology, while capturing recent Subbasin operations. The period WY 1991 through 2015 has an average annual precipitation of approximately 11.5 inches, compared to the long-term average of 11.6 inches for the 50-year projected hydrologic period of WY 1969-2018 and includes the recent WY 2012-2015 drought, the wetter years of WY 2010-2011, and periods of normal precipitation.

5.1.3.2. Current Water Budget

The current conditions water budget uses recent historical conditions. The WY 2010 was selected to represent current conditions because it was the last normal water year before the 2012-2015 drought. It represents the current level of development with current agricultural irrigation practices, land use, and urban water use under non-drought conditions and reflects most recent average surface water usage. The average water budget inflows and outflows are taken from WY 2010 of the historical model.

5.1.3.3. Projected Water Budget

The projected water budget is intended to assess the conditions of the Subbasin under projected water supply, agricultural and urban demand, and operational conditions. The Projected Conditions Baseline scenario applies future land and water use conditions to the 50-year hydrologic period of WY 1969-2018. The Projected Condition Baseline assumes 2015 land use development. Urban supplies and demands rely on UWMP projections. Agricultural land use and cropping mix remain at 2015 land use with updated irrigation practices which translates to increased irrigation efficiency.

The Projected Conditions Baseline includes the following conditions:

- Hydrologic period:
  - WY 1969-2018 (50-year hydrology)
- River flow is based on:
  - Tuolumne River: Tuolumne River System (TRS) operations model
  - Merced River: Merced Irrigation District Hydrologic and Hydraulic Optimization (MIDH2O) Model
  - San Joaquin River: CalSim II baseline operations
- Stream-Aquifer Interaction:
  - The water budget analysis refers to stream-aquifer interaction for the three main river systems in the Subbasin (Tuolumne, Merced, and San Joaquin Rivers). These rivers may be referred to as “rivers” or “streams” interchangeably.
  - The contributions to the Subbasin groundwater system from the upper watersheds outside of the Subbasin boundary (such as Dry Creek) are captured as surface and subsurface flows from the Small Watersheds as simulated by the C2VSimTM. These are typically referred to as “tributary” streams.
  - Contributions to the Subbasin from other watersheds that originate within the model area (such as Mustang and Sand Creek) are quantified in the C2VSimTM and are included in the water budget section as a combination of “percolation” and/or “runoff”.
- Land use is based on:
  - 2015 land use and cropping patterns held constant
- Agricultural water demand is based on:
  - IWFM Demand Calculator (IDC) estimates of current land use and modern irrigation practices
  - 2015 AWMP
- Surface water deliveries are based on data from:
  - Tuolumne River System (TRS) operations model
  - Local surface water delivery data from other entities located within the Turlock Subbasin, and in the neighboring subbasins
- Urban water demand is based on:

- 2015 Urban Water Management Plans (UWMPs)

- Urban water supply is based on:
    - Projected urban groundwater production based on 2015 UWMPs distributed to existing wells

Table 5-1: Summary of Groundwater Budget Assumptions

Water Budget Type	Historical	Current	Projected
Tool	C2VSimTM	C2VSimTM	C2VSimTM
Scenario	Historical Simulation	Current Conditions Baseline	Projected Conditions Baseline
Hydrologic Years	WY 1991-2015	WY 2010	WY 1969-2018
Level of Development	Historical	Current Conditions	General Plan buildout
Agricultural Demand	Historical Records	Current Conditions	Projected based on 2015 land use and modern irrigation practices
Urban Demand	Historical Records	Current Conditions	Projected based on local UWMP data
Water Supplies	Historical Records	Current Conditions	Projected based on local reservoir operations model

5.1.4. Water Budget Estimates

The primary components of the stream system are:

Inflows:

- Stream inflows into the Tuolumne River and Merced River at the boundary of the model and San Joaquin River inflows at the confluence of the Merced and San Joaquin River (bounding the Turlock Subbasin)
- Tributary inflows from surface water contributions from small watersheds above the subbasin
- Operational outflow from the TID canal system to the stream system
- Stream gain from the groundwater system

- Surface runoff from precipitation to the stream system. Runoff is equal to precipitation minus infiltration
- Return flow of applied water to the stream system.

Outflows:

- San Joaquin River outflows after the confluence with the Tuolumne River
- Diverted surface water into canal distribution systems
- Stream seepage to groundwater system
- Native & riparian uptake from streams which is evapotranspiration from native vegetation along the riverbank

Since the stream system includes the rivers bordering the Turlock Subbasin, including their inflows, outflows, and interactions with neighboring Subbasins, the stream system water budget is only presented at a Subbasin scale.

The primary components of the land surface system are:

Supplies:

- Precipitation
- Surface water supplies
- Groundwater supplies
- Native and riparian uptake from streams which is evapotranspiration from native vegetation along the riverbank

Demands:

- Evapotranspiration
- Surface runoff from precipitation to the stream system. Runoff is equal to precipitation minus infiltration.
- Return flow from applied water to the stream system. Return flow is applied water that is not taken up by crops, percolated, or stored in the root zone system and flows to the stream system.
- Percolation of water from the root zone to the groundwater system. Percolation in the urban areas is primarily due to the precipitation and applied water for outdoors water use, parks, cemeteries, and other open areas within the urban sphere of influence. Percolation from other sources such as rock wells, retention basins, and underground storage tanks are estimated based on the available data for each municipality.

Land surface system balance

The primary components of the groundwater system are:

Inflows:

- Deep percolation of water from the root zone/unsaturated zone to the aquifer
- Stream seepage from the Tuolumne, Merced, and San Joaquin Rivers.
- Subsurface inflow from neighboring subbasins and the foothills

Outflows:

- Groundwater discharge to stream system
- Groundwater production (pumping) by private wells for agriculture, by TID for agricultural delivery and drainage, and by municipal and private domestic wells for urban/residential water supply.
- Subsurface outflow to neighboring subbasins

Change in groundwater storage. A negative value represents depletion of the groundwater storage.

The estimated water budgets are provided below in **Table 5-2** through **Table 5-9**, with additional description regarding the details of the budget described in the remainder of **Section 5.1**. Each table provides the estimated historical, current, and projected average annual water budgets.

The water budget is divided into three systems, a stream system (**Table 5-2**), a land system (**Table 5-3** to **Table 5-5**) and a groundwater system (**Table 5-6** to **Table 5-9**). Where applicable, additional detail is provided beyond the subbasin level, to estimate the water budgets for each GSA. For ease of review, the tables are grouped together by system. The land surface system and groundwater system budgets are presented for the entire Subbasin and for each GSA (WTSGSA and ETSGSA). The complexity of stream system as each river and stream system traverses through the east and west GSAs does not allow for simplified disaggregation of this system between the east and west GSAs.

Note that the historical water budget tables represent estimated annual averages over the period WY 1991-2015 and the projected water budget tables present the estimated annual averages for the period WY 1969-2018. The data contained in these tables are further described in **Section 5.1.4.1** (Historical Water Budget), **Section 5.1.4.**2 (Current Water Budget) and **Section 5.1.4.3** (Projected Water Budget) below. Information for the climate change water budget is detailed in **Section 5.2** and a sustainable yield analysis water performed using the water budget data and is described in **Section 5.3**.

Table 5-2: Average Annual Water Budget – Stream Systems, Turlock Subbasin (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Stream Inflows	2,342,500	1,747,200	2,563,800
Merced River below Merced Falls	917,300	762,300	942,900
Tuolumne River below La Grange	725,000	585,300	799,900
San Joaquin River upstream of Merced River Confluence	700,200	399,600	821,000
Tributary Inflow[1]	5,400	100	4,700
Operational Outflows	65,100	80,400	48,400
Outflows into Merced River	10,200	16,200	7,500
Outflows into Tuolumne River	16,600	8,100	12,300
Outflows into San Joaquin River	38,400	56,000	28,500
Stream Gain from Groundwater	241,000	191,000	143,400
Turlock Subbasin	118,100	93,300	71,000
Merced River - North[2]	18,100	12,500	4,300
Tuolumne River - South	55,600	43,700	31,300
San Joaquin River - East	44,400	37,100	35,400
Other Subbasins	122,900	97,700	72,400
Merced River - South	17,000	11,800	3,100
Tuolumne River - North	50,600	39,100	26,700
San Joaquin River - West	55,300	46,700	42,600
Surface Runoff to the Stream System[3]	82,200	54,000	109,800
Return Flow to Stream System[3]	99,100	85,800	108,400
Other Flows[4]	19,700	18,800	17,800
Total Inflow	**2,855,000**	**2,177,300**	**2,996,300**
San Joaquin River Outflows	2,104,400	1,321,800	2,117,800
Diverted Surface Water[5]	601,200	680,700	620,800
Stream Seepage to Groundwater	119,500	139,100	216,200
Turlock Subbasin	61,500	72,300	109,400
Merced River - North	35,400	38,800	64,600
Tuolumne River - South	20,200	30,000	37,500
San Joaquin River - East	5,900	3,500	7,300
Other Subbasins	58,000	66,800	106,800
Merced River - South	30,100	31,600	59,400
Tuolumne River - North	20,300	30,300	37,800
San Joaquin River - West	7,700	4,900	9,600
Native & Riparian Uptake from Streams	29,900	35,700	41,500
Total Outflow	**2,855,000**	**2,177,300**	**2,996,300**

1 Tributary inflow include surface water contributions from small watersheds and Orestimba Creek.

2 Represents the location of the Turlock Subbasin relative to the stream, i.e., "North" represents the gains/losses of that stream to the Turlock Subbasin to the North.

3 Includes runoff/return flow from all subbasins adjacent to the stream system, not just the Turlock Subbasin.

4 Other flows are a closure term that captures the stream system including gains and losses not directly measured or simulated within IWFM. Some of these features include but may not be limited to direct precipitation, evaporation, unmeasured riparian diversions and return flow, temporary storage in local lakes and regulating reservoirs, and inflow discrepancies resulting from simulating impaired flows.

5 This does not include diversions for Turlock, Modesto, or Merced Irrigation Districts as their diversion point is upstream of the subbasin boundary. However, it includes riparian diversions from Merced, Tuolumne, and San Joaquin Rivers, as well as other diversions on San Joaquin River to Delta Mendota Subbasin.

Table 5-3: Average Annual Water Budget – Land Surface System, Turlock Subbasin (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	226,000	193,900	237,500
Agricultural Water Supply	786,500	810,300	777,700
Agency Surface Water	437,800	448,600	439,500
Agency Groundwater	79,200	60,200	51,300
Private Groundwater	269,700	301,300	287,000
Urban Areas Precipitation	34,900	33,800	41,900
Urban Water Supply	55,500	52,800	75,800
Groundwater	55,500	52,800	75,800
Surface Water	-	-	-
Native Areas Precipitation	74,100	51,100	61,200
Native & Riparian Uptake from Stream	8,000	11,900	12,600
Total Supplies	**1,185,200**	**1,153,600**	**1,206,800**
Agricultural ET	716,500	724,300	745,300
Agricultural ET of Precipitation	140,400	132,500	147,600
Agricultural ET of Surface Water	293,400	303,700	320,600
Agricultural ET of Agency Groundwater	63,900	45,000	38,000
Agricultural ET of Private Groundwater	218,800	243,000	239,100
Agricultural Percolation	263,700	249,500	234,400
Agricultural Percolation of Precipitation	62,400	46,100	56,900
Agricultural Percolation of Surface Water	130,900	137,300	118,100
Agricultural Percolation of Agency Groundwater	22,900	18,800	12,200
Agricultural Percolation of Private Groundwater	47,500	47,300	47,200
Agricultural Runoff & Return Flow	20,200	13,200	31,600
Urban Runoff & Return Flow	56,200	53,200	72,300
Urban ET	29,200	28,500	33,500
Urban Percolation	5,100	5,300	11,700
Native Runoff	5,200	1,100	11,900
Native ET	64,400	54,200	55,300
Native Percolation	11,800	6,200	6,500
Total Demands	**1,172,300**	**1,135,500**	**1,202,500**
Land Surface System Balance	**12,900**	**18,100**	**4,300**
Land Surface System Balance (% of supplies)	1.1%	1.6%	0.4%

Table 5-4: Average Annual Water Budget – Land Surface System, West Turlock GSA (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	146,500	122,700	145,000
Agricultural Water Supply	563,300	564,900	519,500
Agency Surface Water	426,300	436,100	429,100
Agency Groundwater	79,200	60,200	51,300
Private Groundwater	57,500	68,000	38,800
Urban Areas Precipitation	32,100	31,200	38,300
Urban Water Supply	53,800	51,700	75,000
Groundwater	53,800	51,700	75,000
Surface Water	0	0	0
Native Areas Precipitation	18,800	14,500	16,800
Native & Riparian Uptake from Stream	5,200	8,400	9,700
Total Supplies	**819,400**	**792,800**	**804,000**
Agricultural ET	477,100	465,000	471,800
Agricultural ET of Precipitation	87,900	80,100	92,600
Agricultural ET of Surface Water	283,800	293,100	311,800
Agricultural ET of Agency Groundwater	63,900	45,000	38,000
Agricultural ET of Private Groundwater	41,400	46,700	29,400
Agricultural Percolation	215,400	214,300	180,000
Agricultural Percolation of Precipitation	48,700	38,200	42,100
Agricultural Percolation of Surface Water	129,000	135,900	116,500
Agricultural Percolation of Agency Groundwater	22,900	18,800	12,200
Agricultural Percolation of Private Groundwater	14,800	21,400	9,200
Agricultural Runoff & Return Flow	10,000	7,200	10,100
Urban Runoff & Return Flow	53,300	50,800	69,300
Urban ET	27,800	27,400	32,300
Urban Percolation	4,900	5,200	11,500
Native Runoff	1,100	300	1,100
Native ET	19,500	20,100	22,700
Native Percolation	3,600	2,500	2,800
Total Demands	**812,700**	**792,800**	**801,600**
Land Surface System Balance	**6,700**	**0**	**2,400**
Land Surface System Balance (% of supplies)	0.8%	0.0%	0.3%

Table 5-5: Average Annual Water Budget – Land Surface System, East Turlock GSA (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Agricultural Areas Precipitation	79,500	71,200	92,500
Agricultural Water Supply	223,200	245,400	258,200
Agency Surface Water	11,500	12,500	10,400
Agency Groundwater	-	-	-
Private Groundwater	212,200	233,300	248,200
Urban Areas Precipitation	2,800	2,600	3,600
Urban Water Supply	1,700	1,100	800
Groundwater	1,700	1,100	800
Surface Water	0	0	0
Native Areas Precipitation	55,300	36,600	44,400
Native & Riparian Uptake from Stream	2,800	3,500	2,900
Total Supplies	**365,800**	**360,800**	**402,800**
Agricultural ET	239,400	259,300	273,500
Agricultural ET of Precipitation	52,500	52,400	55,000
Agricultural ET of Surface Water	9,600	10,600	8,800
Agricultural ET of Agency Groundwater	0	0	0
Agricultural ET of Private Groundwater	177,400	196,300	209,700
Agricultural Percolation	48,300	35,200	54,400
Agricultural Percolation of Precipitation	13,700	7,900	14,800
Agricultural Percolation of Surface Water	1,900	1,400	1,600
Agricultural Percolation of Agency Groundwater	0	0	0
Agricultural Percolation of Private Groundwater	32,700	25,900	38,000
Agricultural Runoff & Return Flow	10,200	6,000	21,500
Urban Runoff & Return Flow	2,900	2,400	3,000
Urban ET	1,400	1,100	1,200
Urban Percolation	200	100	200
Native Runoff	4,100	800	10,800
Native ET	44,900	34,100	32,600
Native Percolation	8,200	3,700	3,700
Total Demands	**359,600**	**342,700**	**400,900**
Land Surface System Balance	**6,200**	**18,100**	**1,900**
Land Surface System Balance (% of supply)	1.7%	5.0%	0.5%

Table 5-6: Average Annual Water Budget – Groundwater System, Turlock Subbasin (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Stream Seepage	61,500	72,300	109,400
Seepage from the Merced River	35,400	38,800	64,600
Seepage from the Tuolumne River	20,200	30,000	37,500
Seepage from the from San Joaquin River	5,900	3,500	7,300
Canal & Reservoir Recharge	78,500	82,500	85,400
Deep Percolation	280,500	261,000	252,700
Subsurface Inflow	112,900	118,500	110,300
Inflow from the Sierra Nevada Foothills	2,200	800	2,100
Inflow from the Merced Subbasin	58,700	65,100	59,500
Inflow from the Modesto Subbasin	35,600	34,900	34,300
Inflow from the Delta Mendota Subbasin	16,400	17,700	14,400
Total Inflow	**533,400**	**534,300**	**557,800**
Discharge to Stream	118,100	93,300	71,000
Discharge to the Merced River	18,100	12,500	4,300
Discharge to the Tuolumne River	55,600	43,700	31,300
Discharge to the San Joaquin River	44,400	37,100	35,400
Subsurface Outflow	74,800	65,400	80,300
Outflow to the Merced Subbasin	13,700	11,700	20,300
Outflow to the Modesto Subbasin	33,200	30,900	32,800
Outflow to the Delta Mendota Subbasin	27,900	22,800	27,200
Groundwater Production	404,400	414,300	414,100
Agency Ag. Groundwater Production	79,200	60,200	51,300
Private Ag. Groundwater Production	269,700	301,300	287,000
Urban Groundwater Production	55,500	52,800	75,800
Total Outflow	**597,300**	**573,000**	**565,400**
Change in Groundwater Storage	**-63,900**	**-38,700**	**-7,600**

Table 5-7: Average Annual Net Gain from Stream and Subsurface Inflows – Groundwater System, Turlock Subbasin (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Net Gain from Stream	**-56,600**	**-21,000**	**38,400**
Merced River	17,300	26,300	60,300
Tuolumne River	-35,400	-13,700	6,200
San Joaquin River	-38,500	-33,600	-28,100
Net Subsurface Inflows	**35,900**	**52,300**	**27,900**
Merced Subbasin	45,000	53,400	39,200
Modesto Subbasin	2,400	4,000	1,500
Delta Mendota Subbasin	-11,500	-5,100	-12,800

Positive values represent water flowing into the Subbasin's groundwater system and negative numbers represent water flowing out of the Subbasin's groundwater system.

Table 5-8: Average Annual Water Budget – Groundwater System, West Turlock GSA (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Stream Seepage	28,300	35,100	53,400
Seepage from the Merced River	3,800	4,200	13,600
Seepage from the Tuolumne River	18,600	27,400	32,500
Seepage from the from San Joaquin River	5,900	3,500	7,300
Canal & Reservoir Recharge	73,600	75,900	80,200
Deep Percolation	223,900	222,000	194,400
Subsurface Inflow	77,600	79,200	80,800
Inflow from the Sierra Nevada Foothills	-	-	-
Inflow from the ETSGSA	6,200	6,100	9,700
Inflow from the Merced Subbasin	25,800	26,300	28,500
Inflow from the Modesto Subbasin	29,200	29,100	28,200
Inflow from the Delta Mendota Subbasin	16,400	17,700	14,400
Total Inflow	**403,400**	**412,200**	**408,800**
Discharge to Stream	105,100	84,300	65,900
Discharge to the Merced River	16,900	11,800	4,300
Discharge to the Tuolumne River	43,800	35,400	26,200
Discharge to the San Joaquin River	44,400	37,100	35,400
Subsurface Outflow	152,400	152,900	182,900
Outflow to the ETSGSA	87,000	95,100	112,400
Outflow to the Merced Subbasin	9,100	8,000	14,400
Outflow to the Modesto Subbasin	28,400	27,000	28,900
Outflow to the Delta Mendota Subbasin	27,900	22,800	27,200
Groundwater Production	190,500	179,900	165,100
Agency Ag. Groundwater Production	79,200	60,200	51,300
Private Ag. Groundwater Production	57,500	68,000	38,800
Urban Groundwater Production	53,800	51,700	75,000
Total Outflow	**448,000**	**417,100**	**413,900**
Change in Groundwater Storage	**-44,600**	**-4,900**	**-5,100**

Note: The operational water budget information presented in this table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

Table 5-9: Average Annual Water Budget – Groundwater System, East Turlock GSA (AFY)

Component Hydrologic Period	Historical Condition Water Budget WY 1991- 2015	Current Condition Water Budget WY 2010	Projected Condition Water Budget Hydrology from WY 1969 - 2018
Stream Seepage	33,200	37,200	56,000
Seepage from the Merced River	31,600	34,600	51,000
Seepage from the Tuolumne River	1,600	2,600	5,000
Seepage from the from San Joaquin River	-	-	-
Canal & Reservoir Recharge	4,900	6,600	5,200
Deep Percolation	56,600	39,000	58,300
Subsurface Inflow	128,500	140,500	151,600
Inflow from the Sierra Nevada Foothills	2,200	800	2,100
Inflow from the WTSGSA	87,000	95,100	112,400
Inflow from the Merced Subbasin	32,900	38,800	31,000
Inflow from the Modesto Subbasin	6,400	5,800	6,100
Inflow from the Delta Mendota Subbasin	-	-	-
Total Inflow	**223,200**	**223,300**	**271,100**
Discharge to Stream	13,000	9,000	5,100
Discharge to the Merced River	1,200	700	-
Discharge to the Tuolumne River	11,800	8,300	5,100
Discharge to the San Joaquin River	-	-	-
Subsurface Outflow	15,600	13,700	19,500
Outflow to the WTSGSA	6,200	6,100	9,700
Outflow to the Merced Subbasin	4,600	3,700	5,900
Outflow to the Modesto Subbasin	4,800	3,900	3,900
Outflow to the Delta Mendota Subbasin	-	-	-
Groundwater Production	213,900	234,400	249,000
Agency Ag. Groundwater Production	-	-	-
Private Ag. Groundwater Production	212,200	233,300	248,200
Urban Groundwater Production	1,700	1,100	800
Total Outflow	**242,500**	**257,100**	**273,600**
Change in Groundwater Storage	**-19,300**	**-33,800**	**-2,500**

Note: The operational water budget information presented in this table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers

5.1.4.1. Historical Water Budget

The historical water budget is a quantitative evaluation of the historical surface and groundwater supply covering the 25-year period from WY 1991 to 2015. This period was selected as the representative hydrologic period as it reflects the most recent basin operations and has similar average precipitation compared to a longer historical period (WY 1969-2018). The goal of the water budget analysis is to characterize the water supply and demand, while summarizing the accounting of water demand and supply components and their changes within each GSA, and the Subbasin as a whole.

Figure 5-3 below shows the average annual water budget components for the entirety of the Turlock Subbasin and the interaction between the land surface, stream, and the groundwater systems for the historical simulation.

The existing stream and canal network supplies multiple water users and agencies in the Turlock Subbasin, including Turlock and Merced Irrigation Districts, and sometimes to the private landowners in the ETSGSA during wet years. When analyzing the stream system, it is important to note potentially significant effects resulting from the natural interactions and managed operations of adjacent subbasins. Because of this, the water budget in **Table 5-2** and **Figure 5-4** provides average annual quantities of surface and canal system flows within the Turlock Subbasin, as well as estimates of contributions to and from adjoining subbasins. Average annual surface water inflows to the Subbasin are estimated to be 2,855,000 AFY. Most of these flows enter the Subbasin through inflows from both impaired and unimpaired streams and river courses. This is supplemented by surface runoff from precipitation (82,200 AFY), return flow from irrigation applied water (99,100 AFY), gain from groundwater (241,000 AFY), operational outflows of surface water from TID and Merced ID to the streams (65,100 AFY), and other flows (19,700 AFY). "Other Flows" is a term that captures gains and losses not directly measured or simulated within IWFM, which include but may not be limited to direct precipitation, evaporation, unmeasured riparian diversions and return flow, temporary storage in local lakes and regulating reservoirs, and inflow discrepancies resulting from simulating impaired flows. Outflows from the Turlock Subbasin stream system total 2,855,000 AFY and include stream losses to the groundwater system (119,500 AFY), surface water diversions (601,200 AFY), and riparian uptake (29,900 AFY), which results in approximately 2,104,400 AFY as surface outflow from the Subbasin via the San Joaquin River downstream of Tuolumne confluence. Note that some surface water diversions are upstream of the Tuolumne River or Merced River inflows and thus not included in this stream and canal water budget. The nature of river and stream system in the Turlock Subbasin is complex for several reasons, including: (i) the level of historical monitoring and measurement has been limited, (ii) surface water courses traverse through the Subbasin, and accounting of seepage losses to each GSA may be challenging at best, (iii) the delivery canals convey water through one GSA to deliver to another GSA, with incidental deliveries along the way, which also makes it challenging to allocate seepage losses to each GSA, (iv) the local streams and irrigation canals are not expressly identified and simulated in the model. Therefore, development of stream budgets by each GSA is not feasible.

The land surface system of the Turlock Subbasin, shown in **Figure 5-5**, represents the demand and supplies in the Turlock Subbasin. During the historical period, total average annual water supplies to the Turlock Subbasin is estimated at 1,185,200 AFY, which is based on a combination of precipitation (335,000 AFY), surface water deliveries (437,800 AFY), and groundwater supplies (404,400 AFY), as well as water uptake by riparian vegetation along the river courses (8,000 AFY). Most surface water deliveries occur in the WTSGSA through TID's canal network to their growers. In ETSGSA, main source of water supply for irrigation is private groundwater pumping. There have historically been infrequent and relatively small volumes of surface water delivered to non-district areas in some wet years when there is available surface water.

Average annual water demand components for the land surface system are comprised of crop, landscaping, and native evapotranspiration (810,100 AFY), surface runoff and return flow to the stream system (81,600 AFY), and deep percolation (280,600 AFY). **Figure 5-6** shows the annual amounts of major components of water demand and supplies for the agricultural water use throughout the historical water budget period. Note the surface water supply in this water budget is reflective of the volume of water available to the grower, and thus does not include operational outflow, canal seepage, or canal evaporative losses. **Figure 5-7** shows the annual demand and supply conditions for the urban sector in the Subbasin.

Table 5-6 shows the details of the groundwater budget for the Turlock Subbasin. Based on this table, the groundwater system of the Turlock Subbasin experiences approximately 533,400 AFY of inflows each year. The inflows are comprised of recharge from streams (61,500 AFY), seepage from canals and reservoirs (78,500 AFY), deep percolation from irrigation applied water and precipitation (280,500 AFY), and subsurface inflows from the Sierra Nevada foothills and the neighboring subbasins of Merced, Delta-Mendota, and Modesto (112,900 AFY combined).

Table 5-6 also shows the outflows from the Turlock Subbasin. On average, the outflows exceed the inflows in the Subbasin. The largest component of outflow from the groundwater system is groundwater pumping (404,400 AFY), followed by discharge to streams (118,100 AFY), and subsurface outflow to the neighboring subbasins (74,800 AFY).

Table 5-7 shows the net annual flows between groundwater system and the stream and neighboring subbasins, as estimated by the model. As indicated, during the historical period, Turlock Subbasin groundwater system has been discharging an average of 56,600 AFY to a combination of the Tuolumne, Merced, and San Joaquin River Systems. During the same period, the net subsurface inflows to the Turlock groundwater Subbasin has been 35,900 AFY from the neighboring Subbasins, a large portion of which has been net subsurface inflows from the Merced Subbasin.

Figure 5-8 shows a schematic representation of the Turlock Subbasin historical water budget with details for the West and East Turlock Subbasin GSAs.

Tables 5-8 and **5-9** present the details of historical groundwater budget for the WTSGSA and ETSGSA, respectively. Groundwater pumping for agricultural purposes on the west side includes private agricultural pumping and pumping by TID from drainage and rented wells, both of which are utilized for agricultural supplies within the TID system. Historically, the urban areas, mainly located on the western side of the Subbasin, have relied on groundwater for municipal water supply. Rural residences on the west side also rely on groundwater to meet domestic residential uses. On the east side, the groundwater pumping includes pumping for agricultural irrigation by private wells, as well as some domestic wells for domestic residential use.

To better understand the relationship between water supply conditions and recharge to the groundwater system for the Subbasin as a whole and each GSA, an analysis of net recharge has been performed.

Figure 5-9 shows the total annual groundwater pumped from the Turlock Subbasin and estimated recharge to the groundwater Subbasin. Total pumped water is a combination of groundwater extracted for agricultural and urban use during the historical period. Total annual recharge includes recharge from precipitation, irrigation applied water, outdoor irrigation, and recharge from conveyance canals and Turlock Lake.

Figure 5-10 shows the net recharge in the Turlock Subbasin. This figure indicates that during the historical period, the Subbasin has experienced a variable condition of net recharge, with an average condition on net extraction.

Figure 5-11 through **Figure 5-14** show the same conditions for each GSA. Based on this analysis, while the WTSGSA has been experiencing a condition of net recharge, the groundwater conditions in the ETSGSA have experienced an increasing net depletion during the historical period. This condition is primarily due to increasing groundwater use which has resulted in declining groundwater levels as reported at many wells throughout the ETSGSA.

Between the ETSGSA and WTSGSA, subsurface water is flowing primarily from the WTSGSA to the ETSGSA. These subsurface outflows have significantly affected the change in aquifer storage in each GSA. For example, the net subsurface outflow from WTSGSA to the ETSGSA of 80,800 AFY has resulted in a net groundwater storage deficit of 44,600 AFY in the WTSGSA, despite the condition that WTSGSA has been a net contributor to the groundwater system within its jurisdiction. On the other hand, the ETSGSA groundwater storage deficit is somewhat moderate (19,300 AFY) due in part to the significant subsurface inflows from the WTSGSA and adjoining subbasins.

On a Subbasin-scale, greater outflows than inflows indicate an average annual deficit in groundwater storage of 63,900 AFY. **Figure 5-15** summarizes the average historical groundwater inflows and outflows in the Turlock Subbasin. **Figure 5-16** shows the annual change in the groundwater budget components, as well as cumulative storage, through the 1991 to 2015 period.

Local hydrology plays in integral role in in the overall sustainability of the Turlock Subbasin as the magnitude of historical flows to the aquifer change by water year type. In wet years, precipitation meets more of the water demand and greater availability of surface water reduces the need for groundwater. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation. This leads to an increase in groundwater storage in wet years and a decrease in dry years. **Table 5-10** breaks down the average historical water supply and demand by water year type.

Table 5-10: Average Annual Values for Key Components of the Historical Water Budget by Year Type (AFY)

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	Average
Water Demand						
Agricultural Demand	634,800	684,500	755,400	698,200	743,500	695,400
Urban Demand	52,600	53,400	60,300	59,000	48,300	52,900
Total Demand	**687,400**	**737,900**	**815,700**	**757,300**	**791,700**	**748,300**
Water Supply						
Total Surface Water Supply	501,300	547,200	540,900	567,800	489,700	516,900
Agricultural	501,300	547,200	540,900	567,800	489,700	516,900
Urban	0	0	0	0	0	0
Total Groundwater Supply	279,800	298,900	361,800	330,100	368,800	325,200
Agricultural	224,400	243,000	299,600	269,300	317,900	269,700
Urban	55,400	55,900	62,200	60,800	50,900	55,400
Total Supply	**781,000**	**846,000**	**902,700**	**898,000**	**858,600**	**842,100**
Change in GW Storage	**117,400**	**-24,600**	**-147,300**	**-143,400**	**-199,200**	**-63,900**

All values in Table 5-5 are from WYs 1991-2015

5.1.4.2. Current Water Budget

The current water budget quantifies inflows to and outflows from the basin under existing conditions. WY 2010 was selected to represent current conditions because it reflects an average, non-drought water supply, demand, and land use conditions. Therefore, the water budget tables use the WY 2010 results from the historical model simulation described above as Current Condition. **Figure 5-17** summarizes the average annual inflows and outflow of the Current Conditions Baseline in the Turlock Subbasin surface water network.

Figure 5-18 summarizes the average annual Current Condition supplies and demands in the land surface budget for the Turlock Subbasin.

Figure 5-19 summarizes the average Current Conditions groundwater inflows and outflows in the Turlock Subbasin.

5.1.4.3. Projected Water Budget

The projected water budget is used to estimate future baseline conditions of supply, demand, and subsequent impacts on the aquifer system. The Projected Conditions Baseline simulation of C2VSimTM is used to evaluate the projected conditions of the water budget using hydrology from WYs 1969 to 2018. This represents a hydrologic period of 50 years and has average precipitation like the long-term average.

Development of the projected water demand is based on the population growth trends reported in the 2015 UWMPs, and land use, evapotranspiration, and crop coefficient information from the 2015 AWMP. Projected Tuolumne River inflows to the groundwater Subbasin and surface water supplies are determined through analysis of TID's reservoir operations model (TRS) for the Tuolumne River and are based on projected Don Pedro operations and current minimum flow requirements. Additional information about model development and inputs are detailed in the C2VSimTM Model Development Technical Memo in **Appendix D**.

Figure 5-20 shows the water budget schematic for the Turlock Subbasin with average annual projected values for each component.

Average annual surface water inflows to the Turlock Subbasin's stream system total an average of 2,996,300 AFY. Stream inflows from the Merced River, Tuolumne River, and San Joaquin River comprise the majority of the inflows, with contributions from tributaries (Dry Creek, Mustang Creek, Sand Creek, Peaslee Creek, Orestimba Creek from the west into the San Joaquin River, and other unclassified flows totaling 22,500 AFY), operational outflow from TID's canal system (48,400 AFY), gain from the aquifer (143,400 AFY), surface runoff from precipitation (109,800 AFY), and return flow from applied water to the stream system (108,400 AFY). Of these volumes, it is anticipated that 620,800 AFY will be diverted for local growers to meet agricultural demand and the remaining amount will leave the stream system in the form of seepage to aquifer system (216,200 AFY), riparian uptake (41,500 AFY), and San Joaquin River stream outflow downstream of Tuolumne River confluence (2,117,800 AFY).

Compared to historical conditions, groundwater levels are expected to be lower which explains why there is estimated to be approximately 194,300 AFY less net contribution from the aquifer[21] to the stream system. **Figure 5-21** summarizes the average projected inflows and outflows in the Turlock Subbasin surface water network.

The land surface water budget for the Projected Conditions Baseline has average annual supplies and demands of 1,206,800 AFY. Supplies are comprised of precipitation (340,600 AFY), applied surface water (439,500 AFY), applied groundwater (414,100 AFY), and riparian uptake from streams (12,600 AFY). Demands are comprised of evapotranspiration (834,100 AFY), surface runoff and return flow (115,800 AFY) to the stream system, and deep percolation (252,600 AFY).

Compared to the historical land surface budget, urban supplies and demands increase because of forecasted population growth. Additionally, agricultural demand (evapotranspiration) is higher because agricultural land use is assumed to be at historical high, reflecting more developed acres than average historical conditions. However, there is less percolation out of the root zone because of the assumed improvements in irrigation

[21] Net contribution from the aquifer includes stream gains and losses within and outside of the Turlock Subbasin – any region adjacent to the Merced River, Tuolumne River, and San Joaquin River.

efficiency (e.g., drip irrigation). The higher agricultural return flow and runoff in the projected conditions baseline compared to the historical scenario is driven by higher runoff from precipitation. The projected conditions baseline hydrologic period includes a higher number of wet years which contributes to higher runoff rates. There are no changes in operational or soil parameters assumptions (i.e., curve number) between the historical and projected conditions baseline scenarios.

A summary of these flows can be seen below in **Figure 5-22**. **Figures 5-23** and **Figure 5-24** show the annual change in the land surface water budget components through the simulation period for agricultural and urban land uses respectively.

An analysis of net recharge in the Projected Conditions model was performed for Turlock Subbasin and for each GSA. **Figure 5-25** shows the total annual groundwater pumped from the Turlock Subbasin and estimated recharge to the groundwater Subbasin. Total pumped water is a combination of groundwater extracted for agricultural and urban use during the simulation period. Total annual recharge includes recharge from precipitation, irrigation applied water, outdoor irrigation, and recharge from conveyance canals and Turlock Lake.

Figure 5-26 shows the net recharge in the Turlock Subbasin. This figure indicates that under projected conditions, the Subbasin is expected to experience a variable condition of net extraction at higher levels relative to the historical conditions.

Figure 5-27 through **Figure 5-30** show the net recharge for each GSA under projected conditions. Under the projected conditions, the WTSGSA is expected to continue as a net contributor to the groundwater Subbasin. In the ETSGSA area, unlike the historical conditions (when a steady increase in net extraction condition is experienced due to increasing development) the projected conditions assume that the net groundwater extractions would occur at relatively steady high rates.

The net recharge patterns of the GSAs are like those under historical conditions; however, the ETSGSA is expected to have much more pronounced levels of net extraction, with net recharge in WTSGSA and net extraction in ETSGSA.

Average net subsurface flow from WTSGSA to ETSGSA increased from 81,000 AFY under historical conditions to 102,700 AFY under the projected conditions. However, average annual change in groundwater storage has decreased in both GSAs. This is primarily due to increased seepage from the river system and subsurface flows from neighboring Subbasins.

Anticipated growth in the Projected Conditions Baseline slightly increases groundwater production (414,100 AFY), compared to historical extraction across the Subbasin (**Figure 5-31**). Subsurface outflows to neighboring subbasins (80,300 AF) and stream gain from groundwater (71,000 AFY) bring the total Subbasin discharges to 565,400 AFY.

Under projected conditions, the groundwater system of the Turlock Subbasin experiences an average of 557,800 AFY of inflows each year, of which 252,700 AFY is from deep percolation of rainfall and applied water. Like previously mentioned, deep percolation from applied water is less compared to historical conditions because of assumed improvements in irrigation practices in the future. Other inflows to the groundwater system consist of recharge from stream seepage (109,400 AFY), and seepage from conveyance canals and Turlock Lake (85,400 AFY), and boundary inflows from the Sierra Nevada foothills and subsurface inflows from the neighboring subbasins of Merced, Delta-Mendota, and Modesto (110,300 AFY combined).

Compared to the average historical conditions, modeling results indicate that stream seepage to the Turlock Subbasin is higher by 47,900 AFY in stream reaches that were historically losing to groundwater system. On the other hand, in stream reaches that stream system was gaining, groundwater discharge to the streams is expected to be less by 47,100 AFY. This would result in expected net reduction in streamflow by approximately 95,000 AFY within the Subbasin. In general, under the projected conditions, the streams are expected to lose more to the groundwater system because of lower average groundwater levels.

Under the projected conditions the groundwater outflows are projected to exceed the inflows to groundwater system, resulting in an average annual groundwater storage deficit of 7,600 AFY. While an average groundwater storage decline of 7,600 AFY is significantly less than historical depletion (63,900 AFY), this is at the expense of additional seepage from the stream system, as well as inducement of additional subsurface flows from the neighboring Subbasins. The SMC chapter of the Plan (**Chapter 6**) will address the significance and unreasonableness of this matter in the context of sustainable management criteria, and projects and management actions to bring the Subbasin into sustainable condition.

Figure 5-31 summarizes the average projected groundwater inflows and outflows in the Turlock Subbasin.

Figure 5-32 shows the annual change in the groundwater budget, as well as cumulative storage, throughout the simulation period.

Figure 5-33 shows the water budget within each GSA's jurisdictional boundary under projected conditions. Based on this figure, WTSGSA is projected to experience approximately 5,100 AFY of storage decline under projected conditions. The ETSGSA is expected to experience 2,500 AFY of decline under same conditions. Note that continued groundwater pumping in ETSGSA is expected to result in decline in groundwater levels which induces additional subsurface flows from the WTSGSA as well as from the Merced and Modesto Subbasins. Additionally, the projected groundwater pumping and resulting lower groundwater levels in the ETSGSA is projected to induce more stream seepage from the adjoining Merced and Tuolumne River reaches compared to historical conditions. In certain reaches the model forecasts a change from gaining stream reaches to a losing reaches more frequently, at times potentially resulting in loss of hydraulic connection between the stream and the groundwater system. The additional subsurface inflows and stream seepage are projected to contribute to the groundwater storage in the ETSGSA.

5.2. CLIMATE CHANGE ANALYSIS

5.2.1. Regulatory Background

SGMA requires consideration of uncertainties associated with climate change in the development of GSPs. Consistent with §354.18(d)(3) and §354.18(e) of the SGMA regulations, analyses for the Turlock GSP evaluated the projected water budget with and without climate change conditions.

5.2.2. DWR Guidance

Climate change analysis and the associated methods, tools, forecasted datasets, and the predictions of greenhouse gas concentrations in the atmosphere are continually evolving. The approach developed for this GSP is based on the methodology in DWR's guidance document (DWR, 2018b), which, in combination with Subbasin-specific modeling tools, was deemed to be the most appropriate information for evaluating climate change in the Turlock Subbasin GSP. The following resources from DWR were used in the climate change analysis:

- SGMA Data Viewer
- Guidance for Climate Change Data Use During Sustainability Plan Development and Appendices (Guidance Document)
- Water Budget BMP
- Desktop IWFM Tools

SGMA Data Viewer provides the location for which the climate change forecasts datasets[22] were downloaded for the Turlock Subbasin (DWR, 2019). The guidance document details the approach, development, applications, and limitations of the datasets available from the SGMA Data Viewer (DWR, 2018b). The Water Budget BMP describes in greater detail how DWR recommends projected water budgets be computed (DWR, 2016a). The Desktop IWFM Tools (DWR, 2018c) are available to calculate the projected precipitation and evapotranspiration inputs under climate change conditions.

The methods suggested by DWR in the above resources were used, with modifications where appropriate, to ensure the resolution would be reasonable for the Turlock Subbasin and align with the assumptions of the C2VSimTM. **Figure 5-34** shows the overall process developed for the Turlock GSP consistent with the Climate Change Resource Guide (DWR, 2018b) and describes workflow beginning with baseline projected conditions to perturbed 2070 conditions for the projected model run. For this analysis, it is assumed that the projected climate change conditions for 2070 central tendency is used.

The process described in **Figure 5-34** of developing a projected conditions water budget with and without climate change was discussed with DWR staff[23] and is consistent with the regulations. Further, it enables the analysis to account for variability in demand and supply separate from climate change uncertainty.

[22] In the industry, climate change impacted variable forecasts are sometimes referred to as "data" and their collections are called "datasets." Calling forecasted variable values "data" can be misleading so this document tries to be explicit about when we are referring to data (historical data) vs. forecasts or model outputs.

[23] Pers. Comm. 4/4/2019 meeting with DWR staff.

Table 5-11 summarizes the forecasted variable datasets provided by DWR that were used to carry out the climate change analysis. The "VIC" model (Variable Infiltration Capacity) referred to in

Table 5-11 is the hydrologic model used by DWR to estimate unimpaired flows in upper watersheds. "Unimpaired" streamflow refers to the natural streamflow produced by a watershed, without modifications to streamflow from reservoir regulations, diversions, and other operations. On the other hand, "impaired" streamflow referred to in

Table 5-11 is DWR's terminology for streams whose flow is impacted by ongoing water operations and upstream regulations, such as diversions, deliveries, and reservoir storage. Flows on these streams are simulated using the CalSim II model results from the DWR baseline model. For Turlock Subbasin GSP, New Don Pedro releases and surface water deliveries to TID were utilized from the CalSim II baseline model results. The Merced River releases and deliveries to the Northside Canal were based on the results from the Merced Subbasin GSP. The San Joaquin River flows were also based on the results of the CalSim II baseline model from DWR. All timeseries shown in

Table 5-11 use a monthly timestep. **Section 5.2.3** includes further description of the methodology, datasets, and results.

Table 5-11: DWR-Provided Climate Change Datasets

Input Variable	DWR Provided Dataset
Unimpaired Streamflow	Combined VIC model runoff and baseflow to generate change factors, provided by HUC 8 watershed geometry
Impaired Streamflow (Ongoing Operations)	CalSim II time series outputs in .csv format
Precipitation	VIC model-generated GIS grid with associated change factor time series for each cell
Reference ET	VIC model-generated GIS grid with associated change factor time series for each cell

5.2.3. Climate Change Methodology

Climate change affects precipitation, streamflow, evapotranspiration and, for coastal aquifers, sea level rise, which in turn have impacts on the aquifer system. For the Turlock Subbasin, sea level is not relevant. The method for perturbing the streamflow, precipitation, and evapotranspiration input files is described in the following sections. The late-century, 2070 central tendency climate scenario was evaluated in this analysis, consistent with DWR guidance (DWR, 2018b).

DWR combined 10 global climate models (GCMs) for two different representative climate pathways (RCPs) to generate the central tendency scenarios in the datasets used in this analysis. The "local analogs" method (LOCA) was used to downscale these 20 different climate projections to a scale usable for California (DWR, 2018b). DWR provides datasets for two future climate periods: 2030 and 2070. For 2030, there is one set of central tendency datasets available. For 2070, DWR has provided one central tendency scenario and two extreme scenarios: one that is drier with extreme warming and one that is wetter with moderate warming.

The 2070 central tendency among these projections serves to assess impacts of climate change over the long-term planning and implementation period. For this reason, it was chosen as the most appropriate scenario to assess in the Turlock GSP.

5.2.3.1. Streamflow under Climate Change

Hydrological forecasts for streamflow under various climate change scenarios are available from DWR as either a flow-based timeseries or a series of perturbation factors applicable to local data. DWR simulated volumetric flow in most regional surface water bodies by utilizing the Water Resource Integrated Modeling System (WRIMS, formally named CalSim II). While river flows and surface water diversions in the Tuolumne, Merced, and San Joaquin Rivers are simulated in CalSim II, there are significant variations when compared to local historical data. Due to the uncertainty in reservoir operations, flows from CalSim II provided by the state are not used directly in the Turlock GSP climate change analysis. Instead, relative perturbation factors were used to derive surface water inflows and diversions for analysis with the C2VSimTM.

The major rivers entering the Turlock Subbasin are the Tuolumne River, the Merced River, and the San Joaquin River; all three are regulated by upstream reservoirs. These are expressly simulated in the model. Contributions by other unimpaired streams, such as Dry Creek are indirectly simulated using the small watershed feature in the model.

CalSim II estimated flows for point locations on the Tuolumne River and Merced River were downloaded from DWR. The key flows obtained from CalSim II include:

- **Tuolumne River:** La Grange Outflow
- **Merced River:** Lake McClure Outflow

The San Joaquin River was not adjusted in the climate change analysis because the Friant Dam is located far from the Turlock Subbasin and subbasins that are upstream of the Turlock Subbasin can have significant impacts on stream accretions/depletions, diversions, and operations. As these upstream impacts which are outside of the Turlock Subbasin cannot be captured without detailed analysis of projected flows under climate change conditions, the San Joaquin River flows are assumed to be same as the projected baseline conditions. This would not have a significant impact on the climate change analysis for the Turlock Subbasin, as most of the surface water supplies, and interaction of surface and groundwater systems, take place within Subbasins and along Tuolumne and Merced Rivers.

The streamflow extracted from CalSim II represent projected hydrology with climate change based on reservoir outflow, operational constraints, and diversions and deliveries of water for the State Water Project and the Central Valley Project. CalSim II data from WY 1965 to WY 2003 was available. For WY 2004 to WY 2018, streamflow was synthesized based on similar year methodology, and used flows from WY 1965 to WY 2003 and the DWR San

Joaquin Valley water year type index. **Table 5-12** indicates the water year types that were used for the years with synthesized streamflow (CDEC, 2018). (For example, the streamflow for October 2009 was calculated as the average of the October 1966 and October 1971 streamflow because these are all the Below Normal water years between WY 1965 and WY 2003.)

Table 5-12: DWR San Joaquin Valley Water Year Type Designations

Water Year	Year Type
2003	Below Normal
2004	Dry
2005	Wet
2006	Wet
2007	Critical
2008	Critical
2009	Below Normal
2010	Above Normal
2011	Wet
2012	Dry
2013	Critical
2014	Critical
2015	Critical
2016	Dry
2017	Wet
2018	Below Normal

Source: Water year types based on San Joaquin Valley Water Year Index (CDEC, 2018)

CalSim II outputs are considered more appropriate for impaired streams than streamflow derived using the unimpaired adjustment factors because CalSim II accounts for reservoir operations. As expected, streamflow simulated in CalSim II and those derived using the unimpaired adjustment factors did not present similar trends, particularly in dry years. DWR-provided unimpaired change factors do not account for variations in the operation of the reservoirs that would result from climate change conditions. The CalSim II flows, however, were also not considered completely appropriate for local conditions so a method was derived to compute change factors from CalSim II flows, as described below.

Using DWR's method of deriving the precipitation and evapotranspiration factors as a guide, a hybrid approach was derived to improve upon the discrepancy between the CalSim II and local models while accounting for some change in reservoir operations. In this approach, change factors are generated from the difference between each simulated future climate change CalSim II scenario (i.e., 2070) and the "without climate change" baseline CalSim II run. This "without climate change" baseline run is the CalSim II 1995 Historical Detrended simulation run provided through personal communication from DWR. The change perturbation factors are bounded by a maximum of 5 and minimum 0.2. For the purposes of simplicity, this method is referred to throughout the rest of the document as CalSim II Generated Perturbation Factors (CGPF). The generated change factors are then used to perturb the regulated baseline stream inflows:

- Tuolumne River – CGPF multiplied by the projected conditions baseline Tuolumne River flow from the TID's reservoir operations model (TRS)
- Merced River – CGPF multiplied by the projected conditions Merced River flow from the MercedSIM releases from New Exchequer under FERC Final Environmental Impact Statement (FEIS) Requirements

As previously discussed, the San Joaquin River flows were not perturbed due to the much larger tributary areas of the San Joaquin River that are outside the Turlock Subbasin. The CGPF method presents limitations given that the resulting flows are not directly obtained from an operations model. The actual mass balance on the reservoirs is not tracked in the estimates of the flows and, instead, the method relies on CalSim II tracking that storage and managing the reservoir based on the appropriate rule curves.

Figure 5-35 through **Figure 5-42** provide a comparison of monthly projected conditions baseline and the CGPF method described above. Exceedance curves are included for each of the CGPF flows against the projected conditions baseline.

5.2.3.2. Precipitation and Evapotranspiration under Climate Change

Projected precipitation and evapotranspiration (ET) change factors provided by DWR were calculated using a climate period analysis based on historical precipitation and ET from January 1915 to December 2011 (DWR, 2018b). The Variable Infiltration Capacity (VIC) hydrologic model was used by DWR to simulate land-surface atmosphere exchanges of moisture and energy on a six-kilometer grid. Model output includes both precipitation and reference evapotranspiration change factors. The change factors provided by DWR were calculated as a ratio of a variable under a "future scenario" divided by a baseline. The baseline data is the 1995 Historical Template Detrended scenario by the VIC model through GCM downscaling. The "future scenario" corresponds to VIC outputs of the simulation of future conditions using GCM forecasted hydroclimatic variables as inputs. These change factors are thus a simple perturbation factor that corresponds to the ratio of a future with climate change divided by the past without it. Change factors are available on a monthly time step and spatially defined by the VIC model grid. Supplemental tables with the time series of perturbation factors are available by DWR for each grid cell. DWR has made accessible a Desktop GIS tool for both IWFM and MODFLOW to process these change factors (DWR, 2018c).

5.2.3.2.1. Applying Change Factors to Precipitation

DWR change factors were multiplied by projected conditions baseline precipitation to generate projected precipitation under the 2070 central tendency future scenario using the Desktop IWFM GIS tool (DWR, 2018c). The tool calculates an area weighted precipitation change factor for each model grid geometry. This model grid geometry was generated based on polygons built around the PRISM nodes that are within the model area.

However, the DWR tool only includes change factors through 2011. The remaining seven years of the time series were synthesized according to historically comparable water years (i.e., wet years were synthesized based on a wet year within the available time frame of the DWR tool). The perturbation factor from the corresponding month of the comparable year was applied to the baseline of the missing years (2012-2018) to generate projected values. Months with no precipitation in the baseline were assumed a monthly precipitation of 1 mm under climate change to account for increased precipitation that cannot be calculated from a baseline of 0 mm for these synthesized years. The comparable years that were used can be found in **Table 5-13**.

Table 5-13: Comparable Water Years (Precipitation)

Missing Water Year	Comparable Water Year
2012	1968
2013	2007
2014	2002
2015	1971
2016	1981
2017	1993
2018	1987

The resulting perturbed precipitation values and the baseline precipitation values for the representative historical period can be found in **Figure 5-39** below. The exceedance plot for these two times series can be found in **Figure 5-40**.

Figure 5-41 shows the difference between the regional average under 2070 climate change conditions and the regional average under projected conditions baseline plotted against different amounts of projected monthly precipitation. The average was taken across the area of the Turlock Subbasin.

Figure 5-41 demonstrates that in 2070 with climate change added, in low precipitation months, there is approximately equal probability that the month will be wetter or drier than projected conditions baseline. However, under climate change, the 2070 conditions will be wetter in months with precipitation above approximately 150 mm, indicated by the vertical gray dashed line. Therefore, under climate change conditions (in the scenario selected for the GSP), we can see that the occurrence of low precipitation months will likely not change significantly, but the higher precipitation months are predicted to be wetter overall than the projected conditions baseline.

5.2.3.2.2. Applying Change Factors to Evapotranspiration

Potential ET in the Turlock Subbasin is aggregated to one of twenty-five land use categories but does not vary spatially. DWR provides change factors for ET in the same spatially distributed manner as precipitation, as described above. However, to match the level of discretization with the C2VSimTM, an average ET change factor was calculated across all VIC grid cells within the Turlock Subbasin boundary. Therefore, the tool to process ET provided by DWR was not needed or used. Change factors provided by DWR for November 1, 1964, through December 1, 2011, were averaged. This average ET change factor was then applied to the baseline ET time series for each crop type. Because the same ET change factor was applied over the entire baseline, no synthesis was required in this analysis. Refinement to the simulated evapotranspiration of orchards under 2070 climate conditions is shown in **Figure 5-42** below as an example. For 2070, the average change factor is 1.08.

5.2.3.3. Turlock Subbasin Water Budget Under Climate Change

A climate change scenario was developed for the C2VSimTM to evaluate the hydrological impacts under these conditions. The analysis was based on the projected conditions baseline with climate change perturbed inputs for streamflow, precipitation, and ET.

Under the climate change scenario, the average annual volume of evapotranspiration is over six percent higher than the projected conditions baseline, increasing from 834,100 AFY to 887,800 AFY. Due to changes to local hydrology, the average annual surface water availability is projected to decrease by 2.4 percent from 439,500 AFY to 428,800 AFY.[24] As a result of less surface water and increased agricultural demands, private groundwater production is simulated to increase by approximately 12 percent, from 286,900 AFY to 320,300 AFY. Additionally, higher evapotranspiration rates consume the applied water, leaving less water in the root zone to percolate into the aquifer (228,400 AFY). Under climate change conditions, depletion in aquifer storage is expected to more than double to an average annual rate of 19,300 AFY, from 7,600 AFY in the projected conditions baseline. This has an impact on groundwater to surface-water exchange, which is forecasted to increase the net stream seepage to the aquifer from 38,400 AFY (under the projected conditions baseline) to 60,500 AFY on average.

A graphical representation of simulated changes to evapotranspiration, surface deliveries, and groundwater pumping are presented in **Figure 5-43** though **Figure 5-45** below, and complete water budgets for the climate change scenario are shown in **Figure 5-46** through **Figure 5-48** below.

Tabular results of the detailed water budgets under climate change are presented below in **Table 5-14**, **Table 5-15**, and **Table 5-16**.

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[24] There are various approaches to estimating the effects of climate change on local hydrology. The 2070 Central Tendency used in this GSP according to DWR guidelines for GSP submittal may differ from local studies or certain Flood-MAR scenarios.

Table 5-14: Average Annual Water Budget Under Climate Change – Stream Systems, Turlock Subbasin (AFY)

Component	Projected Condition Water Budget	Climate Change Water Budget
Hydrologic Period	WY 1969 - 2018	WY 1969 - 2018
Stream Inflows	2,563,800	2,570,200
Merced River below Merced Falls	942,900	1,014,100
Tuolumne River below La Grange	799,900	805,900
San Joaquin River upstream of Merced River Confluence	821,000	750,200
Tributary Inflow[1]	4,700	4,000
Operational Outflows	48,400	47,800
Outflows into Merced River	7,500	7,500
Outflows into Tuolumne River	12,300	12,200
Outflows into San Joaquin River	28,500	28,200
Stream Gain from Groundwater	143,400	129,900
Turlock Subbasin	71,000	63,700
Merced River – North[2]	4,300	4,700
Tuolumne River - South	31,300	26,500
San Joaquin River - East	35,400	32,500
Other Subbasins	72,400	66,200
Merced River - South	3,100	3,800
Tuolumne River - North	26,700	21,900
San Joaquin River - West	42,600	40,600
Surface Runoff to the Stream System[3]	109,800	129,300
Return Flow to Stream System[3]	108,400	107,800
Other Flows[4]	17,800	16,800
Total Inflow	**2,996,300**	**3,005,800**
San Joaquin River Outflows	2,117,800	2,098,700
Diverted Surface Water[5]	620,800	617,900
Stream Seepage to Groundwater	216,200	244,500
Turlock Subbasin	109,400	124,200
Merced River - North	64,600	71,300
Tuolumne River - South	37,500	45,000
San Joaquin River - East	7,300	7,900
Other Subbasins	106,800	120,300
Merced River - South	59,400	65,100
Tuolumne River - North	37,800	45,000
San Joaquin River - West	9,600	10,200
Native & Riparian Uptake from Streams	41,500	44,700
Total Outflow	**2,996,300**	**3,005,800**

[1] Tributary inflow include surface water contributions from small watersheds and Orestimba Creek.
[2] Represents the location of the Turlock Subbasin relative to the stream, i.e., "North" represents the gains/losses of the Merced River to the Turlock Subbasin.
[3] Includes runoff/return flow from all subbasins adjacent to the stream system, not just the Turlock Subbasin.
[4] Other flows are a closure term that captures the stream system including gains and losses not directly measured or simulated within IWFM. Some of these features include but may not be limited to direct precipitation, evaporation, unmeasured riparian diversions and return flow, temporary storage in local lakes and regulating reservoirs, and inflow discrepancies resulting from simulating impaired flows.
[5] This does not include diversions for Turlock, Modesto, or Merced Irrigation Districts as their diversion point is upstream of the subbasin boundary. However, it includes riparian diversions from Merced, Tuolumne, and San Joaquin Rivers, as well as other diversions on San Joaquin River to Delta Mendota Subbasin.

Table 5-15: Average Annual Water Budget Under Climate Change – Land Surface System, Turlock Subbasin (AFY)

Component	Projected Condition Water Budget	Climate Change Water Budget
Hydrologic Period	WY 1969 - 2018	WY 1969 - 2018
Agricultural Areas Precipitation	237,500	250,800
Agricultural Water Supply	777,700	800,700
Agency Surface Water	439,500	428,800
Agency Groundwater	51,300	51,300
Private Groundwater	287,000	320,300
Urban Areas Precipitation	41,900	44,300
Urban Water Supply	75,800	75,800
Groundwater	75,800	75,800
Surface Water	-	-
Native Areas Precipitation	61,200	64,600
Native & Riparian Uptake from Stream	12,600	13,700
Total Supplies	**1,206,800**	**1,249,600**
Agricultural ET	745,300	796,300
Agricultural ET of Precipitation	147,600	153,100
Agricultural ET of Surface Water	320,600	332,200
Agricultural ET of Agency Groundwater	38,000	40,200
Agricultural ET of Private Groundwater	239,100	270,800
Agricultural Percolation	234,400	211,400
Agricultural Percolation of Precipitation	56,900	53,200
Agricultural Percolation of Surface Water	118,100	99,000
Agricultural Percolation of Agency Groundwater	12,200	10,200
Agricultural Percolation of Private Groundwater	47,200	48,800
Agricultural Runoff & Return Flow	31,600	37,700
Urban Runoff & Return Flow	72,300	74,700
Urban ET	33,500	34,800
Urban Percolation	11,700	10,300
Native Runoff	11,900	14,300
Native ET	55,300	56,700
Native Percolation	6,500	6,900
Other	400	200
Total Demands	**1,202,500**	**1,243,100**
Land Surface System Balance	**4,300**	**6,500**
Land Surface System Balance (% of supplies)	0.4%	0.5%

Table 5-16: Average Annual Water Budget Under Climate Change – Groundwater System, Turlock Subbasin (AFY)

Component Hydrologic Period	Projected Condition Water Budget WY 1969 - 2018	Climate Change Water Budget WY 1969 - 2018
Stream Seepage	109,400	124,200
Seepage from the Merced River	64,600	71,300
Seepage from the Tuolumne River	37,500	45,000
Seepage from the from San Joaquin River	7,300	7,900
Canal & Reservoir Recharge	85,400	83,700
Deep Percolation	252,700	228,400
Subsurface Inflow	110,300	127,100
Inflow from the Sierra Nevada Foothills	2,100	1,700
Inflow from the Merced Subbasin	59,500	72,000
Inflow from the Modesto Subbasin	34,300	34,700
Inflow from the Delta Mendota Subbasin	14,400	18,700
Total Inflow	**557,800**	**563,400**
Discharge to Stream	71,000	63,700
Discharge to the Merced River	4,300	4,700
Discharge to the Tuolumne River	31,300	26,500
Discharge to the San Joaquin River	35,400	32,500
Subsurface Outflow	80,300	71,600
Outflow to the Merced Subbasin	20,300	17,900
Outflow to the Modesto Subbasin	32,800	31,800
Outflow to the Delta Mendota Subbasin	27,200	21,900
Groundwater Production	414,100	447,400
Agency Ag. Groundwater Production	51,300	51,300
Private Ag. Groundwater Production	287,000	320,300
Urban Groundwater Production	75,800	75,800
Total Outflow	**565,400**	**582,700**
Change in Groundwater Storage	**-7,600**	**-19,300**

5.2.3.4. Opportunities for Future Refinement

The climate change approach developed for this GSP is based on the methodology in DWR's guidance document (DWR, 2018b) and uses "best available information" related to climate change in the Turlock Subbasin. There are limitations and uncertainties associated with the analysis. One important limitation is that CalSim II does not fully simulate local surface water operations. Thus, the analysis conducted for this GSP may not fully reflect how surface and groundwater basin operations would respond to the changes in water demand and availability caused by climate change. For this first GSP iteration, use of a regional model and the perturbation factor approach were deemed appropriate given the uncertainties in the climate change analysis.

A recommendation for future refinements of this analysis is utilization of the local surface water operations model, the Tuolumne Reservoir Simulation (TRS) model. Use of this model would allow for greater resolution in the simulation of Tuolumne River flows and surface water supply based on local management. Additionally, utilization of TRS will allow for analysis of the localized climate conditions effecting snowpack and its implications on reservoir operations and streamflow. Further monitoring and adaptive management should be considered for the next update if the GSP along with improvements in DWR's climate change data.

5.3. SUSTAINABLE YIELD ESTIMATE

Sustainable yield is defined for SGMA purposes 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 §10721(w)). Sustainable yield for the Turlock Subbasin was calculated through development of a C2VSimTM scenario in which the long-term (50-year) SGMA sustainability indicators are met either directly or by groundwater levels as a proxy. The sustainable management criteria defined for the sustainability indicators are explained in more detail in **Chapter 6**. The criteria are used to develop an initial estimate of the Subbasin sustainable yield as part of the water budgets. The assumptions and criteria used in the sustainable yield analysis to avoid undesirable results are summarized below and are described more fully in **Chapter 6**.

- **Reduction of Groundwater Storage –** Over the 50-year planning horizon the subbasin-wide change in storage is zero.
- **Chronic Lowering of Groundwater Levels** – groundwater levels at no more than 33% of the representative monitoring wells do not exceed Fall-2015 minimum thresholds for a period longer than 3 consecutive Fall semi-annual monitoring events (i.e., 3 years).
- **Depletion of Interconnected Surface Water –** groundwater levels at no more than 50% (i.e., 2 wells) of the representative monitoring wells along each stream boundary selected to proxy stream depletions to do not exceed Spring-2014 minimum thresholds for a period longer than 2-years. (4 consecutive semi-annual monitoring events) on the Merced River and to proxy stream depletions to do not exceed low 2015 minimum thresholds for a period longer than 2-years. (4 consecutive semi-annual monitoring events) on the San Joaquin and Tuolumne Rivers.

The sustainable yield water budget is based on the Projected Conditions Baseline and is analyzed by reducing groundwater production through changes in the agricultural and urban demand of the net groundwater extractors in the Subbasin. Net groundwater contributing and net groundwater extracting users in the Turlock Subbasin are divided up into the two sustainability groups listed below and shown in **Figure 5-49**.

The Sustainable Yield Scenario varies from the Projected Conditions Baseline in the following ways:

Sustainability Group 1:

Net groundwater Contributing Users

- Turlock Irrigation District
- Merced Irrigation District
- Riparian surface water users

Sustainability Group 2:

Net groundwater Extracting Users

- Local urban areas including the Cities of Turlock, Ceres, Modesto, and Hughson
- Smaller communities including Delhi, Denair, Hickman, Hilmar, and Keyes
- Eastside Water District
- Ballico-Cortez Water District
- Non-district agriculture

- **Agricultural Water Demand:** Reductions in agricultural water demand are implemented through a reduction in agricultural land use by reducing the projected cropped acreage for each element within Group 2.
- **Urban Water Demand:** Reductions in urban water use are implemented through a percent reduction in the per-capita water use equal to the percent reduction in agricultural use up to a maximum of 12% reduction.

The sustainable yield water budget is intended to estimate future conditions of supply, demand, and aquifer response to the implementation of sustainable conditions in the Subbasin. The sustainable yield is therefore estimated based on reduction of groundwater demand in Group 2 areas, which are net extractors from the groundwater system.

To achieve sustainable conditions and meet the criteria for sustainability indicators listed above, Group 2 municipal users would need to reduce groundwater demand by twelve (12) percent, and Group 2 agricultural users would need to reduce groundwater use by forty (40) percent. This reduction in groundwater usage results in a sustainable yield of approximately 310,700 acre-feet per year for the Subbasin.

This methodology of reducing subbasin wide groundwater pumping to estimate sustainable yield is developed solely for the purpose of estimating the Turlock Subbasin's sustainable yield. It is not intended to prescribe or describe how a water budget balance would be achieved in the Turlock Subbasin during GSP implementation to avoid Undesirable Results. Groundwater demand reduction is the only action utilized in a modeling exercise herein and solely for the purpose of obtaining an initial estimate of the Subbasins' sustainable yield. Collectively, Projects, Management Actions and demand management are intended to achieve sustainable groundwater management. Projects and Management Actions are further discussed in **Chapter 8** of this GSP.

Under the sustainable yield scenario, reductions in urban demands from Group 2 users is expected to increase the net-contribution in the WTSGSA from 109,300 AFY under the Baseline to 116,700 AFY under sustainable yield conditions. Similarly, in the ETSGSA, net-reductions in agricultural demand met through the implementations of projects and management actions are expected to reduce the GSA's overall net-extraction from 182,000 AFY to 98,200 AFY.

The combination of each GSA's operational water budget could balance the Subbasin's net recharge of 18,500 AFY. Localized conditions, particularly the net-extraction and resulting cone of depression in the eastern part of the subbasin, are expected to predominantly stabilize over the 50-year hydrological period by inducement of subsurface flows from the WTSGSA to the ETSGSA and inducement of seepage from streams.

Table 5-17 provides a detailed listing of the water flow components of the Turlock Subbasin's groundwater system across the historical, baseline and sustainable yield conditions. Based on the C2VSimTM model, to achieve sustainability conditions and to maintain groundwater levels approximately the minimum thresholds set, the subbasin would need to experience an average annual net-gain of groundwater storage of 13,400 AFY over the 50-year planning horizon. Based on the modeling analysis, these sustainable conditions that would result in the subbasin operations not relying on long-term withdrawal from groundwater storage are estimated to be met through inflows of 243,900 AFY of deep percolation, 85,300 AFY of canal and reservoir recharge, 82,700 AFY of seepage recharge from the three major rivers, and 2,100 AFY of net-subsurface flow from the Sierra Nevada foothills and 80,700 AFY of inflow from the neighboring Modesto, Delta-Mendota, and Merced Subbasins. In contrast, modeling results indicate that net outflows from the subbasin are expected to include 310,700 AFY of pumping, 79,000 AFY of outflow to the neighboring Modesto, Delta-Mendota, and Merced Subbasins, and 91,600 AFY of groundwater discharge to the three major rivers bounding the Subbasin. The major flow components are represented graphically in **Figure 5-50** and **Figure 5-51**, both on an average annual basis and annually.

Figure 5-52 and **Figure 5-53** show the operational and net recharge for the Turlock Subbasin. Under sustainable conditions, the Turlock Subbasin's operational water budgets were simulated totaling a subbasin-wide net recharge of 18,500 AFY. This is achieved through 243,900 AFY of deep percolation and 85,300 AFY of canal and reservoir recharge offsetting 310,700 AFY of groundwater pumping. Compared to the baseline's net groundwater extraction of 75,900 AFY, this variance is predominantly attributed to a twenty-five (25) percent reduction of groundwater pumping compared to the projected conditions baseline.

Figure 5-54 though **Figure 5-57** show a further break down of the operational and net recharge water budgets for each GSA within the Turlock Subbasin. These figures show that the WTSGSA would continue to be a net contributor and the ETSGSA would continue to be a net-extractor of groundwater. Under the sustainable yield scenario, reductions in urban demands from Group 2 users is expected to increase the net-contribution in the WTSGSA from 109,300 AFY under the Baseline to 116,700 AFY under sustainable yield conditions. Similarly, in the ETSGSA, net-reductions in agricultural demand met through the implementations of projects and management actions are expected to reduce the GSA's overall net-extraction from 182,000 AFY to 98,200 AFY.

The combination of each GSA's operational water budget could balance the Subbasin's net recharge of 18,500 AFY. Localized conditions, particularly the net-extraction and resulting cone of depression in the eastern part of the subbasin, are expected to predominantly stabilize over the 50-year hydrological period by inducement of subsurface flows from the WTSGSA to the ETSGSA and inducement of seepage from streams.

Table 5-17: Sustainable Yield Average Annual Water Budget – Groundwater System, Turlock Subbasin (AFY)

Component	Historical Conditions	Projected Conditions	Sustainable Conditions
Hydrologic Period	WY 1991- 2015	Hydrology from WY 1969 - 2018	Hydrology from WY 1969 - 2018
Stream Seepage	61,500	109,400	82,700
Seepage from the Merced River	35,400	64,600	48,100
Seepage from the Tuolumne River	20,200	37,500	28,400
Seepage from the from San Joaquin River	5,900	7,300	6,200
Canal & Reservoir Recharge	78,500	85,400	85,300
Deep Percolation	280,500	252,700	243,900
Subsurface Inflow	112,900	110,300	82,800
Flow from the Sierra Nevada Foothills	2,200	2,100	2,100
Merced Subbasin Inflows	58,700	59,500	32,700
Modesto Subbasin Inflows	35,600	34,300	29,500
Delta Mendota Subbasin Inflows	16,400	14,400	18,500
Total Inflow	**533,400**	**557,800**	**494,700**
Discharge to Stream	118,100	71,000	91,600
Discharge to the Merced River	18,100	4,300	7,000
Discharge to the Tuolumne River	55,600	31,300	44,600
Discharge to the San Joaquin River	44,400	35,400	40,000
Subsurface Outflow	74,800	80,300	79,000
Merced Subbasin Outflows	13,700	20,300	20,400
Modesto Subbasin Outflows	33,200	32,800	36,600
Delta Mendota Subbasin Outflows	27,900	27,200	22,000
Groundwater Production	404,400	414,100	310,700
Agency Ag. Groundwater Production	79,200	51,300	51,300
Private Ag. Groundwater Production	269,700	287,000	191,200
Urban Groundwater Production	55,500	75,800	68,200
Total Outflow	**597,300**	**565,400**	**481,300**
Change in Groundwater Storage	**-63,900**	**-7,600**	**13,400**

SUMMARY

The sustainable yield of the Turlock Subbasin has been estimated by reducing groundwater demand for the net groundwater extractors in the Subbasin as a planning effort to provide targets for the development of projects and management actions needed to achieve sustainability. This methodology was used to develop a working estimate of the Sustainable Yield of the Subbasin. The goal for groundwater demand reduction exercise was to estimate a level of groundwater pumping that would be balanced against contributions from stream seepage, deep percolation, canal leakage, and inter-subbasin flows from neighboring Subbasins, to meet sustainable management criteria for the sustainability indicators considered, i.e., groundwater storage, groundwater levels, and interconnected stream systems. It is assumed that by using groundwater levels as proxy for other applicable sustainability indicators (i.e., land subsidence), the sustainable yield would address all but one of the applicable sustainability indicators in the Turlock Subbasin. As explained in **Chapter 6**, the water quality sustainability indicator is being addressed through numerous water quality programs being conducted by others. Data will be tracked and analyzed by the GSAs to ensure that GSA management of water levels and groundwater extraction do not exacerbate degraded water quality conditions.

This analysis resulted in an estimated sustainable yield of 310,700 AFY for the annual long term groundwater extraction within the Turlock Subbasin.

This current estimate of sustainable yield is based on the latest data and information available for the Subbasin in the model. It can be anticipated that a sustainable yield estimate will be generated in the 5-year GSP update in 2027. With the additional data and information based on the monitoring program that becomes available from the Subbasin and areas adjoining the Subbasin during GSP implementation of projects and management actions, more extensive measurements of groundwater levels, analyses of interconnected surface water, updated estimates of groundwater demand and estimates of changes in groundwater storage, as well as updates to the integrated hydrologic model, the estimated sustainable yield for groundwater Subbasin may change.

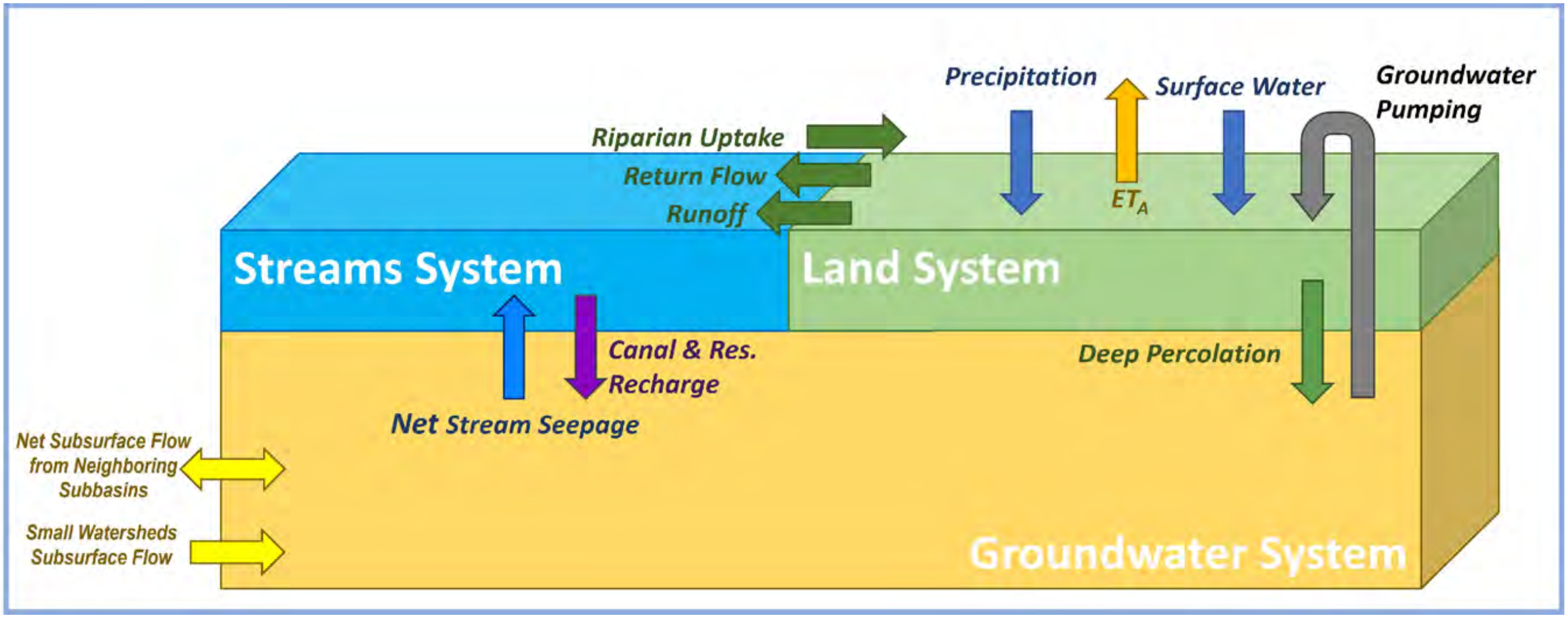

Figure 5-1

Generalized Water Budget Diagram

WOODARD & CURRAN

August 2021

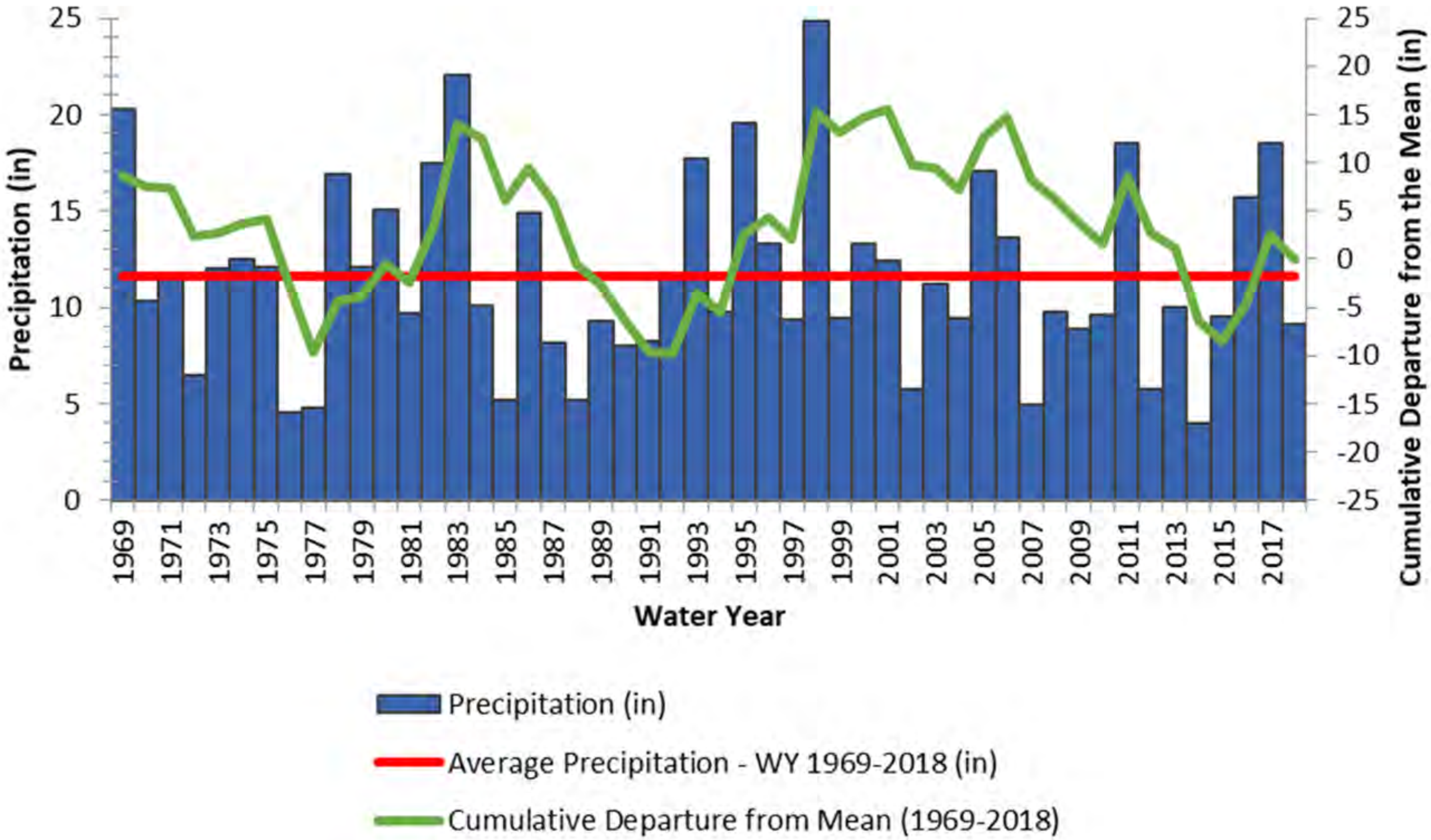

Figure 5-2

50-Year Historical Precipitation
Turlock Subbasin

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August 2021

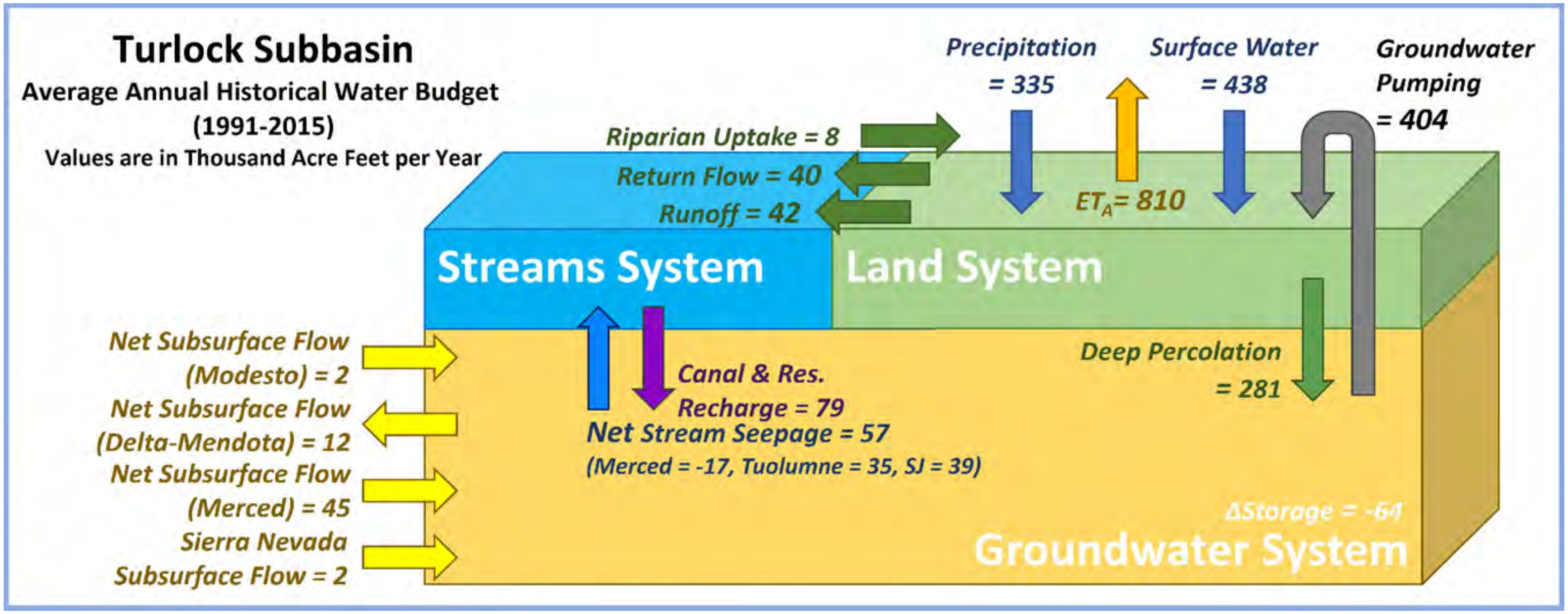

Figure 5-3

Historical Conditions
Water Budget Diagram
Turlock Subbasin

WOODARD & CURRAN

August 2021

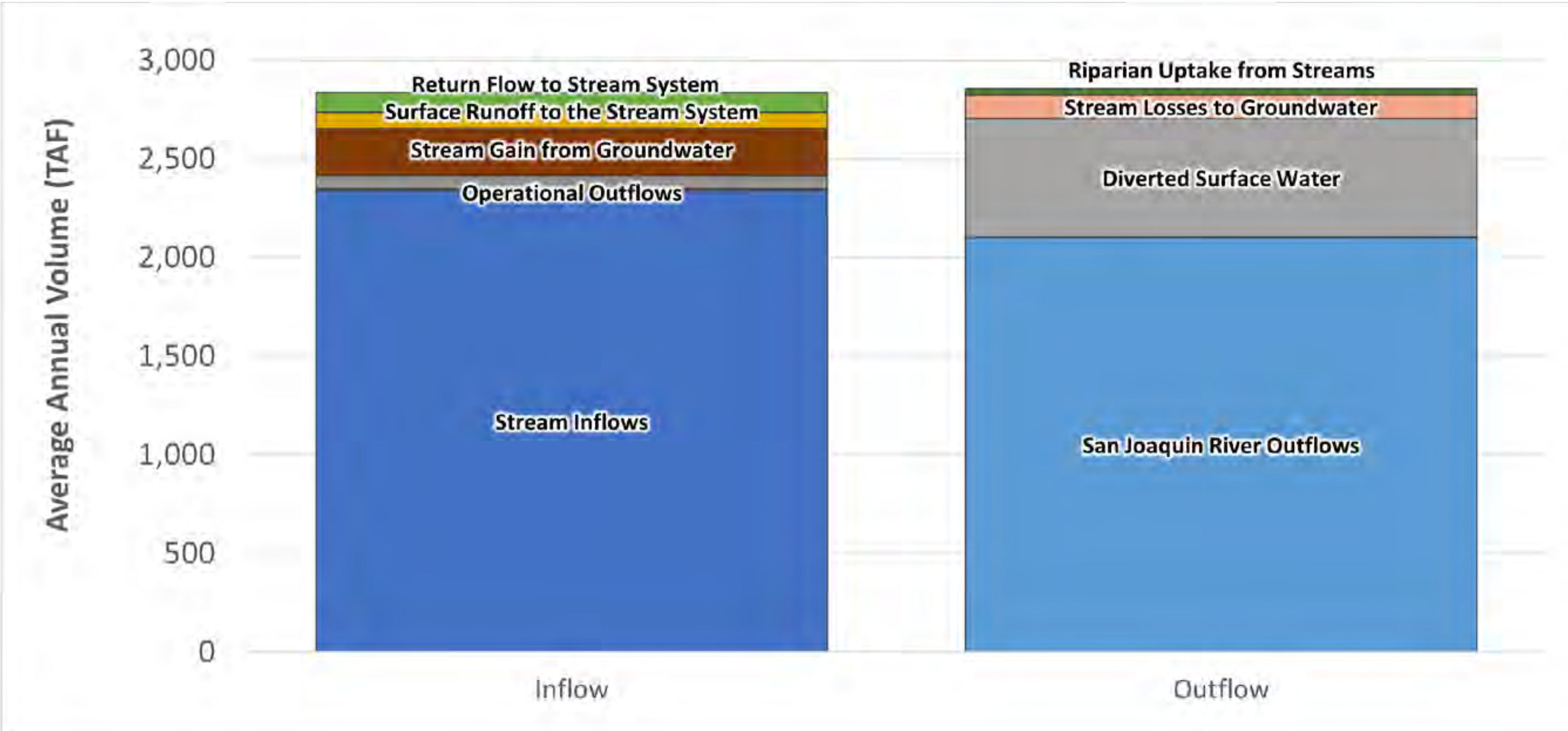

Figure 5-4

Historical Conditions
Average Annual Water Budget - Stream System
Turlock Subbasin

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August 2021

Figure 5-5

Historical Conditions
Average Annual Water Budget - Land Surface System
Turlock Subbasin

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August 2021

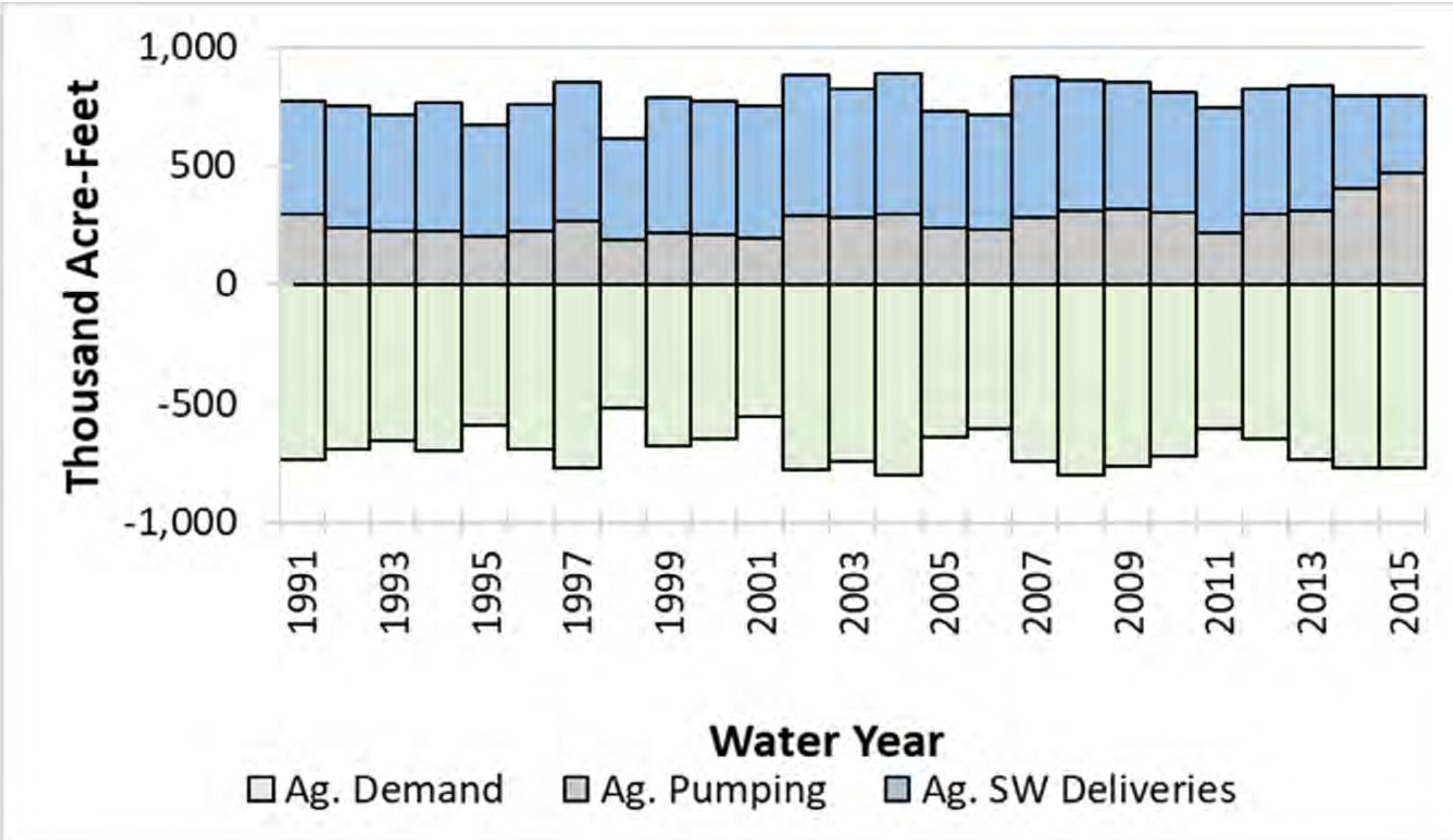

Figure 5-6

Historical Conditions
Average Annual Water Budget - Agricultural
Land Use System
Turlock Subbasin

WOODARD & CURRAN

August 2021

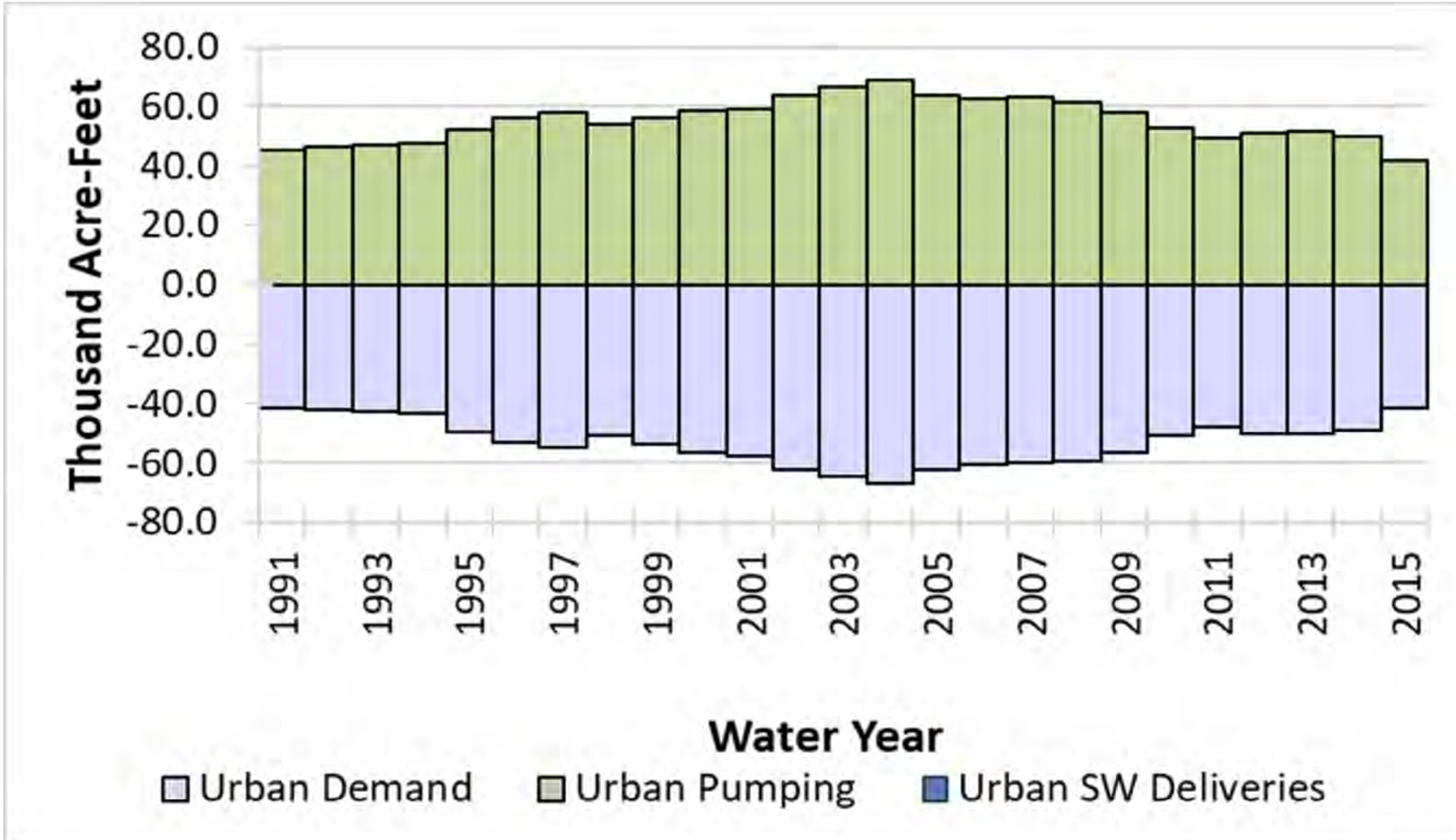

Figure 5-7

Historical Conditions
Average Annual Water Budget - Urban Land Surface System
Turlock Subbasin

WOODARD & CURRAN
August 2021

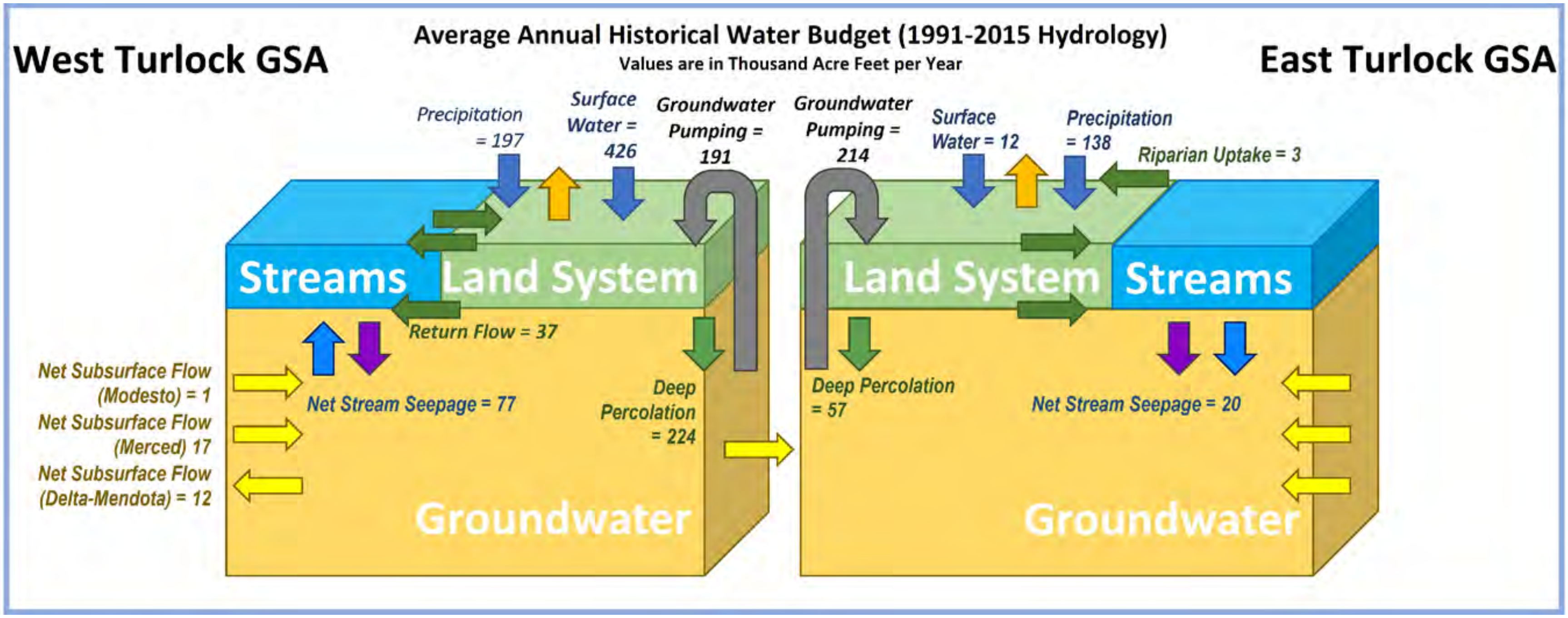

Figure 5-8

Historical Conditions
Water Budget Diagram
WTSGSA & ETSGSA

Note: The cross-boundary flows from WTSGSA to ETSGSA shown in this diagram include the total estimated subsurface flow from the WTSGSA to ETSGSA based on the resolution of the model grid.

WOODARD & CURRAN

August 2021

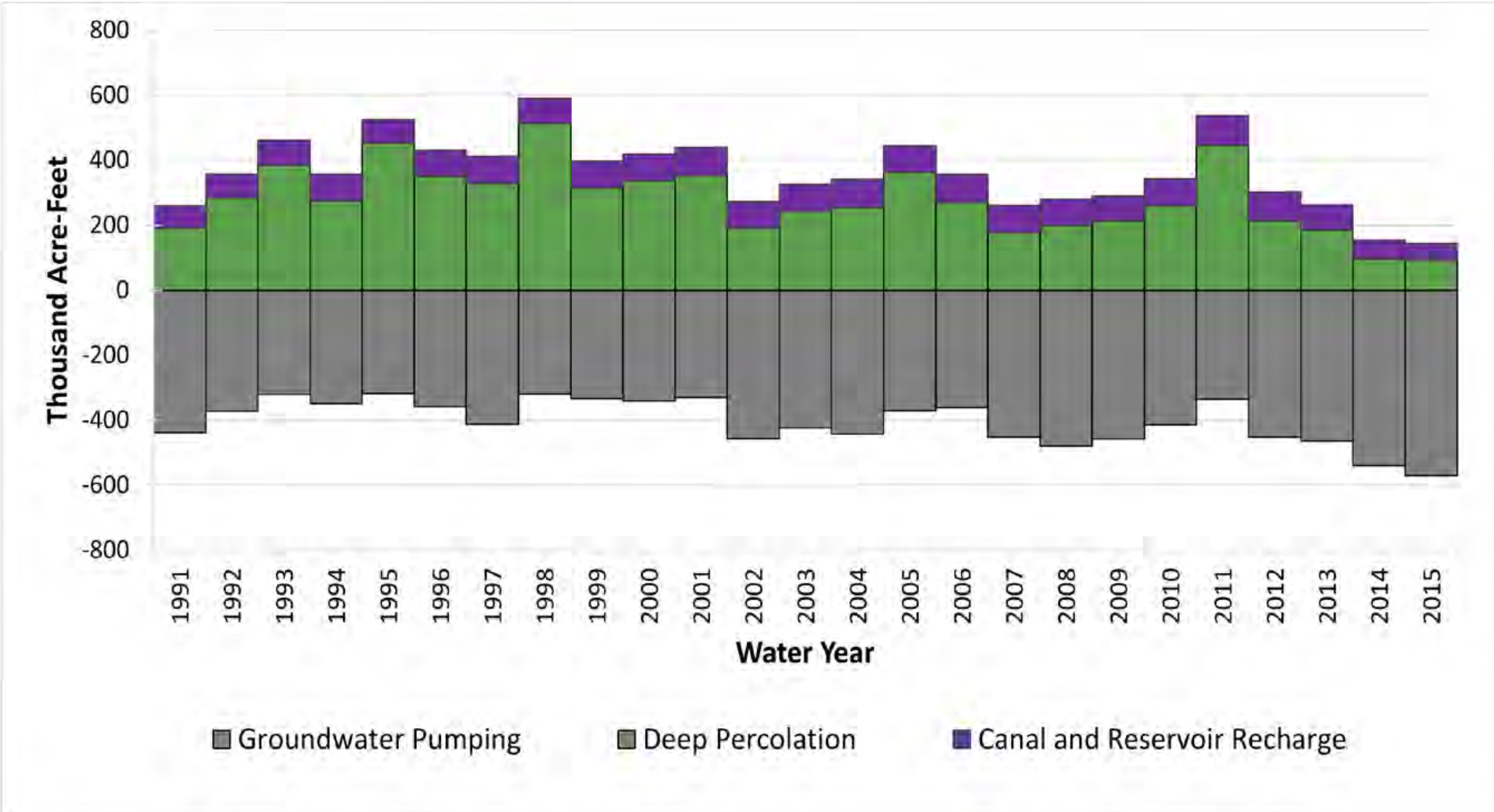

Figure 5-9

Historical Conditions
Groundwater Recharge and Extraction
Turlock Subbasin

WOODARD & CURRAN

August 2021

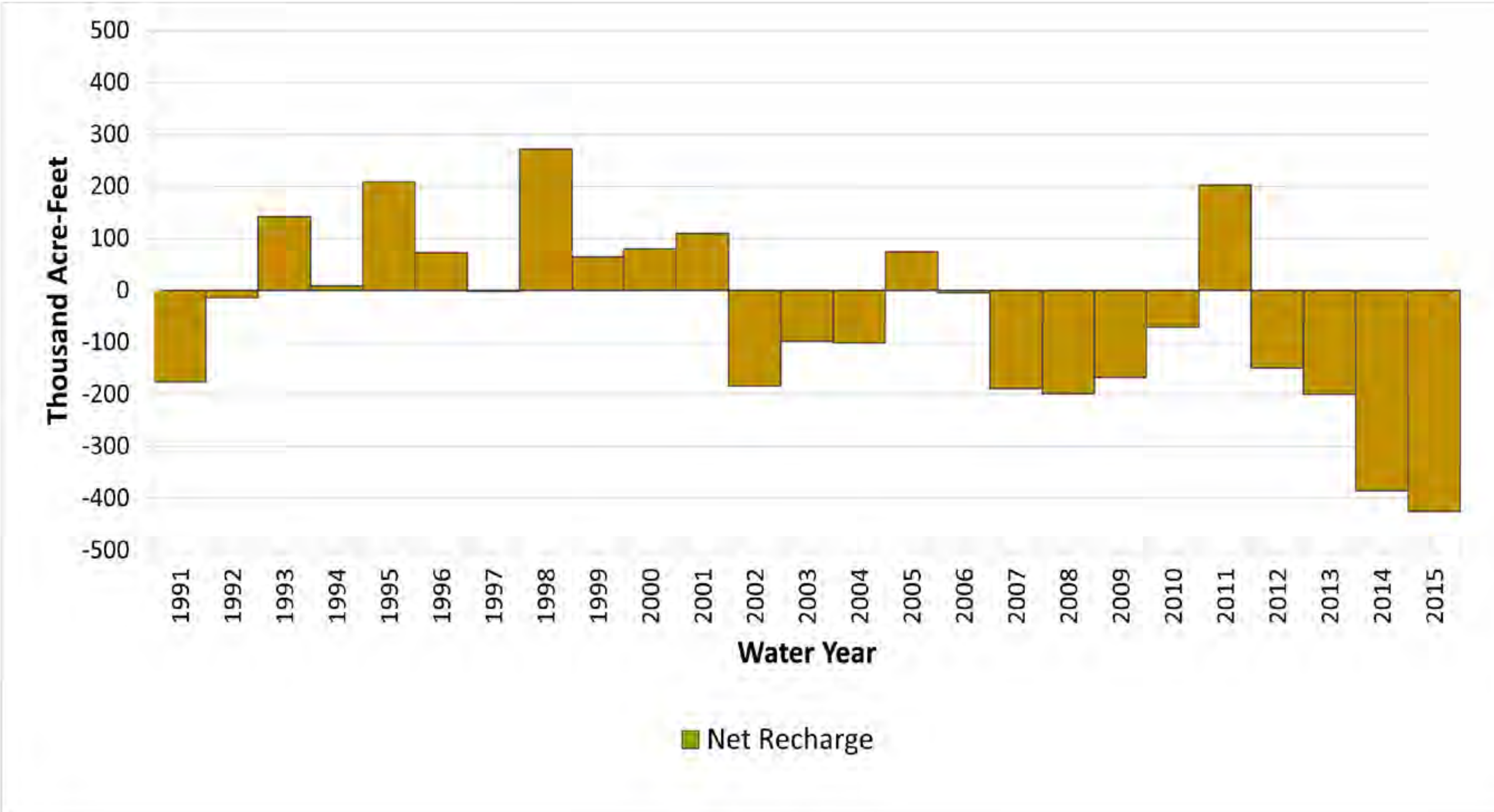

Figure 5-10

Historical Conditions
Net Recharge
Turlock Subbasin

WOODARD & CURRAN
August 2021

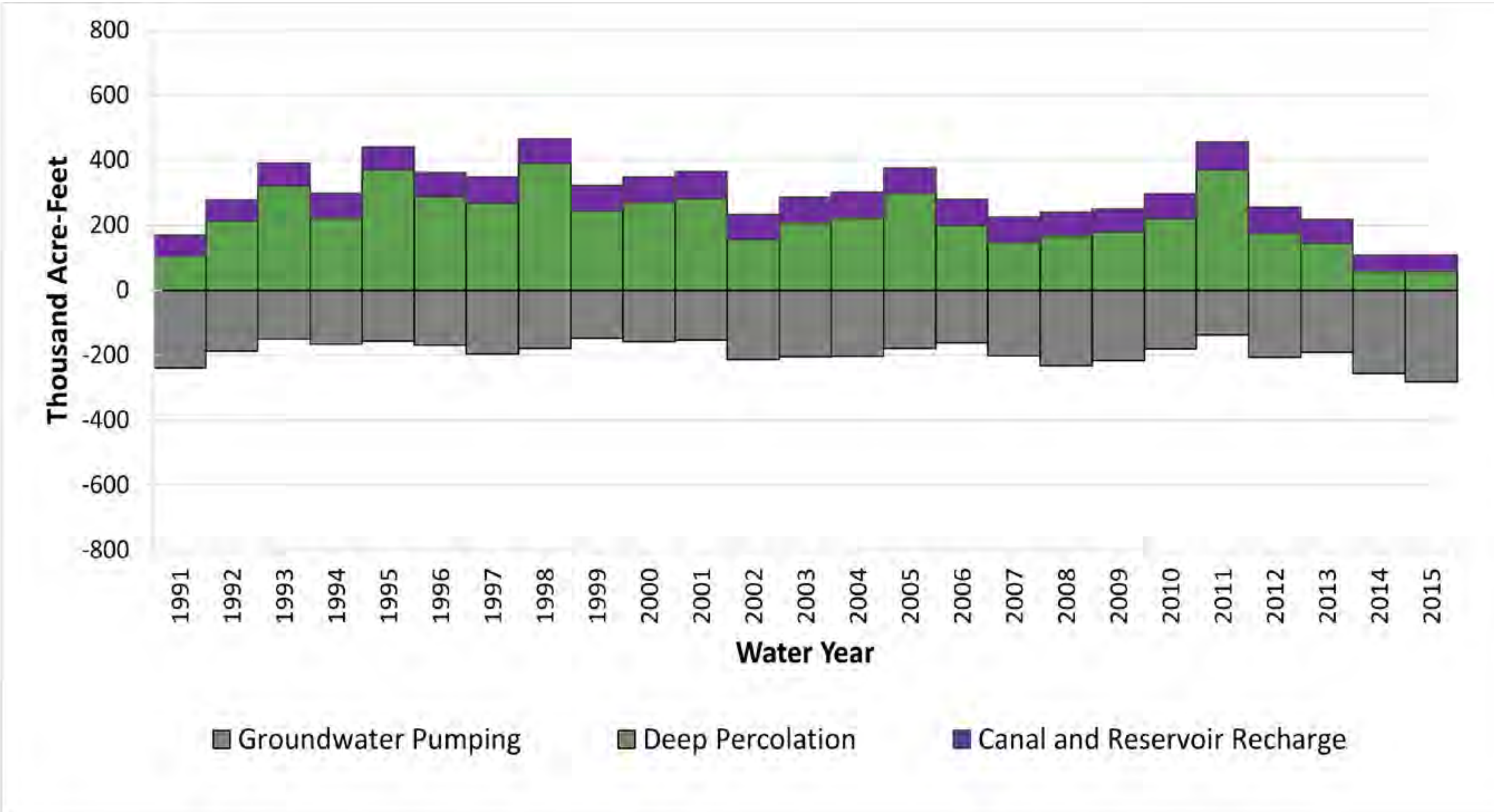

Figure 5-11	**Note:** The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.
Historical Conditions Groundwater Recharge and Extraction WTSGSA	WOODARD & CURRAN August 2021

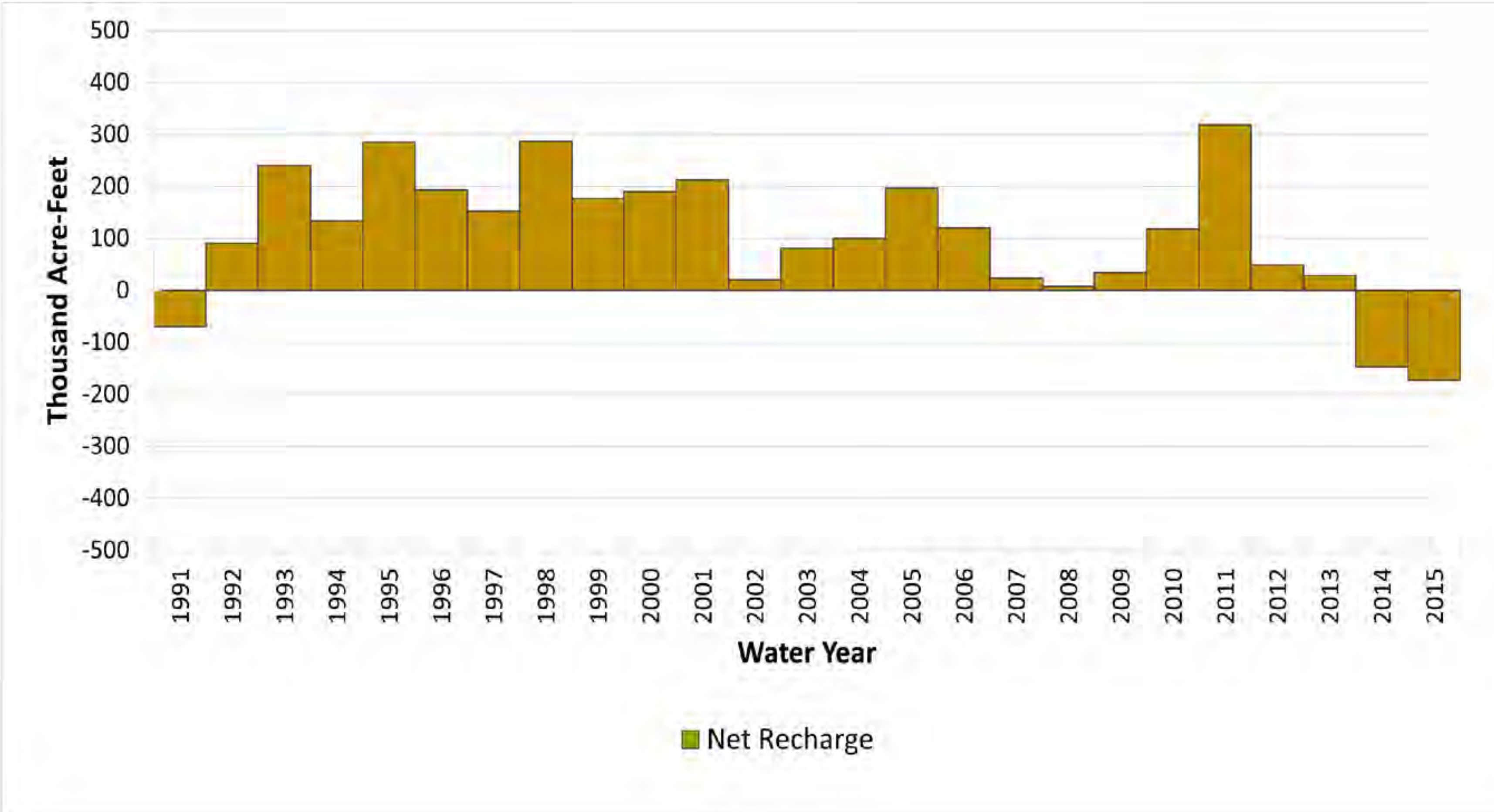

Figure 5-12

Historical Conditions
Net Recharge
WTSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

WOODARD & CURRAN

August 2021

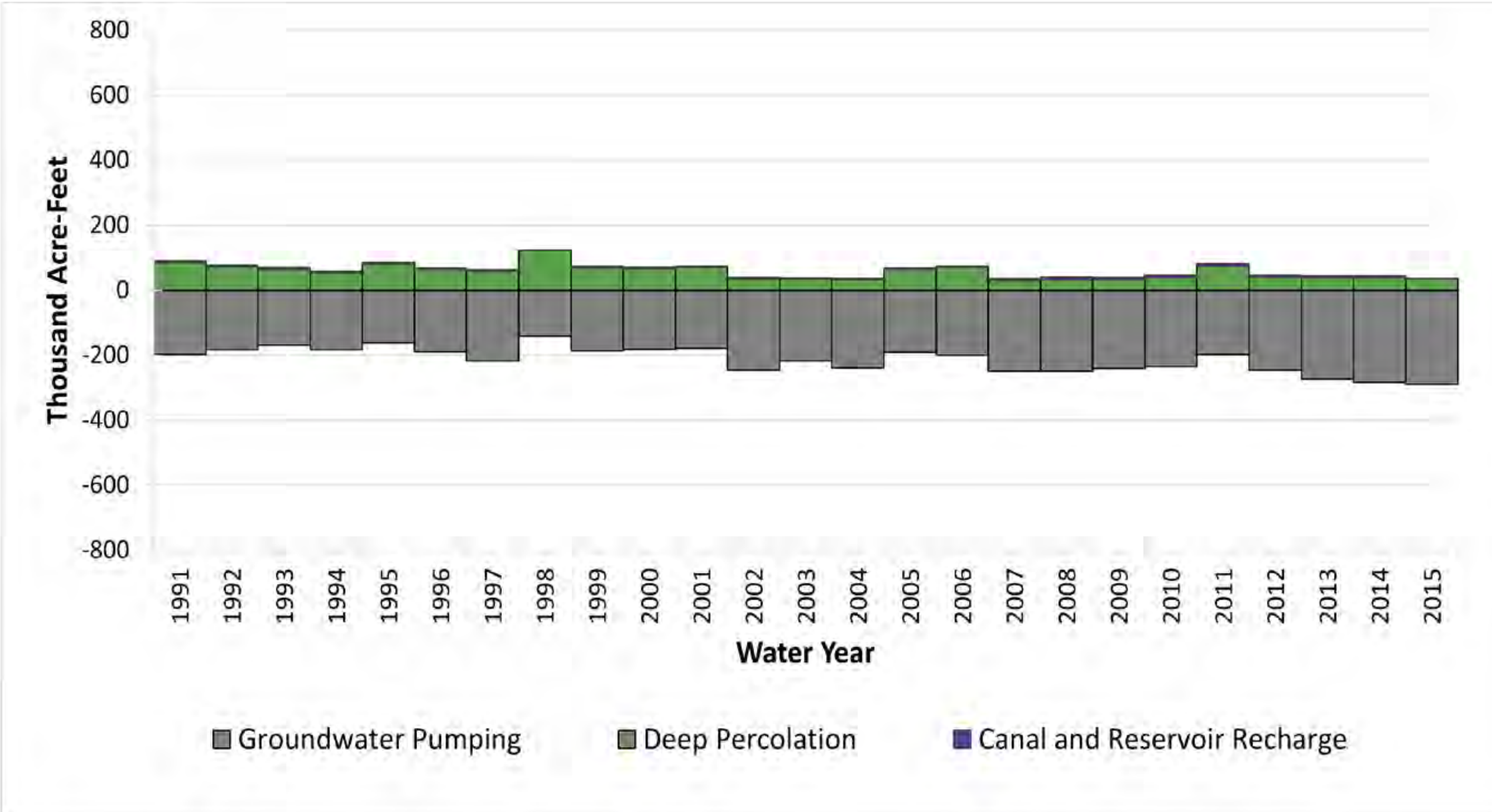

Figure 5-13

Historical Conditions
Groundwater Recharge and Extraction
ETSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

WOODARD &CURRAN

August 2021

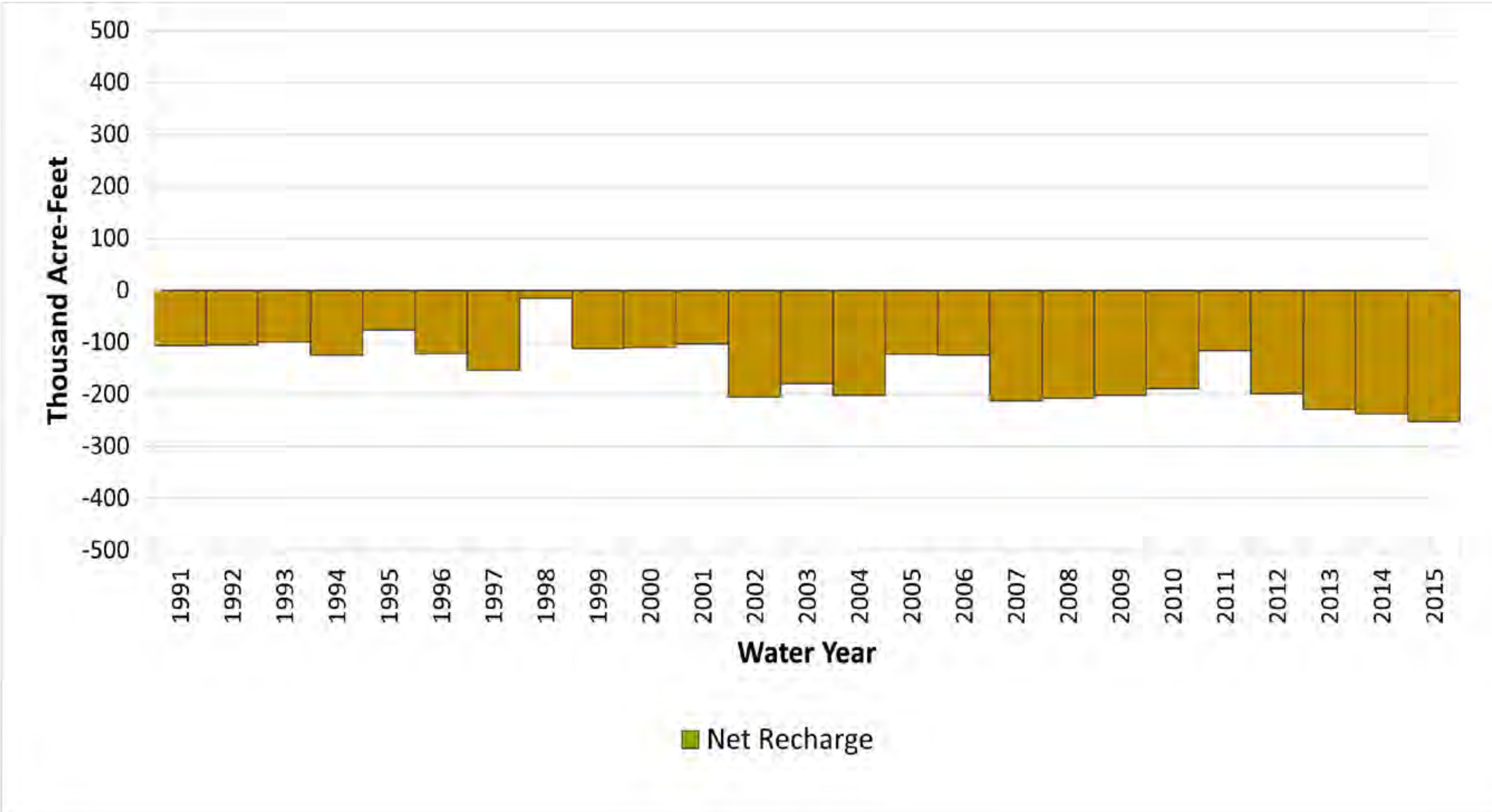

Figure 5-14	**Note:** The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.
Historical Conditions Net Recharge ETSGSA	August 2021

WOODARD & CURRAN

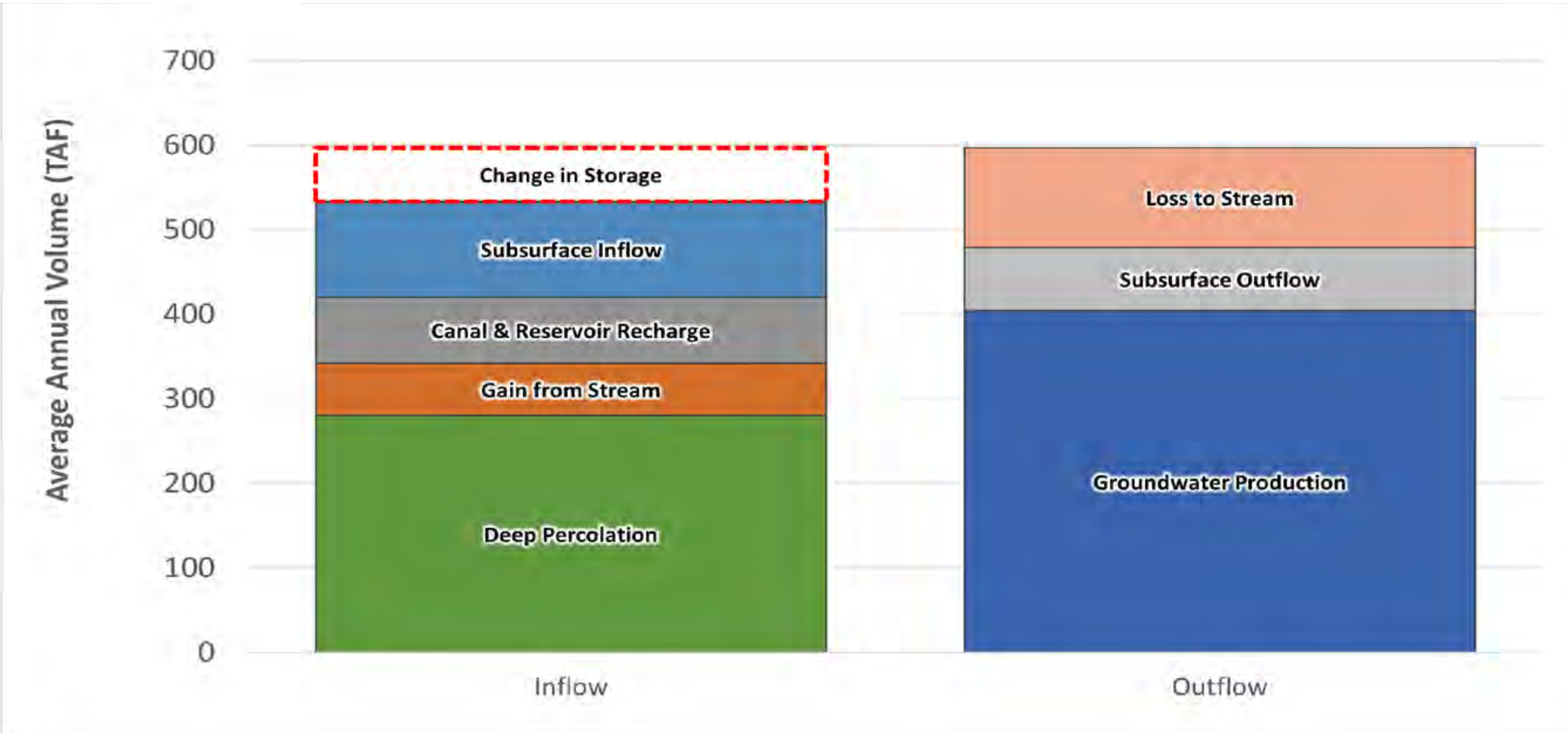

Figure 5-15

Historical Conditions
Average Annual Water Budget -
Groundwater System
Turlock Subbasin

WOODARD & CURRAN
August 2021

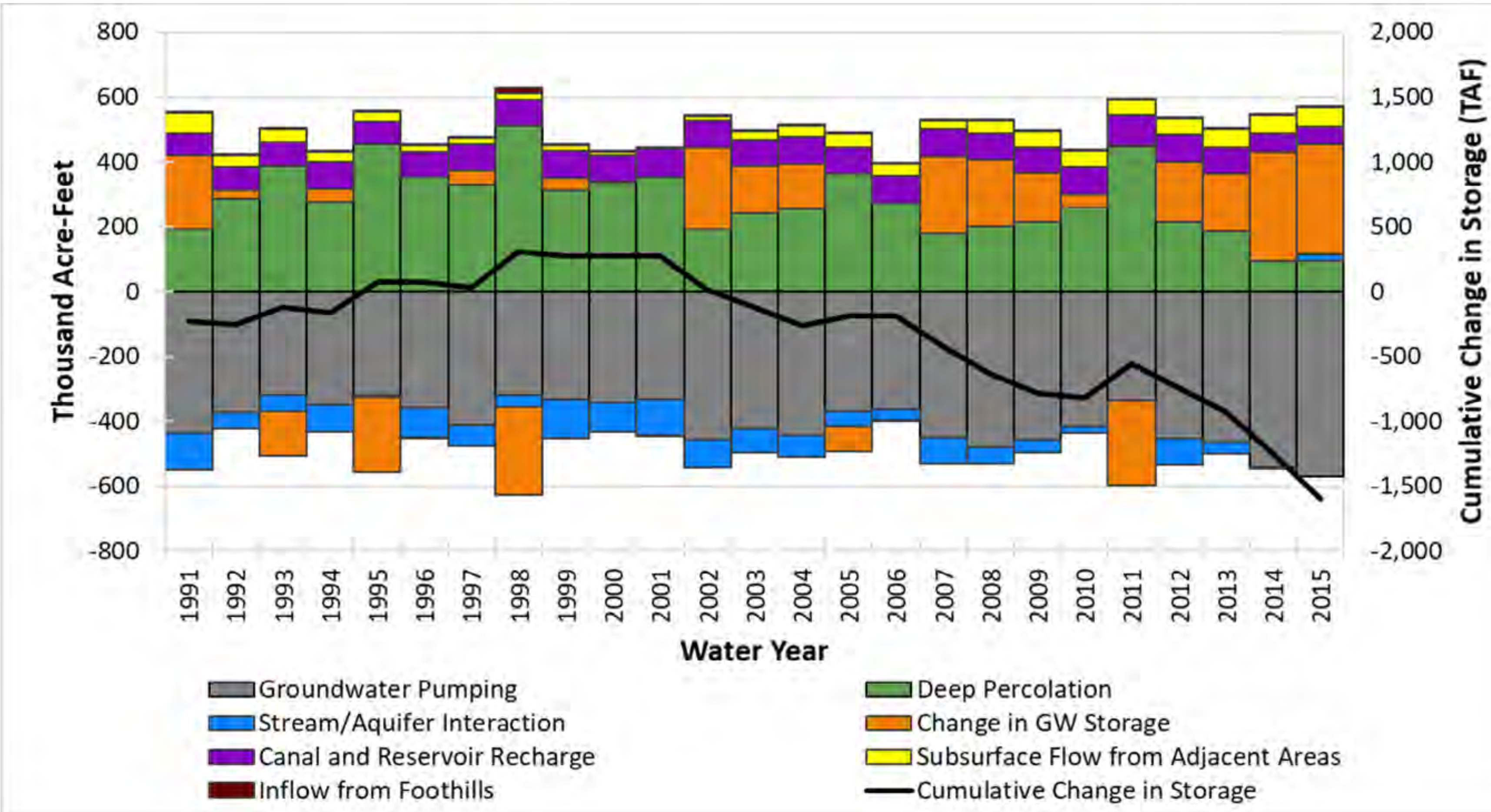

Figure 5-16

Historical Conditions
Annual Water Budget - Groundwater System
Turlock Subbasin

WOODARD & CURRAN

August 2021

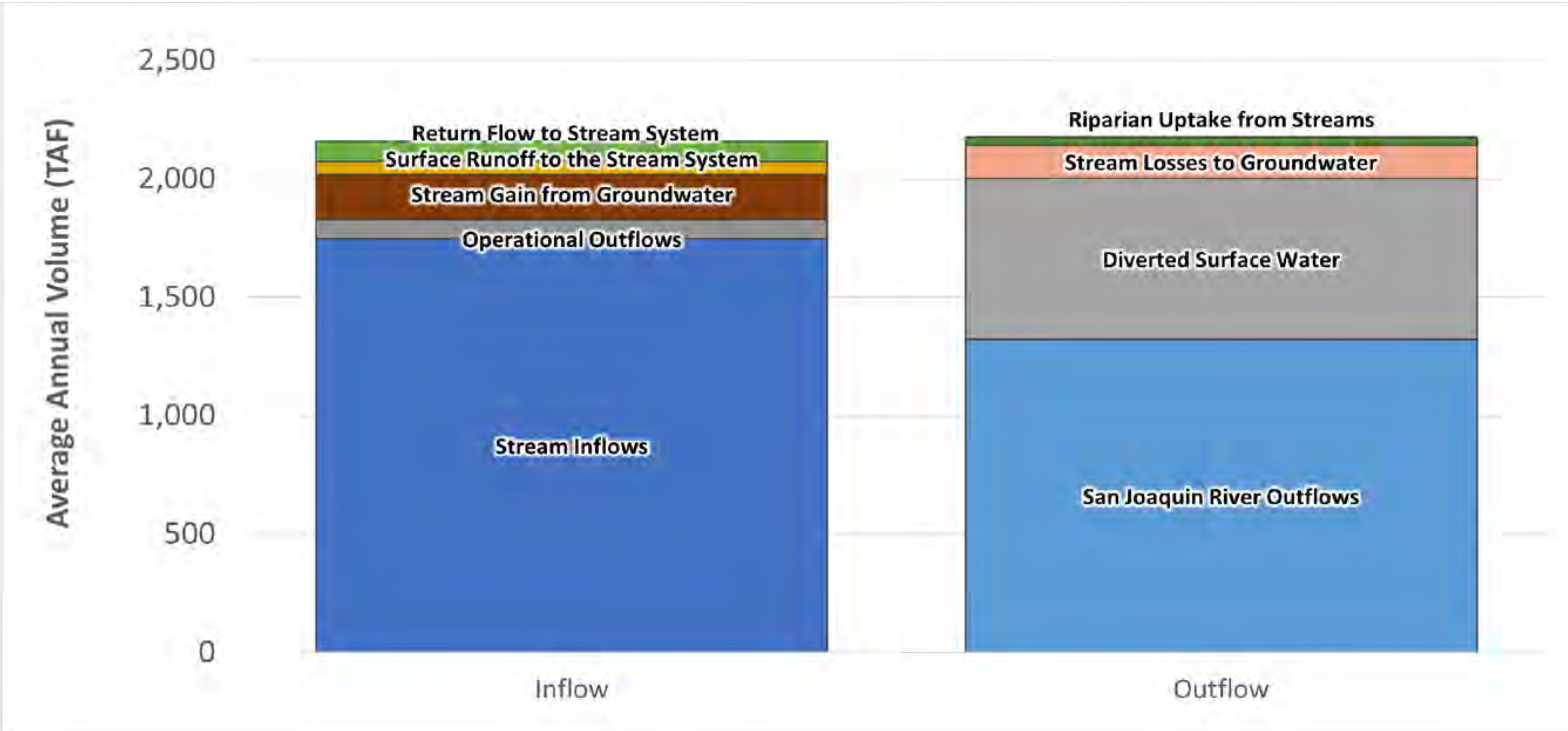

Figure 5-17

Current Conditions
Average Annual Water Budget - Stream System
Turlock Subbasin

August 2021

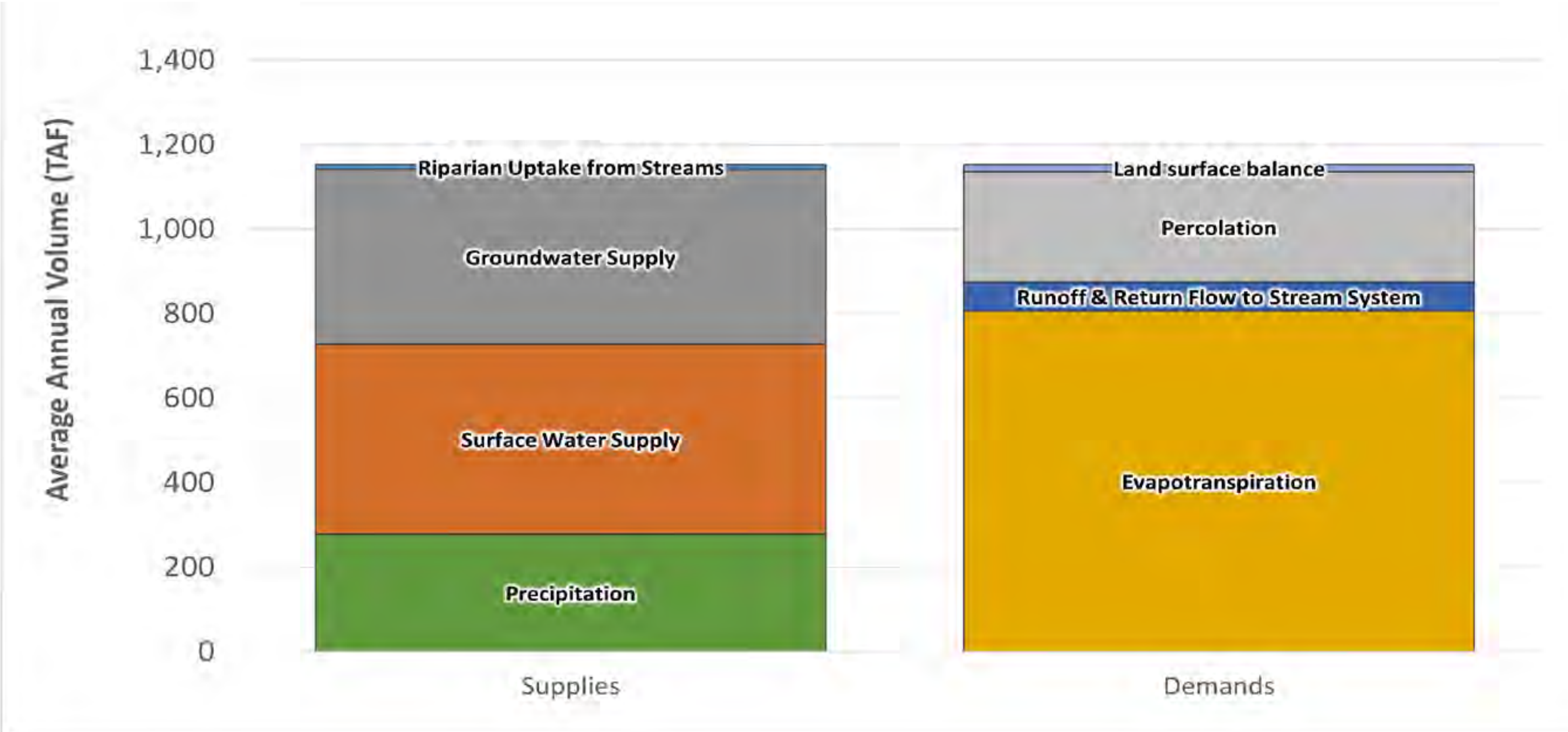

Figure 5-18

Current Conditions

Average Annual Water Budget - Land Surface System

Turlock Subbasin

WOODARD & CURRAN

August 2021

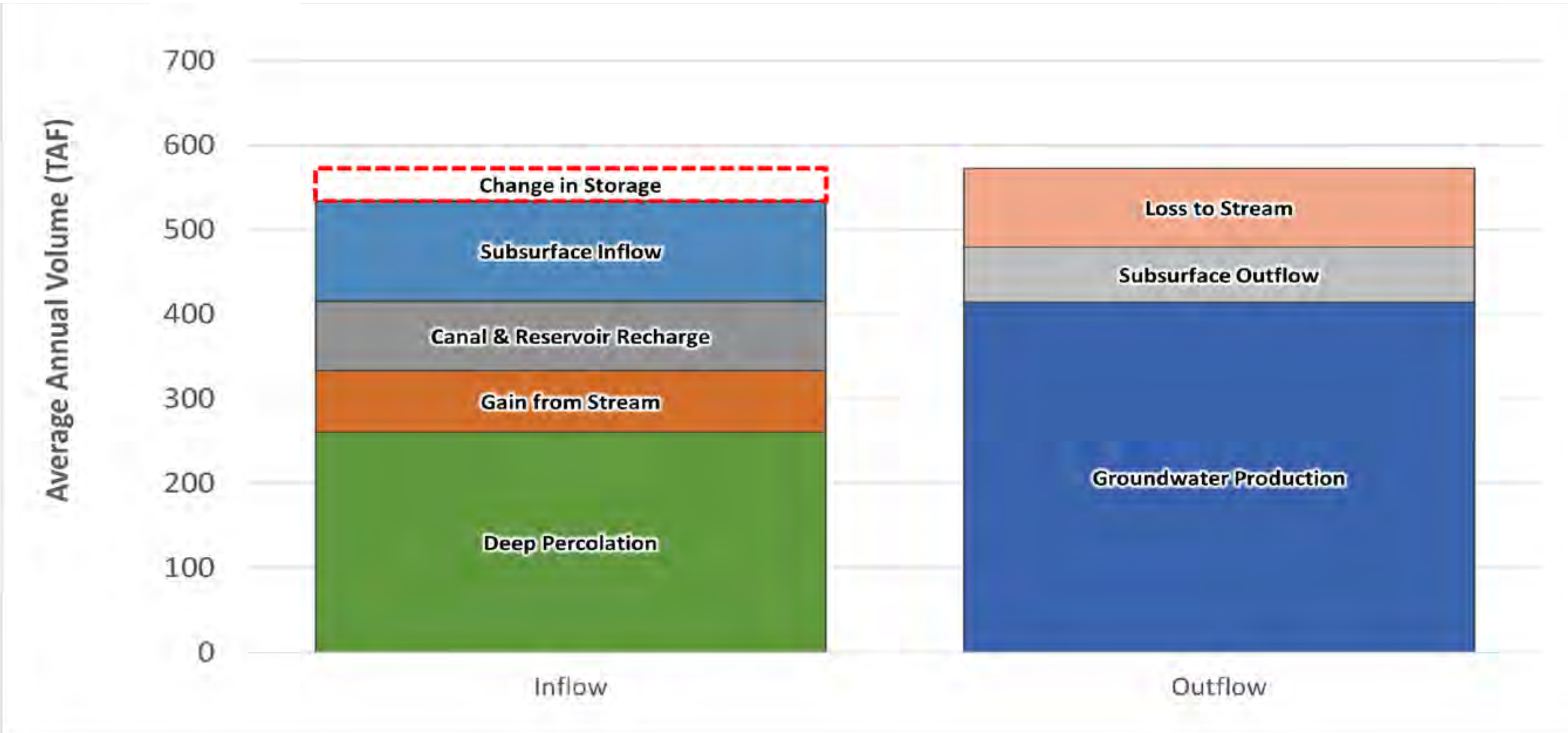

Figure 5-19

Current Conditions
Average Annual Water Budget -
Groundwater System
Turlock Subbasin

WOODARD & CURRAN

August 2021

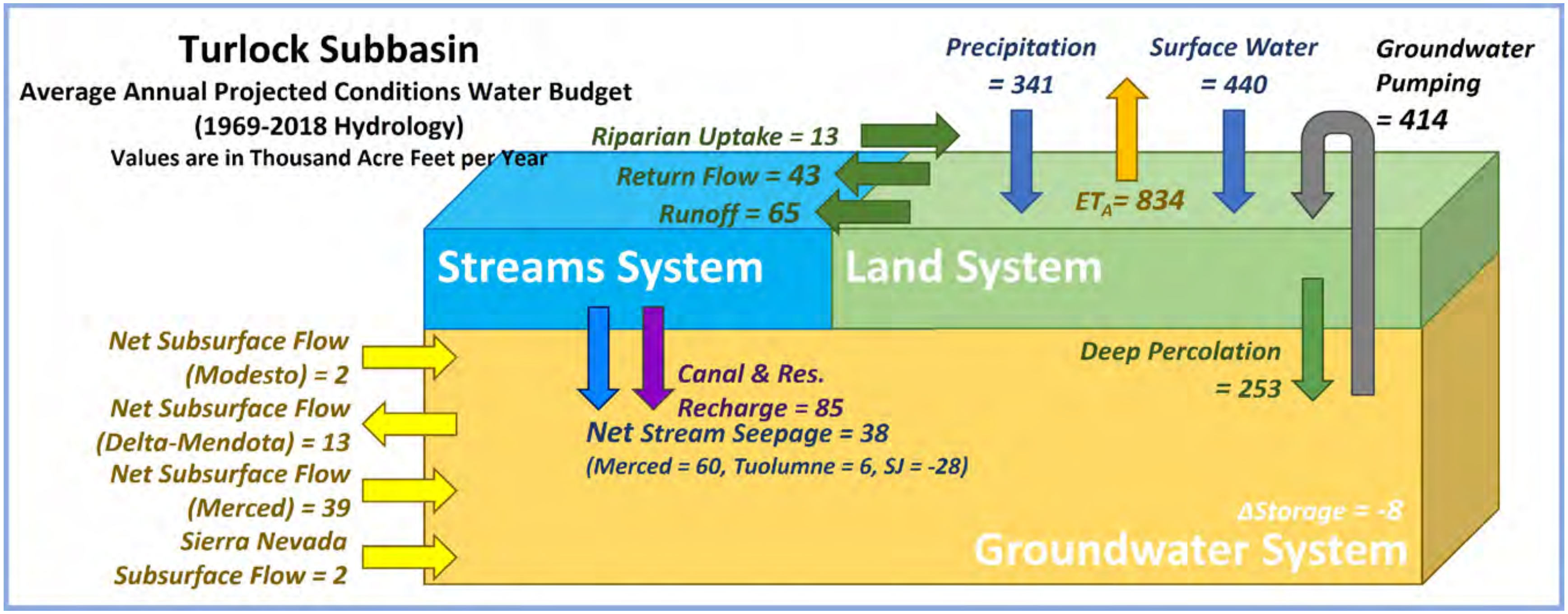

Figure 5-20

Projected Conditions
Water Budget Diagram
Turlock Subbasin

WOODARD & CURRAN
August 2021

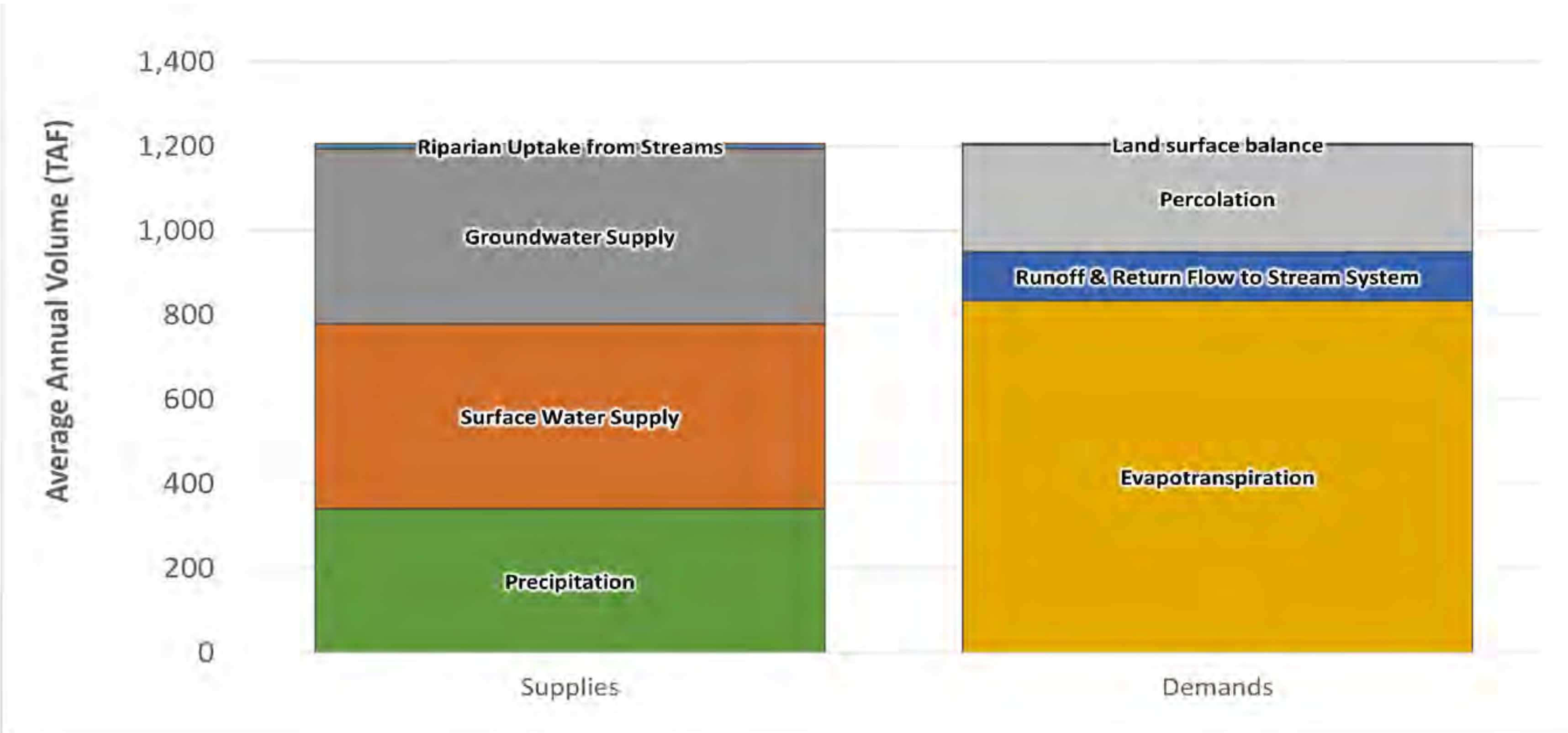

Figure 5-21

Projected Conditions
Average Annual Water Budget - Stream System
Turlock Subbasin

WOODARD & CURRAN
August 2021

Figure 5-22

Projected Conditions
Average Annual Water Budget - Land Surface System
Turlock Subbasin

WOODARD & CURRAN
August 2021

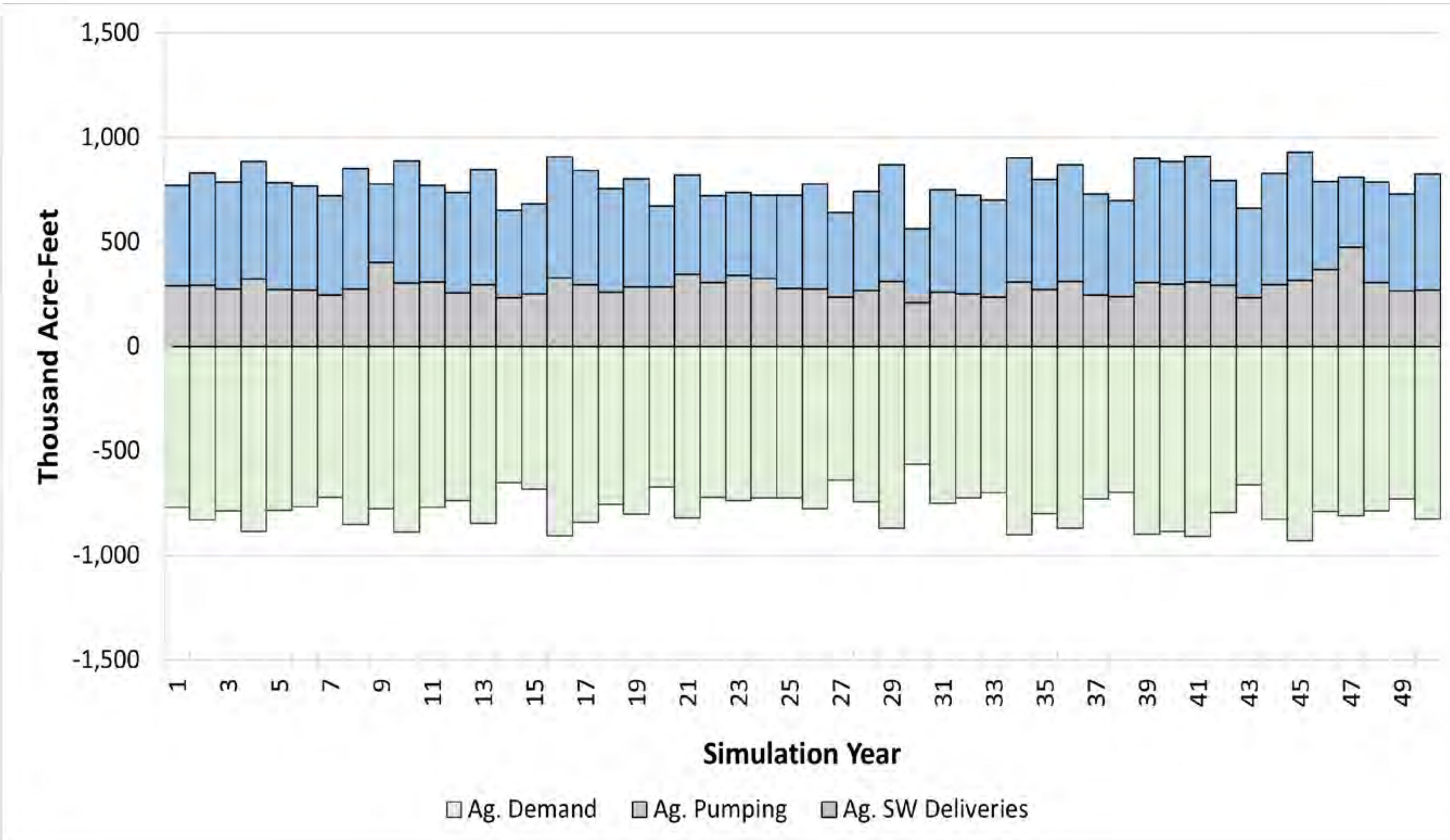

Figure 5-23

Projected Conditions
Average Annual Water Budget - Agricultural Land Use System
Turlock Subbasin

WOODARD & CURRAN
August 2021

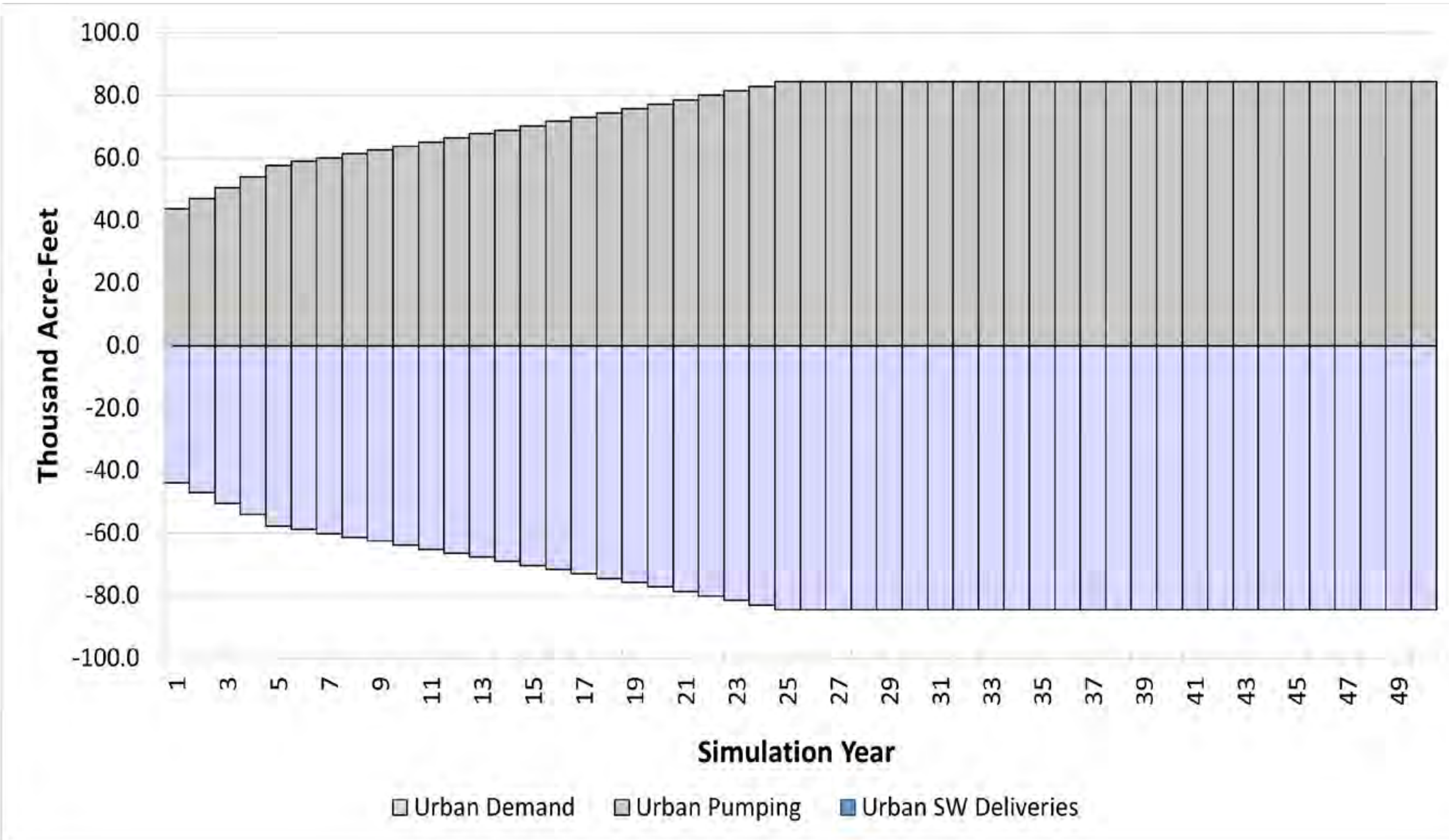

Figure 5-24

Projected Conditions
Average Annual Water Budget - Urban Land Surface System
Turlock Subbasin

WOODARD & CURRAN

August 2021

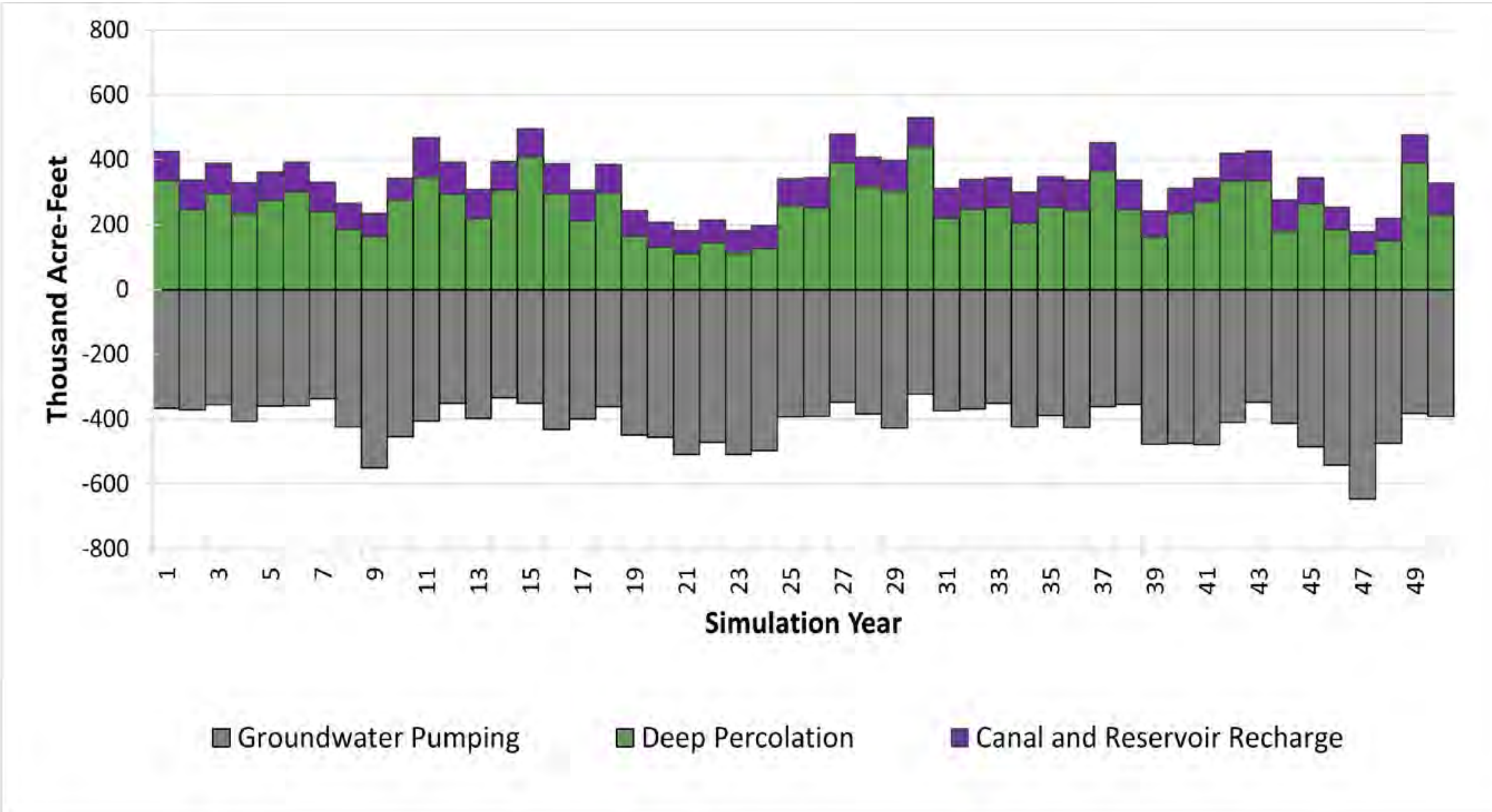

Figure 5-25

Projected Conditions
Groundwater Recharge and Extraction
Turlock Subbasin

WOODARD & CURRAN

August 2021

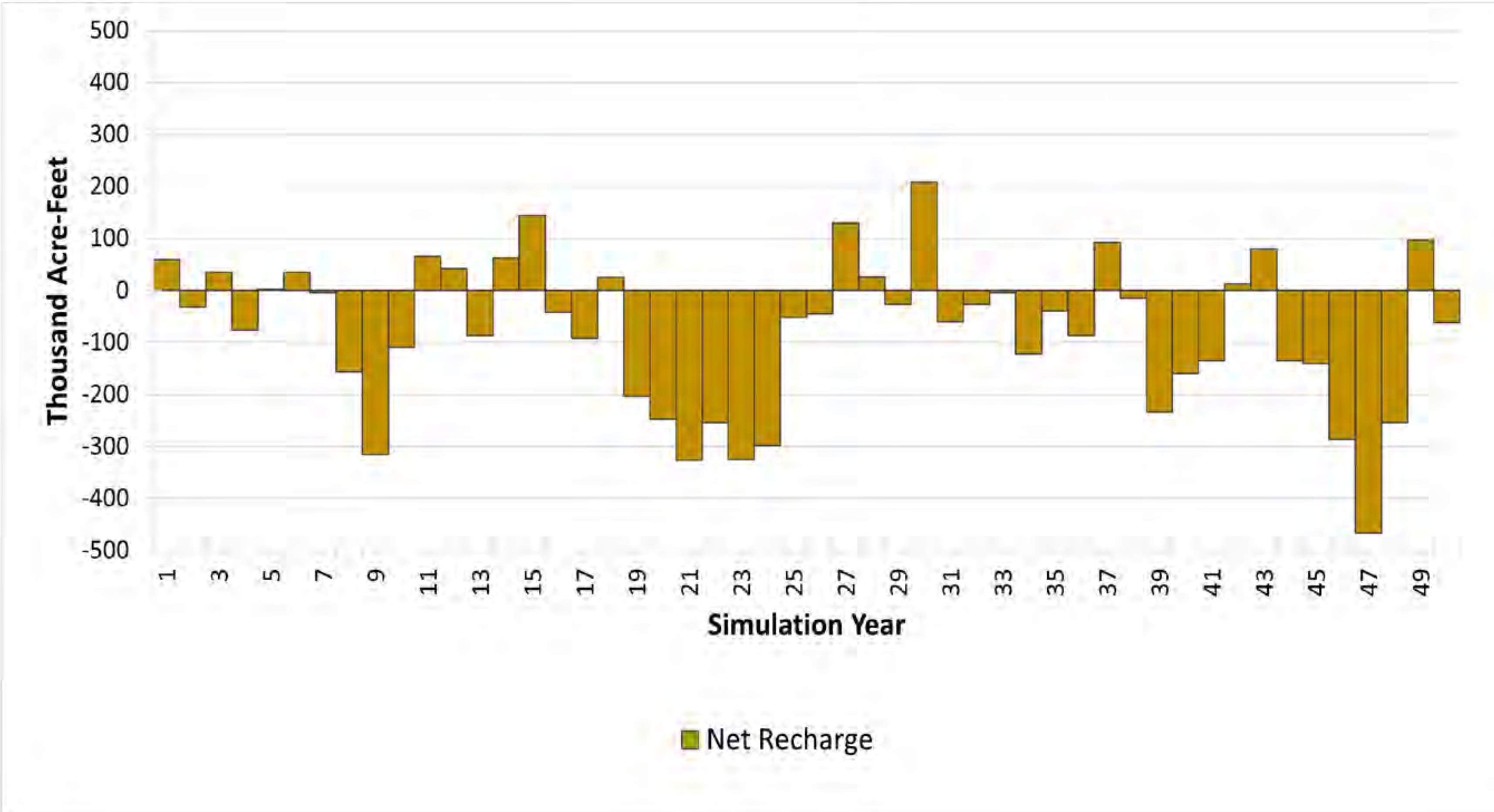

Figure 5-26

Projected Conditions
Net Recharge
Turlock Subbasin

WOODARD &CURRAN

August 2021

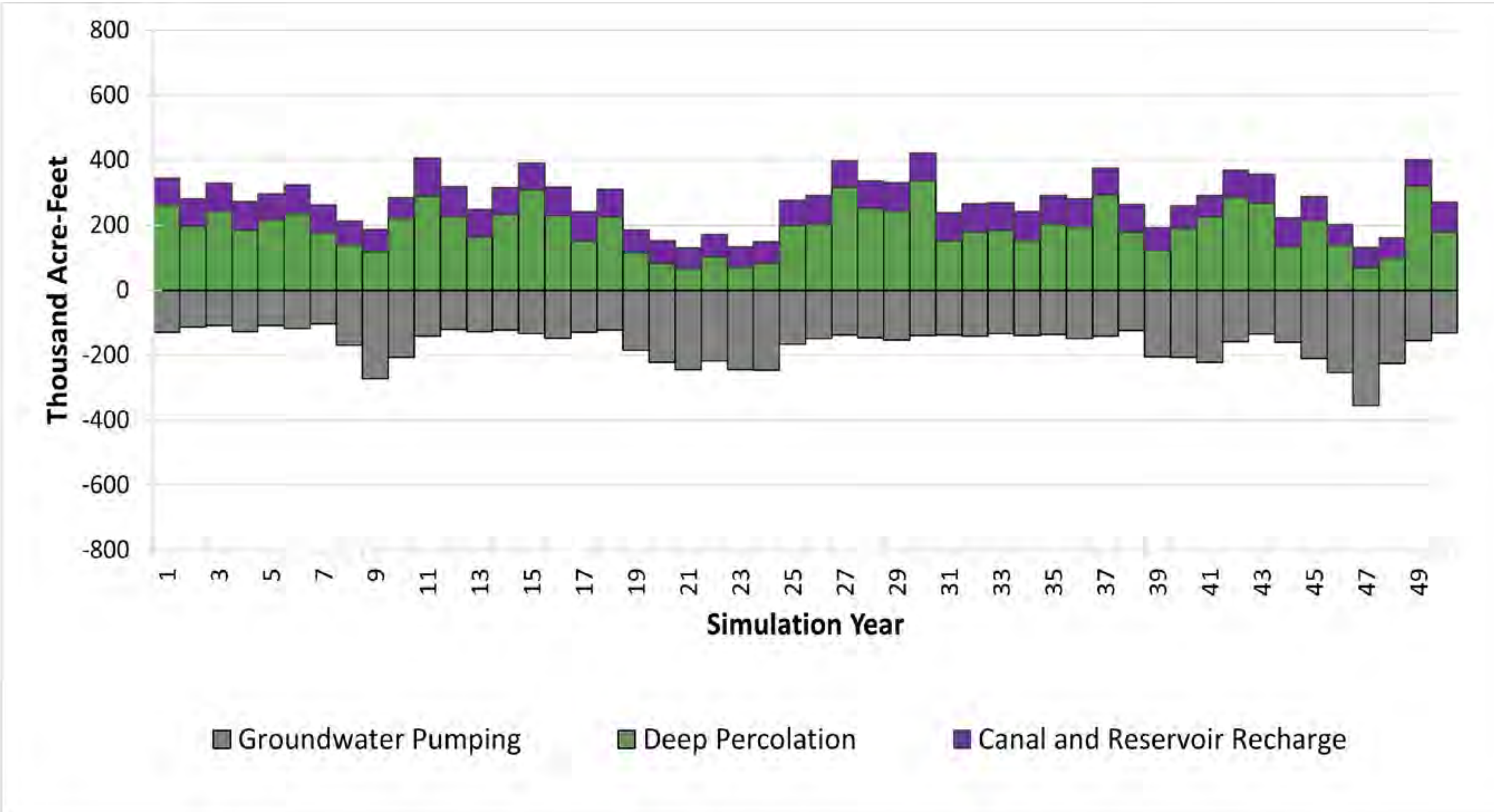

Figure 5-27

Projected Conditions
Groundwater Recharge and Extraction
WTSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

WOODARD &CURRAN

August 2021

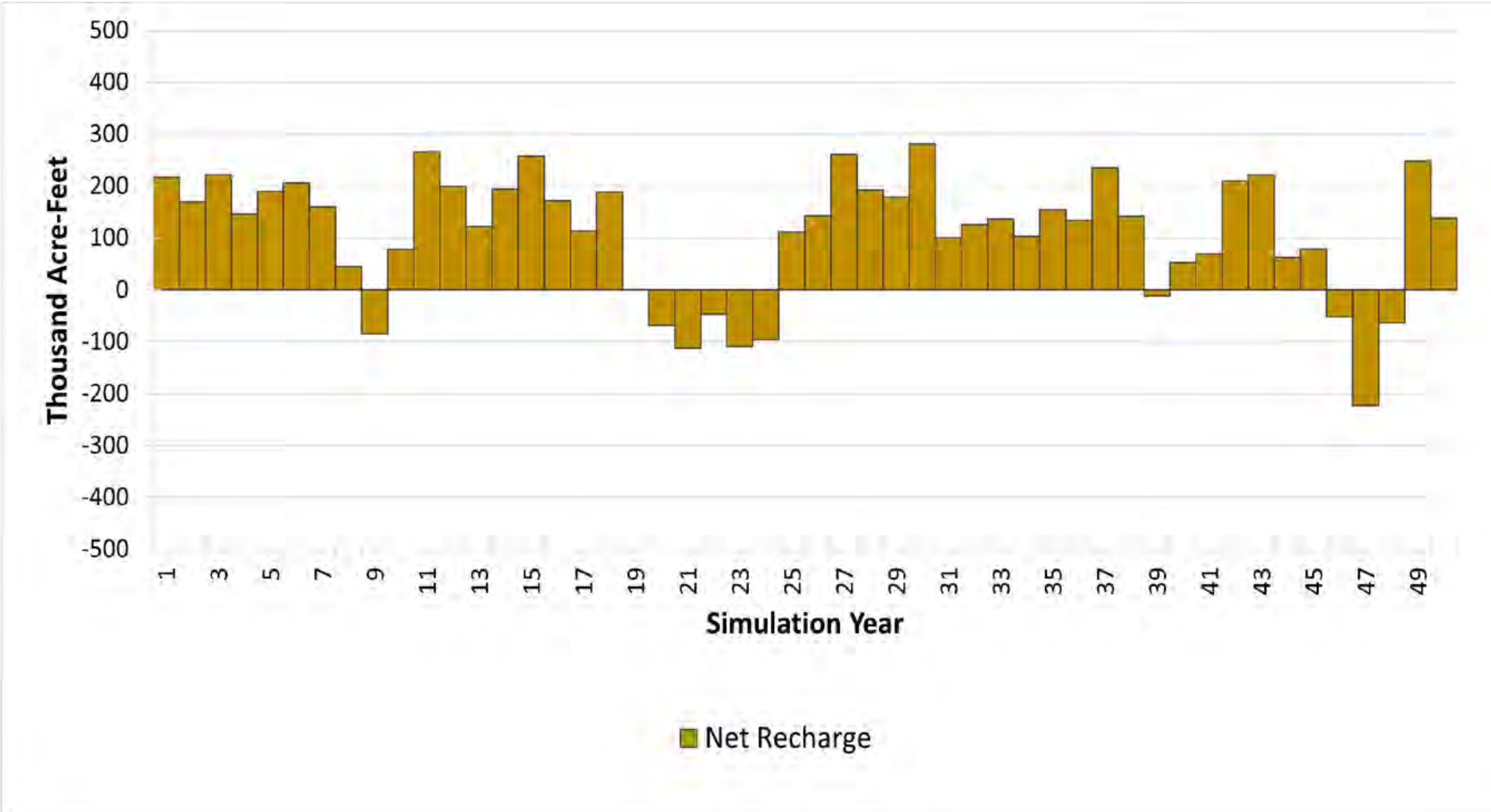

Figure 5-28

Projected Conditions
Net Recharge
WTSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

WOODARD & CURRAN

August 2021

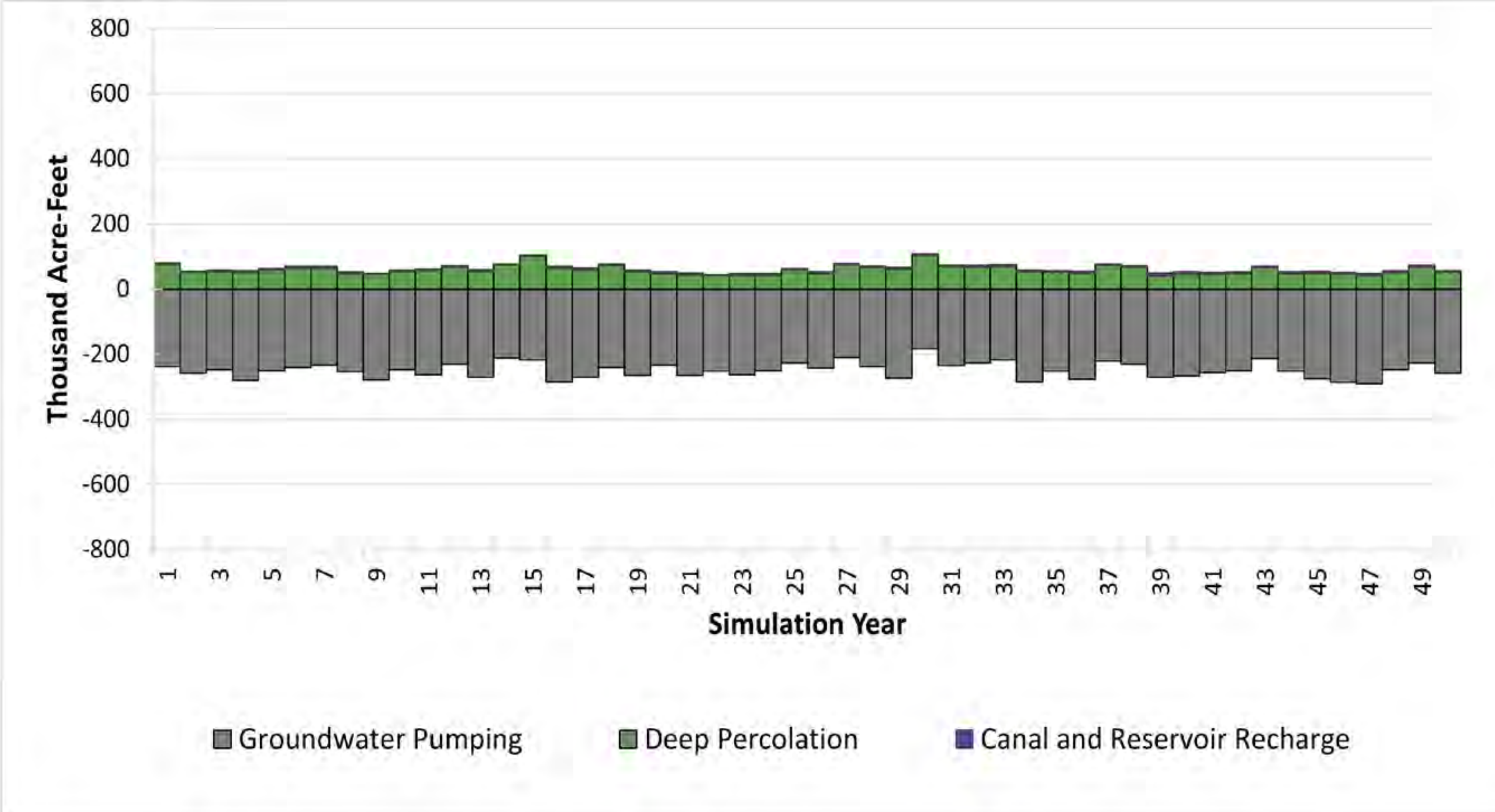

Figure 5-29	**Note:** The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.
Projected Conditions Groundwater Recharge and Extraction ETSGSA	WOODARD & CURRAN August 2021

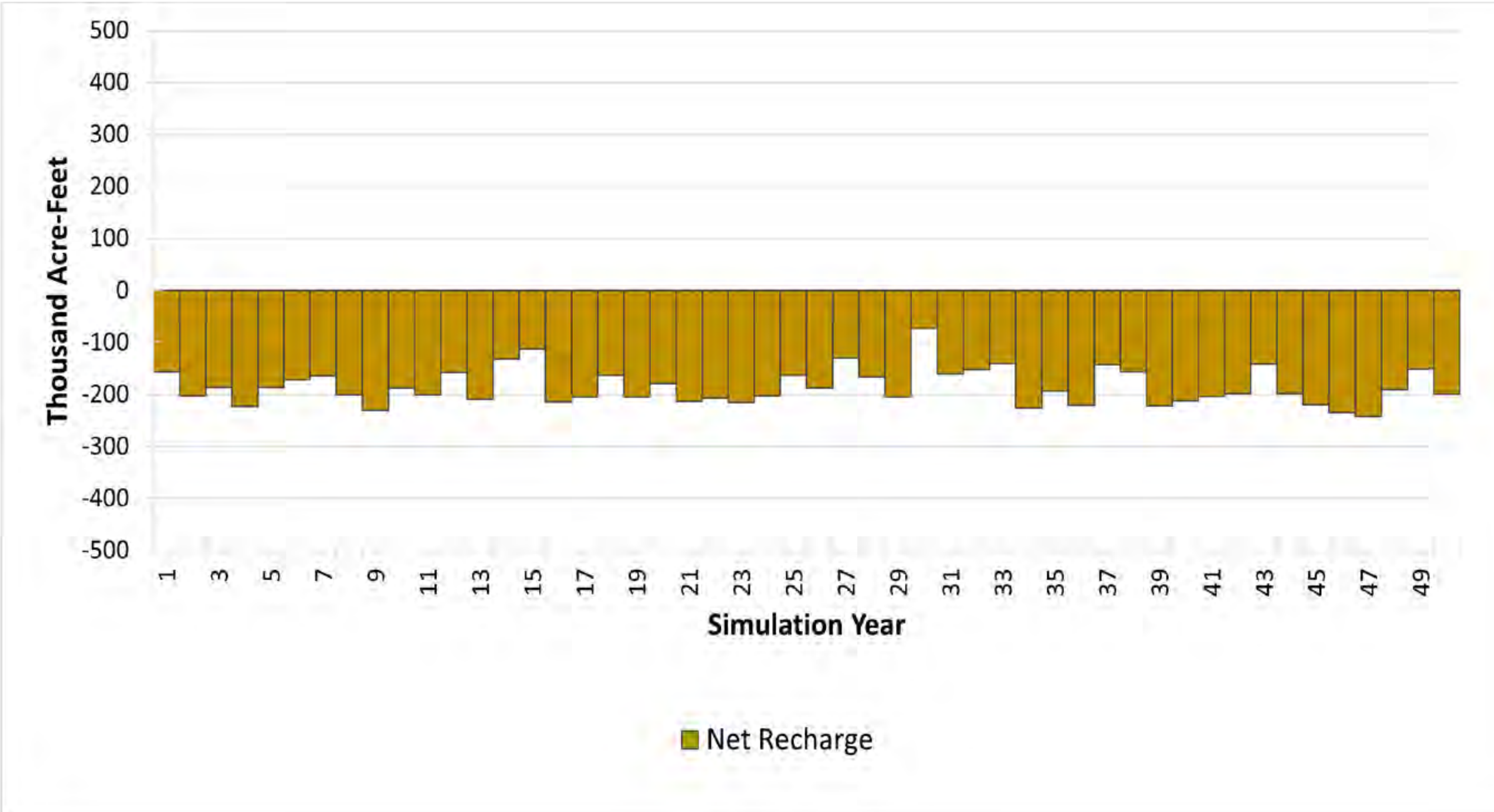

Figure 5-30

Projected Conditions
Net Recharge
ETSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

August 2021

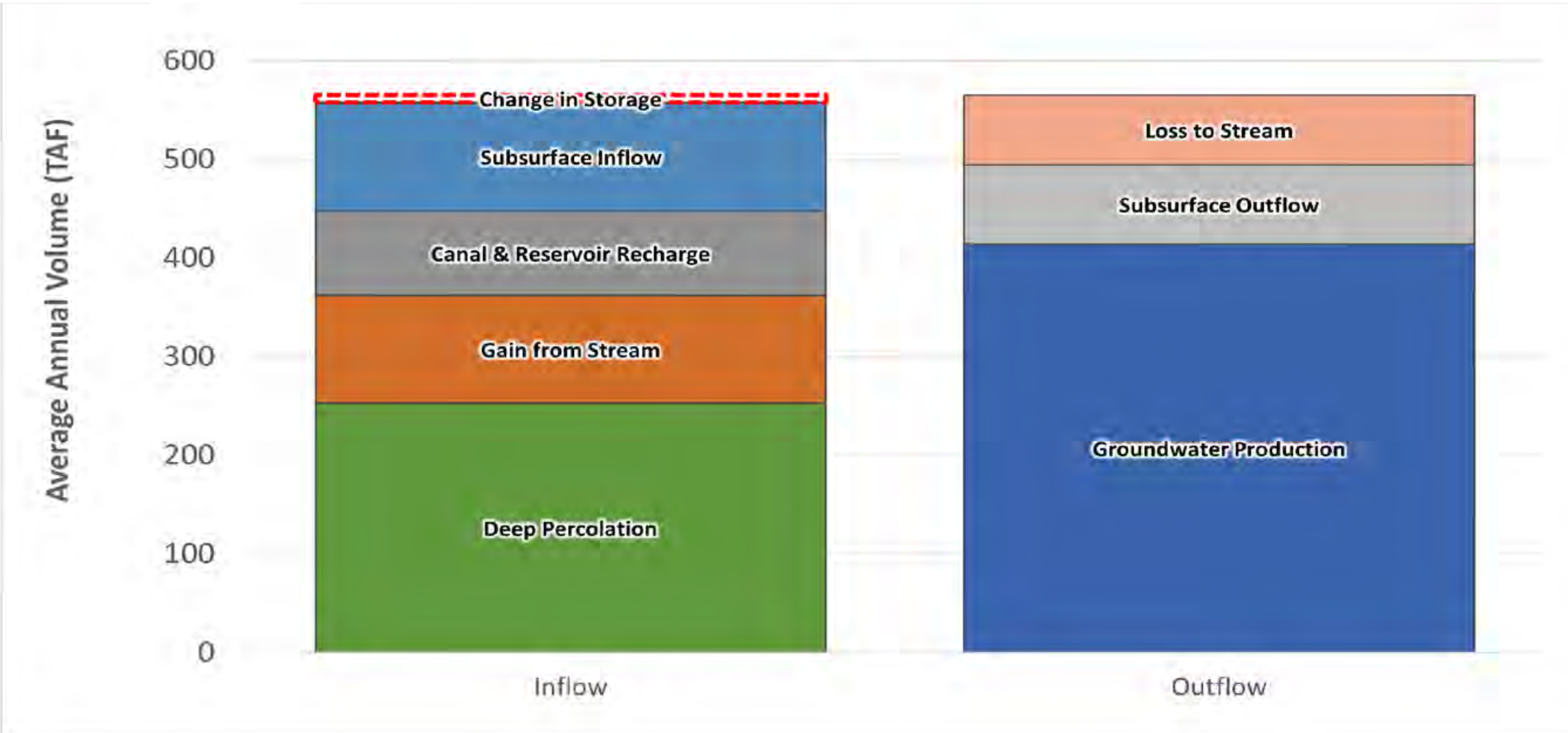

Figure 5-31

Projected Conditions
Average Annual Water Budget -
Groundwater System
Turlock Subbasin

WOODARD & CURRAN
August 2021

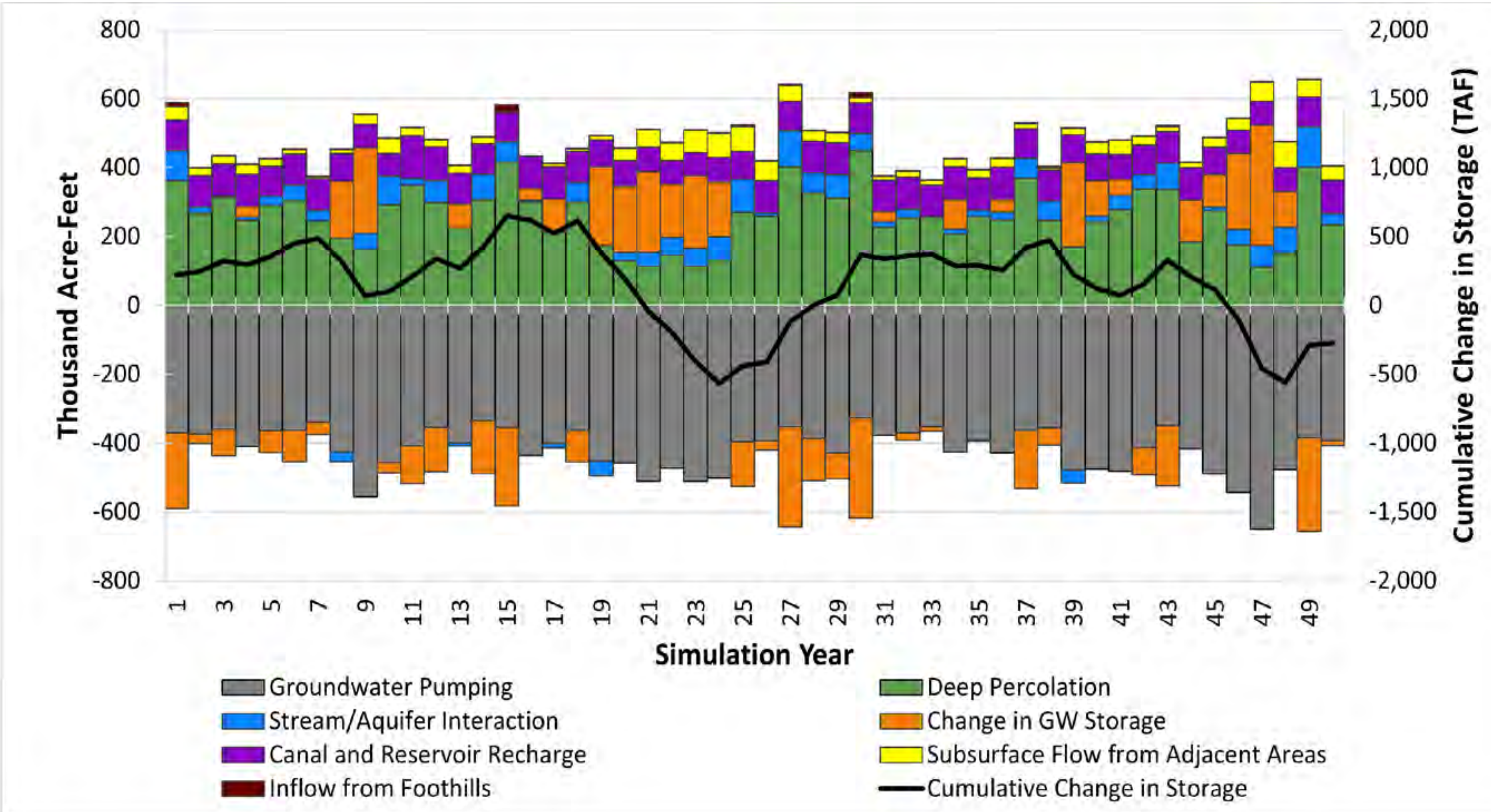

Figure 5-32

Projected Conditions
Annual Water Budget - Groundwater System
Turlock Subbasin

WOODARD & CURRAN

August 2021

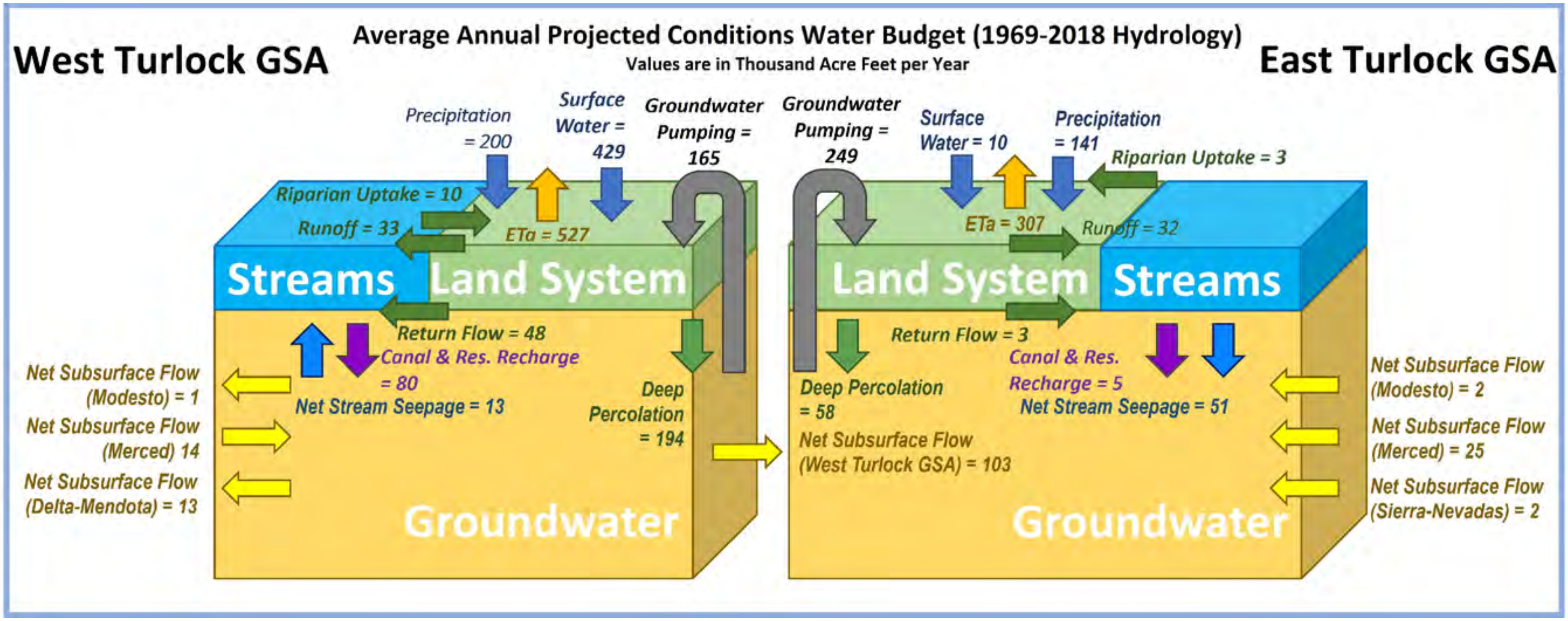

Figure 5-33

Projected Conditions
Water Budget Diagram
WTSGSA & ETSGSA

Note: The cross-boundary flows from WTSGSA to ETSGSA shown in this diagram include the total estimated subsurface flow from the WTSGSA to ETSGSA based on the resolution of the model grid.

WOODARD & CURRAN

August 2021

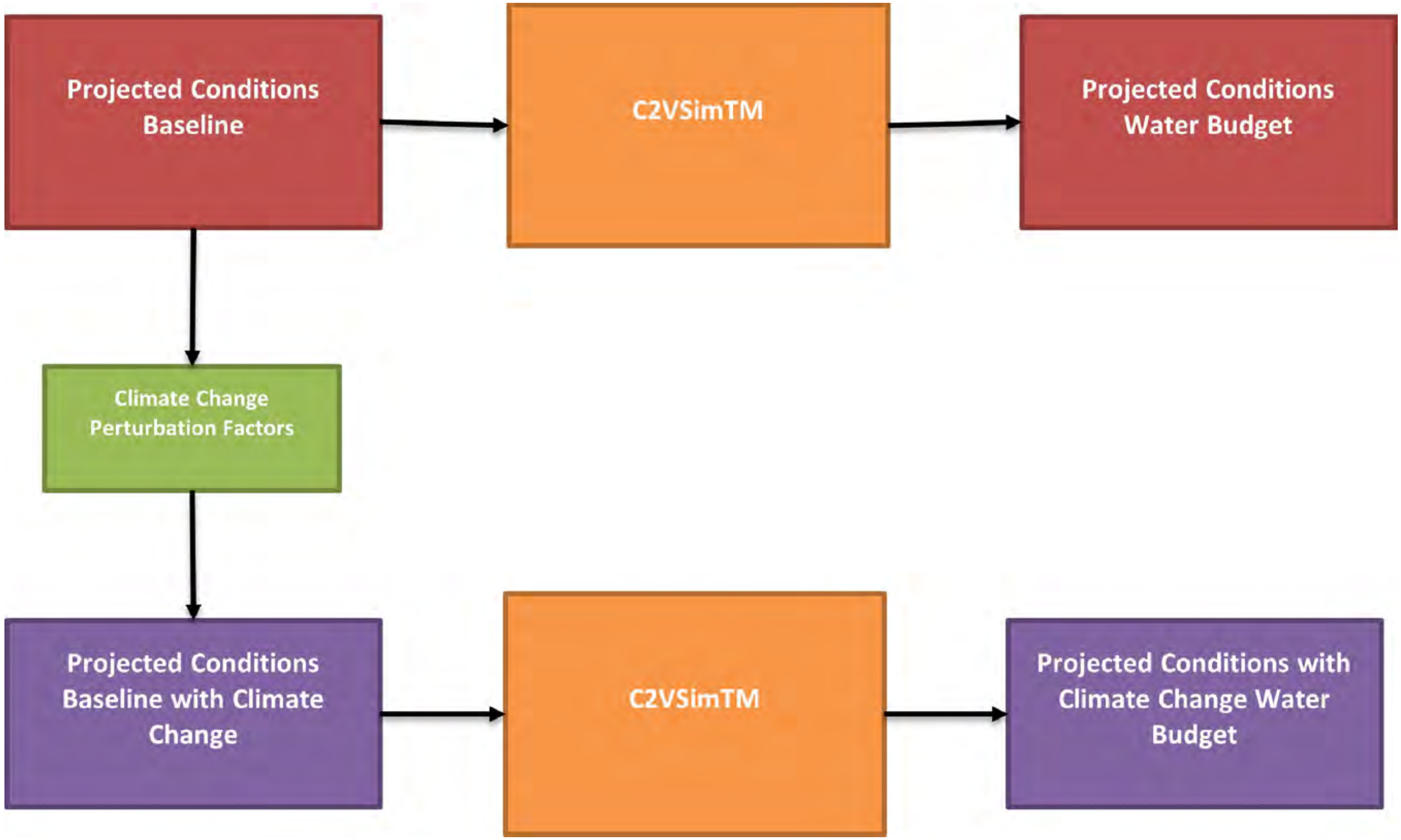

Figure 5-34

Climate Change Scenario
Climate Change Analysis Process
Turlock Subbasin

WOODARD & CURRAN

August 2021

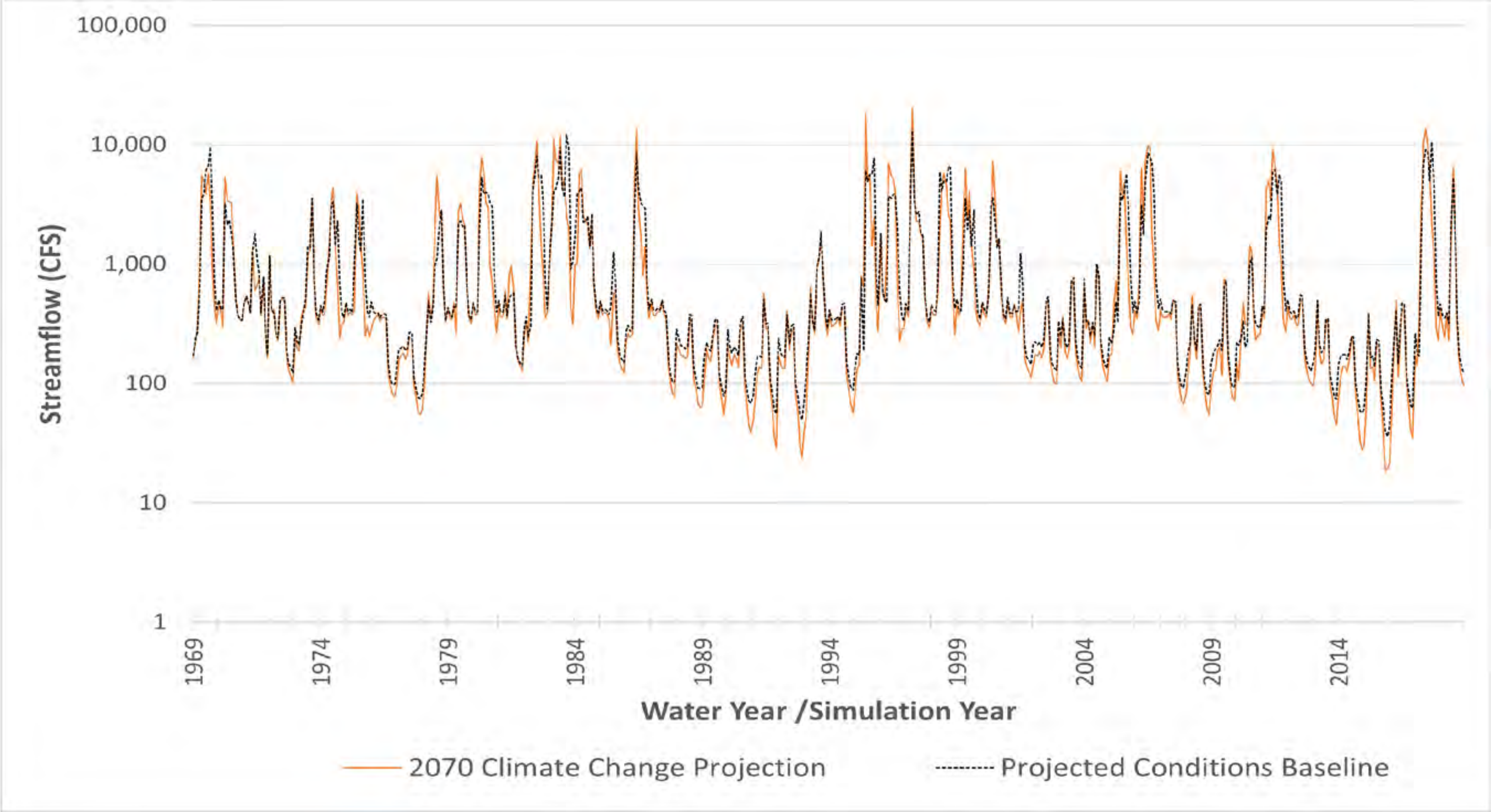

Figure 5-35

Climate Change Scenario
Tuolumne River Hydrograph
Turlock Subbasin

WOODARD & CURRAN
August 2021

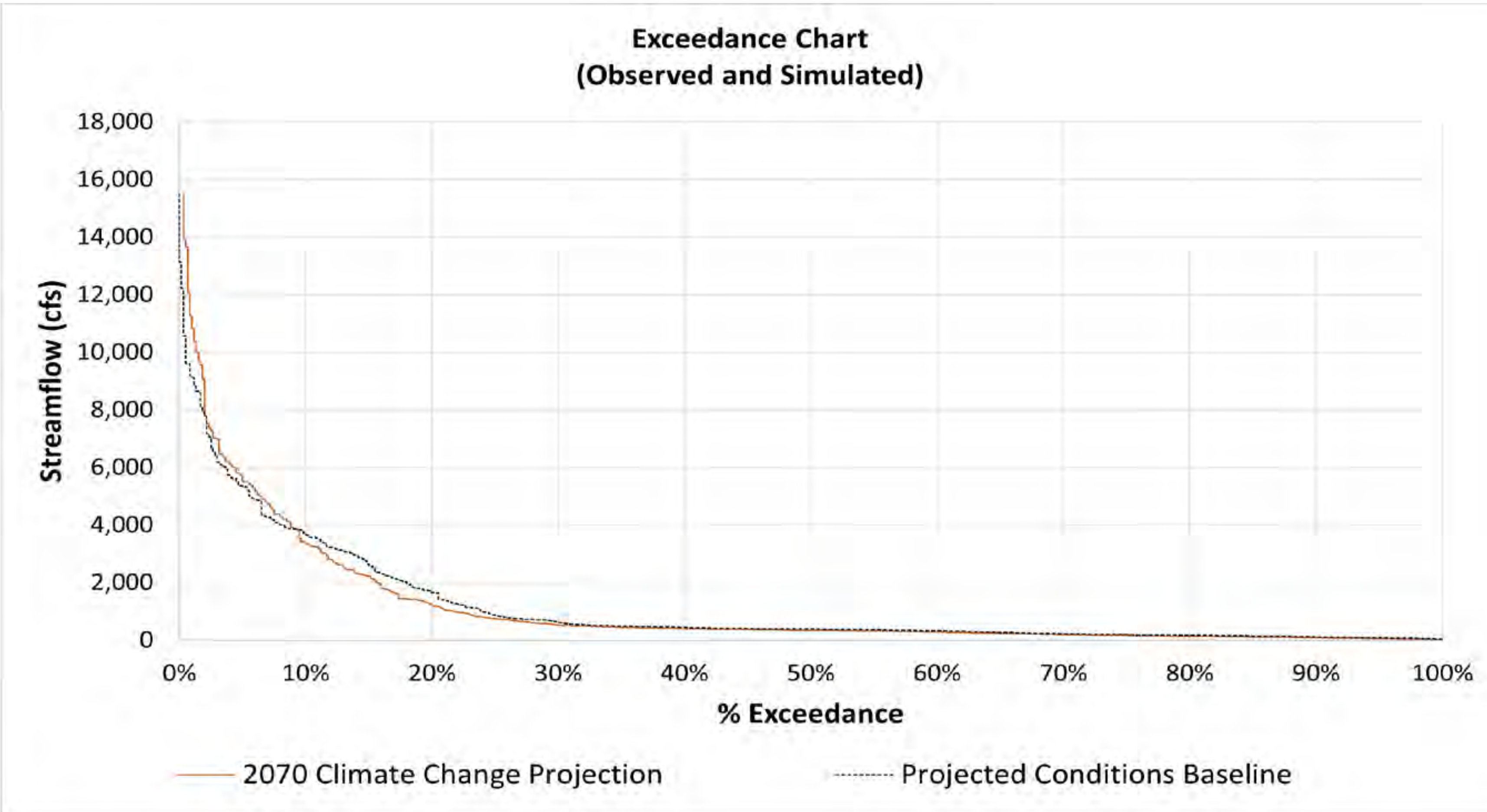

Figure 5-36

Climate Change Scenario
Tuolumne River Exceedance Curve
Turlock Subbasin

WOODARD & CURRAN

August 2021

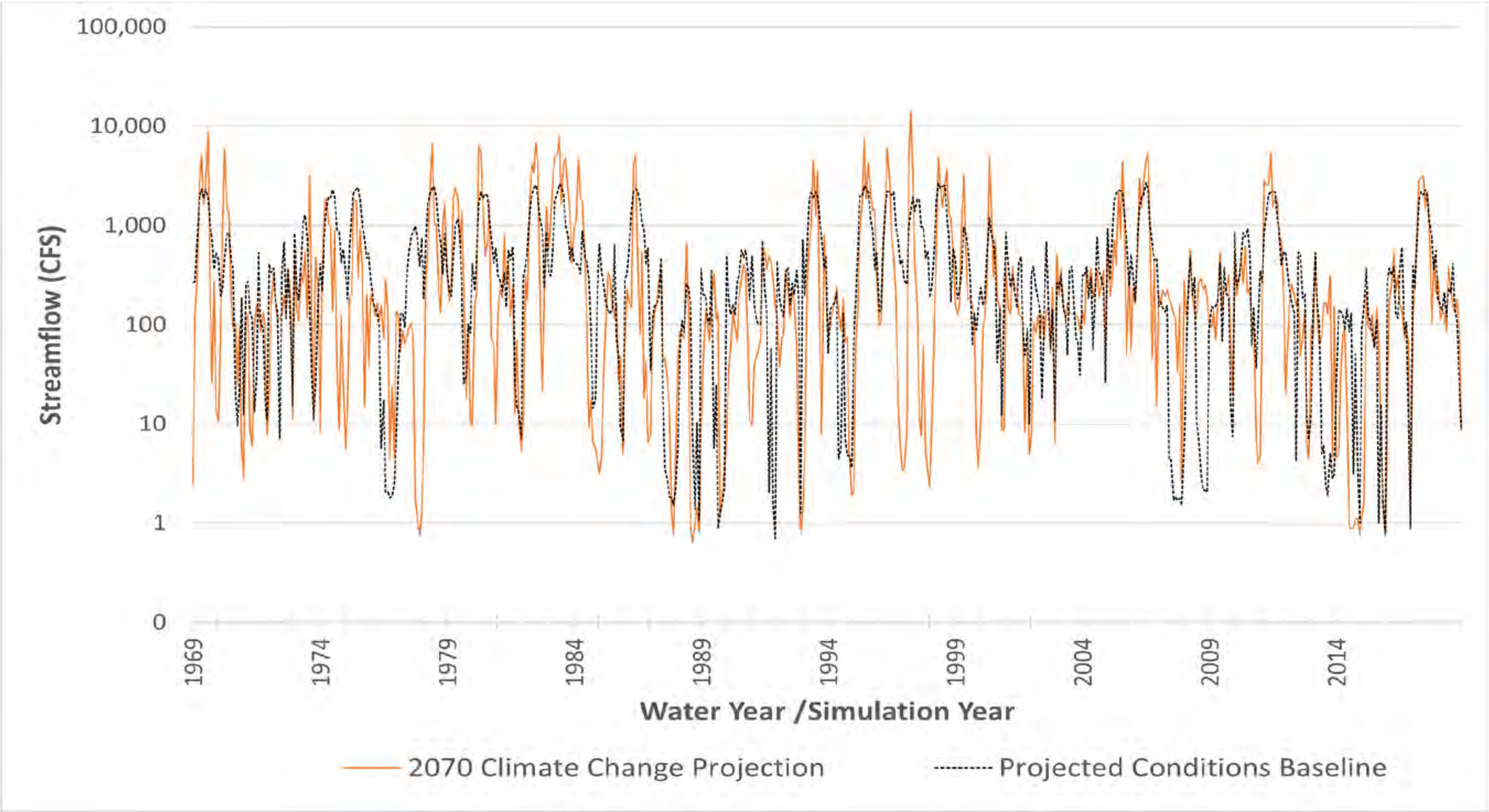

Figure 5-37

Climate Change Scenario
Merced River Hydrograph
Turlock Subbasin

WOODARD & CURRAN

August 2021

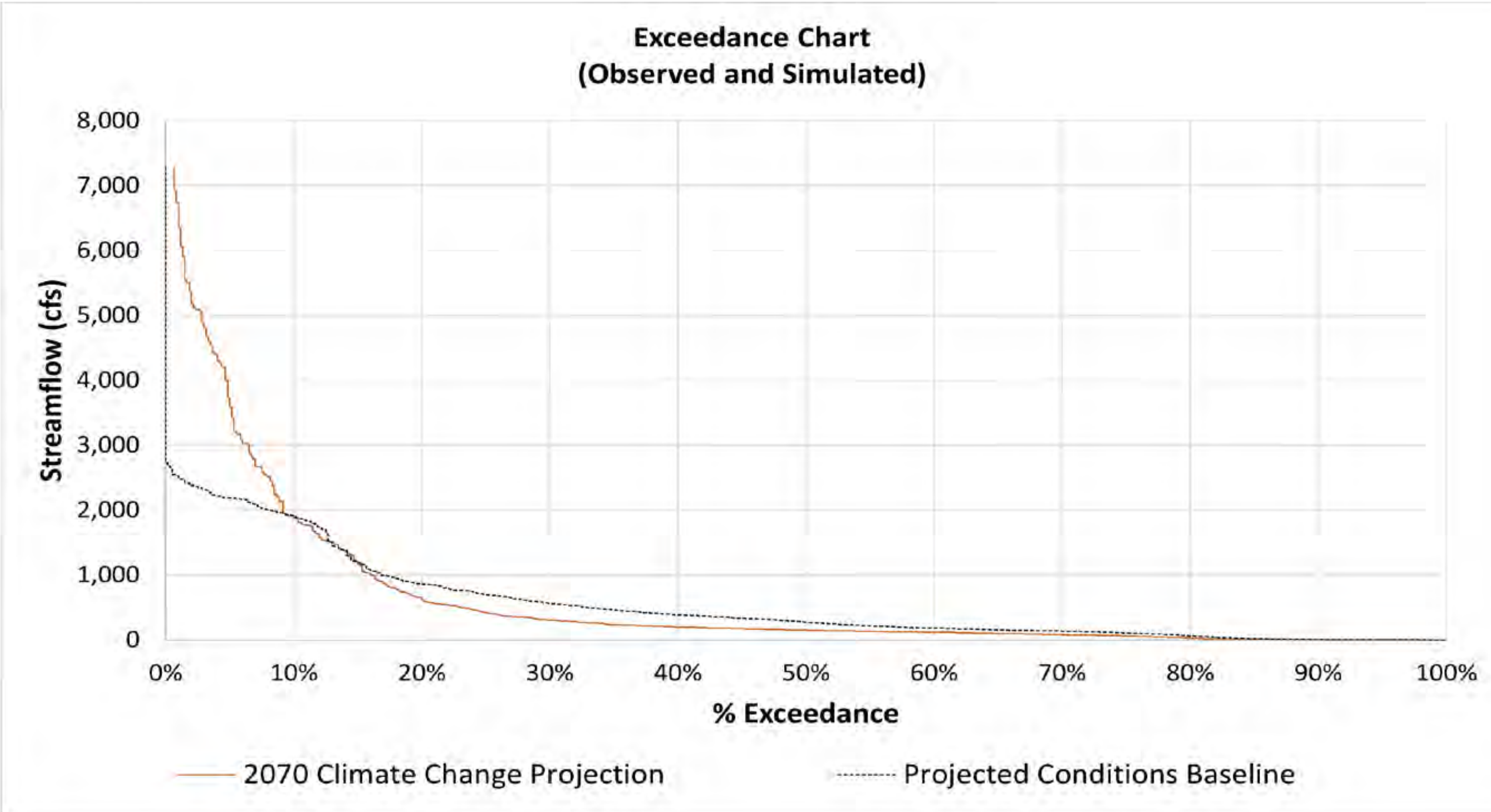

Figure 5-38

Climate Change Scenario
Merced River Exceedance Curve
Turlock Subbasin

WOODARD & CURRAN

August 2021

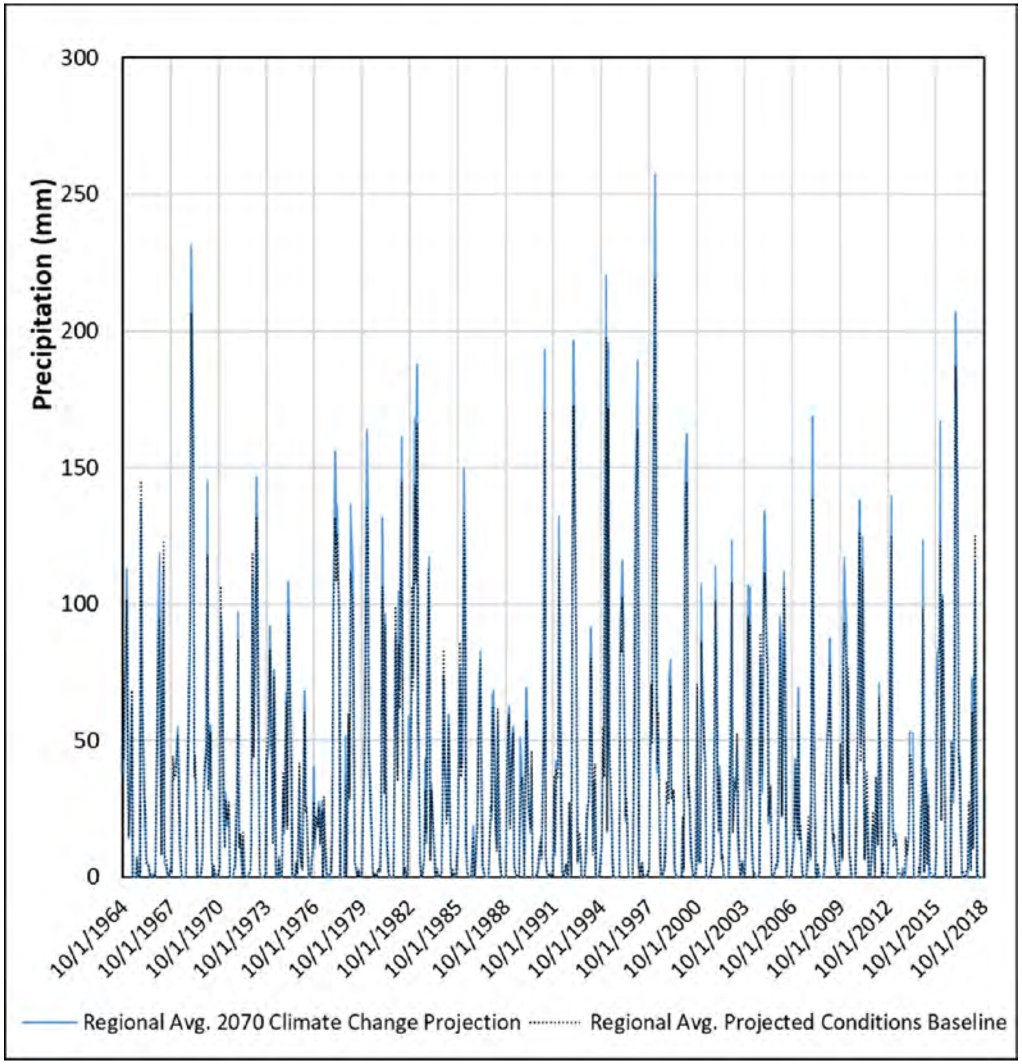

Figure 5-39

Climate Change Scenario
Perturbed Precipitation Under Climate Change
Turlock Subbasin

WOODARD & CURRAN

August 2021

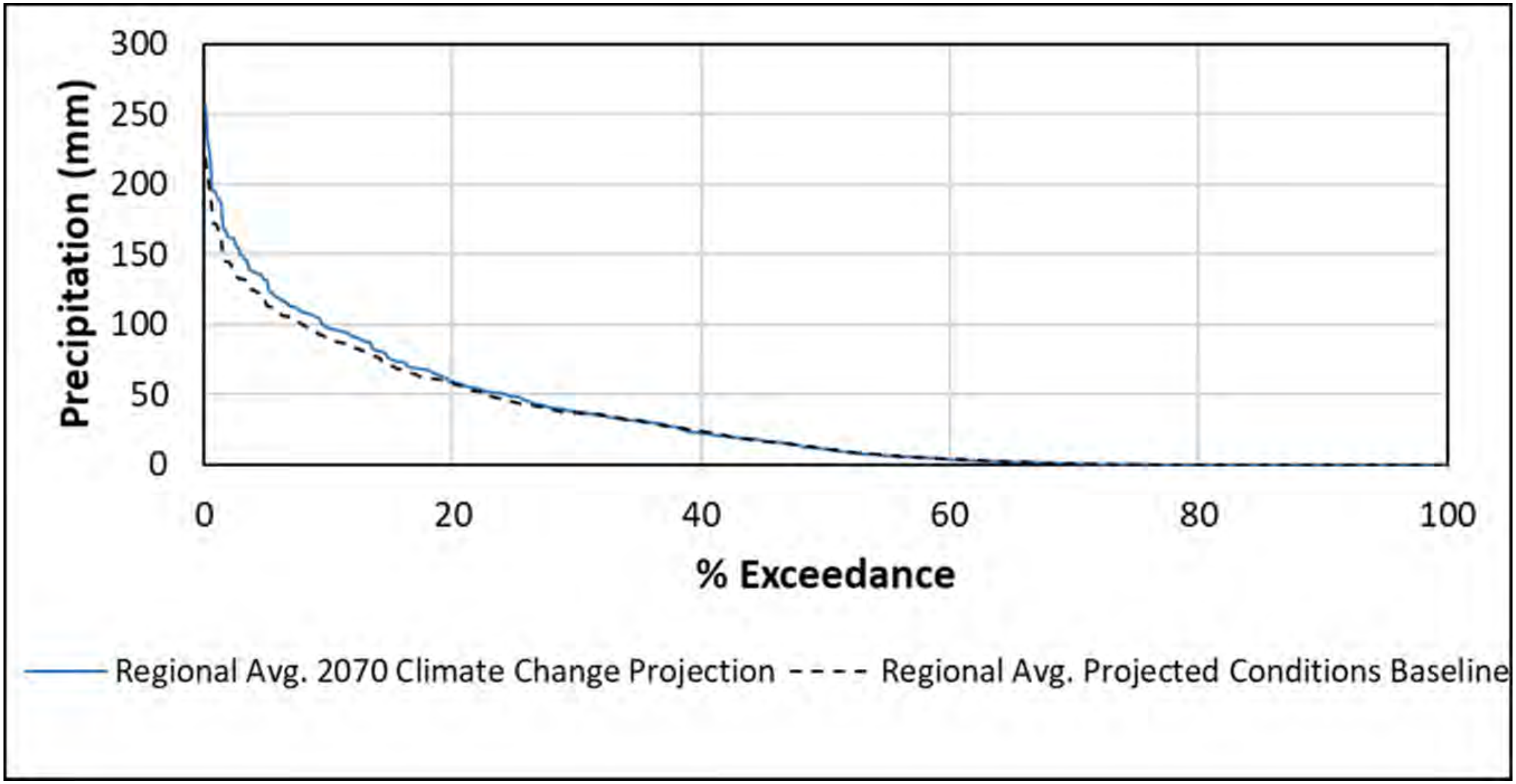

Figure 5-40

Climate Change Scenario
Perturbed Precipitation Exceedance Curve
Turlock Subbasin

WOODARD & CURRAN
August 2021

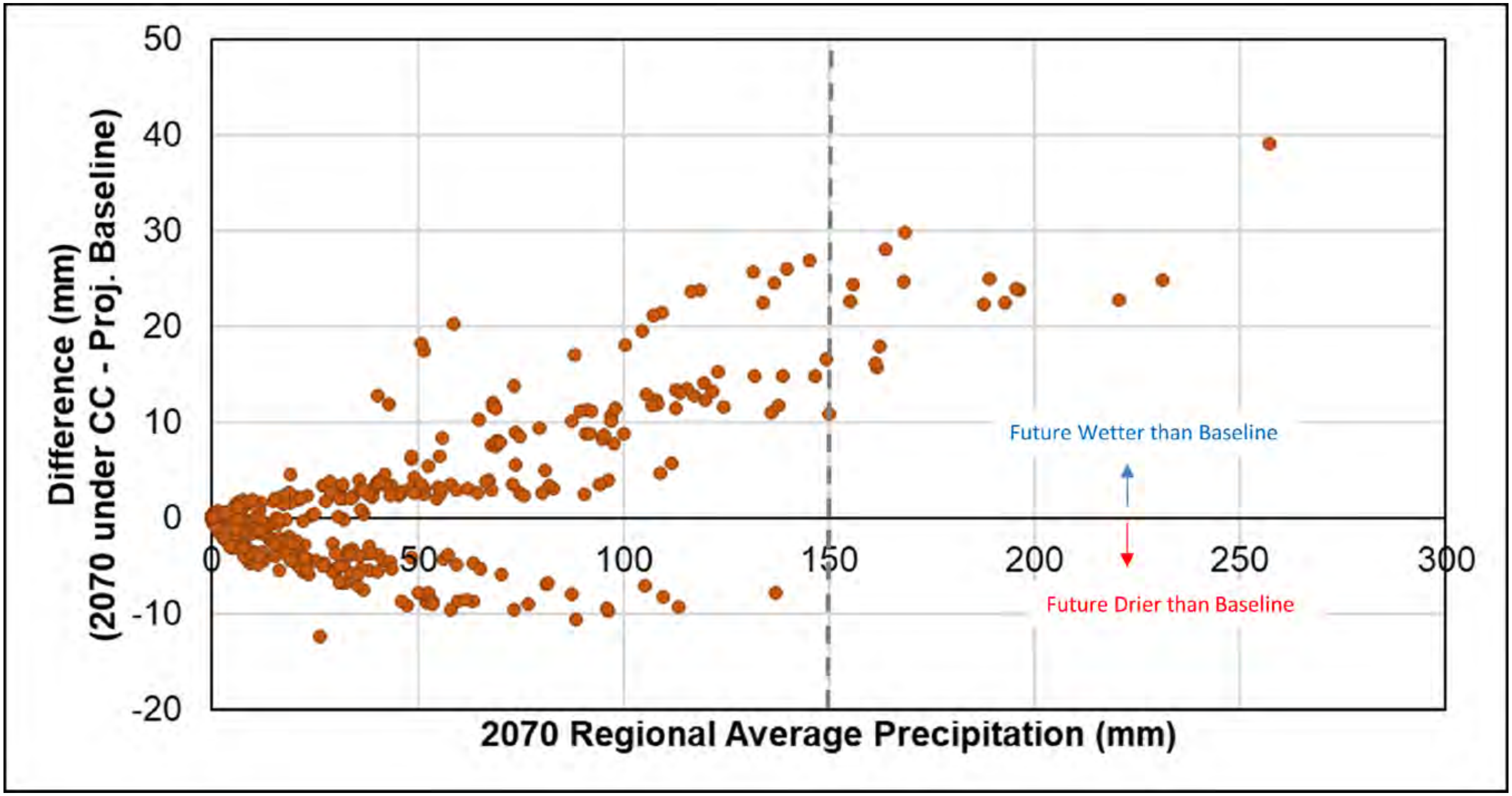

Figure 5-41

Climate Change Scenario
Variation from Baseline of Perturbed Precipitation
Turlock Subbasin

WOODARD & CURRAN

August 2021

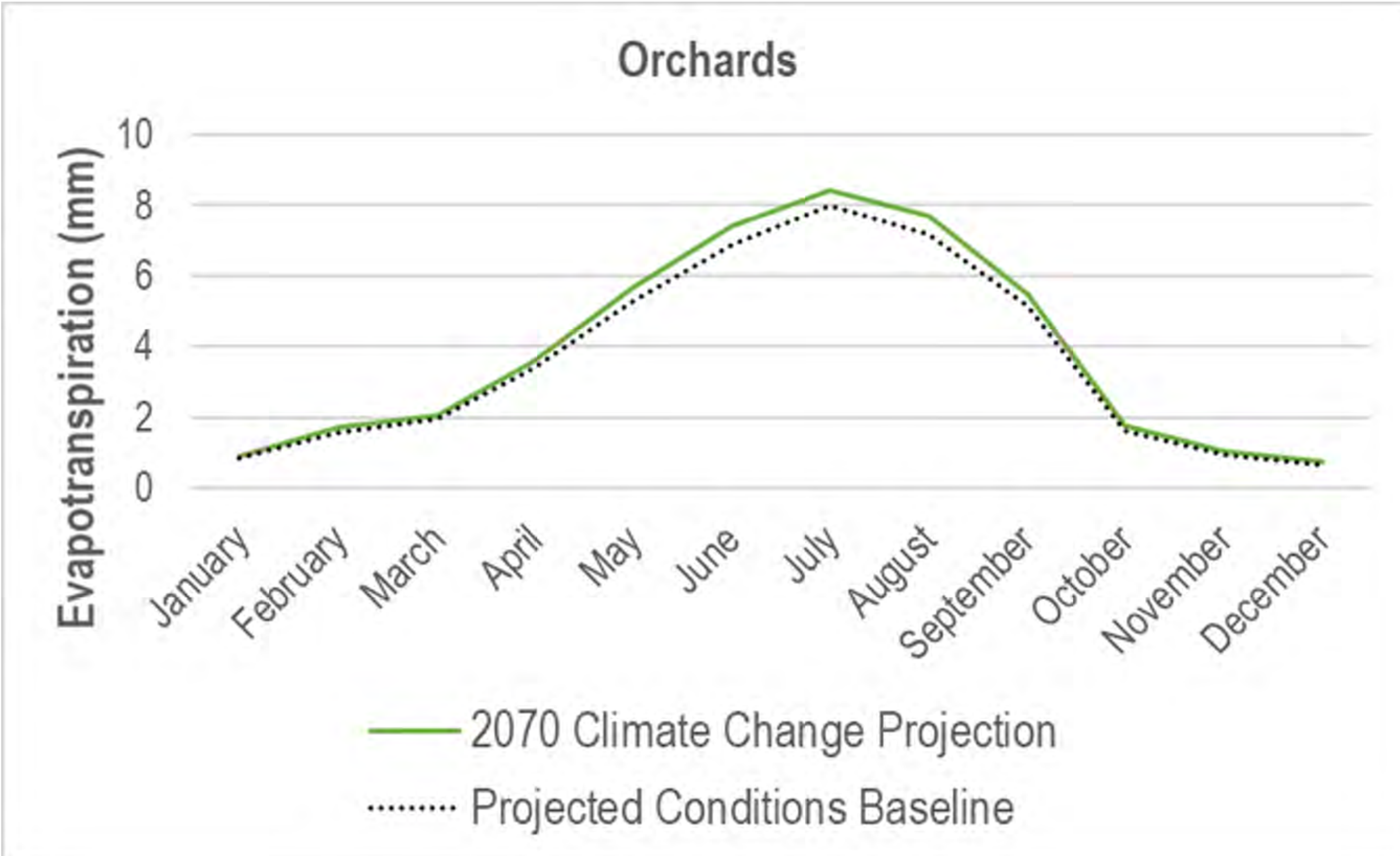

Figure 5-42

Climate Change Scenario
Monthly ET for Sample Crops
Turlock Subbasin

WOODARD & CURRAN

August 2021

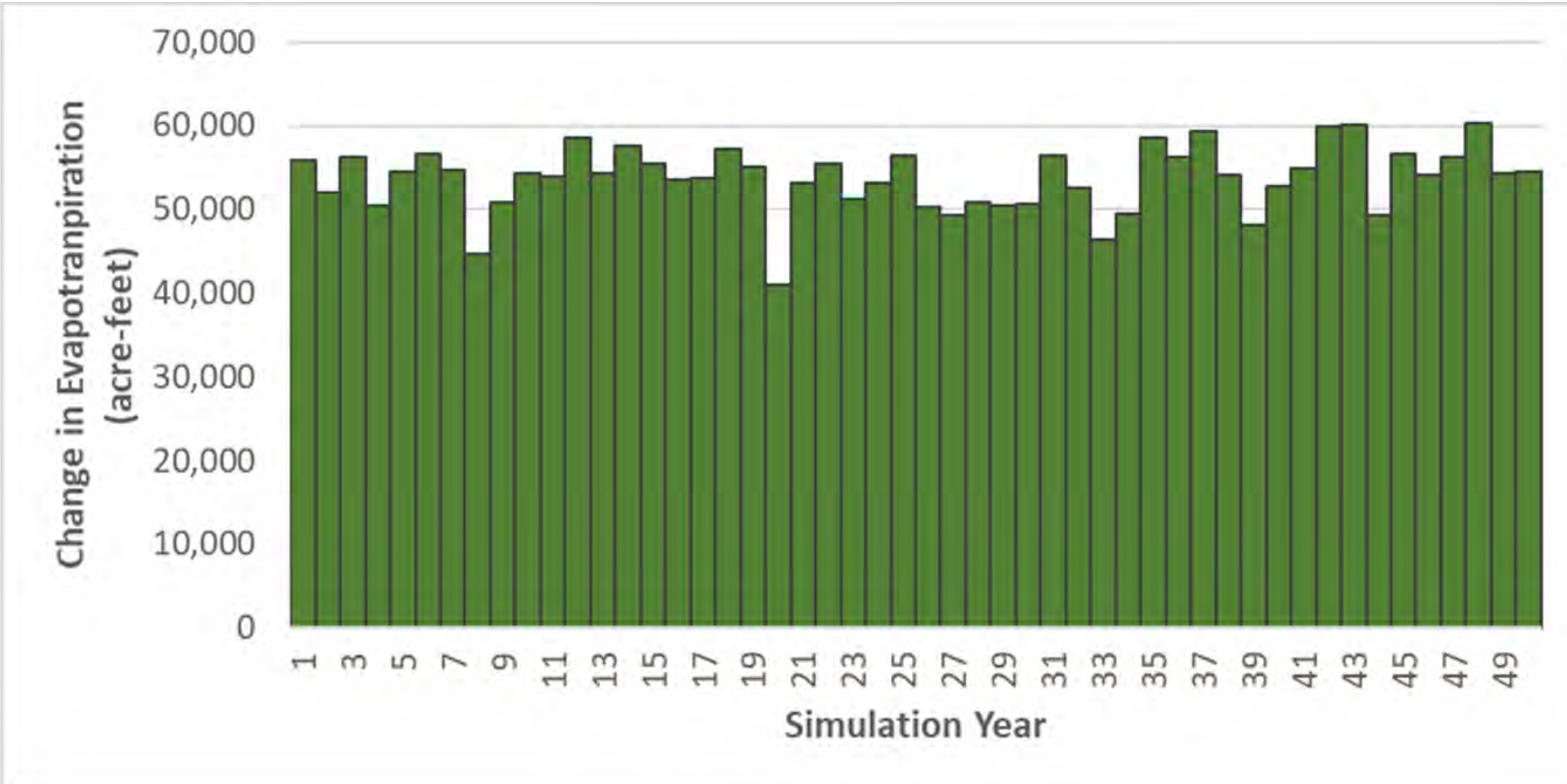

Figure 5-43

Climate Change Scenario
Simulated Changes in Evapotranspiration
Turlock Subbasin

WOODARD & CURRAN

August 2021

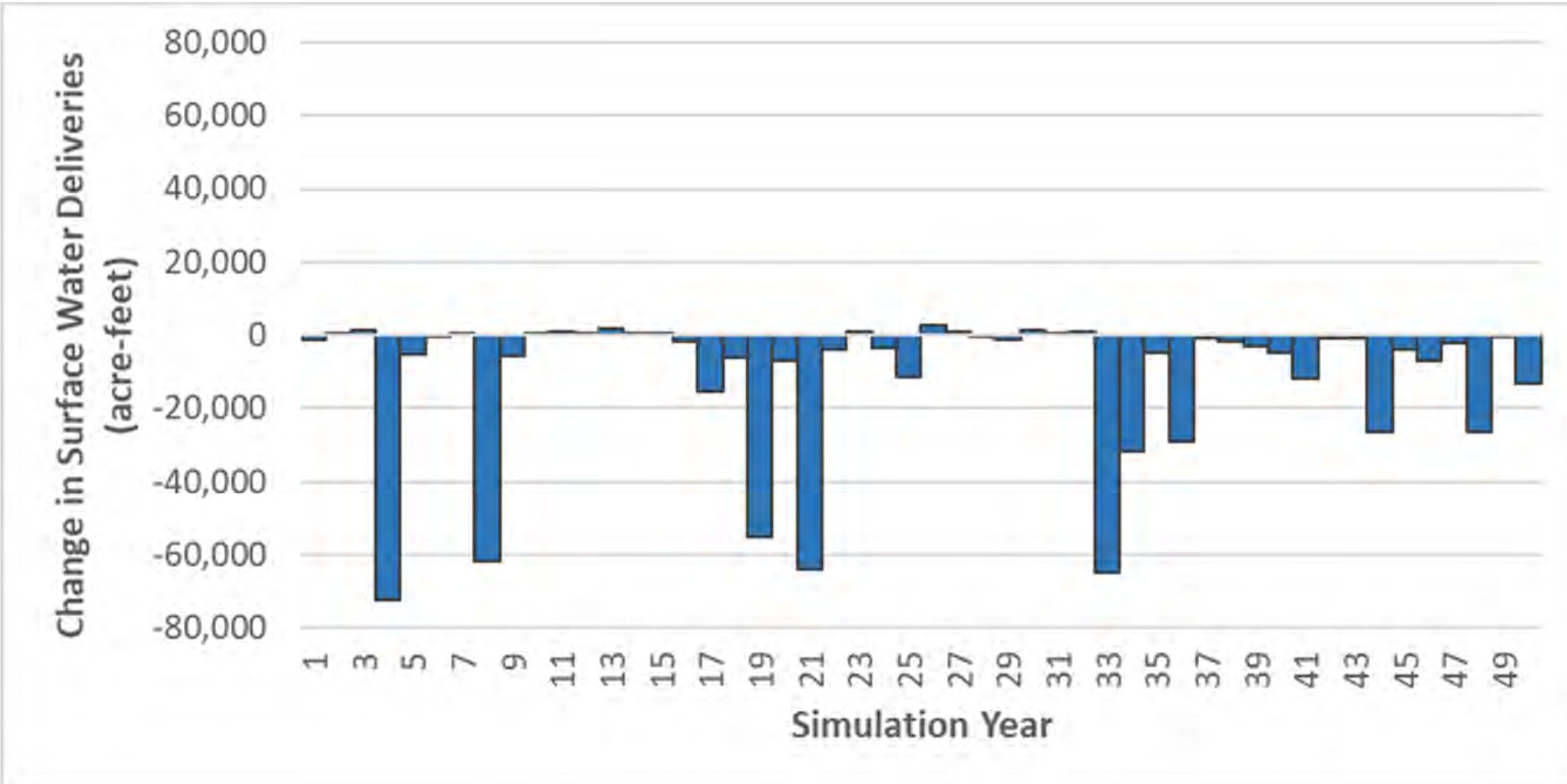

Figure 5-44

Climate Change Scenario
Simulated Changes in Surface Water Supplies
Turlock Subbasin

WOODARD & CURRAN
August 2021

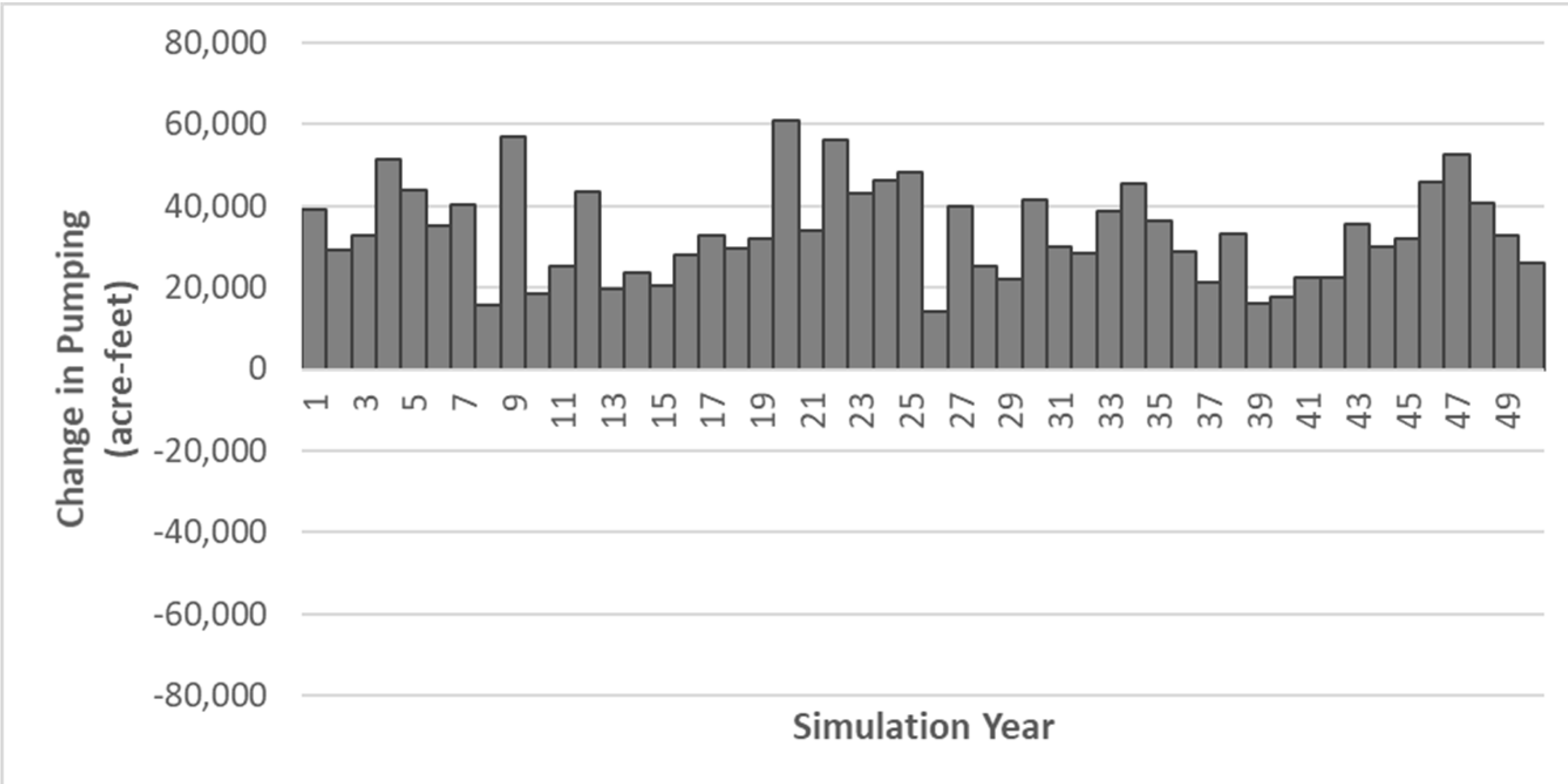

Figure 5-45

Climate Change Scenario
Simulated Changes in Groundwater Production
Turlock Subbasin

WOODARD & CURRAN

August 2021

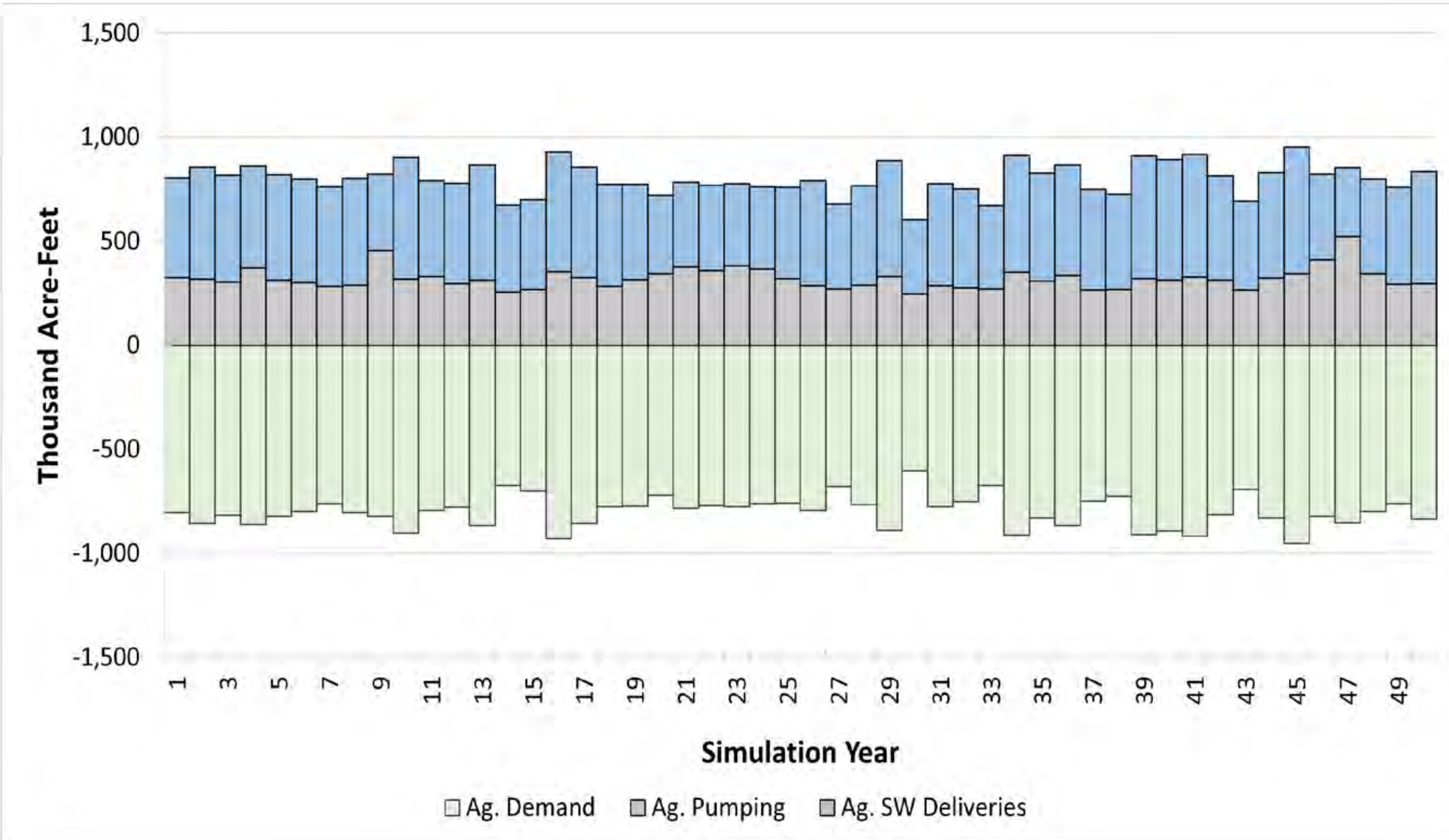

Figure 5-46

Climate Change Scenario
Average Annual Water Budget - Agricultural Land Use System
Turlock Subbasin

WOODARD & CURRAN

August 2021

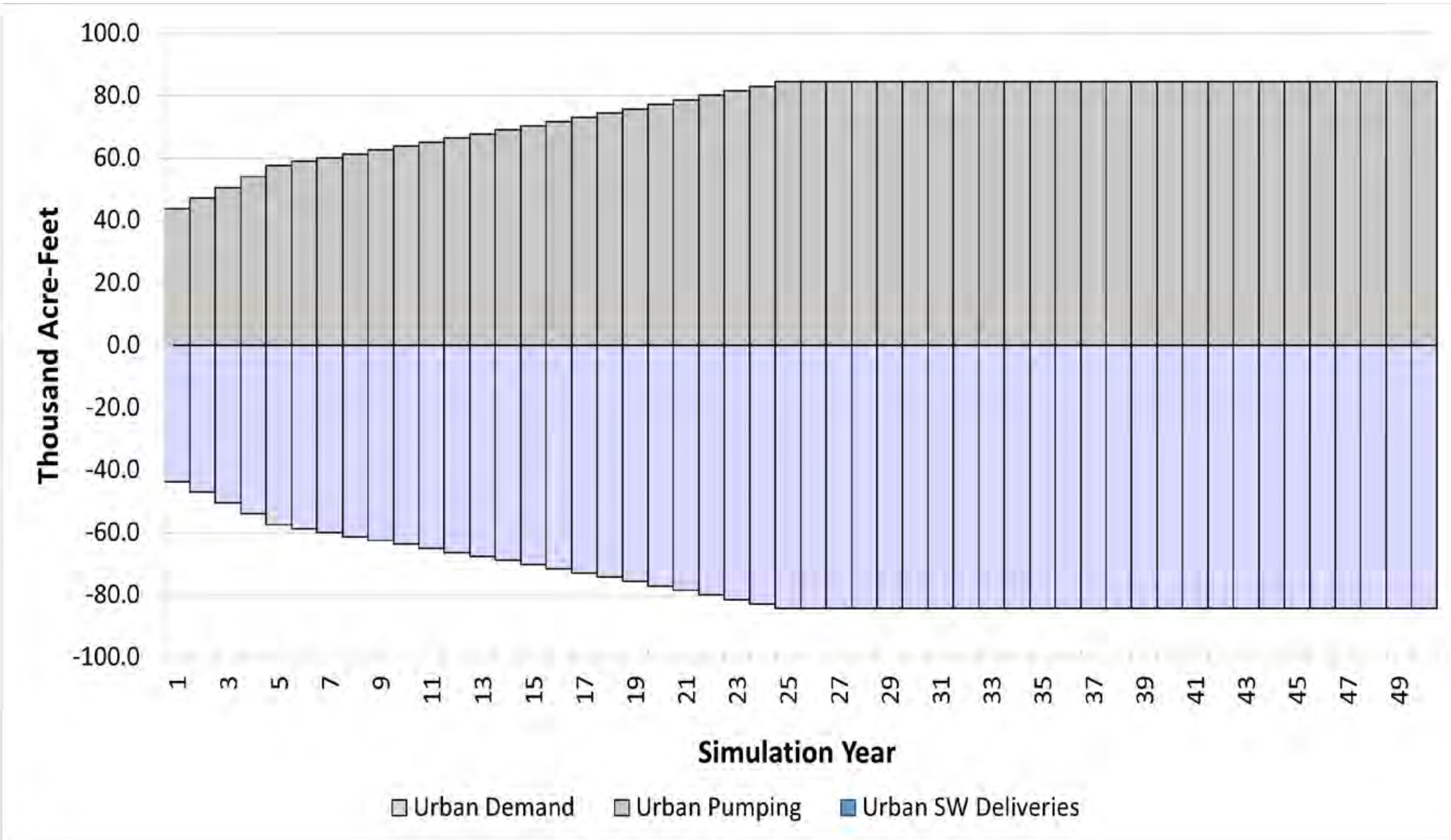

Figure 5-47

Climate Change Scenario
Average Annual Water Budget - Urban Land Surface System
Turlock Subbasin

WOODARD & CURRAN
August 2021

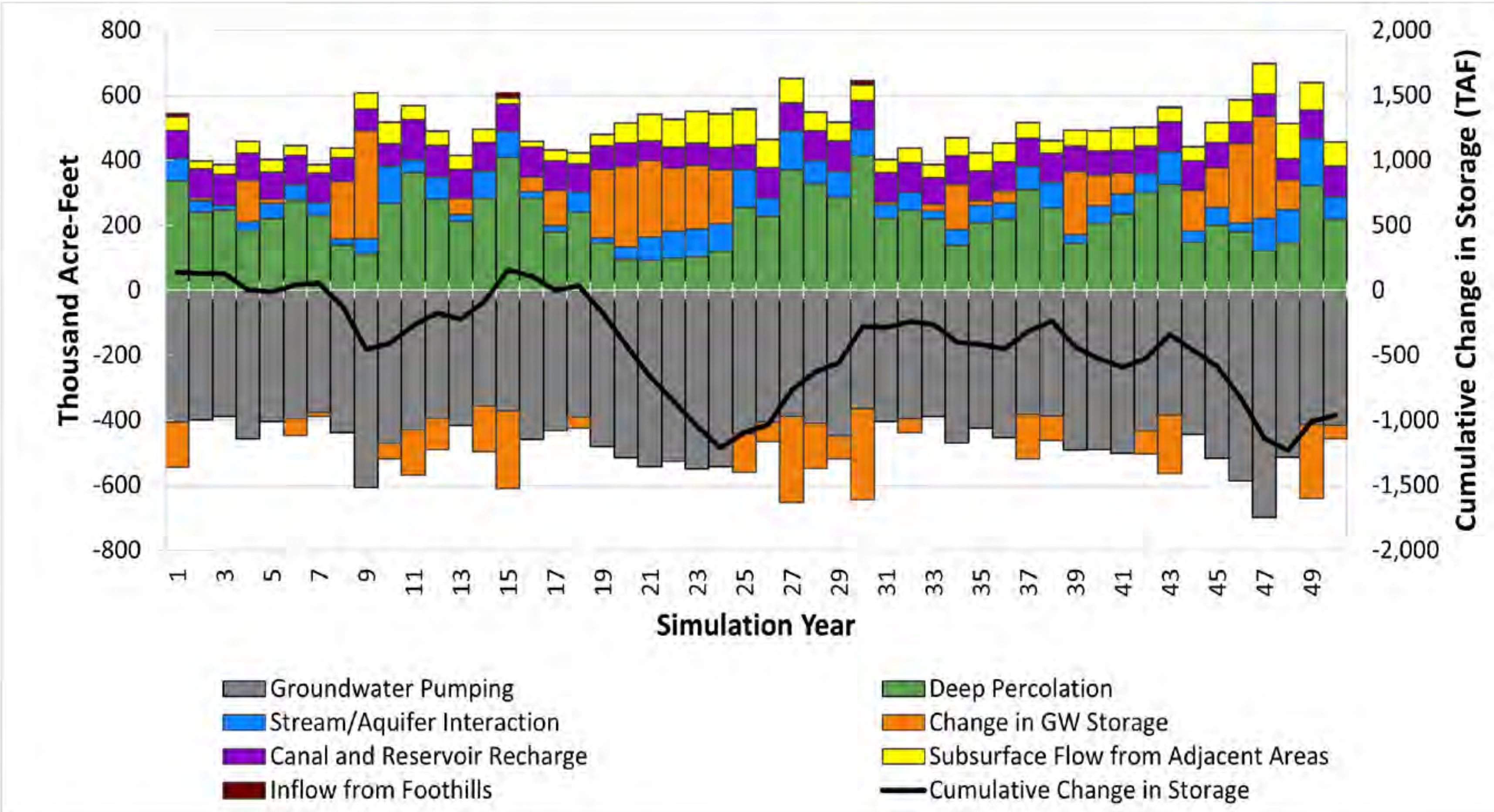

Figure 5-48

Climate Change Scenario
Annual Water Budget - Groundwater System
Turlock Subbasin

WOODARD & CURRAN
August 2021

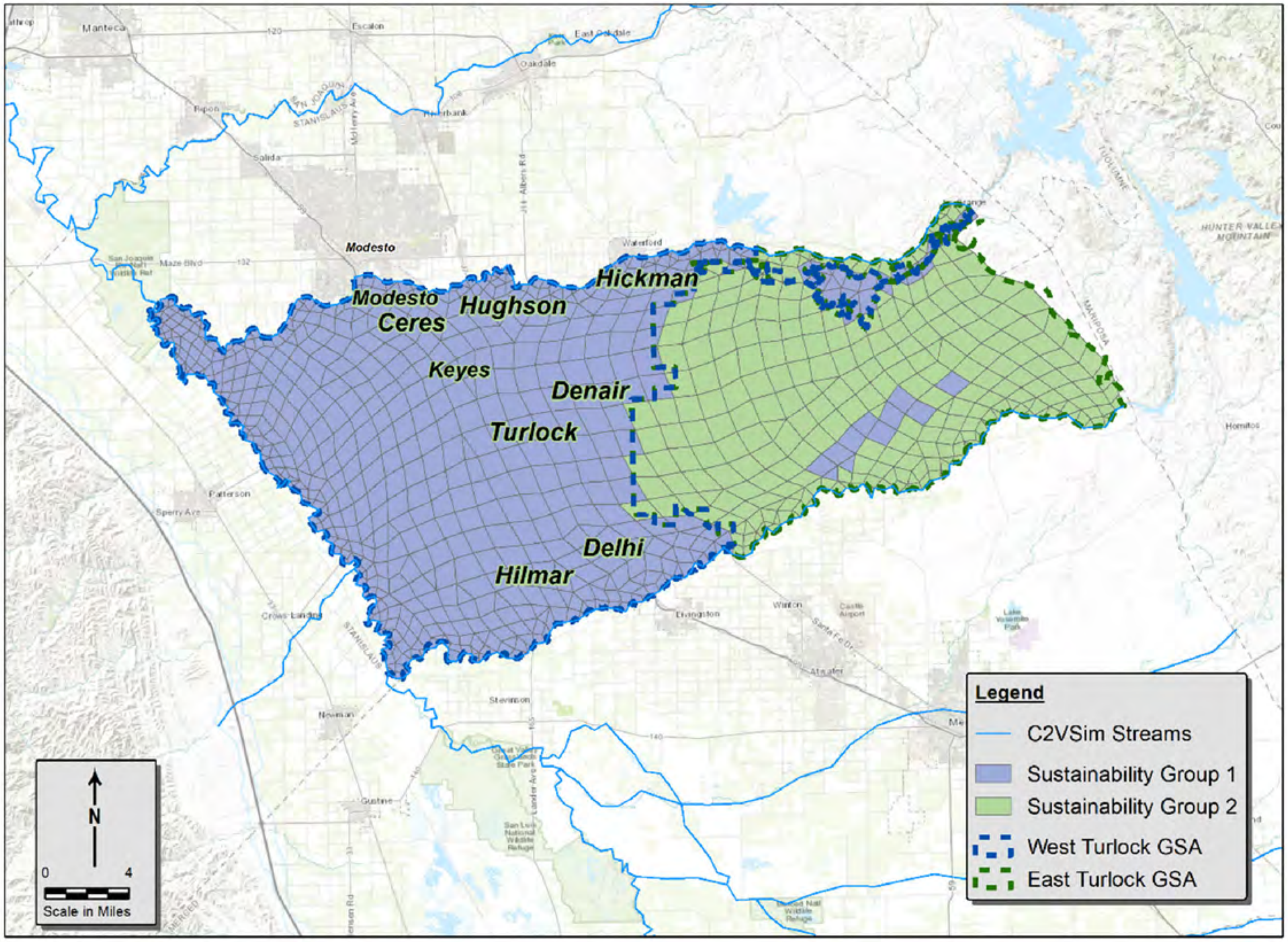

Figure 5-49

Sustainable Yield
Sustainability Groups
Turlock Subbasin

WOODARD & CURRAN

August 2021

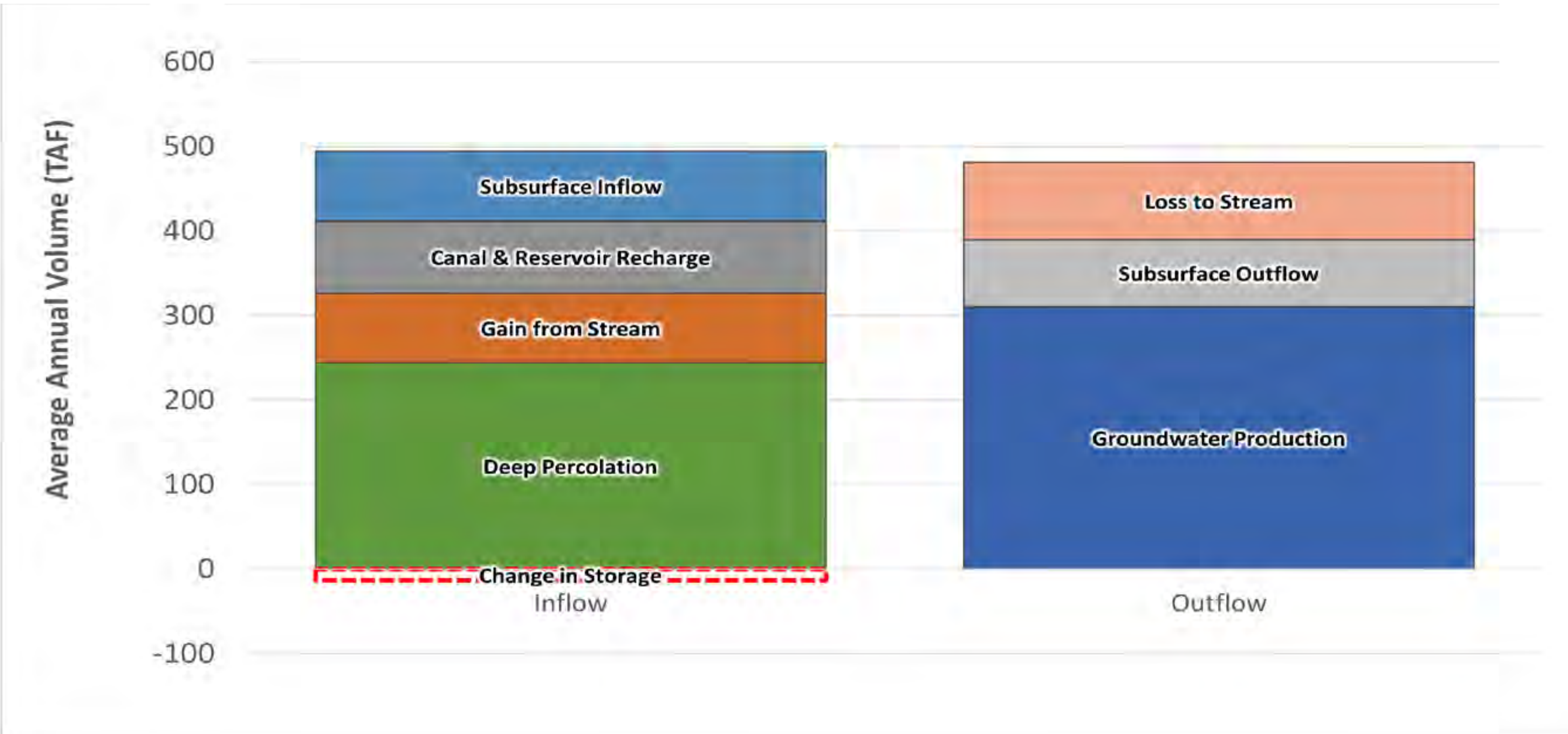

Figure 5-50

Sustainable Yield
Average Annual Water Budget -
Groundwater System
Turlock Subbasin

WOODARD & CURRAN
August 2021

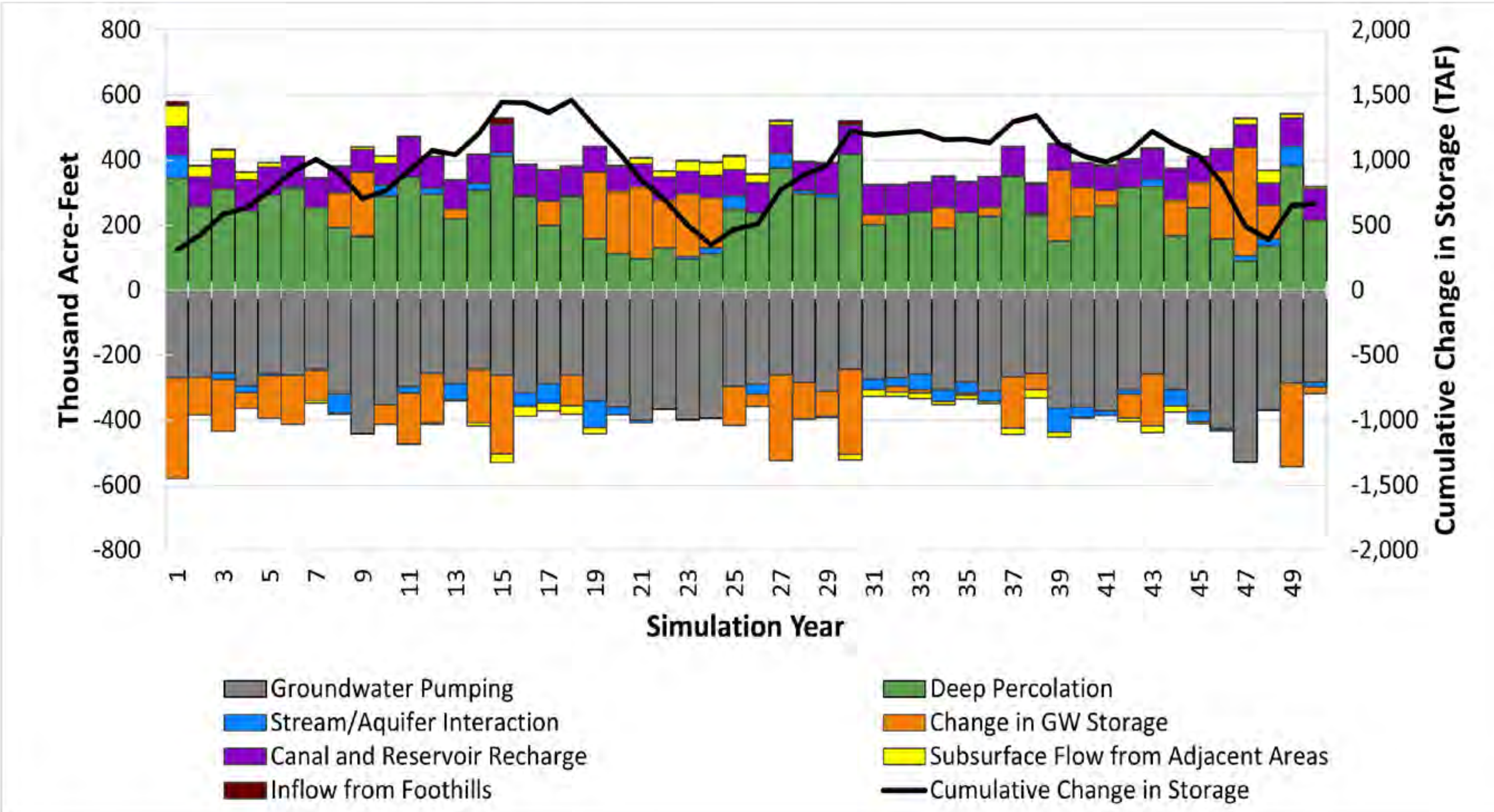

Figure 5-51

Sustainable Yield

Annual Water Budget - Groundwater System

Turlock Subbasin

WOODARD & CURRAN

August 2021

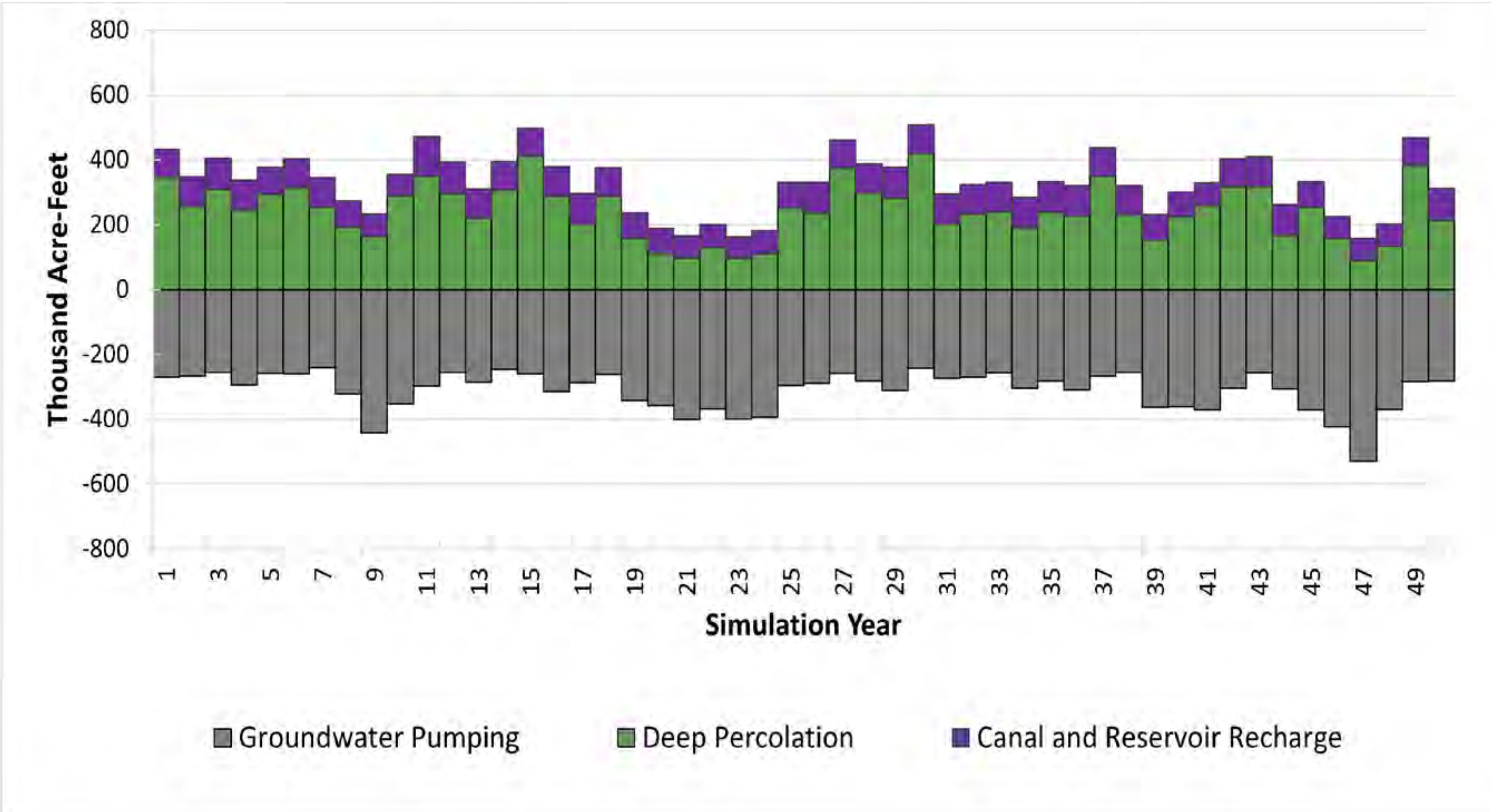

Figure 5-52

Sustainable Yield
Groundwater Recharge and Extraction
Turlock Subbasin

August 2021

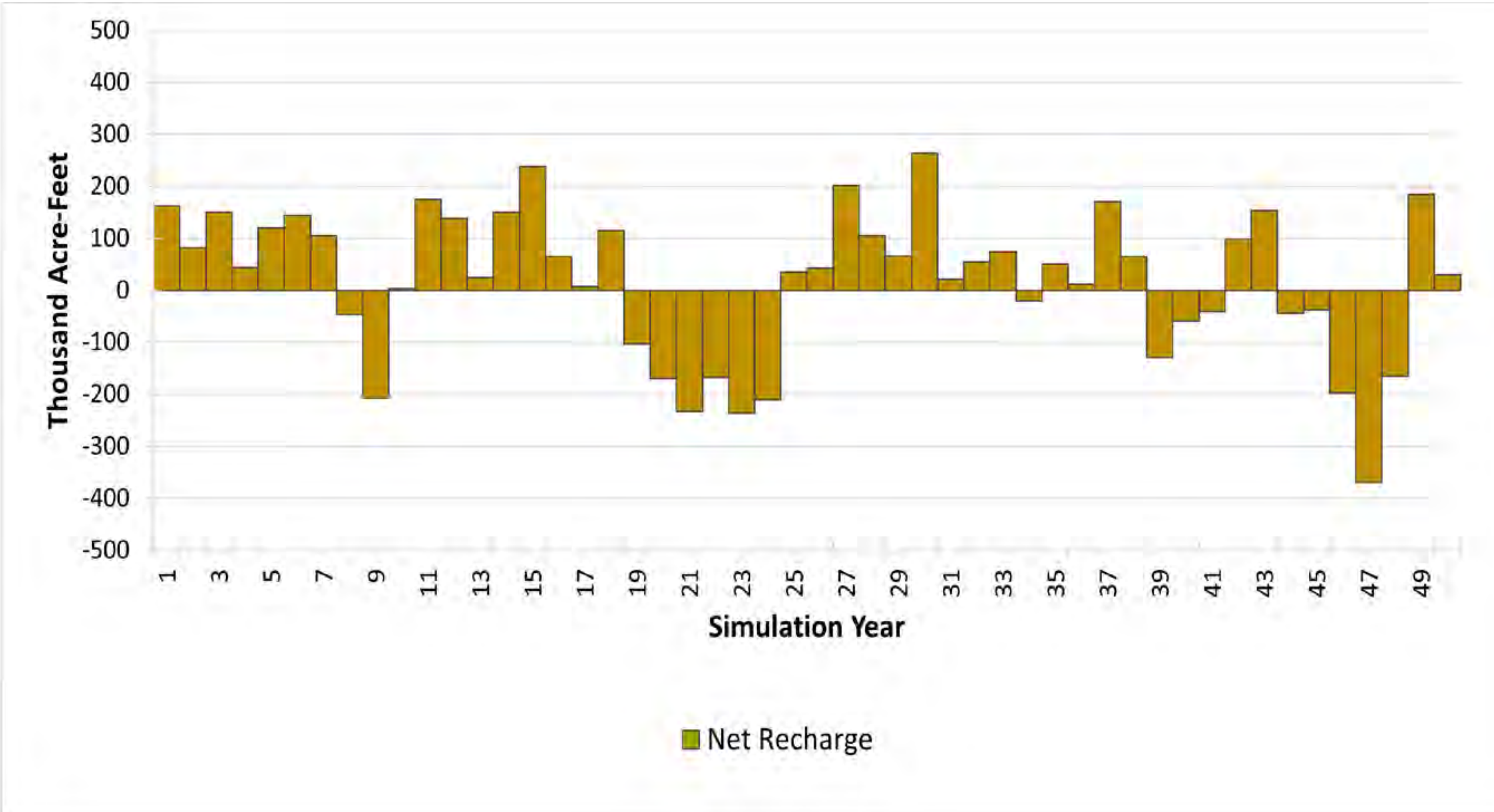

Figure 5-53

Sustainable Yield
Net Recharge
Turlock Subbasin

WOODARD & CURRAN
August 2021

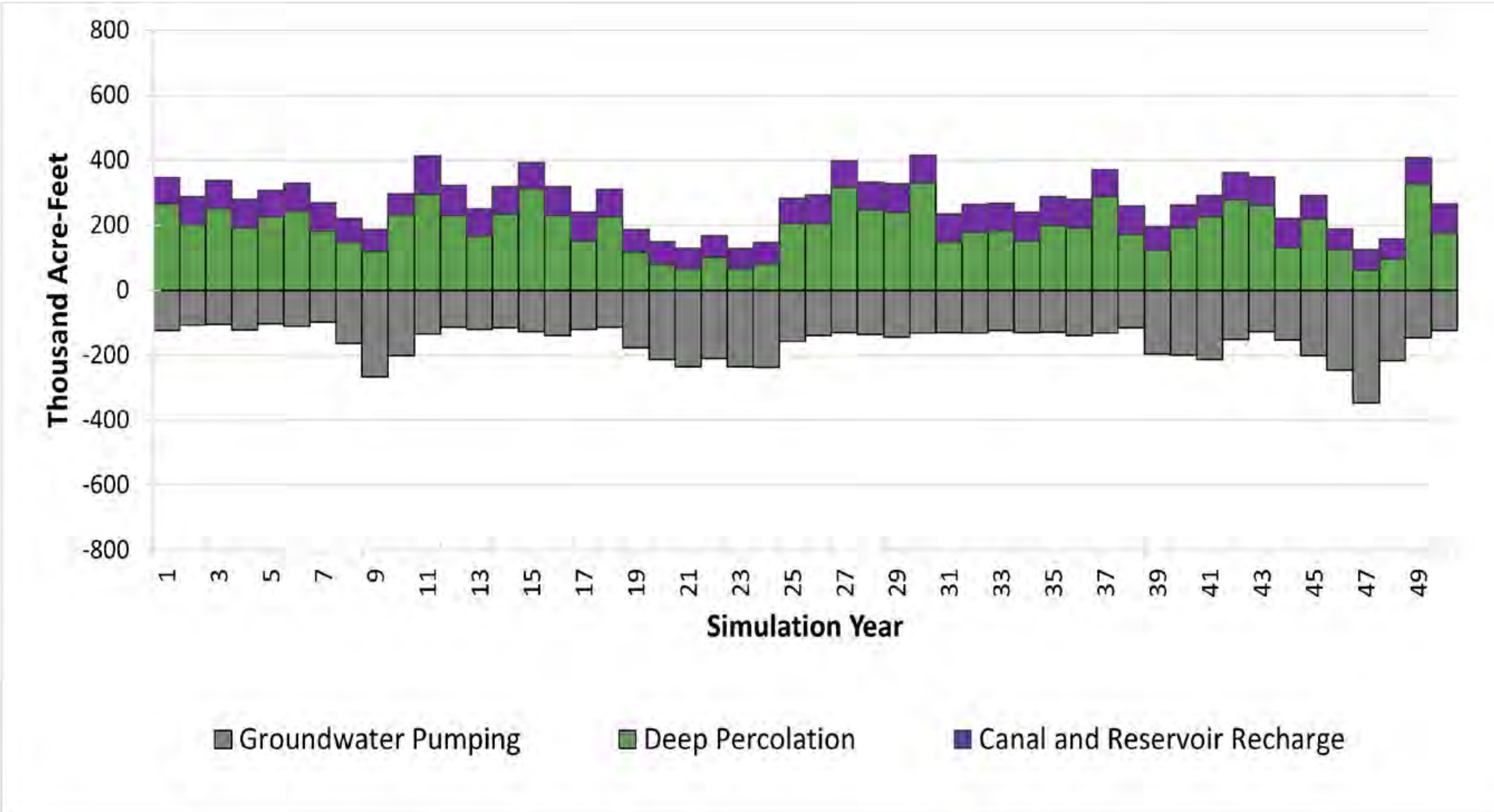

Figure 5-54	**Note:** The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.
Sustainable Yield Groundwater Recharge and Extraction WTSGSA	

WOODARD & CURRAN

August 2021

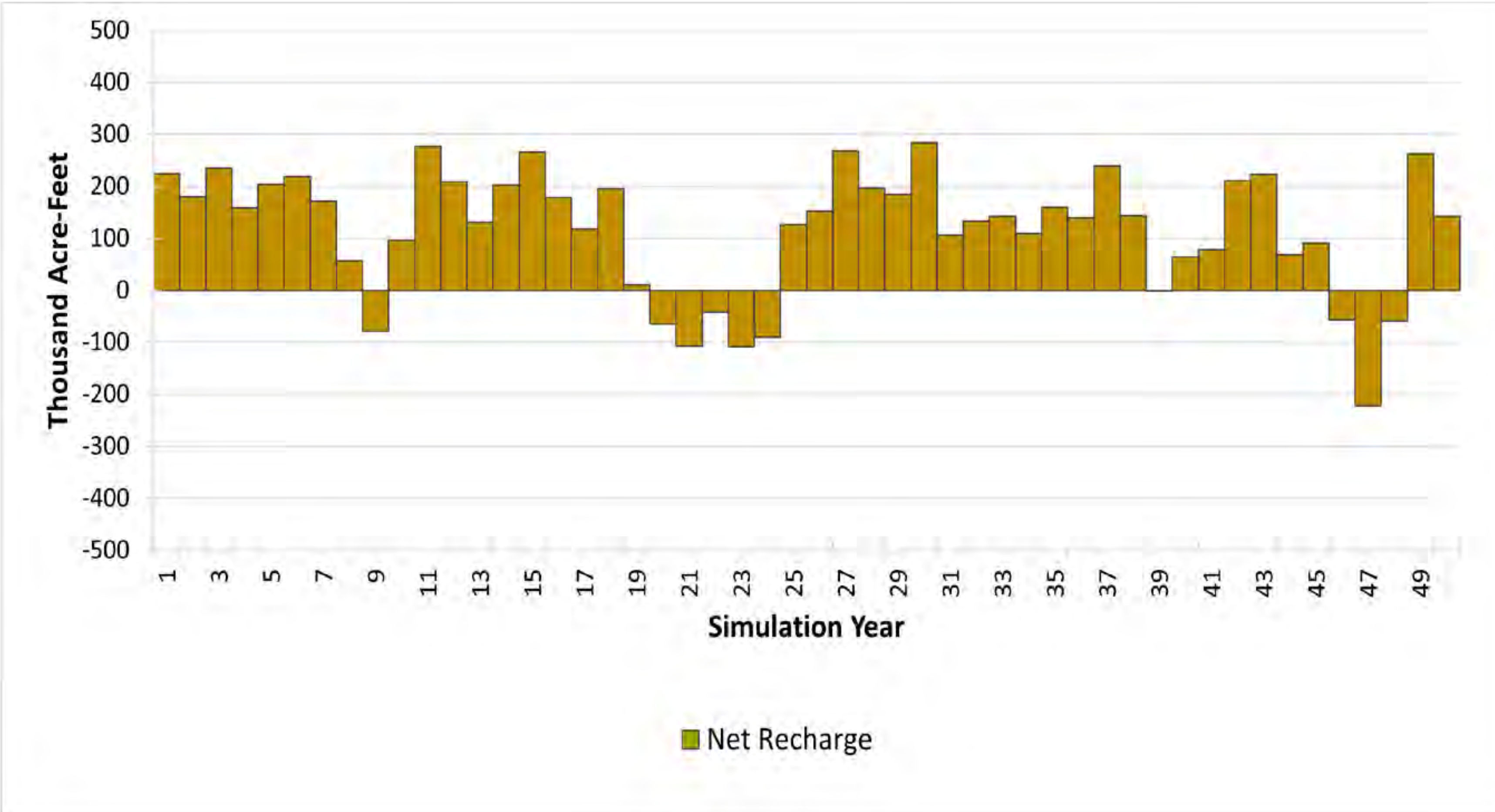

Figure 5-55

Sustainable Yield
Net Recharge
WTSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

WOODARD & CURRAN

August 2021

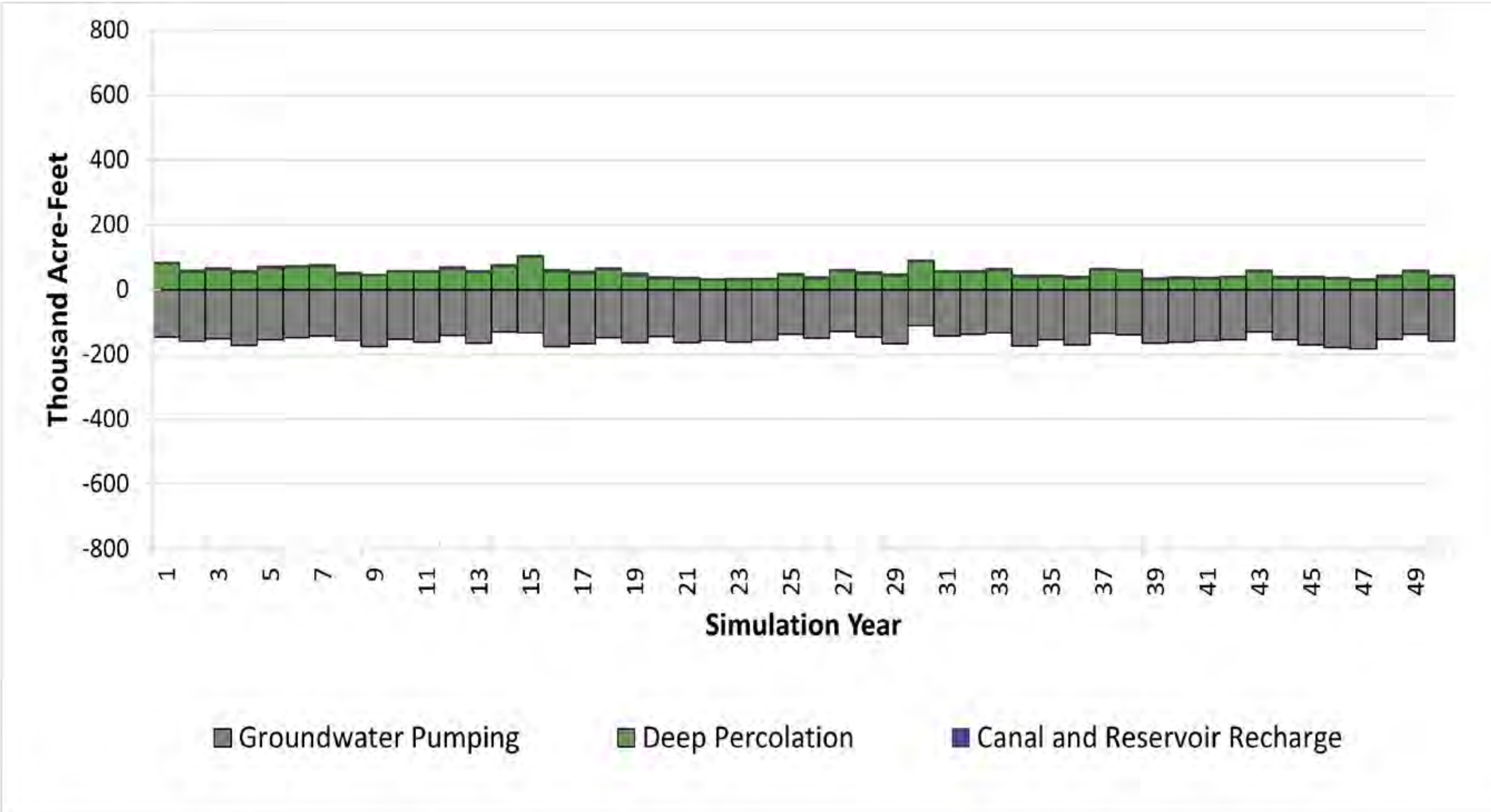

Figure 5-56

Sustainable Yield
Groundwater Recharge and Extraction
ETSGSA

Note: The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.

WOODARD & CURRAN

August 2021

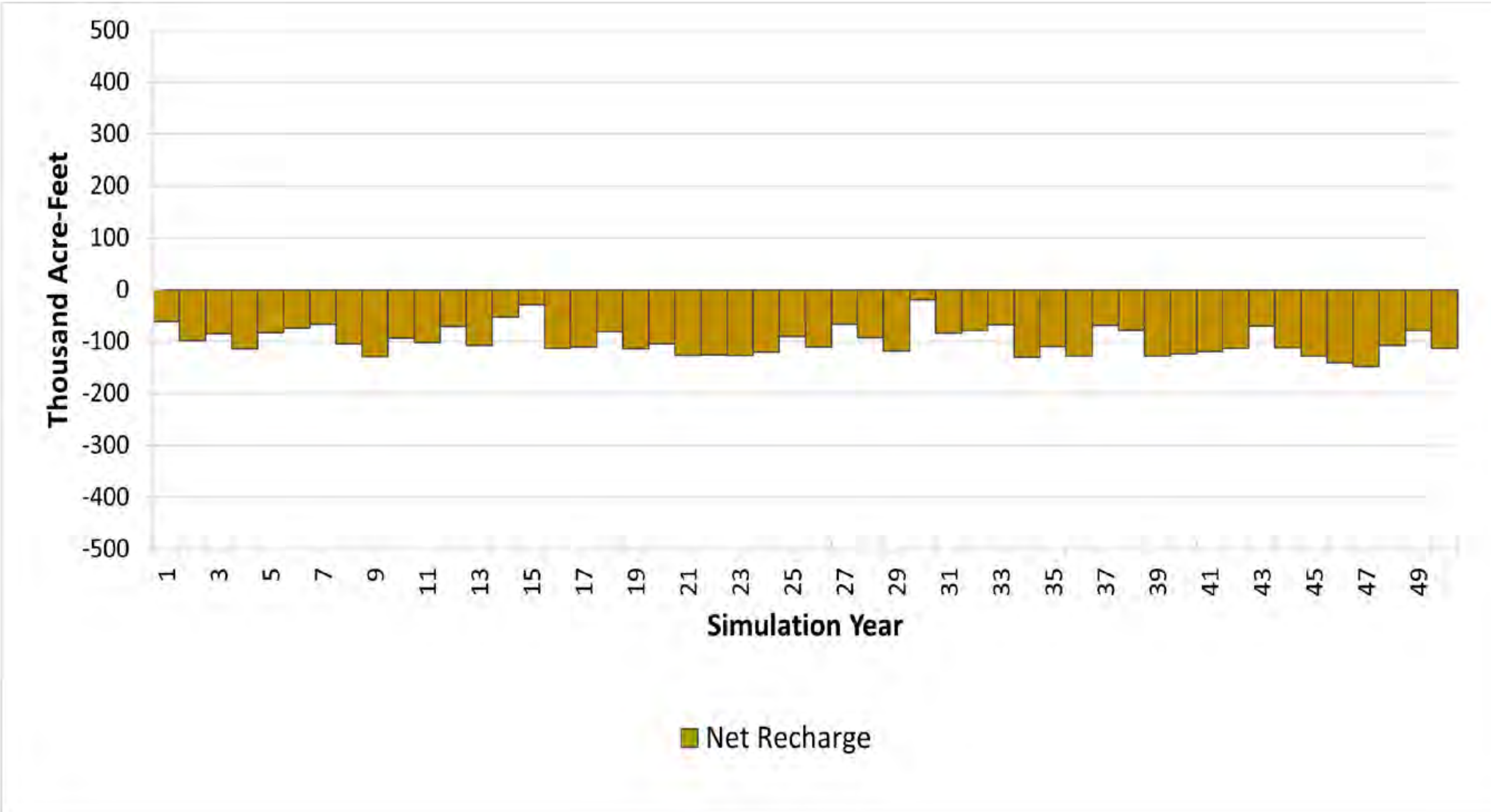

Figure 5-57	**Note:** The operational water budget information presented in this figure or table is based on the jurisdictional boundaries of each GSA as mapped to the resolution of the model grid. This figure does not represent the water budget for the Eastern and Western Principal Aquifers.
Sustainable Yield Net Recharge ETSGSA	WOODARD & CURRAN August 2021

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6. SUSTAINABLE MANAGEMENT CRITERIA

GSP regulations provide a framework for locally-defined and quantitative *sustainable management criteria*, which allows the GSAs to quantitatively measure and track ongoing sustainable management. These criteria include the following terms, along with a brief summary[25] of how each is used in this GSP:

- Undesirable Result – significant and unreasonable adverse conditions for any of the six sustainability indicators defined in the GSP regulations.
- Minimum Threshold (MT[26]) – numeric value used to define undesirable results for each sustainability indicator at representative monitoring sites.
- Measurable Objective (MO[2]) – numeric goal to track the performance of sustainable management at representative monitoring sites.
- Interim Milestone (IM[2]) – target numeric value representing measurable groundwater conditions, in increments of five years, as set by the GSAs as part of the GSP.

Collectively, these terms provide the framework on which to:

- define sustainable management for the Turlock Subbasin
- provide guidelines for favorable groundwater conditions
- identify unfavorable groundwater conditions and associated warning signs
- select and evaluate appropriate management projects and actions
- monitor progress on achieving the sustainability goal.

6.1. SUSTAINABILITY GOAL

A sustainability goal provides a mission statement for what the GSAs wish to achieve through sustainable management. GSP regulations provide requirements for a GSP Sustainability Goal, as follows:

> Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the

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[25] Sustainable management criteria are more fully defined in SGMA (CWC 10721(a) – (ab) and GSP regulations (§351(a) – (an)).

[26] Because of the frequency of use, and to facilitate review of the text, the terms "minimum threshold," "measurable objective," and "interim milestone" are abbreviated as "MT", "MO", and "IM" respectively, throughout remaining sections of the GSP. However, the terms are spelled out in un-abbreviated form where helpful for context and clarity or when contained in a direct quotation.

> sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon. (§354.24).

DWR requires one succinct, common sustainability goal for the entire Subbasin (DWR, 2017). Based on DWR guidance and GSP requirements, the consultant team prepared technical memoranda to facilitate discussion and development of a Draft Sustainability Goal by members of the ETSGSA and WTSGSA Technical Advisory Committees (collectively referred to in this GSP as the Joint TACs). The technical memoranda summarized GSP requirements, provided examples of Sustainability Goals from other San Joaquin Valley subbasins, and prepared a draft initial Sustainability Goal for consideration and revision by the Joint TACs.

The Joint TACs reviewed requirements and discussed aspirations for an initial sustainability goal for the Turlock Subbasin GSP at two public meetings (February 26 and March 26, 2020). The initial Sustainability Goal was revised as the GSP progressed. The most recent draft sustainability goal as revised in August 2021 is provided below.

The Sustainability Goal for the Turlock Subbasin *is to ensure a reliable and sustainable groundwater supply that supports population growth, sustains the agricultural economy, and provides for beneficial uses, especially during drought. This goal is supported by and includes the following actions:*

- *Manage the Subbasin within its sustainable yield and arrest ongoing long-term water level declines.*
- *Support interconnected surface water to avoid adverse impacts to surface water uses.*
- *Manage groundwater extractions and water levels to avoid impacts from future potential land subsidence.*
- *Optimize conjunctive use of surface water, recycled water, and groundwater.*
- *Support efficient water use and water conservation.*
- *Coordinate with GSAs in neighboring subbasins to avoid undesirable results along shared Subbasin boundaries.*
- *Adaptively manage the Subbasin over time to improve operational flexibility and to ensure sustainability of the groundwater resources.*

The sustainability goal will be achieved through implementation of projects and management actions that may involve improved conjunctive use, increased supplies, conservation, and/or reductions in groundwater demand. Achievement of the sustainability goal will be demonstrated through the GSP monitoring network, which will monitor performance of both projects and groundwater conditions and will document the absence of undesirable results.

The sustainable management criteria and monitoring network will be based on the basin setting, including the hydrogeologic conceptual model, groundwater conditions and water budgets – which collectively provide the understanding necessary to define sustainable groundwater management.

6.2. PROCESS FOR SELECTION OF SUSTAINABLE MANAGEMENT CRITERIA

An interactive process was used by the GSAs to develop sustainable management criteria for the Turlock Subbasin. In brief, the Joint TACs led the process, with input from stakeholders, and recommended draft sustainable management criteria to be incorporated into the Draft GSP for consideration by the GSAs. Periodic updates were provided to both of the GSAs' Board of Directors. Steps taken during this process are generally summarized below:

1. Develop a Sustainability Goal (process described above, **Section 6.1**).
2. Analyze Sustainability Indicators.
3. Define Undesirable Results.
4. Assign Minimum Thresholds and Measurable Objectives.
5. Provide for ongoing evaluations of sustainable management criteria as projects and management actions are developed, and adjust criteria, as needed.
6. Develop the GSP monitoring network and finalize criteria based on representative monitoring sites.
7. Select interim milestones for achieving sustainability.

These steps were accomplished through a series of TAC committee meetings and input from members of the Joint TACs and stakeholders at numerous public meetings. More than 20 public meetings were held from February 2020 through September 2021 that focused on various aspects of sustainable management criteria conditions including a review of applicable GSP regulations, DWR Best Management Practices (BMPs) and guidance documents, and relevant groundwater conditions within the Turlock Subbasin and adjacent subbasins.

In February 2021, the Joint TACs formed a smaller working group referred to as the Ad Hoc Committee[27] to move through the technical issues more quickly and provide immediate input to the technical team. For these meetings, the technical team provided focused information and recommendations to the Ad Hoc Committee regarding the items listed above.

[27] The Ad Hoc Committee consists of a small subset of members of the Joint TACs to provide input and recommendations to both the technical team and the Joint TACs.

Once the Ad Hoc Committee agreed upon a recommended approach for specific sustainable management criteria, the recommended draft criteria, along with the technical basis and information for the recommendation, were brought before the Joint TACs in a public meeting for a recommendation to use in the Draft GSP. Each TAC provided periodic updates on this process to its GSA Board of Directors at regularly scheduled public Board meetings. **Chapter 3** provides a more complete summary of the overall outreach process.

6.2.1. Analyze Sustainability Indicators

SGMA defines six sustainability indicators as illustrated in the following diagram, each with its DWR-developed icon. The Joint TACs considered the applicability of each sustainability indicator to conditions in the Turlock Subbasin as described in the basin setting, with particular attention to future projected water budgets (**Sections 4** and **5**).

					
Chronic Lowering of Water Levels	**Reduction of Groundwater in Storage**	**Degraded Water Quality**	**Seawater Intrusion**	**Inelastic Land Subsidence**	**Depletion of Inter-connected Surface Water**

As discussed in the sections below, five of the six sustainability indicators were determined to be applicable to the Turlock Subbasin; seawater intrusion was not applicable to Subbasin groundwater conditions, as discussed further in **Section 6.5**.

As explained in more detail in previous chapters of this GSP, there are a variety of technical considerations for each of the applicable sustainability indicators in the Turlock Subbasin. Those considerations were used to develop the sustainable management criteria and are illustrated on **Figure 6-1**. As shown on the figure, sustainability indicator icons are placed in the general areas of the Subbasin where the indicators have the most potential for future adverse impacts.

Chronic lowering of groundwater levels and reduction of groundwater in storage (overdraft) are primarily concerns in the Eastern Principal Aquifer. Water level declines in the northwestern portion of the aquifer have contributed to domestic well failures during the 2014-2017 drought. The cone of depression in the central portion of the aquifer, as indicated by the Fall 2015 groundwater elevation contours, shows the areas of historical and ongoing extractions where groundwater has served as the primary source of water supply (**Figure 6-1**; see also **Figure 4-30a**). Water level declines and reductions of groundwater in storage are also observed east of this delineated cone of depression, as indicated by groundwater elevations and hydrographs from sparse well data available in that area (see **Figure 4-27**, hydrographs 17 and 18). Chronic lowering of water levels has also impacted drinking water supply wells in the urban communities, including in the cities of Ceres and Turlock and urban communities of Delhi and Hickman.

Concerns regarding degradation of water quality have been documented by public water suppliers – especially in the cities of Turlock and Ceres, as indicated by the degraded water quality icons in those two areas (**Figure 6-1**).

No impacts from land subsidence have been documented to date in the Turlock Subbasin. However, the presence of the Corcoran Clay and associated compressible clay layers suggests the potential for future land subsidence if water levels are allowed to decline and depressurize or dewater regional clays. The western principal aquifers are within the extent of the Corcoran Clay and, as such, are likely the most susceptible areas for potential land subsidence (**Figure 6-1,** see the land subsidence icon and the area highlighted by red stripes). Although the Eastern Principal Aquifer are less likely to experience significant future land subsidence (due to more consolidated aquifers outside of the Corcoran Clay extent), sustainable management criteria and a GSP monitoring network have also been established for the entire Subbasin as a protective measure.

Finally, all three river boundaries are interconnected surface water as defined by SGMA, and sustainable management criteria have been selected based on conditions along each river. The most protective criteria have been established along the Merced River to prevent future projected streamflow depletions and the potential for disconnection from the aquifer. Criteria are also established along the Tuolumne River and San Joaquin River to preserve net gaining conditions along each boundary (**Figure 6-1**).

6.2.2. Define Undesirable Results

For each of the five applicable sustainability indicators, the Joint TACs identified related potential adverse impacts that either had occurred or could occur in the Subbasin. These impacts were considered in the context of the technical analyses in the basin setting including the hydrogeologic conceptual model, groundwater conditions, and water budgets.

The Joint TAC members considered whether impacts were significant and unreasonable, and thereby undesirable results. The causes of existing or potential future undesirable results were identified, as well as locations and timing. Recognizing that management actions and groundwater conditions vary throughout the Subbasin, spatial and temporal characteristics were used to clarify conditions that could lead to undesirable results. Each sustainability indicator was discussed in multiple public TAC meetings and workshops; input from the public was considered throughout the process.

The GSP may, but is not required to, address undesirable results that occurred before, and have not been corrected by January 1, 2015 (§10727.2 (b)(4)). In the Turlock Subbasin, undesirable results for 2015 conditions were identified for chronic lowering of water levels and reduction of groundwater in storage (overdraft). Analysis of future projected conditions suggest that undesirable results for interconnected surface water would likely occur without managing groundwater levels. Finally, although less likely, undesirable results for land subsidence and degraded water quality could also occur under future projected conditions without additional GSA monitoring and management. Accordingly, sustainable management criteria were focused on either improving or, at a minimum, avoidance of worsening groundwater conditions that could lead to undesirable results.

6.2.3. Assign Preliminary Minimum Thresholds and Measurable Objectives

The definition of undesirable results guided the selection of quantitative metrics to serve as sustainable management criteria. Specifically, metrics were identified for minimum thresholds (MTs), exceedances of which may cause undesirable results. Measurable Objectives (MOs) were selected to provide a target metric for sustainable management. MTs and MOs were developed for each sustainability indicator applicable to the Turlock Subbasin. As agreed by the Joint TACs, the seawater intrusion sustainability indicator was found to not apply to the Subbasin; accordingly, no sustainable management criteria were developed for this indicator (see **Section 6.5**).

6.2.4. Adjust Sustainable Management Criteria

The sustainable management criteria were interactively adjusted during the GSP development. Specifically, sustainable management criteria were refined based on the final projected future water budgets (presented August 13, 2020), initial development of a sustainable yield (presented May 13, 2021), and the analysis of projects and management actions (through Fall 2021).

As summarized in **Section 6.10**, the Joint TACs acknowledge that the selected sustainable management criteria represent estimates based on the best available information at this time. Nonetheless, application of these criteria in the Subbasin will likely require future adjustment. Monitoring data and project performance will be evaluated over the first five years of the Plan and criteria will be reevaluated during the five-year GSP update in 2027.

6.2.5. Develop the GSP Monitoring Network

Based on the approach to the sustainable management criteria for each Principal Aquifer and each sustainability indicator, the types and locations of the GSP monitoring network were identified. **Chapter 7** describes the GSP monitoring network developed for the Turlock Subbasin.

6.2.6. Select Interim Milestones

In order to achieve the Subbasin Sustainability Goal of sustainably managing the Turlock Subbasin by 2042, the Joint TACs selected targeted water levels over the 20-year implementation horizon. These targets, or interim milestones, will provide a benchmark at the 5-year, 10-year, and 15-year intervals and considered the timing of projects and the ability to arrest ongoing groundwater level declines.

6.2.7. Organization and Presentation of Sustainable Management Criteria in the GSP

The process described above supports the sustainable management criteria selected for each of the six sustainability indicators, discussed separately in **Sections 6.3** through **6.8** below. Information within each of these sections is organized similarly and tracks the order of GSP requirements provided in *Subarticle 3. Sustainable Management Criteria*. Headings and subheadings are similar in each of the sections on the individual sustainability indicators to facilitate locating the required information. The material for each of the six sustainability indicators is organized as follows:

- Introduction including regulatory definitions
- Definition for <u>Undesirable Results</u> along with quantitative criteria that are used to define when and where undesirable results would occur.
  - Causes of Undesirable Results
  - Potential Effects on Beneficial Uses and Users of Groundwater
- Quantification of <u>Minimum Thresholds</u> (MTs). Quantified MTs are followed by the six topics below that are required to be addressed by the regulations.
  - Justification and Support for Minimum Thresholds
  - Relationship of MT with MTs of the other sustainability indicators and how GSAs determined that undesirable results would be avoided
  - Impacts of MTs on Adjacent Subbasins
  - Effects of MTs on Beneficial Uses and Users of Groundwater
  - Consideration of State, Federal, or Local Standards in MT Selection
  - Quantitative Measurement of Minimum Thresholds
- Quantification of <u>Measurable Objectives</u> (MOs)
- <u>Quantification of Interim Milestones (IMs)</u>

6.3. CHRONIC LOWERING OF GROUNDWATER LEVELS

SGMA defines an undesirable result for the chronic lowering of groundwater levels as a "significant and unreasonable depletion of supply if continued over the planning and implementation horizon" (§10721 (x)(1)). As described in **Section 4.3.1**, the amount of groundwater supply beneath the Turlock Subbasin is large (about 23 to 30 million acre feet, MAF); about 1.6 MAF of this supply has been depleted over the 25-year historical study period, representing a relatively small percentage of the total supply.

Nonetheless, the chronic lowering of groundwater levels in the Subbasin has created adverse impacts to the accessible supply from numerous water supply wells, a condition that can cause undesirable results. As such, the emphasis of this sustainability indicator is depletion of *accessible* supply and focuses on adverse impacts to Subbasin supply wells. This emphasis is also consistent with GSP regulations, which qualify that the depletion of supply is considered "*at a given location*," such as at a well (§354.28(c)(1)).

The SGMA definition of chronic lowering of groundwater levels also addresses water level declines within the context of overdraft and storage as shown below:

> Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods. (§10721 (x)(1)).

This definition allows for water level declines during droughts as long as such declines do not cause undesirable results and as long as water levels recover to acceptable levels over average hydrologic conditions. Accordingly, the analysis of the chronic lowering of groundwater levels focuses on long-term trends of water level declines that cause undesirable results for a significant number of water supply wells.

The undesirable results, including causes and impacts to beneficial uses, are described in **Section 6.3.1** below, with the definition of undesirable results provided at the end of the section along with criteria to quantify where and when undesirable results will occur. **Section 6.3.2** describes the quantification of minimum thresholds (MTs). **Section 6.3.3** provides the approach and selection of measurable objectives (MOs). Interim milestones that cover all of the sustainability indicators are described in **Section 6.9**.

6.3.1. Undesirable Results for Chronic Lowering of Groundwater Levels

The cause of the groundwater level declines in the Turlock Subbasin are the combined results of long-term overdraft and multi-year drought conditions. Increased agricultural production in areas that rely solely on groundwater has caused a historical Subbasin overdraft of about 63,900 AFY (**Section 5.1.4** and **Table 5-6**). This deficit has resulted in chronic declines in groundwater levels, primarily in the east-central portion of the Subbasin where a cone of depression is delineated by groundwater elevation contours around an area of over-pumping (see **Figure 6-1**, **Section 4.3**, and **Figure 4-30a**). This depression has altered natural groundwater flow directions and induced subsurface flows from WTSGSA to ETSGSA (. This reversal of flow has also contributed to the lowering of water levels in areas of the eastern WTSGSA that support numerous domestic wells, more than 150 of which failed during drought conditions in 2013-2016 (**Figure 2-13**).

Numerous factors during drought exacerbate the chronic declines in groundwater levels in the Turlock Subbasin. First, surface water supplies, which support the agricultural economy and other Subbasin beneficial uses, are less available due to decreased precipitation in the associated watersheds of the Sierra Nevada (which feed the Tuolumne and Merced rivers). In addition, requirements for maintenance of minimum flows in the rivers for biological purposes equate to less availability for other Subbasin beneficial uses. In addition, drought conditions are often accompanied by higher temperatures, resulting in a higher water demand for beneficial uses. Finally, lower precipitation in these years also result in less natural recharge on the valley floor. All of these factors result in increased groundwater pumping to meet demands.

In addition to impacts to wells as described below, the lowering of water levels may also lead to additional undesirable results such as reduction of groundwater in storage, land subsidence, depletions of interconnected surface water and adverse impacts to groundwater dependent ecosystems (GDEs). These impacts to the other sustainability indicators are summarized in **Section 6.3.2.2** and described more fully in remaining sections of **Chapter 6**.

6.3.1.1. Causes of Undesirable Results – Adverse Impacts to Wells

The imbalance between groundwater recharge and extraction described above has caused adverse impacts on water supply wells and associated beneficial uses. Lower water levels in a pumping well increase costs to lift the water to the surface. If water levels fall below the pump intake, costs are incurred for pump lowering and/or other well modifications. Further declines can result in water levels falling below the top of well screens, resulting in geochemical changes, air entrainment, and/or decreased capacity from the well. Water level declines can also damage wellbore equipment (including pumps or casing) from cavitation or other mechanisms. If water levels fall below the bottom of the well, the well is completely dewatered and would require replacement to access groundwater.

In general, older wells, shallow wells, and/or wells with casing integrity issues are at the highest risk of failure. SGMA does not require the protection of all groundwater wells nor the correction of historical undesirable results; for this GSP, the analysis of undesirable results considers groundwater conditions during the 2013-2016 drought (which resulted in the largest rate of water level declines) and the need to avoid similar undesirable results in the future.

6.3.1.2. Potential Effects on Beneficial Uses

Well impacts can increase costs, delay operations, damage crops or property, and even jeopardize the ability to secure a reliable drinking water supply for some. Impacts can affect any beneficial use of groundwater from wells including municipal, domestic, industrial, and agricultural water supply.

Although this sustainability indicator is focused on adverse impacts to wells, chronic lowering of groundwater levels can also adversely impact environmental uses of groundwater including GDEs (**Section 4.3.8**). Given that GDEs in the Turlock Subbasin are primarily located along the rivers, GDE impacts are also affected by the interconnected surface water sustainability indicator (**Section 6.8**).

6.3.1.3. Specific Impacts to Wells and Beneficial Uses in the Turlock Subbasin

Long-term water level declines in the Subbasin combined with the 2015 drought conditions resulted in many of the adverse impacts to water supply wells and beneficial uses described above in the Turlock Subbasin. Impacts to wells and beneficial uses were initially discussed in a public workshop of the Joint TACs on February 26, 2020, with numerous follow-up discussions in Ad Hoc Committee meetings and multiple public meetings of the Joint TACs in 2020 and 2021. Many TAC member agencies are also responsible for provision of drinking water supplies; those agencies documented numerous adverse impacts to drinking water supply wells resulting from declining water levels during drought conditions (WY 2014 through WY 2016) that occurred at the end of the historical Study Period.

During that time period, water levels reached then-historic low levels throughout much of the Subbasin, providing an opportunity to observe adverse impacts associated with water level declines. Most agencies observed a decrease in capacity and well efficiency. Some agencies experienced failed wells and other adverse impacts. Numerous domestic wells were also adversely impacted. Significant adverse impacts to Turlock Subbasin water supply wells are summarized in **Table 6-1** as follows.

Table 6-1: Adverse Impacts to Wells Associated with Declining Groundwater Levels

Adverse Impacts to Water Supply Wells from 2014 through 2016	Agencies Reporting Impacts
Dry[1] or failed domestic wells	Stanislaus and Merced counties, Delhi CWD
Dry shallow, older domestic wells (<100 feet deep and > 50 years old)	Stanislaus County
Collapsed casing/borehole in municipal wells	Hickman, Hilmar CWD
Loss of capacity in municipal wells (pump lowering required)	City of Waterford[2]
Dry landscape irrigation wells	City of Turlock
Loss of capacity in rented agricultural wells; curtailed agricultural pumping in some areas	Turlock Irrigation District
Aging wells at risk of failure if water levels decline further	Hilmar CWD, City of Waterford
Water quality issues (increasing arsenic, nitrate, and/or TDS)	Cities of Modesto, Ceres, and Waterford; Hilmar CWD

[1]For purposes of this table, a "dry" domestic well does not necessarily mean that water levels in the aquifer have declined below the bottom of the well; well failures are also associated with water levels falling below a shallow pump intake or below the top of well screens such that capacity is adversely affected.

[2] Although the City of Waterford is located primarily in the Modesto Subbasin, it oversees the urban water supply system for the community of Hickman in the Turlock Subbasin and is an Associate member of the WTSGSA.

With respect to the domestic wells listed as the first two items in **Table 6-1** above, Stanislaus and Merced County representatives documented about 165 impacted domestic wells during drought conditions from 2014-2016 (see **Section 2.3.2.4**). The counties aided well owners through various County and State assistance programs that involved trucked water, provision of storage tanks, assistance with new well installations, and other measures. The City of Turlock attempted to address as many emergency requests to tie into the City water system as feasible (as mentioned by former City employees in public GSP meetings).

Lower groundwater levels also created adverse impacts on agricultural operations in the WTSGSA. For example, TID could not pump groundwater in some areas to supplement surface water deliveries of agricultural supply as was typical in TID operations. Some wells had lost capacity and others were in areas that were adversely impacting nearby wells. Pumping from private agricultural wells also had to be curtailed to avoid local impacts to other wells.

Given the difficulty agencies expressed in managing water supply and the number of failed public and domestic wells, the conditions associated with the 2015 drought (with most of the adverse impacts occurring in 2016) were defined as undesirable results for water supply wells in the western Subbasin. Similar adverse impacts were not identified in the ETSGSA due, in part, to deeper wells, a smaller number of drinking water supply wells, and subsurface groundwater inflow from the west. However, water level declines in the ETSGSA affect areas with domestic wells, such as in the northwestern area of the Eastern Principal Aquifer.

Since that time, the member agencies and domestic well owners have responded to mitigate these adverse impacts associated with drought conditions. Since 2015, DWR well completion reports document about 386 new domestic wells that have been installed in the Subbasin. Most of these wells were constructed in areas of previously failed wells and to deeper depths. Even though water levels have only recovered up to about 20 feet in most areas of the new wells (see **Figures 4-25** and **4-26**), no additional well failures have been reported. This information suggests that long-term maintenance of water levels at or above 2015 levels should be protective of domestic wells, with some decline allowed during future droughts as long as water levels can recover. Additional information on Subbasin domestic wells and adverse impacts associated with declining water levels are provided in **Section 2.3.2.4** of this GSP.

The public water suppliers within the Subbasin (including GSA member agencies) have also responded to mitigate adverse impacts to public water supply wells associated with drought conditions. Various management and mitigation actions have included infrastructure improvements and operational efficiencies. Accordingly, adverse impacts from water levels at or above 2015 levels are thought to be able to be mitigated or managed into the future. However, future adverse impacts are expected to re-occur if ongoing declines in the Subbasin are not arrested.

6.3.1.4. Turlock Subbasin Definition of Undesirable Results

Based on the information summarized above and additional information presented in the basin setting (especially **Sections 2.3.2.4** and **4.3**), a definition has been developed for undesirable results relating to chronic lowering of groundwater levels in the Turlock Subbasin. This definition focuses on adverse impacts to drinking water wells including public water supply wells and domestic wells.

Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria address the number of monitoring sites and events of MT exceedances that would cause an undesirable result. This framework recognizes that a single MT exceedance at one monitoring site is not likely to cause an undesirable result. This framework also allows clear identification for when an undesirable result is triggered under the GSP.

Table 6-2: Undesirable Results for Chronic Lowering of Groundwater Levels

	Undesirable Results Definition	Principal Aquifer(s)
Chronic Lowering of Groundwater Levels	An undesirable result is defined as significant and unreasonable groundwater level declines such that water supply wells are adversely impacted during multi-year droughts in a manner that cannot be readily managed or mitigated. An undesirable result for each principal aquifer will occur when at least 33% of representative monitoring wells exceeds the MT for that Principal Aquifer in three (3) consecutive Fall semi-annual monitoring events.	All

As indicated in the definition above, flexibility is provided for future drought conditions whereby water levels are allowed to decline somewhat during drought as long as periods of decline are relatively short, and ongoing projects/management actions support subsequent water level recovery above the MTs.

The use of three consecutive Fall semi-annual monitoring events in the undesirable result definition recognizes the three-year critically dry period (WY 2013 – WY 2015, see **Figure 4-2**) which caused undesirable results previously; most of the impacts to wells and associated beneficial uses occurred at the end of this three-year period (i.e., Fall 2015) and extended throughout 2016. By comparing Fall events, long-term groundwater level declines are more readily tracked without re-stating the number of exceedances due to partial recovery occurring each Spring.

Between Fall 2015 and Fall 2021, there have been three below normal or dry years, yet no additional undesirable results have been identified. Even though well resiliency has improved with hundreds of new, deeper domestic wells and improvements by public water suppliers, only short-term declines in limited areas of each Principal Aquifer are allowed under this undesirable results definition.

It is also recognized that exceedance of an MT in one well generally is not sufficient to trigger undesirable results as defined above. The use of 33 percent of the representative monitoring wells in each Principal Aquifer represents a rough estimate of the number of wells that might indicate an overall water level decline in each Principal Aquifer. For example, the area represented by the failed domestic and public water supply wells covers more than one-half of the Subbasin with impacts occurring in all three Principal Aquifers. Given these conditions, the estimate of 33 percent in each Principal Aquifer seems sufficiently protective against undesirable results and reasonable given the size of the Subbasin and number and distribution of the GSP representative monitoring wells.

For example, the proposed GSP monitoring program for chronic lowering of groundwater levels includes the following number of wells in each principal aquifer and the number of wells in 33 percent of that program. As indicated from the list below, MT exceedances in only three to seven wells (depending on the Principal Aquifer) would indicate an undesirable result. Numbers of wells and additional details are provided in **Chapter 7**, which describes the GSP monitoring network (see **Section 7.1.1** and **Figures 7-1, 7-2** and **7-3**).

- Western Upper Principal Aquifer: 18 wells (33% - 6 wells)
- Western Lower Principal Aquifer: 8 wells (33% - 3 wells)
- Eastern Principal Aquifer: 21 wells (33% - 7 wells)

The extent of the Western Upper Principal Aquifer and the Eastern Principal Aquifer each cover generally about one half of the Subbasin – roughly 160,000 to 190,000 acres each. (The Western Lower Principal Aquifer lies directly below the Western Upper Principal Aquifer and covers the same area). Each of these areas also have similar numbers of wells in the GSP monitoring network for chronic lowering of water levels (18 wells for the Western Upper Principal Aquifer and 21 wells for the Eastern Principal Aquifer, see **Section 7.1.1**).

Wells are relatively well-distributed across the Subbasin, with a focus on areas of groundwater use (see **Figures 7-1** and **7-3** in **Chapter 7**). Areas of groundwater use can be approximated by the urban and agricultural areas shown on **Figures 2-4** and **2-5**). With water level declines transitional across the Subbasin, it appears that changes in more than 6 or 7 wells could impact adjacent areas in the Subbasin. While far from exact, these estimates provide a preliminary process for estimating areas that may exceed the MTs without triggering undesirable results.

6.3.2. Minimum Thresholds for Chronic Lowering of Groundwater Levels

The quantitative MT metric required by the regulations for this indicator is “the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results” (§354.28 (c)(1). In the Turlock Subbasin, MTs are quantified as the low groundwater elevations observed in Fall 2015 at representative monitoring sites for all three

Principal Aquifers. These MTs generally approximate the groundwater elevations presented in **Figures 4-30a** and **4-30b** of the basin setting. While water levels have continued to decline in many areas of the Subbasin, the Fall 2015 levels represented the historic low water level throughout most of the Subbasin.

These MTs allow GSAs to manage to an existing groundwater surface throughout the Subbasin, demonstrating that hydraulic gradients associated with the MTs can be supported by the Principal Aquifer systems. **Table 6-3** documents the selected approach for the MTs; the MT at each representative monitoring well is presented in **Chapter 7**, which describe the GSP monitoring network (see **Section 7.1.1**).

Table 6-3: Minimum Thresholds for Chronic Lowering of Groundwater Levels

	Minimum Thresholds	Principal Aquifer(s)
Chronic Lowering of Groundwater Levels	Minimum thresholds are established as the low groundwater elevation observed in Fall 2015 at each representative monitoring site in each Principal Aquifer.	All

Information from the basin setting used to support these MTs are summarized in the following section.

6.3.2.1. Justification and Support for Minimum Thresholds

GSP regulations require that MTs for this indicator be supported by:

- The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
- Potential effects on other sustainability indicators. (§354.28 (c)(1)(A)(B)).

Historical declines in groundwater levels across the Subbasin are discussed throughout **Section 4.3** and specifically in **Section 4.3.2**; associated water year types in that section are based on the detailed information in **Section 4.2.2.1** (also see **Figure 4-2**). **Figures 4-23** through **4-27** present hydrographs showing rates of decline in selected wells with relatively long water level records across the Subbasin. **Figure 6-1** provides locations of failed domestic wells from 2014 to 2017, representing undesirable results caused by groundwater level declines. **Figure 2-15** shows the location of new and/or replacement domestic wells drilled since the 2015 drought. A comparison of **Figures 4-28a** and **4-30a** shows the long-term water level decline during the Historical Study Period (WY 1991 to Fall 2015). Rates of decline are summarized briefly by Principal Aquifer below.

- <u>Western Upper Principal Aquifer</u>: relatively shallow and stable water levels in the western Subbasin with minimal – but observable – declines during drought; rates of decline increase in the eastern portion of the aquifer. The water level declines in the eastern portion of the aquifer resulted in failed domestic wells during 2014-2017 drought conditions. The County reported that most of those failures occurred in shallow (less than 100 feet deep) and older (more than 50 years) wells. DWR well completion reports document about 386 new, and generally deeper, domestic wells that have been drilled since 2015 in the Subbasin. Since 2016, no domestic dry wells have been reported on the DWR website[28] for reporting household water supply shortages, even though water levels remain near historic lows.

- Western Lower Principal Aquifer: wells known to be screened in this aquifer only are sparse; nonetheless, water levels appear to be relatively shallow and stable with small rates of decline that increase during drought. Although variable, the rate of decline during drought is estimated at about 1.5 feet/year. Nonetheless, local declines in the southern/southeastern portion of this aquifer resulted in adverse impacts to water supply wells during the 2014-2017 drought (e.g., near Delhi).
- Eastern Principal Aquifer: Overall declines throughout the eastern Subbasin have been observed throughout the historical Study Period with long-term declining trends since the 1990s and increased rates of decline since about 2007. Declining trends and rates vary, with representative overall declines of about 3 feet/year to more than 4.5 feet/year. Although historical water level data are sparse in the easternmost portion of the aquifer, several wells indicate the largest rates of decline in the Subbasin. Water level declines in the northwestern portion of the aquifer caused adverse impacts to a concentrated area of domestic wells.

Replacement wells and other improvements to local water supply wells appear to have mitigated impacts from 2015 levels; even though the Subbasin is close to historic low levels now, water supply wells are being managed without identified undesirable results. The large number of deeper domestic wells drilled since 2015 can be reasonably assumed to accommodate 2015 water levels, with some tolerance for future droughts (**Figure 2-15**). Nonetheless, Subbasin public water suppliers caution that additional adverse impacts to water supply wells could occur if chronic water level declines – especially in the Eastern Principal Aquifer – are not arrested and note the long-term monetary costs of continuing to operate public water supply wells at increasing water level depths over time.

SGMA does not require the GSAs to correct the historical rates of decline that resulted in 2015 conditions. However, setting the MTs at the low water levels of 2015 will prevent significant future groundwater level declines that could lead to undesirable results.

6.3.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). To facilitate a comparison between MTs, a summary table of MTs for each sustainability indicator is provided below. Justification for

[28] https://mydrywatersupply.water.ca.gov/report/

the approach to each MT is described in subsequent sections of this chapter, as indicated in the summary table.

Table 6-4: Summary of Minimum Thresholds by Sustainability Indicator

Sustainability Indicator	Minimum Threshold (MT)	GSP Section
Chronic Lowering of Groundwater Levels	Fall 2015 Groundwater Elevation	**6.3.2.1, 6.3.2.2**
Reduction of Groundwater in Storage	Fall 2015 Groundwater Elevation	**6.4.2.1, 6.4.2.2**
Seawater Intrusion	Not applicable	**6.5**
Degraded Water Quality	MCL of Each Constituent of Concern	**6.6.2.1, 6.6.2.2**
Land Subsidence	Fall 2015 Groundwater Elevation, or top of the Corcoran Clay, whichever is shallower	**6.7.2.1, 6.7.2.2**
Interconnected Surface Water	Tuolumne River and San Joaquin River: Fall 2015 groundwater elevation Merced River: Spring 2014 groundwater elevation	**6.8.2.1, 6.8.2.2**

As indicated in the table above, the Fall 2015 groundwater elevations are used as the MTs for three of the six sustainability indicators and also for two of the three rivers associated with interconnected surface water. For land subsidence, the MT definition also prevents the MT from being set below the top of the Corcoran Clay (applicable to the Western Lower Principal Aquifer only, see **Section 6.7.2.2** for more information).

Only for the interconnected surface water sustainability indicator along the Merced River is the MT represented as a different water level (Spring 2014). Although these levels are higher, the difference is not sufficiently significant such that the lower MTs (Fall 2015 in inland wells) would prevent the higher MTs (Spring 2014 in near-river wells) from being achieved. The monitoring networks, along with the quantification of MTs at each representative monitoring well for these sustainability indicators are provided in **Sections 7.1.1** through **7.1.6**.

As indicated in **Table 6-4**, an MT has not been selected for the Seawater Intrusion indicator because it is not applicable to the inland Turlock Subbasin (see **Section 6.5**). The MT for degraded water quality is the MCL of the constituents of concern. This MT selection does not conflict with the other sustainability indicators, as described in more detail in the following discussions.

All of the MTs are supported by basin conditions. SGMA does not require the GSAs to correct undesirable results that occurred prior to January 1, 2015. By setting the MT at Fall 2015 groundwater elevations (or Spring 2014), the conditions associated with 2015 are not exacerbated by the MTs. The interrelatedness of MTs among the sustainability indicators are summarized below.

- MTs for chronic lowering of groundwater levels are used as a proxy for reduction of groundwater in storage for all three Principal Aquifers and therefore, will not present conflicts between these two indicators. As explained in **Section 6.4**, the use of groundwater elevations as a proxy is supported by the sustainable yield analysis, whereby the Fall 2015 water levels are correlated directly to a sustainable yield volume for the Subbasin, which avoids undesirable results and also meets the requirement to use a volume as the metric for the reduction of groundwater in storage indicator (see **Section 6.4**).
- MTs have not been selected for the Seawater Intrusion indicator because it is not applicable to the inland Turlock Subbasin (see **Section 6.5**).
- MTs for chronic lowering of groundwater levels are supportive of the MTs developed for degraded water quality. By arresting water level declines (as occurs with the proposed MTs for chronic lowering of groundwater levels), potential increases in constituents of concern associated with depth (such as TDS) can be avoided. By managing to a previous groundwater surface (Fall 2015), the MTs will not significantly alter historical hydraulic gradients and will not accelerate the rate of migration of any groundwater contaminants. MTs for chronic lowering of water levels also protect against water level declines in the Western Lower Principal Aquifer, which could potentially exacerbate the vertical migration of contaminants into that aquifer (**Section 6.6**).
- MTs for chronic lowering of groundwater levels are also used as a proxy for the potential for future land subsidence. Because the 2015 groundwater elevations are either close to or above the historic low levels across the Subbasin, these MTs are protective against future land subsidence and undesirable results. The MTs also contain an additional specific stipulation that groundwater elevations will remain above the Corcoran Clay in the Western Lower Principal Aquifer (**Section 6.7**). In this manner, the MTs for chronic lowering of groundwater levels are also protective against the potential for future land subsidence.
- MTs for chronic lowering of groundwater levels are also the same as those proposed for interconnected surface water along the Tuolumne and San Joaquin rivers. If water levels were allowed to continue to decline along these river boundaries, induced recharge and increased depletion of streamflow could occur and may lead to undesirable results for interconnected surface water (see **Section 6.8**).

- MTs for chronic lowering of water levels are similar to and do not interfere with interconnected surface water MTs established for the Merced River. As explained in **Section 6.8**, the MTs along the Merced River are set at slightly higher (Spring 2014) groundwater elevations to maintain interconnectedness along the river and reduce the potential for future streamflow depletion, as predicted by the water budget analysis. By arresting water level declines in the central portions of the Subbasin, the slightly higher MTs set for the Merced River are supported (**Section 6.8**).

These additional sustainability indicators are analyzed separately in subsequent subsections of **Chapter 6** as referenced in the information above.

MT development was based on the connection between adverse impacts to beneficial users of groundwater and groundwater conditions in the Subbasin. Members of the Joint TACs reviewed data and analyses presented by the technical team and provided feedback for MT selection during numerous public Joint TAC meetings and Ad Hoc Committee meetings. For the chronic lowering of groundwater levels, these discussions focused on impacts to beneficial uses and wells, as described in **Section 6.3.1.3** and summarized on **Table 6-1**.

Working with the Joint TACs, the technical team led numerous presentations, workshops, and discussions at public Joint TAC meetings on the chronic lowering of groundwater levels. The first such workshop was held on February 27, 2020; subsequent discussions occurred in meetings in March through June 2020. From July through September 2020, the technical team prepared a framework for the sustainable management criteria for the Joint TACs consideration. During that time, details were clarified regarding water level declines, domestic wells, and how best to define undesirable results for water supply wells.

TAC members provided feedback, agreed upon a list of beneficial users of groundwater, and documented the potential for declining water levels to adversely impact existing or proposed water supply wells and beneficial uses (April and May 2020). At numerous public meetings, the technical team presented details on groundwater conditions including trends and fluctuations of water levels and rates of water level declines, which supported the approach for setting MTs at the Fall 2015 water levels.

The Fall 2015 groundwater elevations would contain the expansion of groundwater level declines and support groundwater levels in areas of water supply wells, including areas where undesirable results had been observed. By managing water levels to a previously-observed groundwater level surface (i.e., 2015 conditions), it is less likely that MTs in one area of the Subbasin will interfere with achieving MTs in another area. Previous basin conditions have demonstrated empirically that the hydraulic gradients associated with these groundwater elevations can be maintained to allow overall compliance with the MTs.

The results of the projected future conditions water budget (presented to the Joint TACs and the public in October and December 2020), provide further support for setting the MTs at 2015 groundwater elevations. Those model results indicate that, unless arrested, the cone of depression would continue to expand to the north and south beneath the Tuolumne and Merced rivers. These declines were projected to increase streamflow depletion and potentially result in disconnection of the river and the groundwater system (see **Section 5.1.4.3**).

Collectively, these projected basin conditions supported the approach for setting the MT at 2015 groundwater elevations to arrest the declines in the central Subbasin and to maintain sustainable management criteria for interconnected surface water. Final criteria for chronic lowering of groundwater levels were reviewed and selected for GSA consideration first by the Ad Hoc Committee and then by the Joint TACs in several meetings in 2021. Stakeholders, including the Leadership Counsel for Justice and Accountability, expressed support for selection of the 2015 groundwater levels as the MTs.

As indicated above, the 2015 water levels are set to work together with the other sustainability indicators. For interconnected surface water, the MTs along the Merced River are slightly more restrictive than the 2015 groundwater levels; however as explained in **Section 6.8**, the MTs are not expected to conflict significantly with lower MTs for the chronic lowering of groundwater levels. Results of the sustainable yield modeling analysis indicated that MTs for chronic lowering of groundwater levels and interconnected surface water could be maintained together (see **Section 5.3**).

Notwithstanding all of the protective measures above, preventing all impacts to water supply wells may be difficult in areas where a large number of densely-spaced water supply wells are pumping at maximum capacities during drought conditions. Closely-spaced pumping wells can cause interference with other wells, even if water levels are managed at reasonable levels. Well interference between two closely-spaced wells is not included in the undesirable results definition. Rather, by setting MTs at the 2015 groundwater elevations across the Subbasin, regional long-term declines are arrested and significant and unreasonable adverse impacts to water supply wells can be avoided.

6.3.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Turlock Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. Through a series of coordination meetings with adjacent subbasin representatives and review of draft and completed GSPs, the MTs selected for chronic lowering of water levels in the three adjacent subbasins were considered together, including the Merced Subbasin to the south, the Delta-Mendota Subbasin to the west, and the Modesto Subbasin to the north. In brief, the Turlock Subbasin MTs are not expected to either cause undesirable results or adversely impact GSP implementation in adjacent subbasins, as summarized below.

6.3.2.3.1. Merced Subbasin

As a critically overdrafted subbasin, the Merced Subbasin submitted sustainable management criteria in its Final GSP in 2020 (W&C, 2019). In that GSP, the Merced Subbasin set its MTs for the chronic lowering of water levels as the depth of the shallowest wells in a two-mile radius of each representative monitoring well or the minimum groundwater elevation prior to the January 1, 2015. An undesirable result would occur if more than 25 percent of those representative monitoring wells fall below the MT in two consecutive non-drought years (all water year types except dry or critically dry).

The Merced Subbasin GSP includes a table of MTs for wells, including monitoring wells, near the subbasin boundary (see Table 3-1 in the Merced Subbasin GSP (W&C, 2019)). Those MTs suggest that groundwater elevations would be allowed to decline to lower levels (e.g., deeper than 30 feet below sea level) than the 2015 levels (MTs) in the Turlock Subbasin. MTs in the Turlock Subbasin are all above sea level along the Merced River boundary (see **Table 7-1** and **Figures 7-2** and **7-3**). Based on these data, it appears that Turlock Subbasin MTs would not cause an undesirable result in the Merced Subbasin.

Recent water levels provided in the Merced Subbasin GSP are higher than allowed by the MTs along the Turlock Subbasin boundary and may not reach the low MTs in this area; water levels are generally higher at the boundary than adjacent groundwater elevations in the Turlock Subbasin. Water budgets for the historical, future projected, and sustainable yield scenarios all estimate a net subsurface inflow into the Turlock Subbasin from the Merced Subbasin on an average annual basis (see **Table 5-17**). However, the average annual subsurface flow under the sustainable yield scenario is only 27 percent of the average historical flows (compare net inflows and outflows for the Merced Subbasin on **Table 5-17**). This suggests that the two subbasins will be closer to being in balance under Turlock Subbasin sustainable yield conditions.

Further, Turlock Subbasin MTs along the Merced River are set at Spring 2014 groundwater elevations – higher than 2015 water levels – to be more protective of groundwater-surface water interaction along the Merced River (see **Section 6.8** below). Accordingly, MTs in the Turlock Subbasin are not anticipated to adversely impact implementation of the Merced Subbasin GSP.

Coordination with the Merced Subbasin will continue as both subbasins implement their respective GSPs. Several member agencies of the Turlock Subbasin GSAs are also member agencies of GSAs in the Merced Subbasin, which will facilitate future inter-basin coordination.

6.3.2.3.2. Delta-Mendota Subbasin

Sustainable management criteria in the adjacent Delta-Mendota Subbasin are provided in the Northern & Central Delta-Mendota Regions GSP (W&C and P&P, 2019). In that GSP, the MTs for water levels are defined as the hydrologic low groundwater level for the Upper Principal Aquifer and 95 percent of the hydrologic low groundwater level for the Lower Principal Aquifer. The 2015 groundwater elevations for both Principal Aquifers appear to be lower than the hydrologic low groundwater elevations for the Turlock Subbasin as indicated by the subsurface outflows estimated for both the historical and future projected water budgets, at 11,500 AFY and 12,800 AFY, respectively (**Table 5-17**). Although outflow is reduced to approximately 3,500 AFY in the sustainable yield scenario, the continuation of subsurface outflow from the Turlock Subbasin will not prevent successful GSP implementation in the Delta-Mendota Subbasin.

6.3.2.3.3. Modesto Subbasin

The Draft GSP chapter for sustainable management criteria has not yet been published by the Modesto Subbasin; however, draft MTs for chronic lowering of water levels have been proposed in multiple public meetings of the GSA Technical Advisory Committee (TAC). As described in those meetings, a draft MT of hydrologic low groundwater elevations is being considered for the Modesto Subbasin. Further, the Subbasin is planning to maintain MTs along the Tuolumne River (boundary with the Turlock Subbasin) at 2015 groundwater levels to coordinate with levels set in the Turlock Subbasin. Although historical and projected water budgets estimate a net subsurface inflow from the Modesto Subbasin into the Turlock Subbasin, the sustainable yield scenario estimates that net subsurface flows will be reversed with a net flow from the Turlock Subbasin into the Modesto Subbasin (see **Table 5-17**). Accordingly, MTs in the Turlock Subbasin are not anticipated to negatively affect GSP implementation in the Modesto Subbasin.

6.3.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

By arresting groundwater level declines in the Subbasin, long-term use of groundwater will become more sustainable and provide benefits to all beneficial uses of groundwater in the Subbasin. However, there are consequences to some current beneficial uses of groundwater.

In brief, the current level of groundwater use will not be able to be sustained without sufficient projects or management actions to replenish the Subbasin. This will require maintenance of water levels in deep wells that could otherwise accommodate additional declines. In the Turlock Subbasin, where growers are currently reliant on groundwater for agricultural beneficial uses, significant investment in projects and supplemental water will be required to continue to support the current level of agricultural production. If projects cannot meet the sustainable yield, demand reduction will need to be considered, which could negatively affect property interests in the Subbasin.

Conversely, the beneficial uses of public water suppliers and domestic well owners will be supported by the MTs. Although water levels will be allowed to decline somewhat during drought conditions, the Subbasin will not be subject to the continual historic lows that would occur with deeper MTs. With improved long-term maintenance of water levels, municipal water suppliers will not lose the use of expensive public supply wells as has occurred in the past (as documented in multiple public meetings by the Cities of Ceres, Turlock, and Modesto, as well as the urban communities including Delhi and Hickman; see **Table 6-1**)).

The prevention of further water level declines will also support the potential GDEs that have been identified in the Subbasin, most of which are located along the river boundaries (see **Section 4.3.8**). Even more protective MTs have been set along the Merced River as described in more detail in **Section 6.8.2**.

6.3.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For the chronic lowering of groundwater levels, the MT consists of quantified water levels in each representative monitoring well. Accordingly, there are no conflicts with regard to other regulatory standards.

6.3.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for the chronic lowering of water levels will be monitored by quantitatively measuring water levels in representative monitoring well networks for each Principal Aquifer as described in **Chapter 7** (Monitoring Network) of this GSP. Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and to adhere to water level sampling protocols (**Chapter 7**).

6.3.3. Measurable Objectives for Chronic Lowering of Groundwater Levels

GSP regulations define measurable objectives (MOs) as “specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin” (§351(s)). The MO is used to identify goals for desired groundwater conditions; MOs provide a margin of operational flexibility above the MTs.

For chronic lowering of water levels, the MT represents a “floor” for maintenance of low water levels, with allowance for short-term exceedances by less than a third of representative monitoring wells during droughts. Accordingly, water levels will be managed generally between the MT and anticipated high water levels that occur during wet periods. This operational range can be represented by the midpoint between the MT and high water levels observed over average hydrologic conditions. Using the average hydrologic condition for the historical water budget study period of WY 1991 – WY 2015, the MO is defined as the midpoint between the selected MT and the high water level during that period (usually observed in 1998) for each representative monitoring location as summarized in the table below.

Table 6-5: Measurable Objectives for Chronic Lowering of Groundwater Levels

	Measurable Objectives	Principal Aquifer(s)
Chronic Lowering of Groundwater Levels	Measurable objectives are established as the midpoint between the MT and the high groundwater elevation observed over the historical Study Period WY 1991 – WY 2015 at each representative monitoring for each Principal Aquifer.	All

Each representative monitoring well is assigned a quantitative MT and MO; these data are provided in **Chapter 7** of this GSP (see **Table 7-1**).

Setting the MO at the midpoint between the MT and the high-water level results in a very small margin of operational flexibility for some western Subbasin wells screened in the Western Upper Principal Aquifer. In the far western areas of the Subbasin, water levels are shallow, and historical water levels have not fluctuated significantly. As a result, the MO is close to the MT; in some portions of the western Subbasin, there are only a few feet between the MO and the MT in representative monitoring wells. Setting the MO higher would not be consistent with the need to manage shallow groundwater such that existing agricultural land use can be preserved. Although the MO is maintained in this GSP for consistency, the GSAs will consider a management action to allow more flexible operation of shallow drainage wells to support local agricultural operations while maximizing beneficial uses of the shallow groundwater.

It is also recognized that this methodology may be setting MOs higher than could be easily attained if ongoing drought conditions persist. At the time of preparation of this GSP, most years since WY 2014 have been dry; these conditions may have reset the range of future expected high water levels in the Subbasin. Nonetheless, this approach to MO selection provides a reasonable method to quantify desired groundwater conditions using best available data. Sustainable management criteria will be reevaluated at the five-year assessment of the GSP and may require revision at that time.

6.4. REDUCTION OF GROUNDWATER IN STORAGE

SGMA defines an undesirable result for the groundwater in storage sustainability indicator as "significant and unreasonable reduction of groundwater storage." (§10721 (x)(2)). GSP regulations require that the MT for the reduction of groundwater in storage be set as "a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results" (§354.28(c)(2)). This requirement contains almost identical language as the SGMA definition of sustainable yield.[29] In addition, regulations require the MT to be supported specifically by the sustainable yield. The sustainable yield analysis for the Turlock Subbasin is presented in **Section 5.3** and discussed in the context of this indicator throughout the remaining subsections of **Section 6.4**, as well as throughout the remaining sections of **Chapter 6**.

Although the Turlock Subbasin is not at risk of depleting a large percentage of its total volume of groundwater supply, the ongoing depletion due to overdraft conditions requires mitigation to meet the Subbasin sustainability goal. The chronic lowering of groundwater

[29] SGMA defines sustainable yield 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." (§10721(w)).

levels caused by overdraft has resulted in adverse impacts to Subbasin water supply wells and may lead to future undesirable results.

The definition of undesirable results for reduction of groundwater in storage, including causes and impacts to beneficial uses, is described in **Section 6.4.1** below, along with additional criteria to quantify where and when undesirable results occur. **Section 6.4.2** describes the selection and quantification of minimum thresholds (MTs), along with the justification and rationale. **Section 6.4.3** provides the approach and selection of measurable objectives (MOs). Interim milestones that cover all of the sustainability indicators are described in **Section 6.9**.

6.4.1. Undesirable Results for Reduction of Groundwater in Storage

As described in **Chapter 5**, the historical reduction of groundwater in storage is estimated at about 63,900 AFY (see **Table 5-17**). That reduction could potentially improve to about 7,600 AFY for projected future conditions but would do so at the expense of significant streamflow depletion of the rivers along the Subbasin boundaries (see **Table 5-7**). That streamflow depletion is reduced under the sustainable yield conditions analysis (see **Table 5-17**). In that analysis, a sustainable yield is estimated at 310,700 AFY (see the total volume of groundwater production in **Table 5-17**). This amount is associated with a positive change in groundwater in storage to support slightly higher groundwater levels for interconnected surface water, primarily on the Merced River.

The sustainable yield modeling analysis incorporated the sustainable management criteria for chronic lowering of water levels and targeted a balanced subbasin over the 50-year implementation and planning horizon (**Section 5.3**). Accordingly, both the chronic lowering of water levels criteria and elimination of overdraft are correlated to the sustainable yield of 310,700 AFY. The volume of 310,700 AFY can be applied as a metric for reduction of groundwater in storage and linked directly to management criteria for the chronic lowering of groundwater levels indicator. Therefore, the chronic lowering of water levels criteria is applied as a proxy for the reduction of groundwater in storage sustainability indicator.

The causes of groundwater conditions that lead to reductions of groundwater in storage are described below. Impacts to beneficial uses are also discussed.

6.4.1.1. Cause of Undesirable Results

Conditions relating to the reduction of groundwater in storage are primarily caused by over-pumping in the central and eastern portions of the Subbasin. Lowering of water levels in this area has resulted in groundwater flow into an existing cone of depression, which has expanded to the south and is inducing additional recharge along the Merced River (see **Figure 6-1**). Although additional recharge from the river would improve the overall groundwater budget – and, in turn, the reduction of groundwater in storage, – these conditions have the potential to cause undesirable results for interconnected surface water.

Agricultural pumping represents the largest outflow component of the water budget (**Table 5-6**). Urban pumping has accounted for about 14 percent of the Subbasin pumping historically but is projected to increase in the future with population growth. Additional historical outflows from the Subbasin that also affect the reduction of groundwater in storage include a net subsurface outflow into the Delta-Mendota Subbasin on the west and discharges to baseflow in the Tuolumne and San Joaquin rivers.

6.4.1.2. Potential Effects on Beneficial Uses

The reduction of groundwater in storage causes lowering of water levels, which in turn, affects beneficial uses of groundwater and wells. The potential impacts to wells from reduction of groundwater in storage are the same as those from chronic lowering of water levels; those impacts are documented in **Sections 6.3.1.1** and **6.3.1.3** above. Impacts to beneficial uses are also the same as for chronic lowering of water levels as documented in **Sections 6.3.1.2** and **6.3.1.3**.

Recognizing that the volume of usable groundwater is relatively large, and the base of freshwater is deep, it is noted that a large groundwater supply would be accessible with sufficiently deep wells. However, the increased costs associated with installation and pumping lifts could ultimately place limits on beneficial uses of groundwater. With the large number of wells in the Subbasin, increased costs could be substantial and could also negatively impact land use and property interests. Operating the Subbasin at significantly deeper levels also has the potential to adversely impact groundwater quality. As noted in **Section 4.3.5.3.2**, high salinity groundwater has been detected in deep wells in several areas of the Subbasin.

6.4.1.3. Turlock Subbasin Definition of Undesirable Results

Based on the information summarized above and presented in the basin setting, a definition of undesirable results has been developed for *Reduction of Groundwater in Storage* in the Turlock Subbasin.

Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria address the number of monitoring sites and events that an MT can be exceeded before causing an undesirable result. This framework builds on the narrative definition and recognizes that a single MT exceedance at one monitoring site may not indicate an undesirable result. This framework also allows clear identification for when an undesirable result is triggered under the GSP.

As explained in the previous section, the sustainable yield modeling, described in **Section 5.3,** demonstrates that the chronic lowering of groundwater levels sustainable management criteria can be linked to the sustainable yield volume of 310,700 AFY. Accordingly, groundwater levels are used as a proxy for this sustainability indicator, which is incorporated into the definition of undesirable results and the quantitative combination of MT exceedances that cause undesirable results, as provided in the following table.

Table 6-6: Undesirable Results for Reduction of Groundwater in Storage

	Undesirable Results Definition	Principal Aquifer(s)
Reduction of Groundwater in Storage	Undesirable results are defined as a significant and unreasonable reduction of groundwater in storage that would occur if the volume of groundwater supply is at risk of depletion and/or may not be accessible for beneficial use. An undesirable result is also defined as long-term overdraft, based on projected water use and average hydrologic conditions. An undesirable result will occur for each principal aquifer when at least 33% of representative monitoring wells exceed the MT for that principal aquifer in three (3) consecutive Fall monitoring events.	All

The use of 33 percent of the representative monitoring wells is based on the chronic lowering of groundwater levels criteria as discussed in **Section 6.3.1.4**. The use of three Fall events for triggering undesirable results recognizes that short-term declines during drought are anticipated. SGMA allows for reduction of groundwater in storage during droughts if water levels recover during wet conditions (see introductory paragraphs in **Section 6.3** above; see also **Section 6.3.1.4**).

The change in groundwater in storage is a required element for the GSP annual reports and will be documented annually in those reports over time. Over average hydrologic conditions, this element can be used to substantiate the correlation of overdraft conditions to the combination of MT exceedances for each Principal Aquifer as provided in the definition above.

The MTs selected for this indicator are also the same as those for chronic lowering of water levels, as presented in the following section.

6.4.2. Minimum Thresholds for Reduction of Groundwater in Storage

The DWR Draft BMP on Sustainable Management Criteria emphasizes the need for a volume to be used as the metric for this indicator and states, "contrary to the general rule for setting MTs, the reduction of groundwater in storage MT is not set at individual monitoring sites. Rather the MT is set for a basin or management area."

As described in **Section 5.3** and summarized in **Table 5-17**, a C2VSimTM sustainable yield scenario has been developed to meet long-term criteria for multiple sustainability indicators to avoid undesirable results. Model results estimate a sustainable yield of about 310,700 AFY for the Turlock Subbasin. This estimate is based on a relatively simplistic analysis that relies on demand reduction only (**Section 5.3**). It is recognized that sustainable yield is not a fixed number and will vary over time with changes in land use, hydrologic conditions, and GSP implementation of projects and management actions. Nonetheless, this sustainable yield represents the current best available estimate to use as a required metric for the MT of this indicator.

Because the MTs selected for the chronic lowering of groundwater levels were incorporated into the sustainable yield modeling analysis, the sustainable yield of 310,700 AFY from model results can also be correlated to the MT for chronic lowering of groundwater levels. In addition, when long-term water level declines are arrested with sustainable management, the reduction of groundwater in storage/overdraft would also be mitigated over average hydrologic conditions. Therefore, using the chronic lowering of groundwater levels criteria as a proxy for the reduction of groundwater in storage MT would both correlate water levels directly to the sustainable yield volume and be protective against undesirable results. Accordingly, the MTs for chronic lowering of groundwater levels are selected as a proxy for the reduction of groundwater in storage indicator, as described below.

Table 6-7: Minimum Thresholds for Reduction of Groundwater in Storage

	Minimum Thresholds	Principal Aquifer(s)
Reduction of Groundwater in Storage	Minimum thresholds are established as the low groundwater elevation observed in Fall 2015 at each representative monitoring site for each principal aquifer.	All

6.4.2.1. Justification and Support for Minimum Thresholds

In the BMP on sustainable management criteria, DWR lists several technical topics to consider when selecting an MT for reduction of groundwater in storage. Those considerations, along with a summary of relevant information from the basin setting (and other related portions of the GSP), are provided below:

- Historical trends, water year types, and projected water use: The historical conditions of overdraft are based on the historical declining trend of groundwater in storage since at least 2001 as depicted by the historical water budgets described in **Section 5.1.4.1** and shown on **Figure 5-16**. Declining water levels and reduction of groundwater in storage in the Turlock Subbasin has been documented since the 1990s by DWR (2006). Average annual reductions of groundwater in storage are shown by water year types on **Table 5-10**, which documents reductions even in years of above normal precipitation. Projected water supply and demand are included in the Projected Conditions water budget on an average annual basis (**Table 5-6**).
- Groundwater reserves needed to withstand future droughts: Groundwater production during the recent critically dry water years of 2013 and 2014 averaged about 525,000

AFY in the Turlock Subbasin. For those years, the annual average reduction of groundwater in storage was estimated at 285,000 AFY. With more than 23 MAF of groundwater in storage, the total groundwater supply may be sufficient to meet future droughts; however, impacts on water levels, streamflow, or other sustainability indicators could lead to undesirable results. Potential negative impacts on water levels affecting beneficial uses of wells during drought are described in **Sections 6.3.1.1** through **6.3.1.4**. Information on other sustainability indicators is discussed in subsequent sections of **Chapter 6**.

- Whether production wells have ever gone dry: As described in **Section 2.3.2.4**, more than 150 domestic wells failed during the 2014 – 2016 drought of record. Additional adverse impacts to public supply wells related to water level declines were also documented (see **Section 6.3.1.4** and **Table 6-1** above).
- Effective storage of the basin: As mentioned previously, the Subbasin contains more than 20 MAF of fresh groundwater in storage and overall depletion of groundwater supply is unlikely (**Section 4.3.1.;** see also **Figure 4-21a**).
- Understanding of well construction and potential impacts to pumping costs: Depths of domestic wells are analyzed in **Section 2.3.2.4**. Well construction was considered in adverse impacts to public water supply wells summarized in **Section 6.3.1.3** above. Most of those wells were sufficiently deep for water supply during the 2015 drought; however, adverse impacts associated with declining water levels were documented (**Section 6.3.1.4** and **Table 6-1**).
- Adjacent Subbasin MTs: MTs for chronic lowering of groundwater levels in the two completed GSPs for the adjacent Merced and Delta-Mendota subbasins and the GSP in progress for the adjacent Modesto Subbasin were considered in the selection of Turlock Subbasin MTs as summarized in **Section 6.3.2.3** above. Because these MTs are used as a proxy for reduction of groundwater in storage MTs, these relationships are also applicable to the reduction of groundwater in storage indicator.

Much of the relevant material from the basin setting used to analyze and justify the MTs for this indicator is provided in **Section 4.3** on groundwater conditions and in **Chapter 5** on water budgets.

6.4.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions for each MT will avoid undesirable results (§354.28(b)(2)). As previously discussed, the MTs for each sustainability indicator are summarized in **Table 6-4** and discussed in **Section 6.3.2.2**.

Section 6.3.2.2 also describes the relationship between the MT for chronic lowering of water levels and the MTs for each of the remaining sustainability indicators. Because the MTs for reduction of groundwater in storage are the same as the MTs for chronic lowering of water levels, that discussion would be identical for the reduction of groundwater in storage. As such, please refer to **Section 6.3.2.2** for this required component of the GSP.

These additional sustainability indicators are also analyzed separately in subsequent subsections of **Chapter 6** as referenced in **Table 6-4**. Additional information on how the MTs avoid undesirable results is provided below along with a summary of the process by which the MTs were selected.

Considerable time was spent reviewing technical information in public meetings of the Joint TACs regarding the chronic lowering of water levels as described throughout **Section 6.3**. In particular, the detailed public process described in **Section 6.3.2.2.** also applied to the reduction in groundwater in storage as the two indicators were typically addressed together by the technical team. By ensuring that MTs for chronic lowering of water levels would avoid undesirable results, and, by ensuring that those MTs would also result in an elimination of reduction of groundwater in storage (overdraft), the sustainable yield analysis shows that undesirable results for both sustainability indicators can be avoided with the same MTs.

6.4.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Turlock Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. Through a series of coordination meetings with adjacent subbasin representatives and review of draft and completed GSPs, the Turlock TACs considered the MTs selected for reduction of groundwater in storage for the three adjacent subbasins including the Merced Subbasin to the south, the Delta-Mendota Subbasin to the west, and the Modesto Subbasin to the north. In brief, the Turlock Subbasin MTs are not expected to either cause undesirable results or affect implementation of adjacent subbasin GSPs as summarized below.

6.4.2.3.1. Merced Subbasin

The Merced Subbasin GSP did not set MTs for the reduction in groundwater in storage indicator because it was not judged applicable to subbasin conditions. As explained in **Section 6.3.2.3.1**, MTs for chronic lowering of water levels in the Turlock Subbasin do not adversely impact the Merced Subbasin GSAs' ability to implement their GSP. Because the MTs for chronic lowering of water levels are assigned as a proxy for the reduction of groundwater in storage indicator, it follows that there is no impact from this indicator on the Merced Subbasin. It is noted that member agencies of GSAs overlap both the Merced and Turlock subbasins and are committed to ongoing data sharing and coordination on GSP implementation.

6.4.2.3.2. Delta-Mendota Subbasin

Both the Delta-Mendota and Turlock subbasins are using MTs for chronic lowering of water levels as a proxy for the reduction of groundwater in storage. As explained in **Section 6.3.2.3.2**, the Turlock Subbasin contributes a net subsurface flow into the Delta-Mendota Subbasin under historical, projected future, and sustainable yield scenarios (see **Table 5-17**). As such, the MTs for reduction of groundwater in storage will not impact the implementation of the Delta-Mendota GSP.

6.4.2.3.3. Modesto Subbasin

Draft sustainable management criteria presented in various public meetings indicate that the Modesto Subbasin plans to use Fall 2015 groundwater levels as a proxy for the MT of the interconnected surface water sustainability indicator along the Tuolumne River – the boundary between the two subbasins. As mentioned in **Section 6.3.2.3.3**, this is the same approach being used for the Turlock Subbasin MTs along the Tuolumne River boundary. Under those conditions, the sustainable yield scenario for the Turlock Subbasin indicates a net subsurface outflow on an average annual basis from the Turlock Subbasin into the Modesto Subbasin. Collectively, these conditions indicate that the Turlock Subbasin would not affect GSP implementation in the Modesto Subbasin.

6.4.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

Benefits of these MTs on the beneficial uses and users of groundwater are similar to those stated for the chronic lowering of groundwater levels in **Section 6.3.2.4**. Long term benefits include a more sustainable groundwater supply for all beneficial uses.

Lift costs for pumping groundwater will be reduced for all well owners. In particular, public water suppliers and domestic well owners will benefit from the long term sustainable supply with relatively stable groundwater levels. In addition to well owners, environmental uses of groundwater, including any potential GDEs, will benefit from management of groundwater levels to the selected MTs. With these management criteria, the Subbasin will not be subject to the continual reduction of groundwater in storage that causes ongoing water level declines.

6.4.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For the reduction of groundwater in storage indicator, the MT consists of quantified water levels in each representative monitoring well. Accordingly, there are no conflicts with regard to other regulatory standards.

6.4.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for the reduction of groundwater in storage will be monitored by quantitatively measuring water levels in representative monitoring well networks for each Principal Aquifer as described in **Chapter 7** (Monitoring Network) of this GSP. Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and adhere to water level sampling protocols (**Chapter 7**). **Table 7-1** provides the quantitative MTs for each representative monitoring well used to monitor both chronic lowering of groundwater levels and reduction of groundwater in storage. Representative monitoring wells in the GSP network for reduction in groundwater in storage are also the same wells used for chronic lowering of groundwater levels (**Figures 7-1** through **7-3**)

6.4.3. Measurable Objectives for Reduction of Groundwater in Storage

In the same manner that the MTs for chronic lowering of groundwater levels are used for the reduction in groundwater in storage, the same approach for setting MOs is also applied to this indicator as shown in the following table.

Table 6-8: Measurable Objectives for Reduction of Groundwater in Storage

	Measurable Objectives	Principal Aquifer(s)
Reduction of Groundwater in Storage	Measurable objectives are established at the midpoint between the MT and the high water level observed over the historical Study Period WY 1991 – WY 2015 at each representative monitoring site for each principal aquifer.	All

Even though GSP regulations note that reduction in groundwater in storage is controlled by a single value for the Subbasin, the management of that single value (310,700 AFY) is manifested by applying chronic lowering of water levels criteria as a proxy for reduction of groundwater in storage including both the MTs and MOs in the same representative monitoring wells. MOs are listed for representative monitoring wells on **Table 7-1** for chronic lowering of groundwater levels, which are used as a proxy for reduction of groundwater in storage.

6.5. SEAWATER INTRUSION

GSP regulations define *Seawater Intrusion* as "the advancement of seawater into a groundwater supply that results in degradation of water quality in the basin and includes seawater from any source." The minimum threshold for the indicator "sh*all be defined by a chloride concentration isocontour*…where seawater intrusion may lead to undesirable results." Further, a description is also required regarding how the seawater intrusion minimum threshold considers the effects of "*current and projected sea levels*" (§354.28 (c)(3) *emphasis added*).

This information is consistent with a coastal groundwater basin where aquifers can be in direct communication with the open ocean, either directly or by interconnected waterways such as bays, deltas, or inlets. As an inland basin, the Turlock Subbasin is not directly or indirectly connected to the open ocean. The Subbasin aquifers are separated from the Pacific Ocean by the bedrock units of the Coast Ranges; further Subbasin aquifers are more than 20 miles upgradient from the edge of the from the Sacramento-San Joaquin Delta and not influenced by deltaic seawater intrusion.

The consulting team developed a technical memorandum on this indicator to frame the issues and facilitate discussions. The Joint TACs, with input from the public, reviewed the technical information, and discussed this indicator at its regularly scheduled public meetings held via webinar[30] in April, May, and June 2020.

A key issue was whether the reported higher-salinity groundwater in deep sedimentary units beneath the Turlock Subbasin would be applicable to this sustainability indicator. The groundwater beneath the base of fresh water could potentially impact Turlock Subbasin aquifers if localized pumping resulted in upwelling of poor-quality water. The total dissolved solids (TDS) content of this deeper groundwater is likely due to dissolution of sedimentary units (due to long groundwater residence times) and older connate water from marine sediments; these conditions are not related to a current connection to the open ocean. Importantly, the Joint TACs determined that any potential adverse impact from this deep groundwater could be readily addressed by a separate sustainability indicator, which addresses degraded water quality (see discussion of TDS as a constituent of concern in **Section 6.6.2.1.4**).

Accordingly, the consulting team was directed to revise the memorandum to memorialize the technical issues and allow the Joint TACs to make the following findings and recommendations to the GSAs:

- Seawater intrusion, as defined by GSP regulations, does not exist in the inland Turlock Subbasin and does not have the potential to occur in the future.
- Sustainable management criteria are not applicable and will not be defined for the seawater intrusion indicator in the Turlock Subbasin.
- Deeper high salinity groundwater in the Subbasin is not related to seawater intrusion but is recognized as a potential future impact to Subbasin groundwater quality; accordingly, this condition will be addressed by the degraded water quality sustainability indicator (as discussed in **Section 6.6.2.1.4**).

The WTSGSA and the ETSGSA approved the Joint TAC findings and recommendations at a Joint meeting of the GSA Boards on November 15, 2021 (Resolution 2021-06).

6.6. DEGRADATION OF WATER QUALITY

Similar to the other sustainability indicators, GSAs are not required to correct degraded water quality that occurred before January 1, 2015. However, GSAs want to avoid causing any future water quality degradation resulting from management of groundwater use or by GSA projects or management actions. Because GSAs have the legal authority to regulate pumping and groundwater levels, GSA management could potentially affect groundwater quality. In addition, GSA projects and management actions could introduce potential constituents of concern from other water sources into the Subbasin or cause migration of constituents through project implementation. GSP regulations specifically require the

[30] TAC meetings are public meetings and were held via webinar to comply with orders from the State Department of Public Health during the COVID-19 pandemic.

consideration of management actions that could inadvertently exacerbate the migration of contaminant plumes, which could impair water supplies. (§354.28(c)(4))

Nonetheless, the GSAs are not mandated to assume responsibility for water quality conditions that are under the purview of other primary water quality regulatory agencies. The SWRCB DDW, the associated RWQCB, the California DTSC, and local County environmental departments have primary responsibilities for groundwater quality, and the GSAs are not meant to duplicate those efforts. The Joint TACs have reviewed information from the technical team regarding the need to coordinate and confer with regulatory programs and agencies on water quality management (Moran and Belin, 2019). Because almost all of the public drinking water suppliers in the Turlock Subbasin are also member agencies of the GSAs, there is already close coordination between GSA members and water quality regulators.

The undesirable results associated with degraded water quality, including causes and impacts to beneficial uses, are described in **Section 6.6.1** below, with a definition of undesirable results at the end of the section. **Section 6.6.2** describes the quantification of minimum thresholds (MTS), along with justification on how MTs avoid undesirable results. **Section 6.6.3** provides the approach and selection of measurable objectives (MOs). Interim milestones are described in **Section 6.9** but are not set for this sustainability indicator.

6.6.1. Undesirable Results for Degraded Groundwater Quality

SGMA defines an undesirable result for the water quality sustainability indicator as "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies." (§10721 (x)(4)). GSP guidance clarifies that GSAs are responsible for degraded water quality that is caused by management activities including regulation of pumping and water levels, along with projects and management actions conducted as part of GSP implementation (Moran and Belin, 2019). In addition, as with the other sustainability indicators, GSAs are not required to correct any undesirable results that have occurred prior to January 1, 2015. Recognizing that numerous constituents have already been detected in water supply wells above MCLs, the focus is not to exacerbate these conditions.

The GSAs are not responsible for enforcing drinking water requirements or for remediating groundwater quality problems caused by others (Moran and Belin, 2019). Further, the existing regulatory framework does not require the GSAs to take affirmative actions to manage the existing groundwater quality. Rather, GSAs are responsible for ensuring that their groundwater management activities do not cause or contribute to exceedances of drinking water standards. In the event that GSP projects and management actions might have impacted water quality standards, the GSAs will confer and coordinate with the appropriate regulatory agencies responsible for water quality.

6.6.1.1. Causes of Undesirable Results

As mentioned above, GSAs could cause degradation of water quality through management of water levels and pumping, which could increase concentrations of constituents that vary with depth or induce the vertical or horizontal migration of contaminants. In addition, GSA projects could introduce constituents of concern from other water sources through recharge projects.

Degraded water quality can impair groundwater supplies and impose restrictions and/or costs on drinking water supply wells. If constituents exceed drinking water standards, public water suppliers may need to abandon impacted wells, re-distribute wellfield pumping, blend contaminants with clean wells, drill additional wells, install wellhead or regional treatment facilities, and/or make other operational changes. Immediate notifications to customers may be required. If constituents of concern impact domestic wells, residents may lose their water supply; if water quality is not well known, impacts to public health and safety could occur.

Constituents of concern originate from a variety of sources including naturally-occurring constituents and human related (anthropogenic) sources. Public water suppliers have noted some deterioration in water quality during the 2015 drought conditions, especially for the naturally-occurring constituents of concern such as arsenic, uranium, and TDS; however, the depth-related impacts are complex.

High salinity water has been documented at depth in the Subbasin as mentioned in **Section 6.5** above. Pumping in deep wells could potentially produce groundwater elevated in TDS or lower vertical gradient such that elevated TDS groundwater could mix with lower TDS groundwater in other aquifers.

For the anthropogenic constituents of concern, including nitrate, 1,2,3-TCP and PCE (and some sources of TDS), the source of impacts to groundwater quality likely occurs at or near the ground surface (compared to naturally-occurring constituents, which can occur at depth). This suggests that shallow aquifers are often more impacted from these constituents. However, pumping can cause these contaminants to migrate to deeper aquifers either through more permeable portions of an aquitard or in conduits such as wells.

6.6.1.2. Potential Effects on Beneficial Uses

As summarized above, degraded water quality can cause considerable operational costs or constraints on public water suppliers. Certain constituents can harm crops, limit water supply for certain industrial processes, harm pipes, cause accelerated corrosion or clogging of fixtures, cause staining on bathtubs and sinks, produce bad taste or odor, and cause acute or chronic health effects.

For the Turlock Subbasin, five of the six constituents of concern have primary MCLs that are associated with health concerns such as toxicity (i.e., nitrate, uranium) or carcinogens (i.e., arsenic, 1,2,3-TCP, and PCE). Accordingly, elevated concentrations of these constituents in drinking water can cause deleterious health effects. These health-based limits affect operations and costs for public water suppliers to provide a safe drinking water supply.

The regulatory drinking water standard for TDS is not health based and is a secondary MCL, which is related to aesthetics of the water such as taste or odor. However, elevated TDS concentrations in groundwater can affect crop yields and impact agricultural beneficial uses of groundwater. TDS can also limit industrial beneficial uses for industrial processes requiring low salinity water. Finally, elevated TDS in wastewater can affect costs of recycled water.

As indicated above, most of the constituents of concern have been identified due to potential impacts to drinking water supplies. In particular, the cities of Turlock and Ceres have had to remove water supply wells from service to address local water quality issues (see water quality icon locations on **Figure 6-1**).

6.6.1.3. Turlock Subbasin Definition of Undesirable Results

Based on the information summarized above and presented in the basin setting, a definition for undesirable results has been developed for degraded water quality in the Turlock Subbasin.

Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). This framework allows clear identification for when an undesirable result is triggered under the GSP.

The definition of undesirable results for degraded water quality is provided in the following table.

Table 6-9: Undesirable Results for Degraded Water Quality

	Undesirable Results Definition	Principal Aquifer(s)
Degraded Water Quality	Undesirable results are defined as significant and unreasonable adverse impacts to groundwater quality caused by GSA projects, management actions, or management of water levels or extractions such that beneficial uses are affected and well owners experience an increase in operational costs. The undesirable result will occur if a new (first-time) exceedance of an MT is observed in a potable water supply well in the representative monitoring network that results in a well owners increase on operational costs and is caused by GSA management activities as listed above.	All

The undesirable result is conservative in that it requires analysis of every first-time exceedance of an MT for a constituent of concern in each potable supply well monitored for that constituent. Accordingly, historical data for each well must be reviewed on an annual basis to determine if the constituent has been exceeded in that well in the past. Each new (i.e., first-time) exceedance occurring after January 31, 2022, must be tracked and analyzed separately to determine if such an exceedance could have been caused by GSA regulated groundwater levels, extractions, or projects/management actions, and if additional operational costs are incurred by the well owner.

This analysis will consider the recent groundwater elevations and extractions near each impacted well. Data will be analyzed in the context of the historical record to establish correlations between groundwater levels, monitoring well locations and construction, and water quality analyses. Changes in water levels and water quality in nearby wells will be incorporated into the analysis. Each constituent of concern will be analyzed as to the likely source (geogenic or anthropogenic), historical records of nearby and regional wells, and occurrence/concentrations with respect to the principal aquifer and well screens.

Increases in concentration will also be tracked to comply with the measurable objective described in **Section 6.6.3** below. Hydrographs and chemographs will be used to support the analyses, as needed. Analyses will be coordinated with local public agencies providing drinking water supply including member agencies of the GSAs. Data and analyses will be reported in annual reports and coordinated with the regulatory agencies responsible for water quality. Any undesirable results will be identified, and GSAs will coordinate with regulatory agencies on options and mitigation measures for water quality impacts.

These analyses will fill, in part, a data gap that was identified by the water quality analysis in **Section 4.3.5** regarding changes in water quality with depth in the Subbasin (see data gaps list in **Section 4.4**).

The MTs are quantified in the following section. The MOs, quantified in subsequent **Section 6.6.3,** provide further support for analysis of degraded water quality by examining increasing concentrations for constituents of concern in addition to new exceedances.

6.6.2. Minimum Thresholds for Degraded Water Quality

GSP regulations require that the MT metric for degraded water quality be set at the water quality measurement that indicates degradation at the monitoring site (DWR, 2017). As provided in the basin setting (**Section 4.3.5**), historical data for numerous water quality constituents have been analyzed as potential constituents of concern. From this analysis, six constituents of concern were selected based on the exceedances of water quality standards, including MCLs (when designated), over a relatively widespread area of the Subbasin with an emphasis on areas where groundwater provides most of the Subbasin drinking water supply (Western Principal Aquifers and western portions of the Eastern Principal Aquifer). Although total dissolved solids (TDS) did not indicate widespread exceedances, TDS is a designated constituent of concern as an overall indicator of groundwater quality and as an indicator of potential increasing salinity with depth (see **Section 6.5** above).

As explained above, the GSAs do not wish to exacerbate existing water quality conditions in the Subbasin as a result of GSA actions. Accordingly, MTs are set as a new exceedance of a MCL for any of the constituents of concern at a potable water supply well to ensure that future water quality issues are identified even if the GSAs are not responsible for the adverse impacts. The MTs for this indicator are expressed as follows.

Table 6-10: Minimum Thresholds for Degraded Water Quality

	Minimum Thresholds	Principal Aquifer(s)
Degraded Water Quality	Minimum thresholds are set as a new (first-time) exceedance of a drinking water quality standard (primary or secondary MCL) in a potable supply well in the representative monitoring network for any of the Subbasin constituents of concern as listed below: • Nitrate (as N) – 10 mg/L • Arsenic – 10 µg/L • Uranium – 20 pCi/L • Total dissolved solids (TDS) – 500 mg/L • 1,2,3-Trichloropropane (1,2,3-TCP) – 0.005 µg/L • Tetrachloroethene (PCE) – 5 µg/L	All

6.6.2.1. Justification and Support for Minimum Thresholds

Analysis of existing groundwater quality conditions in the Turlock Subbasin was provided in **Section 4.3.5** as part of the basin setting Results of that study analyzed potential constituents of concern, six of which were determined to have elevated concentrations above water quality standards over a relatively widespread area of the Subbasin. Data are summarized by Principal Aquifer (where known) on **Figures 4-36** through **4-57**.

All three principal aquifers are used for groundwater supply, with most municipal and urban drinking water systems concentrated in the Western Upper Principal Aquifer and Western Lower Principal Aquifer including Turlock, Ceres, Hilmar, Delhi, and Keyes. Hughson, Hickman, parts of Denair, and other small water systems, rely on the Eastern Principal Aquifer for drinking water supply.

Potential constituents of concern were selected from database reviews and other local knowledge regarding ongoing water quality issues with water supply wells. Six of those potential constituents of concern were selected to be assigned an MT in this GSP based on the prevalence of detections above the MCL within the Subbasin and widespread distribution of recent elevated concentrations. Additional information on the water quality database is provided in **Section 4.3.5.1**. Summary information on the six constituents of concern assigned an MT in this GSP is provided below; more detailed information is provided in **Section 4.3.5** and on the water quality distribution maps (**Figures 4-37** through **4-57**).

6.6.2.1.1. Nitrate

Nitrate is the most widespread groundwater contaminant in the Turlock Subbasin. Because of its serious health effects, the MCL of 10 mg/L of nitrate as N is selected as the MT. Sources, recent concentrations, and occurrence of nitrate in Turlock Subbasin groundwater are described in **Section 4.3.5.3.1** and shown on **Figures 4-37** and **4-38**.

Elevated nitrate concentrations occur in all of the Principal Aquifers with most of the higher concentrations located in the western Subbasin. Highest concentrations are in the Western Upper Principal Aquifer generally west of Highway 99 and in Ceres. High nitrate concentrations also occur in the Eastern Principal Aquifer near Denair, Hughson, and the nearby Tuolumne River. Because nitrates are most often sourced from surface/shallow application of nitrogen, elevated concentrations would more likely occur in the Western Upper Principal Aquifer and shallow portions of the Eastern Principal Aquifer rather than the Western Lower Principal Aquifer. Nonetheless, high levels of nitrate have been observed in the Western Lower Principal Aquifer indicating downward vertical migration. Depending on the construction of each well, nitrate in shallow groundwater may be above wells screens during high water level conditions and pulled into lower well screens when water levels decline.

The widespread contamination of groundwater by nitrogen in California's Central Valley is being regulated by the Central Valley RWQCB under three broad programs (in addition to individual site regulatory orders); those three programs are the General Dairy Order (Dairy Order), the Irrigated Lands Regulatory Program (ILRP), and the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS). Nitrate concentrations in domestic wells are being mitigated through the Nitrate Control Program, which involves management areas where participants are mandated to provide safe drinking water to impacted well owners (**Section 2.4.4**).

6.6.2.1.2. Arsenic

Arsenic is a naturally-occurring trace element in the rocks, soils, and groundwater of the Turlock Subbasin. Given its toxicity, the MT has been set at the arsenic MCL of 10 micrograms per liter (µg/L). Although the arsenic MCL has been exceeded in wells within all three Principal Aquifers, elevated concentrations are more widespread and higher in western aquifers within the extent of the Corcoran Clay. Elevated arsenic concentrations can occur through dissolution of iron or manganese oxyhydroxides under reducing conditions, geochemical conditions that may be more prevalent below the Corcoran Clay. Drinking water wells in the Subbasin are monitored for arsenic, and several municipalities note that increasing arsenic concentrations have been correlated with declining groundwater levels.

However, an exploratory drilling program conducted in 2018 for the City of Turlock indicated highly variable levels of arsenic throughout the principal aquifers and depth-related concentrations are not straightforward (see **Section 4.3.5.3.3** and **Figures 4-41** and **4-42**).

6.6.2.1.3. Uranium

Uranium is another naturally-occurring trace element emitted from radioactive elements in the rocks, soils, and groundwater of the Turlock Subbasin. It is toxic and associated with health effects. Although less widespread than arsenic, increases in uranium concentrations have been correlated with declining groundwater levels in supply wells in Ceres and Turlock. Uranium has been detected close to or above its MCL of 20 pCi/L in all three principal aquifers, but concentrations have been higher in aquifers adjacent to the Corcoran Clay. Hydrogeologic investigations in the cities of Turlock and Ceres found the highest concentrations of uranium at the base of the Corcoran Clay (see **Section 4.3.5.3.5** and **Figures 4-45** and **4-46**). The City of Ceres operates a drinking water treatment plant for uranium removal.

6.6.2.1.4. Total Dissolved Solids

TDS is a sum of the dissolved substances in water and is used as a general indicator of salinity. TDS in groundwater occurs naturally from the dissolution of minerals in adjacent aquifer materials. Evaporative enrichment from irrigation of crops and application of synthetic fertilizers, manures, and wastewater treatment facilities can all contribute salts to groundwater.

The MT for TDS, is set at the regulatory-recommended secondary MCL of 500 mg/L. Several thresholds are used in California for drinking water supplies and consist of a Recommended MCL of 500 mg/L, an Upper Limit MCL of 1,000 mg/L, and a Short Term MCL of 1,500 mg/L. Using the Recommended MCL as the MT is based on current TDS data in the Subbasin, which indicates ambient concentrations at or below this secondary MCL throughout most of the Subbasin; locally elevated TDS values are indicated in shallow wells near the San Joaquin River and in wells near Ceres (**Figures 4-39** and **4-40**). In addition, this lower MCL is more protective of Subbasin crops. TDS concentrations at or below 640 mg/L is recommended for irrigation of almond orchards, a primary crop in the Subbasin (see notes on **Figure 4-39;** see **Figure 2-4** for Subbasin crops).

Elevated TDS has been documented in both shallow and deep wells in the Subbasin. Exceedances in shallow wells may be caused by salt loading at the surface while elevated TDS at depth may be the result of older marine sediments and/or other deep high-salinity groundwater zones. The City of Ceres encountered TDS at concentrations of 1,200 mg/L in a 460-foot well below the Corcoran Clay. The City controls operation of this well to avoid groundwater quality impacts to their distribution system. In the eastern Subbasin, a 1,680-foot well reportedly encountered brackish water; this deep well has been properly abandoned to prevent the upward migration of high-TDS groundwater.

As indicated on **Figure 4-40**, construction data is not available for many wells with exceedances of the secondary MCL in the western Subbasin. Additional information will be needed to determine which of the two western principal aquifers has higher concentrations. (For more information on TDS, see **Section 4.3.5.3.2** and **Figures 4-39** and **4-40**).

6.6.2.1.5. 1,2,3-Trichloropropane (1,2,3-TCP)

1,2,3-TCP is a manufactured chlorinated hydrocarbon that has been used for cleaning and degreasing and has also been associated with soil fumigants, which were widely used in agriculture through most of the 1980s. A MCL of 0.005 µg/L was only recently established (effective 2018), and historical data are sparse.

Detections above the MCL have been observed in all three Principal Aquifers. Elevated concentrations have been observed in Ceres and Turlock wells and in other areas of the WTSGSA. Ceres has recently installed wellhead treatment for TCP on multiple wells. Elevated concentrations in the Eastern Principal Aquifer have occurred near Denair, Hughson, Delhi, and southeast of Turlock Lake (See **Section 4.3.5.3.8** and **Figures 4-51** and **4-52**).

6.6.2.1.6. Tetrachloroethene (PCE)

PCE is a common industrial solvent that was used for decades in a variety of industrial applications including widespread use in dry cleaning. Discharges from a number of dry cleaners in the City of Turlock have resulted in local contaminant plumes of PCE. Elevated concentrations of PCE have occurred in all three principal aquifers but the highest concentrations are associated with several potential point sources within urban areas occurring along the Highway 99 corridor. PCE has migrated vertically into the Western Lower Principal Aquifer beneath the City of Turlock and has impacted three City wells. The City of Turlock has been working cooperatively with the Central Valley RWQCB and DTSC to install facilities to pump and treat the PCE for containment and management of the plume of contamination (See **Section 4.3.5.3.9** and **Figures 4-53** and **4-54**).

6.6.2.1.7. Potential GSA Management Impacts on Degraded Water Quality

The relationship between elevated concentrations and depth would be helpful in interpreting whether GSA activities could potentially affect groundwater quality and lead to undesirable results. If GSAs allowed water levels to decline such that constituents at depth produce elevated concentrations, then there would be an increased potential for undesirable results. In other parts of the Central Valley, naturally-occurring arsenic, uranium, and TDS have been correlated with depth and observed to increase in concentration when water levels decline.

However, the linkage between constituents of concern with depth is not straightforward and those naturally-occurring constituents do not consistently increase in deeper wells. Many wells are screened in both western principal aquifers that complicate the interpretations. Separate hydrogeologic investigations for wellfields in the cities of Turlock and Ceres suggest that discrete sand layers within the principal aquifers may cause elevated concentrations. The City of Modesto also reports that correlating increased concentrations of certain constituents of concern with depth are not straightforward, especially in water supply wells with multiple screens.

Anthropogenic constituents of concern such as nitrates, 1,2,3-TCP and PCE are typically released at the surface and are often associated with the shallow-most aquifers. However, if well screens are relatively deep, these constituents can increase with declining water levels, as shallow constituents are no longer above the top of the screen. Although those constituent concentrations are more likely to be higher in the Western Upper Principal Aquifer and shallow wells in the Eastern Principal Aquifer, occurrences do occur in the Western Lower Principal Aquifer, confirming vertical migration.

Through management of groundwater use, GSAs could also inadvertently allow pumping to spread contaminants throughout the aquifer. In addition to defined contaminant plumes, elevated concentrations of other constituents could be pulled horizontally or vertically allowing poor quality groundwater to spread within the aquifer system.

Finally, GSA projects could introduce constituents of concern to the aquifer, exacerbating salt loading or causing local exceedances of MTs. As projects are implemented, the potential impacts to water quality will be assessed, primarily through regulatory and CEQA compliance. New monitoring wells may be installed and added to the GSP water quality monitoring network to demonstrate both project performance and the avoidance of undesirable results for water quality.

The annual water quality analysis of the six constituents of concern will need to consider the local conditions within the aquifer, historical water levels and water quality data, well construction, and concentrations in other Principal Aquifers in nearby wells. These details will assist with the interpretations of whether GSA management activities are causing undesirable results.

6.6.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). To facilitate a comparison between MTs, a summary of MTs for each sustainability indicator was provided in **Table 6-4** and discussed previously in **Section 6.3.2.2**.

As provided in **Section 6.3.2.2**, the MCLs for each constituent of concern – selected as the MTs – would not interfere with the MTs for the other sustainability indicators. In addition, the MTs for the other indicators are generally supportive of the water quality indicator. As indicated in **Table 6-4**, the MTs for chronic lowering of water levels, reduction of groundwater in storage, land subsidence, and interconnected surface water are all based on previous water levels in the Subbasin (Spring 2014 or Fall 2015 conditions). By preventing future long-term lowering of groundwater levels, depth-related water quality impacts would not be expected to worsen.

In addition, the use of previously observed water levels associated with these snapshots in time across the Subbasin will generally preserve general groundwater flow directions and be protective again spreading any constituents of concern into unimpacted areas. If groundwater flow conditions are altered as a result of GSP projects, the analysis of projects would consider those conditions.

By setting the MT for water quality at the MCLs for the six primary constituents of concern in the Subbasin, any new increases in constituent concentrations above the MCL will be tracked and evaluated with respect to the GSP implementation and GSA management. In this manner, beneficial uses of groundwater for drinking water will be preserved. Data will be compiled and analyzed annually as part of the Annual Report and coordinated with member agencies responsible for provision of public drinking water supplies and with regulatory agencies primarily responsible for water quality protection.

These MTs are also developed to work in concert with the MOs for water quality (see **Section 6.6.3**). By setting the MOs at concentrations at or below the historical maximum at representative monitoring wells, increases in constituent concentrations in wells that have already exceeded MCLs will also be tracked and analyzed.

Throughout the process of establishing sustainable management criteria for the degraded water quality indicator, the Joint TACs coordinated with other regulatory programs in the Subbasin including the Nitrate Control Program, CV-Salts, and drinking water quality monitoring conducted by the municipal public water suppliers in the Subbasin, all of whom are member agencies in the GSAs. Representatives from the Valley Water Collaborative – a coalition responsible for implementing the Nitrate Control Program – provided a presentation at a public Joint TAC meeting in December 2020. Many Subbasin landowners are directly participating in the NCP, providing additional opportunities for coordination. DWR representatives for the Turlock Subbasin also attended public meetings in which the water quality indicator was discussed and provided comments both at meetings and in follow-up conversations with members of the Joint TACs.

6.6.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Turlock Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. Through intra-basin coordination and a review of draft and completed GSPs, the Turlock TACs considered the MTs selected for degraded water quality in the three adjacent subbasins including the Merced Subbasin to the south, the Delta-Mendota Subbasin to the west, and the Modesto Subbasin to the north. In brief, the Turlock Subbasin MTs are not expected to either cause undesirable results or affect implementation of adjacent subbasin GSPs as summarized below.

6.6.2.3.1. Merced Subbasin

The Merced Subbasin GSP focused on those constituents where groundwater management activities have the potential to cause undesirable results and selected salinity as the only constituent of concern (W&C, 2019). The undesirable result would occur if at least 25 percent of the representative monitoring sites exceeded the MT for two consecutive years.

Undesirable results were related to deeper high salinity groundwater that has migrated upward in some areas of the Subbasin as a result of groundwater pumping. These areas are located along the San Joaquin River near Livingston and Atwater. No high salinity groundwater has been identified adjacent to the Turlock Subbasin. TDS was used as the overall indicator of salinity, and an MT of 1,000 mg/L was determined to be protective against undesirable results. The GSP incorporated the monitoring program conducted by ESJWQC, which includes two wells adjacent to the Merced River, both west of Highway 99, in the Western Upper and Western Lower principal aquifers.

Several monitoring wells from the GeoTracker portal occur in that same area in the Turlock Subbasin just north of the Merced River. Because these data are used as the Turlock Subbasin representative monitoring network, it should be straightforward to coordinate TDS concentrations with the Merced Subbasin. Because TDS is also a constituent of concern for the Turlock Subbasin – with similar depth-related concerns – there should be no conflicts between the MTs for degraded water quality selected in the two subbasins.

6.6.2.3.2. Delta-Mendota Subbasin

The Delta-Mendota Northern & Central GSP focused on constituents that are linked to groundwater elevations or other groundwater-related activities. Undesirable results are to be triggered if TDS, nitrate, or boron exceed the MCL or water quality objectives (WQOs) in three consecutive sampling events in non-drought years or additional degradation where current groundwater quality already exceeds the MCLs or WQOs. An undesirable result would also occur if a recharge project exceeded 20 percent of the aquifer's assimilative capacity without justification of a greater public benefit.

MTs were set at each monitoring site based on these criteria. Two water quality monitoring wells in the Upper Aquifer, 03-001 and 03-003, are located adjacent to the Turlock Subbasin. For the Lower Aquifer, only one Delta-Mendota water quality monitoring well (06-003) appears to be within three miles of the San Joaquin River, closest to the northwest edge of the Turlock Subbasin.

For the Upper Aquifer, the MTs selected for both wells close to Turlock Subbasin were higher than the MCLs for TDS (4,000 mg/L) or nitrate (80 mg/L) based on current groundwater quality. Although concentrations were lower in the Lower Aquifer – with MTs set for TDS at 2,000 mg/L and for nitrate at 50 mg/L – MTs still exceeded the MCLs. In the Turlock Subbasin, TDS concentrations are also elevated (>1,000 mg/L) in the Western Upper Aquifer in wells adjacent to the San Joaquin River, but nitrate concentrations are low in that area (see **Figures 4-37** and **4-39**).

The water budget analyses suggest that subsurface outflow occurs from the Turlock Subbasin into the Delta-Mendota Subbasin under historical (11,500 AFY) and future projected conditions (12,800 AFY). However, under the sustainable yield analysis, subsurface outflow is greatly reduced (about 3,500 AFY) (see **Tables 5-7** and **5-17**). In addition, except for TDS, no elevated concentrations of constituents of concern in the Turlock Subbasin were observed within about two miles of the San Joaquin River. As such, no water quality impacts are anticipated on the Delta-Mendota Subbasin from the Turlock Subbasin.

6.6.2.3.3. Modesto Subbasin

The Modesto Subbasin has defined undesirable results for degraded water quality in a similar manner to the Turlock Subbasin, using MCLs for seven constituents of concern as the MTs. The constituents of concern in the Modesto Subbasin include all of the constituents of concern in the Turlock Subbasin with the same MTs assigned to each. Both subbasins have similar water quality issues and will coordinate the tracking and analysis across the Tuolumne River boundary.

In addition to the coordination of sustainable management criteria, two member agencies of the Turlock Subbasin GSAs provide groundwater supply in both subbasins, allowing for close coordination of any water quality issues along the Tuolumne River boundary. Specifically, the City of Modesto operates drinking water wells and samples water quality in both the Turlock and Modesto subbasins. The City of Waterford in the Modesto Subbasin operates drinking water supply wells in the Turlock Subbasin for the community of Hickman. Water quality data for both subbasins will be analyzed annually using similar data sources and methods, which will allow for close coordination of any degraded water quality across the two subbasins.

6.6.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

The setting of MCLs as the MTs is protective with respect to the avoidance of undesirable results. By protecting drinking water quality, the long-term quality and quantity of useable groundwater for all beneficial uses will be preserved.

Anthropogenic contaminants such as PCE has degraded water quality in some portions of the Subbasin causing water supply wells to be removed from service (see **Section 4.3.5.3.9**). By tracking and analyzing impacts on a PCE plume from local groundwater extractions – as is being done by the City of Turlock – the cost and reliability of drinking water supplies can be better managed.

The commitment to analyze a large dataset of groundwater quality data across the Subbasin on an annual basis will improve GSA understanding of water quality in each Principal Aquifer and lead to better management practices. This fulfills two data gaps identified in the basin setting with respect to water quality, including the coordination with water quality agencies on both contaminant plumes and the need to characterize water quality with depth (see **Section 4.4**).

Expanded and ongoing data collection and analysis will also support ongoing regulatory monitoring, allowing others to evaluate their local water quality monitoring data in the context of Subbasin-wide water quality. For example, an improved understanding of water quality with depth allows future wells to be sited and designed such that water quality is optimized. Overall, these improvements will support all beneficial uses of groundwater in the Subbasin.

6.6.2.5. Consideration of State, Federal, or Local Standards in MT Selection

In setting MTs for degraded water quality, GSP regulations require that GSAs consider local, state, and federal water quality standards applicable to the Subbasin (354.28(c)(4)). As provided above, the degradation of water quality indicator relies on California MCLs for the MT; in this manner, the MT adheres to drinking water quality standards set by California, which are either as protective or more protective than federal standards. The MCLs are also consistent with the local standards and water quality objectives (WQO) in the Central Valley RWQCB Basin Plan for the San Joaquin River Basin (2018). Accordingly, there are no conflicts with regard to regulatory standards.

6.6.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for the degradation of water quality will be quantitatively monitored through existing monitoring programs conducted by public agencies, regulated coalitions, and private well owners in representative monitoring wells for each Principal Aquifer using regulatory-approved sampling protocols. All of these existing water quality monitoring programs have been approved by the SWRCB or other water quality regulatory agency. Data will be downloaded from the State GeoTracker water quality website and supplemented with data from the salt and nutrient regulatory programs in the Subbasin (see **Section 2.4.4**). Water quality data will be analyzed for constituents of concern in each Principal Aquifer as described in **Chapter 7** (Monitoring Network) of this GSP (see **Section 7.1.4**). Analyses will be included in the Subbasin GSP annual reports.

More than 300 wells with water quality data for Turlock Subbasin constituents of concern were available from GeoTracker from January 2020 to May 2021; these water quality monitoring sites are shown on **Figure 7-4** in **Chapter 7** and tabulated in **Appendix H**. Wells were distributed throughout the Subbasin but focused in areas of drinking water supply wells including in Disadvantaged Communities (DACs, SDACs, and EDAs – see **Figure 3-1**). Although monitored wells will change from year to year based on regulatory monitoring requirements, public water suppliers generally monitor and report water quality data for all active drinking water wells (see **Section 2.4.2** and **Table 2-2**). GeoTracker also includes water quality monitoring data from sites with contaminant plumes as a part of the RWQCB regulatory programs (see summary data on **Figure 4-57**).

Additional wells from supplemental regulatory programs are also either included on GeoTracker or available for public download to allow for a broad analysis of water quality on an annual basis. Monitoring programs for TDS and nitrate are conducted by ESJWQC in coordination with the CV-SALTS program and the Nitrate Control Program, which requires growers in management zones to ensure safe drinking water supplies for well owners impacted by nitrate concentrations (see **Section 2.4.4**). As a result of this large dataset, the GSAs are not planning to develop a separate GSP water quality monitoring network, and no water quality sampling will be conducted by the GSAs.

However, the GSAs may monitor water quality in existing wells or install new water quality monitoring wells in the future if required by GSP projects or management actions. GSAs will ensure that projects and management actions comply with regulatory water quality requirements and will consider appropriate constituents, MCLs, and water quality objectives (WQOs), as needed, to avoid undesirable results. Potential water quality considerations for currently proposed projects will be evaluated, in part, through the CEQA process, which is already underway on a programmatic basis.

MTs and MOs will be quantitatively analyzed through an evaluation of the water quality datasets. Results will be reported in annual reports. MTs will involve analysis for new exceedances of MCLs for each of the six constituents of concern. MOs will involve analysis for increases in concentrations for the six constituents of concern as described below.

6.6.3. Measurable Objectives for Degraded Water Quality

To avoid exacerbation of the nature and extent of current groundwater quality by management activities, the GSAs establish a target water quality condition whereby GSA management does not cause an increase in historical concentrations of constituents of concern (i.e., further degradation of water quality). This target is managed by the definition of measurable objectives for degraded water quality as follows.

Table 6-11: Measurable Objectives for Degraded Water Quality

	Measurable Objectives	Principal Aquifer(s)
Degraded Water Quality	Measurable objectives are defined as no increase above the maximum historical concentration for any constituent of concern in a potable water supply well in the GSP monitoring program caused by GSA management activities.	All

The same monitoring data summarized in **Section 6.6.2.6** above will be used to analyze MOs for the constituents of concern (see also **Figure 7-4**).

6.7. LAND SUBSIDENCE

SGMA defines an undesirable result for land subsidence as “significant and unreasonable land subsidence that substantially interferes with surface land uses” (§10721 (x)(5)). In general, land subsidence can interfere with land use by causing damage to either the natural land surface (e.g., surface fissures) or to structures on the land surface (e.g., roads or pipelines). Potential impacts from land subsidence are documented in **Section 4.3.6** and summarized in **Section 6.7.1.1** below.

As described in **Section 4.3.6**, there have been no known impacts from inelastic land subsidence in the Turlock Subbasin to date. Land subsidence associated with groundwater extraction has been documented across large segments of the San Joaquin Valley since the 1950s, but these areas are located significant distances to the south of the Turlock Subbasin.

Although local conditions vary, much of the documented subsidence to the south is associated with increases in groundwater pumping, which lowers pore pressure and can lead to the subsurface compaction of regional clay layers, such as those associated with the widespread Corcoran Clay. Subsurface compaction allows the land surface to subside. In the southern portion of the adjacent Merced Subbasin, land subsidence is thought to be related to groundwater extraction below the Corcoran Clay that depressurized clay layers in the deep confined aquifer system (W&C, 2019) (see also **Figure 4-59**).

As described in **Chapter 4** (see **Section 4.2.4**), the Corcoran Clay is the regional aquitard in the western Turlock Subbasin that separates the Western Upper Principal Aquifer (unconfined) from the Western Lower Principal Aquifer (confined). Clay layers are also present in the Eastern Principal Aquifer but regional compressible clay layers, such as the Corcoran Clay, have not been identified and are not likely present. Although impacts from land subsidence have not been documented anywhere within the Turlock Subbasin, the potential for future undesirable results associated with land subsidence cannot be dismissed. Because groundwater drains slowly from compacted clay layers, there is a time lag between the triggering mechanisms that cause land subsidence and the actual depression on the land surface. A slow and small rate of decline in the land surface can go unnoticed until disruption of infrastructure or other physical manifestation of the problem occurs.

Given these conditions, the Joint TACs have determined that the land subsidence sustainability indicator is applicable to the Turlock Subbasin. Sustainable management criteria have been selected for all principal aquifers, while recognizing the higher potential for impacts in the Western Upper Principal Aquifer and the Western Lower Principal Aquifer that are within the extent of the Corcoran Clay (see striped area on **Figure 6-1**).

A GSP monitoring network for land subsidence has been established for the entire Subbasin, and includes all three principal aquifers, based on Fall 2015 groundwater levels (see **Section 7.1.5**). In addition, Subbasin-wide remote sensing data will be incorporated into the GSP monitoring program to provide annual screening to supplement the groundwater elevation monitoring network (see **Section 7.1.5** and also **Section 6.7.2.6** below).

Potential undesirable results, including causes and impacts to beneficial uses, are described in **Section 6.7.1** below, with a definition of undesirable results provided at the end of the section. **Section 6.7.2** describes the quantification of minimum thresholds (MTs) and provides additional information on rationale and coordination of MTs in adjacent subbasins. **Section 6.7.3** provides the approach and selection of measurable objectives (MOs). Interim milestones that cover all of the sustainability indicators are described in **Section 6.9**.

6.7.1. Undesirable Results for Land Subsidence

Vertical displacement of the land surface can be caused by a variety of mechanisms, including extraction of oil and gas, the wetting of collapsible soils, piping of sediment from underground pipeline or tank leaks, collapse from underground mining facilities, tectonic activity along geological faults, and other conditions. This GSP focuses on land subsidence related to groundwater extraction only. The sections below summarize the physical processes that could cause potential future land subsidence in the Turlock Subbasin as well as the related causes and effects of potential undesirable results.

6.7.1.1. Causes of Undesirable Results for Land Subsidence

As mentioned above, no impacts from land subsidence have been documented in the Turlock Subbasin; accordingly, no undesirable results have been observed. However, hydrogeological conditions in the western Turlock Subbasin are similar to areas in the San Joaquin Valley where significant amounts of land subsidence have been recorded. Many of these areas have linked subsidence with groundwater pumping below the thick and compressible Corcoran Clay. As pumping removes groundwater from storage, the pore pressure and support of the aquifer framework are reduced, and sediments can be realigned and compacted at depth. This subsurface compaction reduces the volume of sediments, and the ground surface can subside. Although the actual processes and mechanisms that result in land subsidence are more complex than summarized herein, the concept of subsurface compaction is typically used to provide a general understanding of the physical causes of land subsidence. Additional information on the process of land subsidence is summarized in **Section 4.3.6** and illustrated on **Figure 4-58**.

Given the correlation of land subsidence to areas within the extent of the Corcoran Clay – both in the adjacent subbasin to the south and throughout much of the Central Valley – the western Turlock Subbasin is thought to be the area most susceptible to future land subsidence (see **Figure 6-1**). Groundwater production zones east of the extent of the Corcoran Clay in the Turlock Subbasin contain no known regional clay zones similar to the Corcoran Clay and are generally more consolidated; accordingly, the Eastern Principal Aquifer is judged to be less susceptible to subsurface compaction. However, pumping in this aquifer could impact water levels in adjacent western aquifers.

Further, recent InSAR data published by DWR indicates areas of vertical displacement in the Eastern Principal Aquifer (see **Section 4.3.6** and **Figure 4-61**). It isn't known if this vertical displacement is related to groundwater extraction or other mechanisms described in **Section 6.7.1** above. However, the highest rates of vertical displacement occur in areas of historical groundwater pumping. Accordingly, MTs are designated for all principal aquifers and a representative monitoring network is defined for land subsidence across the entire Subbasin. Groundwater extraction that could cause land subsidence in the Subbasin is described below.

Many of the cities and urban communities (e.g., Turlock, Ceres, Delhi, Hilmar, and Keyes) rely on groundwater wells in the Western Lower Principal Aquifer (i.e., the confined aquifer system below the Corcoran Clay that has been associated with land subsidence to the south). Private wells are also completed in that aquifer, but the number of active wells, locations, and pumping details are unknown. Although there have been no significant long-term groundwater level declines in the Western Upper Principal Aquifer, water levels from wells screened solely in the Western Lower Principal Aquifer are sparse; water levels in this aquifer have been identified as a data gap in the basin setting description in this GSP (see

Section 4.4). Additional pumping in the hydraulically-connected Eastern Principal Aquifer – outside of the Corcoran Clay extent – has resulted in a large volume of subsurface outflow from the western aquifers toward the east (see **Table 5-8**, subsurface outflow to ETSGSA). This subsurface flow could also contribute to depressurization of clay layers in the Western Lower Principal Aquifer.

Although the Eastern Principal Aquifer is outside the extent of the Corcoran Clay, it is possible that localized land subsidence could occur in this aquifer as well. Clay layers are observed on lithologic logs within the aquifer, although their compressibility and susceptibility to compaction is unknown. As a precautionary measure, sustainable management criteria are assigned to manage water levels at or near the historic low water levels to prevent extractions from triggering inelastic land subsidence in the future.

The western Subbasin is likely to be more susceptible to land use impacts that would cause undesirable results. There are larger urban areas with utilities and pipelines in the western Subbasin along with surface water canals and major transportation corridors including freeways and bridges. Cracks in foundations, canals, roads, or bridges, or damage to utilities or pipelines could cause an interruption to vital services; any of these examples could lead to undesirable results from land subsidence. In addition to cracks and breaks, land subsidence can affect gravity drainage in sewers, pipelines, and water conveyance canals and can also increase risk of flooding (LSCE, 2014; W&C, 2019; W&C and P&P, 2019).

The technical team provided numerous examples of land subsidence causes and impacts for TAC consideration, including documentation in GSPs completed in adjacent subbasins and other Central Valley subbasins. The Merced Subbasin defined an undesirable result from land subsidence as the interference with *the viability of the use of infrastructure* (W&C, 2019). In the Delta-Mendota GSP, undesirable results are described as significant property damage, adverse impacts to natural resources, or conditions that threaten public health or safety (W&C and P&P, 2019). Concepts from these undesirable definitions in adjacent subbasins were incorporated into the Turlock Subbasin definition of undesirable results as described in subsequent subsections of this GSP below.

6.7.1.2. Effects on Beneficial Uses of Groundwater

Adverse impacts of land subsidence on beneficial uses of groundwater have been well-documented throughout California (LSCE, 2014). Two commonly-cited effects in the Central Valley include damage to casings in water supply wells and interference with water canal capacity and conveyance.

Widespread collapse of well casings resulting from land subsidence have been documented in numerous areas of both the Sacramento and San Joaquin Valleys. Near El Nido, California, well casings have been observed protruding above the land surface, in some cases balancing the connected concrete well pad in the air (LSCE, 2014). Casing damage typically requires well replacement, resulting in significant costs to beneficial users of groundwater.

Given the close linkage between groundwater and surface water use in the Central Valley, land subsidence impacts on water conveyance facilities have also had a negative impact on the beneficial users of groundwater. Land subsidence has reduced freeboard and flow capacity in large water conveyance canals such as the Delta-Mendota Canal, the California Aqueduct, and the Friant-Kern Canal. Repairs to restore conveyance capacity along critical segments of the Friant-Kern Canal alone is estimated to cost as much as $200 million or more (FWA, 2018). In the GSP for the Merced Subbasin, undesirable results for land subsidence were related primarily to the viability of the Eastside Bypass canal, where subsidence has caused a reduction in freeboard and capacity over the last 50 years. Collectively, the impacts to these canals have resulted in an increase in groundwater pumping, often from groundwater basins already associated with overdraft conditions.

Subsurface compaction of clay layers is also associated with a permanent removal of some groundwater from storage. Although the usable storage capacity of an aquifer is not substantially impacted by the dewatering and compaction of clay layers, there is some amount of groundwater that is permanently lost. Pumping an identical amount of groundwater after this loss can result in a lower water level than before the clay layer was drained, resulting in higher pumping lift costs and other negative effects on beneficial uses of groundwater (LSCE, 2014).

Land subsidence could cause disruption for any activities on the physical land surface including agricultural production. Changes to the land, such as a surface depression, could affect how both surface water and groundwater is conveyed onto and within productive parcels and create inefficiencies in beneficial water use or interferences with agricultural land uses.

In the Turlock Subbasin, land subsidence could affect beneficial uses of groundwater in a variety of ways. Well owners would be affected by well failures from land subsidence. In the western Subbasin, groundwater elevations are shallow and can create wet surficial conditions that interfere with farming. Historically, shallow groundwater is controlled in these areas by pumping shallow wells (referred to as drainage wells) to allow ground conditions to support heavy equipment and machinery. Land subsidence in these areas could exacerbate these conditions and require more pumping to control soil moisture locally. In addition, elevation changes along the widespread network of surface canals could interfere with the efficient delivery of surface water and increase groundwater use. Increased groundwater use could lower water levels locally, potentially impacting environmental users of groundwater such as GDEs.

6.7.1.3. Turlock Subbasin Definition of Undesirable Results

In consideration of the land use and infrastructure impacts summarized above, undesirable results that could interfere with land uses are considered to be either physical surficial impacts that disrupt land use operations or potential damage to engineered structures such as roads, bridges, utilities, pipelines, canals, and/or well casings that are linked to land subsidence. An undesirable result would occur if groundwater extractions caused significant damage to the ground surface or to critical infrastructure and adversely impact its intended use.

Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria address the number of monitoring sites and events that an MT can be exceeded before causing an undesirable result. This framework builds on the narrative definition and recognizes that a single MT exceedance at one monitoring site may not indicate an undesirable result. This framework also allows clear identification for when an undesirable result is triggered under the GSP.

The narrative definition of undesirable results and the quantitative combination of MT exceedances that cause undesirable results are provided as follows.

Table 6-12: Undesirable Results for Land Subsidence

	Undesirable Results Definition	Principal Aquifer(s)
Land Subsidence	Undesirable results are defined as significant and unreasonable inelastic land subsidence, caused by groundwater extraction and associated water level declines, that adversely affects land use or reduces the viability of the use of critical infrastructure. An undesirable result will occur in the Western Upper Principal Aquifer when 33% of representative monitoring wells exceed the MT in three consecutive Spring monitoring events. An undesirable result will occur in the Western Lower Principal Aquifer when 33% of representative monitoring wells exceed the MT in two consecutive Spring monitoring events. An undesirable result will occur in the Eastern Principal Aquifer when 33% of representative monitoring wells exceed the MT in three consecutive Fall monitoring events.	As specified

The use of 33 percent of the representative wells was developed for the chronic lowering of water levels indicator as discussed in **Section 6.3.1.4** and is also appropriate for land subsidence because the monitoring networks for the two indicators are identical in numbers and locations of monitoring sites for each Principal Aquifer. The 33 percent value represents 6 of 18 in the Western Upper Principal Aquifer, 3 of 8 wells in the Western Lower Principal Aquifer, and 7 of 21 wells in the Eastern Principal Aquifer. By establishing a portion of the aquifer that would indicate undesirable results, the criteria recognizes that land subsidence is typically triggered by compressible clay layers that are relatively regional in extent and would not be expected to vary on a well by well basis.

Spring monitoring events are used for the more susceptible western aquifers because low water levels in Fall may result in higher rates of subsidence that will recover when water levels rise the following Spring (elastic land subsidence). The use of only two consecutive Spring exceedances for the Western Lower Principal Aquifer acknowledges the higher susceptibility for land subsidence in the Western Lower Principal Aquifer.

Because land subsidence is less likely to cause undesirable results in the Eastern Principal Aquifer – due to the more consolidated nature of the aquifer systems as well as a lower density of critical infrastructure – the undesirable result definition is modified for that principal aquifer to align with the MT exceedances allowed for both the chronic lowering of groundwater levels and the reduction of groundwater in storage indicators (i.e., Fall monitoring events).

Water level monitoring will be supplemented by annual screening of InSAR data. These data will be re-evaluated with the water level monitoring network in the five-year GSP evaluation. If InSAR data indicate increasing rates of subsidence, the monitoring network will be bolstered by additional monitoring, such as the installation of GPS stations, in targeted areas of the Subbasin.

6.7.2. Minimum Thresholds for Land Subsidence

As provided in the GSP regulations, the MT for land subsidence "shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results" (§354.28(c)(5)). The MTs are required to be supported by:

- Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence, including an explanation of how these uses and interests were determined.
- Rationale for establishing MTs in consideration of the above effects
- Maps and graphs showing the extent and a rate of land subsidence in the basin that defines the MT and MO.

Given the lack of undesirable results associated with land subsidence in the Turlock Subbasin, it is not possible to correlate a rate of subsidence to undesirable results. Current rates from incomplete data sets indicate low rates of vertical displacement across the Subbasin. Supporting technical information on land subsidence in the Turlock Subbasin is provided in **Section 4.3.6** and summarized below in **Section 6.7.2.1**.

Because the greatest risk for land subsidence in the Turlock Subbasin is thought to be the dewatering/depressurization of clays within and below the Corcoran Clay, maintaining groundwater levels at or above historic low levels and, at a minimum, above the top of the Corcoran Clay in both of the western principal aquifers was viewed as a reasonable strategy for minimizing any future subsidence. In this manner, groundwater levels would be protective against worsening conditions that could lead to future undesirable results for land subsidence and could serve as a proxy for direct subsidence monitoring.

Because data availability and hydrogeologic conditions provide different considerations for the Western Upper Principal Aquifer compared to the Western Lower Principal Aquifer, the approach for MTs is slightly different, as described below.

WESTERN UPPER PRINCIPAL AQUIFER

Most of the land subsidence documented in the San Joaquin Valley is related to groundwater extraction in the confined aquifer below the Corcoran Clay (Western Lower Principal Aquifer in the Turlock Subbasin) (LSCE, 2014). Nonetheless, relatively thick clay lenses occur in the Western Upper Principal Aquifer (for example, see **Figure 4-14**), which could potentially contribute to future land subsidence.

The MT for the chronic lowering of water levels sustainability indicator – set at the low water level in 2015 – is sufficiently protective to mitigate the future potential for inelastic land subsidence and avoid undesirable results. These water levels are at or above the historic low levels recorded for wells across the Western Upper Principal Aquifer and are also maintained above the Corcoran Clay. Based on these conditions, the MTs for the chronic lowering of water levels in the Western Upper Principal Aquifer are selected as a proxy for the land subsidence indicator.

WESTERN LOWER PRINCIPAL AQUIFER

The Western Lower Principal Aquifer is considered a higher risk for triggering land subsidence in the Turlock Subbasin compared to the other principal aquifers. In addition, there are data gaps for historical water levels in this aquifer (**Section 4.4**).

The MT for the chronic lowering of water levels sustainability indicator – set at the low water level in 2015 – would be sufficiently protective to avoid future potential undesirable results for land subsidence; where data are available, this level is at or above historic low water levels. However, some of the measured water levels appear to be close to the top of the Corcoran Clay. Given the data gaps, it is unclear if water levels are near the top of the clay in other portions of the lower aquifer. If water levels fall below the top of the clay layer, the potential for future land subsidence could increase. New monitoring wells are being installed in the Western Lower Principal Aquifer to address the current data gap, but it will not be possible to document accurate historical low water levels in new wells. However, the location of the Corcoran Clay in each new well will be readily available.

Based on these considerations, the MT for the Western Lower Principal Aquifer will be either the estimated Fall 2015 water level based on generalized water level contours or the top of the Corcoran Clay, whichever is shallower.

EASTERN PRINCIPAL AQUIFER

As discussed above, the Eastern Principal Aquifer is considered a lower risk for potential land subsidence compared to the Western principal aquifers. The sustainable management criteria established for both chronic lowering of water levels and reduction of groundwater in storage are protective against potential land subsidence in the Eastern Principal Aquifer because they manage groundwater levels at or above historic low levels in the area. Accordingly, the use of these criteria and water level MTs are used as a proxy for land subsidence potential in the Eastern Principal Aquifer.

The undesirable results definition for these other indicators guards against significant lowering of water levels and overdraft conditions, a definition which also guards against the potential for significant rates of future land subsidence. Similarly, MTs are above historic low water levels, so that any small rates of ongoing land subsidence will not be exacerbated.

Considerations provided above are used to quantify the MTs selected for each principal aquifer for land subsidence. Although MTs have been selected for each principal aquifer to meet slightly different considerations, the MTs can be summarized for all principal aquifers as provided in the following table.

Table 6-13: Minimum Thresholds for Land Subsidence

	Minimum Thresholds	Principal Aquifer(s)
Land Subsidence	Minimum thresholds are the low groundwater elevations observed in Fall 2015 or the top of the Corcoran Clay (where present), whichever is shallower, at each representative monitoring site for each principal aquifer.	All

Additional support and justifications for the MTs, along with the quantitative criteria for the combination of MT exceedances provided in the undesirable results definition, are discussed in the following section.

6.7.2.1. Justification and Support for Minimum Thresholds

As indicated above and discussed in **Section 4.3.6**, estimated rates of subsidence in the Turlock Subbasin are available at an existing global positioning system (GPS) station[31] south of the City of Turlock (**Figure 4-60**) and from InSAR data published by DWR (**Figure 4-61**). GPS data from July 2012 to July 2018 indicates a total amount of land subsidence of -0.22 feet (-2.64 inches), indicating a rate of about -0.037 feet per year (-0.44 inches per year) over that six-year period.

[31] Installed and operated by the U.S. Bureau of Reclamation in connection with the San Joaquin River Restoration Program.

InSAR data available from June 2015 to September 2019 (4.2 years) indicate no vertical displacement of the land surface over about one-half of the extent of the western principal aquifers. Remaining portions suggest negative displacement (land subsidence) from about -0.002 feet (-0.024 inches) to about -0.18 feet (-2.16 inches) over the 4.6-year period; these data suggest land subsidence rates between about -0.005 and -0.47 inches per year.[32] Data and maps were reviewed by the Joint TACs in several public meetings including a technical presentation on June 25, 2020.

Given the limited vertical displacement data and the lack of noticeable impacts, it is not possible to link specific rates of subsidence directly to undesirable results for the Turlock Subbasin. Most of the adverse impacts from land subsidence documented in the Central Valley have occurred in areas with several feet or more of subsidence (LSCE, 2014). With an overall rate of -0.44 inches per year (GPS station data), it would take about 27 years before land subsidence in the Turlock Subbasin would reach a magnitude of one foot.

Increased subsidence rates are often triggered during drought conditions (LSCE, 2014); the available recent land subsidence data in the Turlock Subbasin were collected during the long-term (and ongoing) drought conditions that produced historic low water levels throughout the Subbasin. These conditions were in place by January 2015; as previously mentioned, GSAs are not responsible for correction of undesirable results occurring before and/or currently as of January 2015. It is not possible to know whether the current rates will continue or if land subsidence triggered to date is capable of being arrested.

Nonetheless, the GSAs wish to prevent exacerbation of land subsidence in the Subbasin by managing water levels at or above the historical low levels. As an additional backstop, the GSAs will institute a monitoring program using annual InSAR data published by DWR for screening purposes in the Subbasin. This tracking will allow ongoing evaluation of the rate and extent of land subsidence and a re-evaluation of the data in the required five-year evaluation in 2027. if significant rates of subsidence are indicated at that time, additional monitoring, such as GPS stations will be installed, targeting the area of high rates.

In this manner, the GSAs will also ensure that the potential for impacts on land uses from land subsidence throughout the entire Subbasin is not missed. Screening data will be used to develop an on-ground monitoring network including use of existing GPS stations and/or installation of additional GPS stations, as needed. This approach is reasonable based on the best available data and associated uncertainty.

6.7.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT

[32] InSAR data accuracy is estimated at about ±0.1 inches per year (Towill, 2021).

will avoid undesirable results (§354.28(b)(2)). To facilitate this comparison, MTs for each sustainability indicator was summarized in **Table 6-4** as discussed in **Section 6.3.2.2** above.

Section 6.3.2.2 also provides a discussion on the relationship between the MT for chronic lowering of water levels and the MTs for each of the remaining sustainability indicator. Because the MTs for land subsidence are the same as the MTs for chronic lowering of water levels (and also for the reduction in groundwater in storage), that discussion would also be applicable to the land subsidence sustainability indicator. As such, the discussion in **Section 6.3.2.2** fulfills most of this required component of the GSP.

One additional qualifier relating to the Corcoran Clay has been incorporated into the land subsidence MT. As shown in **Table 6-13** above (and also in **Table 6-4**), the MT is either the low groundwater elevation observed in Fall 2015 (for the Western Upper Principal Aquifer and the Eastern Principal Aquifer) or the shallower of the low groundwater elevation observed in Fall 2015 and the top of the Corcoran Clay (for the Western Lower Principal Aquifer). The MT for the Western Lower Principal Aquifer prevents inadvertently setting the MT below the top of the Corcoran Clay if local water levels have declined below that contact (recognizing the data gap regarding water levels in the Western Lower Principal Aquifer – see **Section 4.4**). As explained in **Section 6.7.2**, the Western Lower Principal Aquifer is the area most likely to experience significant future land subsidence in the Turlock Subbasin. In the southern San Joaquin Valley, adverse impacts from land subsidence have been caused by groundwater extraction below the Corcoran Clay that has depressurized or dewatered compressible layers within that zone. Managing water levels above historic low levels will be protective against land subsidence. By ensuring that the MT is set above the Corcoran Clay for the Western Lower Principal Aquifer, the MT ensures that any land subsidence that may have already been triggered in the aquifer will not be exacerbated.

These additional sustainability indicators are also analyzed separately in subsequent subsections of **Chapter 6** as referenced in **Table 6-4**. Additional information on how the MTs avoid undesirable results is provided below along with a summary of the process by which the MTs were selected for context.

The interrelatedness of all of the sustainability indicators is recognized throughout the discussions on sustainable management criteria in **Chapter 6**; potential impacts from the land subsidence MT on the remaining applicable [33]sustainability indicators is summarized below.

- The land subsidence MTs are the same MTs used for the chronic lowering of water levels MTs and the reduction of groundwater in storage (see **Section 6.3.2** and **Section 6.4.2**), with an additional backstop of using the top of the Corcoran Clay if shallower than the water level MT. These criteria will affect Subbasin operations

[33] Seawater intrusion indicator is not applicable to the inland Turlock Subbasin and no sustainable management criteria are assigned.

similarly, and MTs for either of the two sustainability indicators do not interfere with management of the other.

- The MTs for reduction of groundwater is storage are identical to the chronic lowering of water levels (see above). As such, the land subsidence MTs do not present conflicts for sustainable management of groundwater in storage (**Section 6.4**).
- The MT for land subsidence supports the degraded water quality indicator. By maintaining water levels at or close to the 2015 water levels, constituents of concern that have increasing concentrations with depth can be avoided (**Section 6.6**).
- The MT for land subsidence is also supportive of the interconnected surface water MTs (**Section 6.8**). The MTs for the two sustainability indicators are based on the same water levels (Fall 2015) along the San Joaquin River and the Tuolumne River. For interconnected surface water along the lower reach of the Merced River, MTs in the Western Upper Principal Aquifer are slightly higher (based on Spring 2014 levels), than MTs in the same area for land subsidence (Fall 2015 levels). However, water levels are sufficiently similar (less than 10 feet) such that water levels could be managed to meet the higher MTs for closely-spaced wells in each GSP monitoring program. In addition, higher water levels would be more protective for potential land subsidence impacts.

These additional sustainability indicators are analyzed separately in subsequent sections of **Chapter 6** as noted above. Additional information on the land subsidence indicator is provided below.

Technical information relating to sustainable management criteria for land subsidence was reviewed by the Joint TACs with an initial public presentation on February 26, 2020, and additional focused discussions on June 25, 2020, meeting where recent InSAR data were available. A draft technical memorandum was prepared for the TACs in July to provide additional details on sustainability indicators including details on land subsidence and associated regulatory requirements. Relevant information from the memorandum has been updated and incorporated into this GSP.

6.7.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Turlock Subbasin MTs impact the ability of an adjacent subbasin to achieve its sustainability goal. Through a series of coordination meetings with adjacent subbasin representatives and review of draft and completed GSPs, the Turlock TACs considered the MTs selected for land subsidence in the three adjacent subbasins including the Merced Subbasin to the south, the Delta-Mendota Subbasin to the west, and the Modesto Subbasin to the north. In brief, the Turlock Subbasin MTs are not expected to either cause undesirable results or affect implementation of adjacent subbasin GSPs as summarized below.

6.7.2.3.1. Merced Subbasin

As documented in its GSP (W&C, 2019), the highest rates of land subsidence in the Merced Subbasin occurred in the southwest, about 25 miles south of the Turlock Subbasin. Subsidence in that area was thought to be caused primarily by groundwater extraction and compaction of clay layers beneath the Corcoran Clay (W&C, 2019). Although the Corcoran Clay is present in the western subbasin adjacent to the Turlock Subbasin, rates of subsidence are much lower. As illustrated in the Merced Subbasin GSP (Figure 2-79 in W&C, 2019) and reproduced in the Turlock Subbasin GSP as **Figure 4-59**, similar rates of subsidence (<0.15 feet/year) occur in each subbasin along both sides of the Merced River. The Merced Subbasin GSP did not set MTs for the lower rates of land subsidence in areas adjacent to the Turlock Subbasin (W&C, 2019).

For the Turlock Subbasin, water levels will be maintained generally above historic low levels (at Spring 2014 levels) adjacent to the Merced Subbasin boundary in accordance with the sustainable management criteria for interconnected surface water (see **Section 6.8**). Even though MTs for land subsidence are slightly lower further inland in the Turlock Subbasin, the higher water levels along the Merced River are protective of land subsidence in both the Turlock Subbasin as well as the Merced Subbasin. Therefore, the land subsidence MTs will not adversely impact the ability of the Merced Subbasin to implement its GSP.

6.7.2.3.2. Delta Mendota Subbasin

As documented in the Northern & Central Delta-Mendota GSP, the Delta-Mendota Subbasin has not experienced significant land subsidence along the shared San Joaquin River boundary with the Turlock Subbasin (see Figure 5-113 *in* W&C and P&P, 2019). For that GSP, land subsidence MTs in the management area adjacent to the Turlock Subbasin were based on an acceptable loss in distribution capacity to be determined in a future study (W&C and P&P, 2019). One close subsidence monitoring station was identified (03-006) adjacent to the Turlock Subbasin on the San Joaquin River, but the MT had not yet been quantified. However, given the protective MTs established for the Turlock Subbasin, no land subsidence would be triggered in the Delta-Mendota Subbasin by Turlock Subbasin MTs.

In addition, both subbasins have set chronic lowering of groundwater levels MTs at or near 2015 levels along the subbasin boundary. In the Delta-Mendota Subbasin, the MTs for chronic lowering of water levels are based on either the historic low water level at representative wells (Upper Principal Aquifer) or 95 percent of the historic low water level (Lower Aquifer). At the time of its GSP (2019), those historic low water levels were typically reached in 2015. As discussed in **Section 6.3.2**, MTs for chronic lowering of water levels are also set at 2015 low water levels in the Turlock Subbasin. By setting these levels to a consistent time period, GSAs can be sure that aquifer conditions can support hydraulic gradients across the boundary similar to gradients in 2015.

Finally, as discussed in **Section 6.3.2.3.2**, the sustainable yield modeling analysis (**Section 5.3**) indicates that a net subsurface outflow occurs from the Turlock Subbasin into the Delta Mendota Subbasin of about 3,500 AFY. This net outflow provides additional evidence that

MTs in the Turlock Subbasin will not adversely impact GSP implementation in the adjacent Delta-Mendota Subbasin.

6.7.2.3.3. Modesto Subbasin

Both the Turlock Subbasin and Modesto Subbasin have approved MTs for interconnected surface water that are based on Fall 2015 water levels along both sides of the Tuolumne River (see **Section 6.8**). In that manner, the two GSPs are coordinating on MTs and avoiding undesirable results for streamflow depletion. Accordingly, MTs in the Turlock Subbasin for land subsidence will not have an adverse impact on GSP implementation in the Modesto Subbasin.

6.7.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

The setting of MTs is protective with respect to the avoidance of undesirable results. However, the MTs place operational constraints on agricultural wells or other water supply wells, especially during long-term multi-year droughts. Agricultural wells in the Western Upper Principal Aquifer have a problem with shallow groundwater and require pumping to drain fields and allow access for farming. Given the small fluctuations in these wells, maintaining water levels at MTs may impose restrictions on drainage well pumping; a management action is being considered to allow shallow groundwater to be pumped in these areas for beneficial uses.

Notwithstanding the constraints placed on various well owners, groundwater users would benefit from the control and mitigation of potential impacts from land subsidence in the future. Those impacts could negatively affect agricultural or urban land uses or other beneficial uses of groundwater as explained in **Section 6.7.1** above.

6.7.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For land subsidence, the MT consists of managing water levels in each representative monitoring well, which would not conflict with other regulatory standards.

6.7.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for land subsidence will be monitored by quantitatively measuring water levels as a proxy in representative monitoring well networks for each applicable Principal Aquifer as described in **Chapter 7** (Monitoring Network) of this GSP. Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and adhere to water level sampling protocols (**Chapter 7**).

For land subsidence, supplemental monitoring is also planned. To provide a backstop for the uncertainties associated with future rates and extents of land subsidence, the GSAs also intend to monitor the Subbasin annually using the DWR-published InSAR data that covers the entire subbasin. Additional analysis would be needed to determine whether any InSAR-indicated land subsidence, especially small rates within the uncertainty of the method, represent actual inelastic land subsidence associated with groundwater extraction in the Subbasin. Data from existing GPS stations will also be incorporated in the annual analysis as available. Collectively, these supplemental monitoring analyses will serve as screening tools to identify optimal locations for future GPS stations to be added to the GSP monitoring network, as needed.

6.7.3. Measurable Objectives for Land Subsidence

The same approach for setting MOs for chronic lowering of water levels is used for land subsidence MOs, which are also established at the same representative monitoring sites. That approach involves the midpoint between the MT and the historical high water level (WY 1991 – WY 2015). An additional qualifier is added to the MO definition for the Western Lower Principal Aquifer and applies to all representative monitoring wells that use the top of the Corcoran Clay as the MT (when 2015 groundwater elevations are lower than the top of the Corcoran Clay - see **Section 6.7.2** above).

In that case, the average between the top of the Corcoran Clay and an estimated historic high groundwater level may result in a MO closer than 20 feet from the top of the Corcoran Clay. As a more protective measure for land subsidence in the Western Lower Principal Aquifer – the aquifer most susceptible for causing land subsidence – the MO is designated to be no lower than 20 feet above the clay.

Based on this information the definition of measurable objectives for the land subsidence sustainability indicator is as follows.

Table 6-14: Measurable Objectives for Land Subsidence

	Measurable Objectives	Principal Aquifer(s)
Land Subsidence	Measurable objectives are the midpoint between the MT and the high groundwater elevation observed over the historical study period WY 1991 – WY 2015 at each representative monitoring site for each principal aquifer. For any future representative monitoring site with an MT set at the top of the Corcoran Clay (when shallower than the 2015 water level), the MO will be set as above, but no less than 20 feet above the MT.	All

6.8. Depletion of Interconnected Surface Water

SGMA defines an undesirable result for the interconnected water sustainability indicator as "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water." (§10721 (x)(6)). For the Turlock Subbasin, the Tuolumne, Merced, and San Joaquin rivers are all interconnected surface water. Along these boundary rivers, groundwater occurs above the channel invert elevation on an average basis, allowing groundwater to interact with surface water (**Figure 6-1**).

Beneficial uses of these rivers are provided in the Basin Plan for the Sacramento River Basin and the San Joaquin River Basin (CVRWQCB, 2018). All three rivers are associated with almost all categories of beneficial uses including municipal (potential uses), agricultural, and/or industrial supply; recreation; freshwater habitat, migration, and spawning; and wildlife habitat. The rivers also support large riparian corridors. A preliminary evaluation of vegetative and wetland areas mapped by TNC as natural communities commonly associated with groundwater indicates potential GDEs along most of the river reaches in the Turlock Subbasin (DWR, 2018d) (see **Section 4.3.8**).

For the Tuolumne and Merced rivers, GSA member agencies TID and Merced ID operate upstream reservoirs and hold surface water rights on these rivers, respectively. The districts provide local management of surface water resources including diversions and conveyance, primarily for agricultural irrigation. Agency experience was used to guide the analysis of streamflow depletions and undesirable results. Both TID and Merced ID contributed to the information and data used in the integrated surface water-groundwater modeling (C2VSimTM) of streamflow depletion under historical, current, and projected future water budgets (see **Chapter 5**).

The undesirable results, including causes and impacts to beneficial uses, are described in **Section 6.8.1** below, with a definition of undesirable results at the end of the section, along with additional criteria to quantify where and when undesirable results occur. **Section 6.8.2** describes the quantification of minimum thresholds (MTs). **Section 6.8.3** provides the approach and selection of measurable objectives (MOs). Interim milestones that cover all of the sustainability indicators are described in **Section 6.9**.

6.8.1. Undesirable Results for Interconnected Surface Water

Analyses of groundwater conditions and water budget modeling in the Turlock Subbasin highlight the linkages between groundwater extractions, reduction of groundwater in storage, and interconnected surface water. In its Water Budget BMP, DWR notes that increases in groundwater extraction will initially result in a decline in groundwater in storage. However, over time, this decline in storage will be ultimately balanced by decreases in groundwater flow to streams (DWR, December 2016). This condition induces groundwater recharge from the rivers. Although beneficial to water levels and storage, this increase in recharge removes water from the rivers, leading to potential impacts on beneficial uses of surface water including surface water rights holders, instream habitat, and potential GDEs.

The model has demonstrated the linkage between streamflow depletions and declining water levels in water supply wells near the river. This linkage indicates that water levels can be used as a proxy for monitoring surface water-groundwater interaction over time.

Although these interactions are best measured with a series of shallow monitoring wells adjacent to and transitioning away from the river, such monitoring wells do not currently exist along the Tuolumne and Merced rivers (see **Section 7.1.6**, **Table 7-2**, and **Figure 7-5**). However, current GSP monitoring wells have been demonstrated to be connected directly to the rivers and are screened in aquifers where extractions have led to streamflow depletion. As such, current wells, when combined with coordinated annual groundwater modeling, are likely to be sufficient for monitoring surface water-groundwater conditions in the short term. A management action to improve the monitoring network provides for additional shallow monitoring wells to be installed along the rivers over time (**Chapter 8**).

6.8.1.1. Causes of Undesirable Results

In the Turlock Subbasin, groundwater extractions have created a cone of depression in the east-central Subbasin that caused most of the decline in groundwater in storage under historical conditions (see **Figure 6-1**; see also **Table 5-6** and **Figure 4-30a**). Over time, the cone has expanded to the north and south toward the Tuolumne and Merced river boundaries, intercepting groundwater that would otherwise have flowed toward the rivers. This condition is exacerbated with local groundwater pumping from wells along the river. As the cone of depression expands along the river boundaries (especially along the Merced River), lower water levels are predicted to induce additional recharge from the rivers, which increases the depletion of streamflow.

The combination of local pumping near the rivers and the expansion of the cone of depression that intercepts the rivers have caused the potential for future undesirable results along both the Tuolumne and the Merced rivers. If not arrested, the groundwater system could become disconnected from the rivers, especially along the Merced River where water levels are low compared to the river channel. This change for each of the three river boundaries is presented in **Table 5-7**, where the net seepage from the rivers (which represents streamflow depletion) increases from an overall negative number (groundwater contributions to the river) for the Tuolumne River and San Joaquin River to a positive number on those rivers, reflecting an increase in recharge and streamflow depletion. The Merced River is already a net losing river (positive number) under both historical and projected future conditions (compare gains from and discharges to the Merced River on **Table 5-17**).

Operations of the river have become more difficult with increases in streamflow depletion. Merced ID notes that more water will have to be released to meet the same downstream flows at the compliance point on the Merced River than in the recent past. Both TID and Merced ID noted concerns over decreases in baseflow during low flow conditions in the river and potential impacts to habitat and other environmental uses. The Ad Hoc Committee recommended, and the Joint TACs agreed, that disconnection from the groundwater system would be an undesirable result and noted potential resulting adverse impacts on riparian vegetation, habitat, and GDEs.

GSAs are not required to correct undesirable results that occurred prior to January 1, 2015. Conditions leading to undesirable results for this indicator in the Turlock Subbasin resulted from the overall increases in Subbasin pumping that have occurred over time in the Subbasin. The Joint TACs want to keep these conditions from getting worse in the future. In this manner, future streamflow depletion will be less than predicted and connection between the groundwater and surface water system will be maintained along each of the three river boundaries.

6.8.1.2. Potential Effects on Beneficial Uses

As noted above, the future projected increases in streamflow depletion would have negative impacts on both surface water rights holders and environmental beneficial uses. Operation of the river would become more difficult, especially during low-flow conditions. Riparian habitat and GDEs would be negatively affected. If the rivers became disconnected GDEs would lose their water supply and other downstream beneficial uses reliant on flow requirements could also be adversely impacted.

6.8.1.3. Turlock Subbasin Definition of Undesirable Results

Based on the discussion of undesirable results above and information in the basin setting, a definition of undesirable results has been developed for interconnected surface water in the Turlock Subbasin.

Regulations also require that the undesirable result definition include quantitative criteria used to define when and where groundwater conditions can cause an undesirable result (§354.26(b)(2)). These criteria address the number of monitoring sites and events that an MT can be exceeded before causing an undesirable result. This framework builds on the narrative definition and recognizes that a single MT exceedance at one monitoring site may not indicate an undesirable result. This framework also allows clear identification for when an undesirable result is triggered under the GSP.

The definition of undesirable results along with the quantitative combination of MT exceedances that cause undesirable results are provided as follows.

Table 6-15: Undesirable Results for Interconnected Surface Water

	Undesirable Results Definition	Principal Aquifer(s)
Interconnected Surface Water	Undesirable results for interconnected surface water are defined as significant and unreasonable adverse impacts on the beneficial uses of surface water caused by groundwater extractions. An undesirable result will occur on one of the three monitored rivers when 50% of the representative monitoring sites for that river exceed the MT in two consecutive Fall monitoring events. The 50% criterion is based on the relatively small number of wells in the initial GSP monitoring network; additional wells are planned. The criterion may be adjusted downward after the number of interconnected surface water monitoring sites has been finalized.	All

As indicated above, MT exceedances of one half of the representative monitoring wells on each river will constitute an undesirable result. As noted, the 50 percent criterion is used because of the relatively small number of representative monitoring wells available for the GSP network along each river. The total number of current wells and the number of MT exceedances is summarized below and shown on **Figure 7-5**.

- San Joaquin River: 3 wells (50% - 2 wells)
- Tuolumne River: 3 wells (50% - 2 wells)
- Merced River: 6 wells (50% - 3 wells)

Additional wells are planned for interconnected surface water monitoring. A Management Action to improve the GSP monitoring networks (**Chapter 8**) includes plans for installation of shallow wells along the river and inland to establish local gradients. Once these wells are installed, the 50 percent criterion may be adjusted.

The limitation for exceeding the MT is limited to two consecutive Fall events (semi-annual monitoring). Spring events will be monitored but not used in the criterion because of the increase in water levels associated with Spring events would not be representative of potential negative impacts during low flows on the rivers.

6.8.2. Minimum Thresholds for Interconnected Surface Water

GSP regulations require the MTs to be "the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results" (§354.28(c)(6)). As explained in **Section 6.8.2.1**, the predicted increase in streamflow depletion is caused by lowering of water levels. Therefore, specific water levels can be directly correlated to levels of streamflow depletion as a proxy for interconnected surface water MTs.

The increase in streamflow depletions from historical conditions (average WY 1991 through WY 2015) to sustainable yield conditions is approximately 48,000 AFY, only about two percent of the total surface water outflows from the Subbasin (see **Section 5.3** and **Tables 5-7 and 5-17**). By selecting MTs at or above 2015 conditions, as was tested in the sustainable yield modeling, the increase in streamflow depletions to avoid undesirable results can be tracked with groundwater elevation monitoring. As discussed in more detail in **Section 5.3**, sustainable yield modeling controlled groundwater elevations at Spring 2014 levels for the Merced River and at Fall 2015 levels for the San Joaquin and Tuolumne rivers as indicated in the table as follows.

Table 6-16: Minimum Thresholds for Interconnected Surface Water

	Minimum Thresholds	Principal Aquifer(s)
Interconnected Surface Water	For the Merced River, the MT will be expressed as the groundwater elevation observed in Spring 2014 at each representative monitoring site. For the Tuolumne River and San Joaquin River, the MT will be expressed as the low groundwater elevation observed in Fall 2015 at each representative monitoring site.	Western Upper and Eastern Principal Aquifers

6.8.2.1. Justification and Support for Minimum Thresholds

GSP regulations require that the MTs be supported by:

- Location, quantity, and timing of depletions of interconnected surface water
- A description of the groundwater and surface water model used to quantify surface water depletion (§354.28(c)(6)(A)(B)).

The location, quantity, and timing of deletions were analyzed using the integrated surface water-groundwater model C2VSimTM. The local model is based on the regional C2VSim model, which has been revised to include local water budget data for both the Turlock and Modesto subbasins. In addition, local detailed data used for the GSP in the Merced Subbasin was also incorporated into the modeling analysis. These revisions provided increased ability and accuracy for modeling interconnected surface water across Turlock Subbasin north and south river boundaries. The documentation of the revised C2VSimTM model is provided in **Appendix D** of this GSP; interconnected surface water analysis is described in **Chapter 5**. Background information for the interconnected surface water analysis is provided in **Section**

4.3.7, followed by a preliminary analysis of potential GDEs, which occur along the river boundaries (**Section 4.3.8** and **Figure 4-64**).

Interconnected surface water was analyzed with historical, current, and future projected water budgets (**Chapter 5**) including separate average annual water budgets for the Turlock Subbasin surface water systems (see **Table 5-2**). Total surface water inflows to the Subbasin historically have averaged about 2,342,500 AFY with an estimated 2,563,800 AFY inflow under future projected water budget conditions (**Table 5-2**).

Sustainable yield modeling (**Section 5.3**) was conducted to test the groundwater level MTs selected for interconnected surface water (Fall 2015 levels for the Tuolumne and San Joaquin rivers and Spring 2014 for the Merced River). Model results indicated that the San Joaquin and Tuolumne rivers remained net gaining rivers over the implementation and planning horizon. In addition, all three rivers remained interconnected with the groundwater system with the MTs selected above. The MTs improved surface water conditions over the projected future water budgets.

The comparison of streamflow depletions in the projected future conditions and the sustainable yield conditions are summarized in **Table 6-17** below. For this presentation, positive numbers represent the net amount of water that is depleted from the surface water (net seepage to groundwater) on an average annual basis. Negative numbers represent contributions of groundwater to the surface water system (baseflow).

Table 6-17: Sustainable Yield Improvements to Interconnected Surface Water compared to Projected Future Baseline Conditions

Turlock Subbasin Surface Water	Projected Future Conditions (AFY)	Sustainable Yield Conditions (AFY)	Improvement* of Projected Conditions	
			(AFY)	(%)
Total GW-SW Interaction	38,400	-8,900	47,300	123%
San Joaquin	-28,100	-33,800	5,700	20%
Tuolumne	6,200	-16,200	22,400	361%
Merced	60,300	41,100	19,200	32%

Positive numbers represent a net recharge from surface water (SW) to groundwater (GW) (i.e., streamflow depletion) over average hydrologic conditions.
Negative numbers represent a net contribution to surface water (SW) from groundwater (GW) (i.e., net baseflow, also referred to as a net gaining river) over average hydrologic conditions.
**"Improvement" means less streamflow depletion under sustainable yield conditions.*

As shown in the table, streamflow depletion in the Turlock Subbasin rivers is estimated at 38,400 AFY under the projected future conditions with most of the depletion occurring on the Merced River. Under sustainable yield conditions, which incorporated the MTs, the streamflow depletion of 38,400 AFY is eliminated, and the overall surface water system becomes a net gaining (negative number) system with a larger contribution from groundwater than recharge to groundwater. Sustainable yield shows an improvement of 47,300 AFY (see more details in **Section 5.3**).

The largest improvement for sustainable yield conditions over projected future conditions is for the Tuolumne and Merced rivers, both of which see about 20,000 AFY less streamflow depletion than projected under future conditions.

6.8.2.2. Relationship between MTs of Each Sustainability Indicator

Regulations require a description of the relationship between the MTs for each sustainability indicator and how the GSAs have determined that basin conditions at each MT will avoid undesirable results (§354.28(b)(2)). **Table 6-4** summarizes the MTs for all sustainability indicators for reference.

The use of water levels as a proxy for interconnected surface water correlates well with the other sustainability indicators, most of which are also tied to water levels. The relationship between the MTs for interconnected surface water and the other MTs are summarized below:

- MTs for interconnected surface water are the same as those selected for the chronic lowering of water levels along the San Joaquin River and Tuolumne River and more protective along the Merced River. As such, MTs for chronic lowering of water levels and the San Joaquin and Tuolumne rivers are based on the same groundwater elevation surface (**Figure 6-1**). Although the higher MTs on the Merced River may be more difficult to maintain, the criteria provide sufficient flexibility so as to not cause conflicts for compliance (see **Section 6.3.2.2** and **Table 6.4**). The monitoring wells for chronic lowering of water levels and interconnected surface water do not overlap, allowing for a relatively smooth transition from MTs in the inland Subbasin to MTs along the rivers (see monitoring networks for both indicators in **Chapter 7**).
- MTs for reduction of groundwater in storage are the same as those for the chronic lowering of water levels and interact with MTs for interconnected surface water in the same manner as discussed above (see also **Section 6.5**).
- MTs have not been selected for the Seawater Intrusion indicator because it is not applicable to the inland Turlock Subbasin (see **Section 6.5**).
- MTs for interconnected surface water will not affect water quality and, as such, will not conflict with degraded water quality MTs. In addition, by maintaining water levels at or above the historic low levels along the rivers, groundwater will continue to contribute fresh water to the rivers and will not be degraded by lower quality water at depth. (**Section 6.6**).

- The MTs for chronic lowering of water levels are used as a proxy for land subsidence. As such, the interaction between the MTs for land subsidence and interconnected surface water are the same as the interaction described for chronic lowering of groundwater levels MTs described in the first bullet above (see also **Section 6.7**).

Projected water budgets were developed for the Subbasin with data and assistance from TID and Merced ID on water availability, reservoir operations, and surface water use over the 50-year implementation and planning horizon. GDEs were evaluated concurrently and presented to the Joint TACs at a public meeting November 5, 2020. Results from the projected water budget analysis indicate future increases in streamflow depletion, especially along the Merced River.

The Ad Hoc Committee focused on interconnected surface water to determine the potential for future undesirable results. Merced ID and TID assisted the committee and the technical team with operational considerations, information on undesirable results, and the selection of MTs. The committee determined that streamflow depletion associated with the projected future conditions for the Tuolumne and Merced rivers would be an undesirable result. The committee also wanted to avoid future disconnection between the surface water and groundwater beneath the Merced River. Water levels were linked to projected depletions and were discussed as a proxy for avoiding disconnection. The technical team conducted several modeling simulations to develop and test various MTs along the rivers and the selected MTs were found to significantly reduce future streamflow depletions . MTs were recommended for use in the GSP by the Joint TACs at a public meeting on June 10, 2021.

6.8.2.3. Impacts of MTs on Adjacent Subbasins

Regulations require consideration of how Turlock Subbasin MTs impact the ability of adjacent subbasins to achieve its sustainability goal. Through a series of coordination meetings with adjacent subbasin representatives and review of draft and completed GSPs, the Turlock TACs considered the MTs selected for interconnected surface water in the three adjacent subbasins including Merced Subbasin to the south, Delta-Mendota Subbasin to the west, and Modesto Subbasin to the north. In brief, the Turlock Subbasin MTs are not expected to either cause undesirable results or affect implementation of adjacent subbasin GSPs as summarized below.

6.8.2.3.1. Merced Subbasin

In the Merced Subbasin GSP, the sustainable management criteria for chronic lowering of groundwater levels are used as a proxy for interconnected surface water. Accordingly, the MT, MO, and undesirable result definition are all the same as chronic lowering of water levels. As mentioned in **Section 6.4.2.3.1** above, the MTs closest to the Turlock Subbasin boundary are generally lower than the MTs in the Turlock Subbasin.

The Turlock Subbasin TACs coordinated with Merced ID, as the holder of surface water rights on the Merced River, to determine acceptable levels of streamflow depletion. Based on input from Merced ID, Spring 2014 groundwater levels were selected as MTs for interconnected surface water along the Merced River in the Turlock Subbasin. Sustainable yield modeling indicated a 32 percent improvement in streamflow depletion compared to projected future conditions (**Table 6-2**).

The sustainable yield modeling analysis (**Section 5.3**) indicates a net subsurface inflow of 12,300 AFY into the Turlock Subbasin from the Merced Subbasin under sustainable management conditions (compare Merced Subbasin inflows and outflows for sustainable conditions on **Table 5-17**). However, that amount is much less than under historical conditions, which indicated a net inflow into the Turlock Subbasin of 45,000 AFY from the Merced Subbasin. Collectively, the improved condition of subsurface flow, as well as the Turlock Subbasin MTs that set water levels higher along the Merced River for interconnected surface water, indicate that the Turlock Subbasin will not prevent successful GSP implementation by the Merced Subbasin.

6.8.2.3.2. Delta-Mendota Subbasin

The Delta-Mendota Northern & Central GSP defines undesirable results for interconnected surface water as a percentage increase in streamflow depletions that is to be determined within the first five years of GSP implementation. A quantitative MT is not set due to insufficient data. The data to be incorporated into the evaluation will be collected from two wells along the San Joaquin River adjacent to the Turlock Subbasin (see wells 03-001 and 03-003 on GSP Figure 6-7 *in* W&C and P&P, 2019). In the interim, the GSP selects a narrative MO, which states “no increased depletions of surface water occur as a result of groundwater pumping.” (W&C and P&P, 2019).

In the absence of a quantitative MT for interconnected surface water, the MT for the Turlock Subbasin seems sufficiently high as not to prevent the Delta-Mendota Subbasin from achieving its sustainability goal. As mentioned previously, MTs for chronic lowering of water levels have been set similarly in both subbasins adjacent to the San Joaquin River. Sustainable yield modeling shows that MTs for the San Joaquin River in the Turlock Subbasin are correlated to conditions that contribute net baseflow volumes to the river of 33,800 AFY (**Table 6-2**), an amount within 12 percent of the average historical net baseflow of 38,500 AFY (subtract outflows from inflow for the San Joaquin River on **Table 5-6**); this represents an improvement of about 20 percent over future projected baseline conditions estimate of 28,100 AFY of baseflow (see **Table 6-2**). With this contribution to baseflow and MTs from 2015 conditions on both sides of the river, the MT for interconnected surface water in the Turlock Subbasin would not be expected to negatively impact implementation of the Delta-Mendota Northern & Central GSP.

6.8.2.3.3. Modesto Subbasin

The TAC in the Modesto Subbasin has approved using Fall 2015 water levels as the MT for interconnected surface water in coordination with the Turlock Subbasin. Sustainable yield modeling in both subbasins indicate similar net contributions to baseflow on both sides of the river (16,200 AFY from Turlock Subbasin and 11,000 AFY from Modesto Subbasin).

6.8.2.4. Effects of MTs on Beneficial Uses and Users of Groundwater

The setting of MTs is protective with respect to the avoidance of undesirable results. By arresting groundwater level declines along the river boundaries, future projected streamflow depletions can be partially mitigated, and long-term use of groundwater can become more sustainable. Environmental uses of surface water and groundwater would be supported.

However, there will be consequences on current uses of groundwater. The MTs will not be able to be achieved without sufficient projects or management actions to raise and maintain water levels along the Subbasin river boundaries. This will require significant investment in projects to replenish the groundwater basin. Property interests would be impacted if significant demand reduction is required to meet the Subbasin sustainability goal.

6.8.2.5. Consideration of State, Federal, or Local Standards in MT Selection

GSP regulations require that GSAs consider how the selection of MTs might differ from other regulatory standards. For interconnected surface water, the MT consists of water levels quantified for each representative monitoring well. Surface water rights holders – Merced ID for the Merced River and TID for the Tuolumne River – estimate that the MTs set will not adversely impact surface water rights and will allow for compliance with state and federal requirements. Accordingly, there are no conflicts with regard to other regulatory standards.

6.8.2.6. Quantitative Measurement of Minimum Thresholds

As stated above, the MTs for interconnected surface water will be monitored by quantitatively measuring water levels in representative monitoring well networks for each applicable Principal Aquifer as described in **Chapter 7** (Monitoring Network) of this GSP (see **Section 7.1.6**, **Table 7-2,** and **Figure 7-5**). Monitoring will occur on a semi-annual basis, in Spring and Fall, to represent the seasonal high and low water level and adhere to water level sampling protocols (**Chapter 7**).

6.8.3. Measurable Objectives for Interconnected Surface Water

As used for other sustainability indicators above, the MO for interconnected surface water is set as the midpoint between the high groundwater elevation and the MT in each of the representative monitoring wells established for this indicator. As explained in **Section 6.3.3**, the MTs represents a “floor” for maintenance of low water levels, with allowance for short-term exceedances during droughts. Accordingly, water levels will be managed over an operational range generally occurring between the MT (with temporary exceedances in drought) and anticipated high water levels that occur during wet periods.

Table 6-18: Measurable Objectives for Interconnected Surface Water

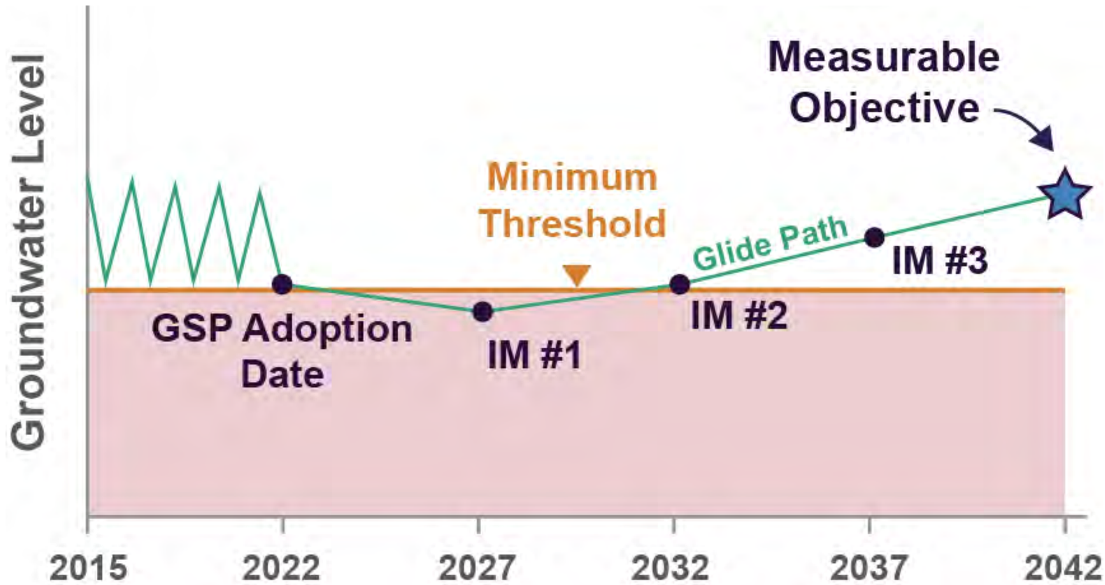
	Measurable Objectives	Principal Aquifer(s)
Interconnected Surface Water	Measurable objectives are established at the midpoint between the MT and the high water level observed over the historical Study Period WY 1991 – WY 2015 at each representative monitoring site for each river boundary.	Western Upper and Eastern Principal Aquifers

6.9. Interim Milestones

GSP regulations define interim milestones (IM) as "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan." For the Turlock Subbasin, water levels are used as a metric for the IMs, consistent with the metric being used for MTs and MOs for all sustainability indicators except degraded water quality.

IMs provide a glide path for the Turlock Subbasin to reach its sustainability goal. The incremental approach recognizes that the path to sustainability is determined by the timing and effectiveness of GSP implementation, including projects and management actions designed to manage water levels to avoid undesirable results. For the Turlock Subbasin, a glide path provides needed flexibility for areas of the Subbasin that will continue to decline – at rates dependent on future hydrologic conditions – until projects and management actions are implemented.

The following graphic prepared by DWR illustrates the concept of how IMs relate to the MT and MO. As shown, the IMs provide a glide path to sustainable management whereby MTs and MOs are maintained to avoid undesirable results.



In this conceptual graphic, the pink area represents water levels below the MT for a representative monitoring well (i.e., an MT exceedance). In this example, water levels are expected to continue to decline after the GSP is adopted as projects are being brought online. This concept acknowledges that the aquifer response to projects and management actions will take time. Interim milestones are illustrated in increments of five years following Plan adoption to define the glide path from undesirable results to the MO and achieving sustainable management by 2042.

In the Turlock Subbasin, long-term declines have occurred in the Eastern Principal Aquifer where groundwater has been the primary source of agricultural water supply (**Figure 6-1**). In addition, a few wells in the western principal aquifers have not yet fully recovered from 2014-2017 drought conditions and may be below or fall below MTs during GSP implementation. Accordingly, 2027 target values below the MT have been developed for all wells in the Eastern Principal Aquifer and selected wells in the western principal aquifers, as needed.

The amount of the anticipated declines between adoption and 2027 is dependent on future unknown hydrologic conditions. Since the establishment of 2014 or 2015 water levels as the MTs (depending on the sustainability indicator), dry hydrologic conditions have persisted in the Subbasin. Water year types as categorized by the DWR San Joaquin Valley indices since 2014 are summarized in the following table.

Table 6-19: Water Year Hydrologic Classification Indices Since 2015

Water Year	Water Year Type San Joaquin Valley Water Year Index
2014	Critically Dry
2015	Critically Dry
2016	Dry
2017	Wet
2018	Below Normal
2019	Wet
2020	Dry

Source: https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

As shown in the table, five out of seven water years between WY 2014 and WY 2020 have been categorized as below normal, dry, or critically dry. Water level declines associated with the last seven years may continue if hydrologic conditions do not improve, and/or if the aquifer response to GSP project implementation is delayed.

In order to plan for a worst-case scenario, a 2027 IM has been developed for Eastern Principal Aquifer wells based on the declines observed over the last seven years. By 2032, project implementation is expected to support water level recovery and the 2032 IM is set as the MT. If needed, the IM for 2037 is defined as the halfway point between the MT and MO. This trajectory is similar to the DWR conceptual diagram illustrated above. The 2027 IMs are provided in **Chapter 7** (see **Tables 7-1** and **7-2**) and shown on the hydrographs in **Appendix G**.

Most wells in the western principal aquifers have already recovered above the MTs and do not appear to need the flexibility for IMs to be set below the MT. While it is possible that continual declines in some areas might affect wells that have already recovered, it will take some time for the ongoing declines to propagate across the Subbasin. In the interim, one GSP project is anticipated to support water levels in the Western principal aquifers because it allows urban pumping to be immediately decreased as treated surface water is supplied for municipal drinking water.

This project, referred to as the Regional Surface Water Supply Project, has been in development for several years and is already being implemented (details of this project are in **Chapter 8**). Water supply is scheduled to begin in 2023 (SRWA, 2021). This project will raise water levels in the western principal aquifers and provide protection for avoiding undesirable results until water levels in the Eastern Principal Aquifer can respond to additional GSP projects.

IMs have been designated conservatively on an as needed basis but will not be used to defer implementation of GSP projects or management actions. Other projects and/or management actions may also be needed during the first five years of GSP implementation to avoid undesirable results near wells if water levels reach the IMs. Project development has been expedited, with a Programmatic CEQA analysis already underway for environmental compliance.

6.10. SUSTAINABLE MANAGEMENT CRITERIA AND ADAPTIVE MANAGEMENT

Collectively, the sustainable management criteria discussed in the sections above provide a robust set of criteria to avoid undesirable results and achieve the Turlock Subbasin sustainability goal. Sustainable management criteria are summarized in **Table 6-20**, including the definition of undesirable results, minimum thresholds (MTs) and measurable objectives (MOs) for all sustainability indicators applicable to the Turlock Subbasin GSP.

Turlock Subbasin GSAs note that this initial sustainable management criteria employs new SGMA terminology and represents reasonable estimates for sustainable management of groundwater through the planning horizon. Nonetheless, it is recognized that sustainable management criteria – including the definition of undesirable results – may require adjustment in the future.

Improvements to the GSP monitoring network including new installations of monitoring wells are incorporated into this GSP. As the GSAs implement the GSP and monitoring network, additional information will be routinely compiled and analyzed to evaluate aquifer response to the initial sustainable management criteria. GSAs recognize that monitoring results may indicate that the initial undesirable results definition and MTs require adjustment in the future. Actual MTs that lead to undesirable results may be higher or lower than those selected in **Table 6-20** as projects and management actions are implemented. Consistent with the concept of adaptive management, the GSAs will re-evaluate the criteria in the five-year assessment of the GSP and make appropriate adjustments to ensure that the Subbasin meets its sustainability goal within the GSP implementation period as required.

Table 6-20: Sustainable Management Criteria Summary

Sustainability Indicator	Undesirable Result Definition		Minimum Thresholds (MTs)	Measurable Objectives (MOs)	Principal Aquifers	GSP Section
	Narrative	Quantitative				
Chronic Lowering of Water Levels	An undesirable result is defined as significant and unreasonable groundwater level declines such that water supply wells are adversely impacted during multi-year droughts in a manner that cannot be readily managed or mitigated.	An undesirable result for each principal aquifer will occur when at least 33% of representative monitoring wells exceed the MT for that principal aquifer in 3 consecutive Fall semi-annual monitoring events.	Low groundwater elevation observed in Fall 2015 at each representative monitoring site for each principal aquifer.	Midpoint between the MT and the high groundwater elevation observed over the historical Study Period WY 1991 - WY 2015 at each representative monitoring site for each principal aquifer.	All Principal Aquifers	6.3
Reduction of Groundwater in Storage	An Undesirable result is defined as significant and unreasonable reduction of groundwater in storage that would occur if the volume of groundwater supply is at risk of depletion and/or may not be accessible for beneficial use. An Undesirable Result is also defined as long-term overdraft, based on projected water use and average hydrologic conditions.	An undesirable result will occur for each principal aquifer when at least 33% of representative monitoring wells exceed the MT for that principal aquifer in 3 consecutive Fall semi-annual monitoring events.	Low groundwater elevation observed in Fall 2015 at each representative monitoring site for each principal aquifer.	Midpoint between the MT and the high groundwater elevation observed over the historical Study Period WY 1991 - WY 2015 at each representative monitoring site for each principal aquifer.	All Principal Aquifers	6.4
Seawater Intrusion	Not applicable to the Turlock Subbasin (N/A)	N/A	N/A	N/A	N/A	6.5
Degraded Water Quality	An Undesirable Result is defined as significant and unreasonable adverse impacts to groundwater quality caused by GSA projects, management actions, or management of groundwater levels or extractions such that beneficial uses are affected and well owners experience an increase in operational costs.	An undesirable result will occur when a new (first-time) exceedance of an MT is observed in a potable water supply well in the representative monitoring network that is caused by GSA management activities as listed at left.	Minimum thresholds are set as a new (first-time) exceedance of a drinking water quality standard (primary or secondary MCL) in a potable supply well in the representative Monitoring network for any of the Subbasin constituents of concern as listed below: Nitrate (as N) - 10 mg/L Arsenic - 10 ug/L Uranium - 20 pCi/L Total dissolved solids - 500 mg/L 1,2,3-TCP - 0.005 ug/L PCE - 5 ug/L.	No increase above the maximum historical concentration for any constituent of concern in a potable water supply well in the GSP monitoring program caused by GSA management activities.	All Principal Aquifers	6.6
Land Subsidence	An Undesirable Result is defined as significant and unreasonable inelastic land subsidence, caused by groundwater extraction and associated water level declines, that adversely affects land use or reduces the viability of the use of critical infrastructure.	An undesirable result will occur in the Western Upper Principal Aquifer when 33 percent of representative monitoring wells exceed the MT in 3 consecutive Spring monitoring events.	Low groundwater elevation observed in Fall 2015 at each representative monitoring site.	Midpoint between the MT and the high groundwater elevation observed over the historical Study Period WY 1991 - WY 2015 at each representative monitoring site.	Western Upper Principal Aquifer	6.7
		An undesirable result will occur in the Western Lower Principal Aquifer when 33 percent of representative monitoring wells exceed the MT in 2 consecutive Spring monitoring events.	Low groundwater elevation observed in Fall 2015 or the elevation on the top of the Corcoran Clay, whichever is shallower, at each representative monitoring site.	Midpoint between the MT and the historical high groundwater elevation at each representative monitoring site as above. If MT is set as the top of the Corcoran Clay (when shallower than the 2015 water level MT), the MO will be set as above, but no less than 20 feet above the Corcoran Clay.	Western Lower Principal Aquifer	6.7
		An undesirable result will occur in the Western Upper Principal Aquifer when 33 percent of representative monitoring wells exceed the MT in 3 consecutive Fall monitoring events.	Low groundwater elevation observed in Fall 2015 at each representative monitoring site.	Midpoint between the MT and the high groundwater elevation observed over the historical Study Period WY 1991 - WY 2015 at each representative monitoring site.	Eastern Principal Aquifer	6.7
Interconnected Surface Water	An Undesirable Result is defined as significant and unreasonable adverse impacts on the beneficial uses of surface water caused by groundwater extraction.	An undesirable result will occur on one of the three monitored rivers when 50 percent of representative monitoring wells for that river exceed the MT in two consecutive Fall monitoring events. The 50 percent criterion is based on the limited number of monitoring wells in the current monitoring network; additional wells are planned for the future. The percent criterion may be adjusted downward when the network has been finalized.	For the **San Joaquin River**, low groundwater elevation observed in Fall 2015 at each representative monitoring site.	Midpoint between the MT and the high groundwater elevation observed during the historical Study Period SY 1991 - WY 2015 at each representative monitoring site.	Western Upper Principal Aquifer	6.8
			For the **Tuolumne River**, low groundwater elevation observed in Fall 2015 at each representative monitoring site.		Eastern Principal Aquifer and Western Upper Principal Aquifer	6.8
			For the **Merced River**, the groundwater elevation observed in Spring 2014 at each representative monitoring site.		Eastern Principal Aquifer and Western Upper Principal Aquifer	6.8

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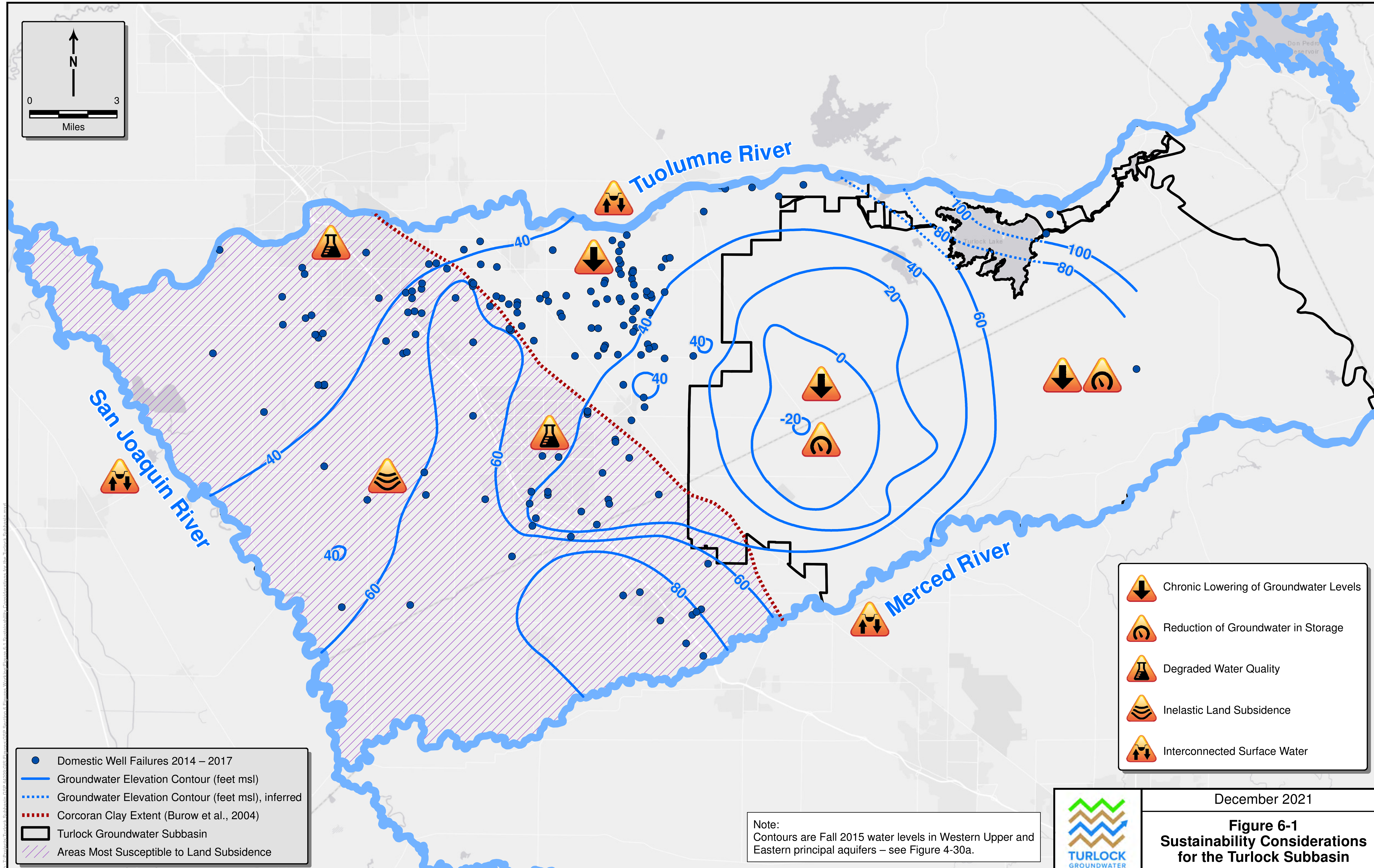

December 2021

Figure 6-1
Sustainability Considerations for the Turlock Subbasin

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7. MONITORING NETWORKS

The overall objective of the monitoring network for this Groundwater Sustainability Plan (GSP) is to yield representative information about groundwater conditions to guide and evaluate GSP implementation. Specifically, the GSP monitoring network is designed to:

- Evaluate groundwater conditions relative to sustainability indicators.
- Monitor for minimum thresholds to avoid undesirable results.
- Track interim milestones and measurable objectives to demonstrate progress on reaching sustainability goals for the Subbasin.
- Expand the existing monitoring network to better represent the entire Subbasin and address data gaps.
- Reduce uncertainty and provide better data to guide management actions, document the water budget, and improve understanding of the interconnection of surface water and groundwater.
- Identify and track potential impacts on beneficial uses and users of groundwater.

This GSP builds on existing monitoring programs with the intent to provide sufficient data for demonstrating short-term, seasonal, and long-term trends in groundwater levels. Existing monitoring programs include the CASGEM monitoring program, public water supplier groundwater monitoring programs in the cities and community service districts, agricultural area monitoring programs, and the Irrigated Lands Regulatory Program. These existing monitoring programs are described in **Section 2.4**. Additional monitoring wells to address data gaps and improve the GSP network will be added as described in **Section 7.1**. Further refinements to the monitoring networks may be made as data become available during implementation as discussed in **Chapter 8**.

The following sections summarize the monitoring network. **Section 7.1** describes the monitoring network for each sustainability indicator. **Section 7.2** provides protocols for data collection and monitoring. **Section 7.3** describes how the monitoring network will be assessed and improved. **Section 7.4** summarizes the data management system (DMS) for data collected from the monitoring network. Figures and tables for **Chapter 7** are provided at the end of the text to minimize interruption and facilitate multiple references to each table or figure.

7.1. DESCRIPTION OF MONITORING NETWORK

Groundwater level monitoring networks were developed for the chronic lowering of groundwater levels, reduction of groundwater in storage, land subsidence, and depletions of interconnected surface water. The applicability and rationale for using groundwater elevations to monitor each of these four sustainability indicators is discussed in **Chapter 6**, Sustainable Management Criteria. The monitoring networks are composed of representative monitoring wells that will be used to monitor sustainable management criteria for these sustainability indicators during the GSP implementation and planning horizon. Accordingly, groundwater elevations have been selected for a minimum threshold (MT) and measurable objective (MO) for each well in the monitoring network.

As described in **Chapter 6**, 2027 Interim Milestones (IMs) were developed for monitoring network wells in the Eastern Principal Aquifer and a few wells in the Western Principal Aquifers. The IMs are 2027 target values that provide a buffer to allow water levels to drop below the MT between 2022 and 2027, recognizing that water levels in these wells may continue to decline after the GSP is adopted as projects are being brought online. This concept acknowledges that the aquifer response to projects and management actions will take time. IM values are based on the assumption that recent water level declines will continue at similar rates between 2022 and 2027.

As described in **Chapter 6**, the monitoring network for degradation of water quality will be based on wells monitored by others and available at the State Water Resources Control Board (SWRCB) GeoTracker website. This network consists of drinking water supply wells, regulated facilities, and regional water quality programs such as GAMA. When combined with additional data from regulated water quality coalitions, this collective dataset represents a comprehensive network for tracking and evaluating water quality with respect to the sustainable management criteria. Additional information on this monitoring network is provided in **Section 7.1.4** below.

A monitoring network was not developed for the seawater intrusion sustainability indicator. As discussed in **Chapter 6**, the GSAs found that seawater intrusion, as defined by GSP regulations, is not applicable to the inland Turlock Subbasin. Specifically, the GSAs determined that seawater intrusion is not present in the Subbasin and is not likely to occur in the future (see **Section 6.5**). In accordance with GSP regulations, no sustainable management criteria have been assigned to this indicator, and no monitoring network has been established (§354.34(j)).

The monitoring network is composed of both existing and proposed wells. Existing wells include selected CASGEM wells, municipal multi-completion wells in the Cities of Ceres and Turlock and the town of Denair, USGS monitoring wells, a City of Ceres inactive irrigation well, and a series of active and inactive production wells and monitoring wells in the eastern Subbasin developed as part of the ETSGSA monitoring program. The monitoring network also anticipates incorporation of new monitoring wells that will be constructed in Winter 2021/2022, with Proposition 68 grant funding from DWR. Additional new monitoring network wells are planned for construction within ETSGSA in calendar years 2022 and 2023, funded through the DWR Technical Support Services (TSS) program.

The monitoring networks are illustrated on **Figures 7-1** through **7-5.** The figures show locations of the wells in each monitoring network and the MT and MO for each well. **Figure 7-6** presents a summary of all the monitoring network wells in the Subbasin.

The additional monitoring wells proposed to be installed by the GSAs in 2022 and 2023 are not shown on the figures in this chapter because locations have not been chosen. These include shallow monitoring wells along the river boundaries, and multi-completion monitoring wells within the Western Principal Aquifers and in the northwestern Eastern Principal Aquifer.

Summaries of the monitoring networks are provided in **Tables 7-1** and **7-2**. Information on these tables include the well ID, State Well Number, CASGEM identification number where applicable, well type, Principal Aquifer and GSA in which the well is located, location coordinates, well depth, screen interval depths, the MT and MO and a brief summary of how the MT and MO were developed, and the IM where applicable.

Hydrographs for each monitoring network well are provided in **Appendix G**. The hydrographs include well screen interval, ground surface elevation, the MT and MO for each well, and the IM where applicable. Hydrograph presentation meets the data and reporting standards for hydrographs in Article 3 of the GSP regulations (§352.4(e)).

In addition to the representative wells in the monitoring network, the GSAs will measure groundwater elevations in more than 50 additional wells. These wells are designated as SGMA monitoring wells and will not be used to monitor the sustainability indicators, and therefore do not have MTs and MOs. However, the groundwater elevation data collected from the SGMA monitoring wells will be used for monitoring overall groundwater hydraulic conditions. These data will be used to support analyses for annual reports. In the five-year update to the GSP, the groundwater level data from the SGMA monitoring wells will be evaluated along with the data from representative monitoring wells as part of the monitoring network assessment required by GSP regulations (§354.38(a)). The SGMA monitoring wells, as of the adoption of this GSP, are summarized in **Table 7-3** and illustrated on **Figure 7-6**.

Some of the SGMA monitoring wells, additional wells that are identified during future evaluations, or additional new monitoring wells may be added to the representative monitoring network in the future, if needed to reduce uncertainty. Additional wells may also be monitored as SGMA wells depending on access, well attributes, and need.

Improvements to the monitoring network are already being addressed with the installation of new monitoring wells in Fall 2021 and the negotiation of access agreements. A GSP Implementation Support Activity (ISA) has been incorporated into the GSP to identify and address data gaps and to identify potential improvements to the current GSP monitoring network (see **Section 9.2**).

The monitoring networks for each sustainability indicator are described in the following sections.

7.1.1. Chronic Lowering of Groundwater Levels

The monitoring network for chronic lowering of groundwater levels for each of the three principal aquifers is presented on **Figures 7-1, 7-2** and **7-3.** The wells in this monitoring network are summarized in **Table 7-1**.

Well density was an important consideration in identifying monitoring network wells for this sustainability indicator. DWR guidance (DWR, 2016a, see Table 1) generally recommends between one and ten monitoring wells per 100 square miles. This monitoring network is consistent with this guidance.

The following is a description of the monitoring network for each principal aquifer for chronic lowering of groundwater levels.

7.1.1.1. Western Upper Principal Aquifer

The monitoring network for the Western Upper Principal Aquifer is illustrated on **Figure 7-1**. The monitoring network is composed of 18 wells, including 16 CASGEM wells and 2 wells that will be constructed in Winter 2021/2022 with Proposition 68 grant funding. Well information is summarized in **Table 7-1**.

The wells in this monitoring network were chosen based on the following scientific rationale:

- Known locations and construction, with screen intervals above the Corcoran Clay (in the Western Upper Principal Aquifer).
- Spatial distribution and density of wells throughout the Western Upper Principal Aquifer.
- Length, completeness, and reliability of historical groundwater level record.
- Accessibility for future water level measurement.

The two monitoring wells that will be constructed with Proposition 68 grant funding in Winter 2021/2022 (WTS-1 Shallow and WTS-2 Shallow) will be completed and screened above the Corcoran Clay (**Figure 7-1**).

Hydrographs for the CASGEM wells in this monitoring network are presented in **Appendix G**. The CASGEM wells have historical water level records, many with water level data throughout the GSP study period of WY 1991 to WY 2015. As described in **Chapter 6**, the MT for the chronic lowering of groundwater level sustainability indicator is the low groundwater elevation observed in Fall 2015 and the MO is the midpoint between the historical high groundwater elevation and the MT. For each of the CASGEM wells in the monitoring network, measured water level data were available in Fall 2015. Therefore, the MTs and MOs were based on direct measurements in each well.

Static groundwater elevations will be measured twice a year in these monitoring wells to represent seasonal high and seasonal low groundwater conditions.

There are SGMA monitoring wells in the Western Upper Principal Aquifer that will be monitored semi-annually. Future water level data from these wells will be evaluated, and some of these wells, additional wells that are identified during future evaluations, or additional new monitoring wells may be added to the monitoring network during the GSP five-year update, if warranted. More SGMA monitoring wells may also be added when available.

7.1.1.2. Western Lower Principal Aquifer

The monitoring network for the Western Lower Principal Aquifer contains eight wells as illustrated on **Figure 7-2** and summarized in **Table 7-1**. The monitoring network includes multi-completion monitoring wells in the Cities of Ceres and Turlock and the town of Denair, a USGS well, and three wells that will be constructed in Winter 2021/2022 with Proposition 68 grant funding. The Subbasin GSAs are working with the USGS to obtain ownership and access to the USGS monitoring well. As described in **Section 9.2** coordination between the GSAs and the USGS to gain access to these monitoring wells is included in the GSP as an Implementation Support Activity (ISA 2) see **Section 9.2.4.2**).

The wells in this monitoring network were chosen because they have known locations and construction, with discrete screen intervals in the Western Lower Principal Aquifer (below the Corcoran Clay), and because they can be accessed for water level measurement in the future. The three wells that will be constructed in Winter 2021/2022 with Proposition 68 grant funding will be completed and screened below the Corcoran Clay (see wells with red symbols on **Figure 7-2**).

The multi-completion wells located within the Cities of Ceres and Turlock and the town of Denair consist of three or four discretely-screened wells at each location, all of which are screened in the Western Lower Principal Aquifer. One representative well was chosen for the monitoring network from each multi-completion cluster based on a review of the water level data, lithologic logs, and geophysical logs for each of the wells in the cluster. The multi-completion wells chosen for the monitoring network are screened in conductive sand or gravel units and have similar water levels to most, if not all of the other wells in the same cluster. The remaining wells in these clusters are SGMA monitoring wells and are summarized in **Table 7-3** and illustrated on **Figure 7-6**. Future water level data from the SGMA monitoring wells will be evaluated, and if warranted, some of these wells may be added to the monitoring network during the GSP five-year update.

As shown on **Figure 7-2**, most of the wells in the monitoring network are in the eastern region of the Western Lower Principal Aquifer, with the two Proposition 68 wells in the western/southwestern region of the aquifer. There is a data gap of wells screened in the central/northwestern Western Lower Principal Aquifer. This data gap of groundwater elevations in the Western Lower Principal Aquifer is identified in **Section 4.4**. Further improvements to the monitoring network are described in an Implementation Support Activity incorporated into the GSP in **Chapter 9** (**Section 9.2.1**).

Hydrographs for wells in this monitoring network are presented in **Appendix G**. There are no measured data in Fall 2015 at any of these monitoring network wells. As noted in **Table 7-1**, the MTs selected for the Western Lower Principal Aquifer wells are based on estimates from the Fall 2015 groundwater elevation contour map (see **Figure 4-30a**), or for the USGS well, Fall 2015 model groundwater elevation contours. The MOs are based on the available measured data at the well. The MTs and MOs for the Proposition 68 monitoring wells will be established after the wells are constructed. MTs and MOs will be established for any additional monitoring wells that are constructed in the future and added to the monitoring network.

Static groundwater elevations will be measured twice a year in these monitoring wells to represent seasonal high and seasonal low groundwater conditions.

7.1.1.3. Eastern Principal Aquifer

The monitoring network for the Eastern Principal Aquifer consists of 21 wells, as shown on **Figure 7-3**. The monitoring network includes a CASGEM well, a multi-completion well in the City of Turlock, ETSGSA monitoring program wells, Proposition 68 monitoring wells and future TSS monitoring wells. Well information is summarized in **Table 7-1**. The TSS monitoring wells will be multi-completion well clusters, with multiple wells at each location. However, well construction has not been determined yet, and therefore the TSS wells are listed once per location on **Table 7-1**.

The wells were chosen for this monitoring network based on their representative locations and known construction, accessibility for future water level measurement, and because they have good spatial distribution throughout the Eastern Principal Aquifer. The ETSGSA monitoring program wells are a mixture of inactive irrigation wells, active domestic and fertigation wells, and monitoring wells. Access agreements have been established between the well owners and ETSGSA to allow for long-term monitoring. Electronic pressure transducers for water level data collection have been installed in most of the ETSGSA monitoring program wells.

The monitoring network wells provide good spatial distribution throughout the Eastern Principal Aquifer, with the exception of the northwest portion of the aquifer between the communities of Hughson, Denair, and Hickman (see **Figure 7-3**). Although monitoring wells do not extend to the easternmost edge of the Eastern Principal Aquifer, the network covers almost all of the developed irrigated agriculture (see **Figure 2-4**) and is capable of monitoring the effects of future groundwater extraction on the aquifer in this area of the Subbasin. The WTSGSA plans to install an additional monitoring well in the northwest region of the Eastern Principal Aquifer. A specific location has not been chosen, but this well will be funded by the WTSGSA during either the current (2021-2022) or the following (2022-2023) fiscal year.

The ETSGSA monitoring program wells in the easternmost Eastern Principal Aquifer address a data gap described in **Section 4.4**, where historical water level data were lacking south and southeast of Turlock Lake. Proposition 68 and TSS well locations were chosen to augment the existing ETSGSA monitoring program in other areas of sparse data.

Hydrographs for wells in this monitoring network are presented in **Appendix G**. Several methods were used to develop MTs and MOs, based on available data. For wells with a sufficient record of historical water levels, measured data were used to select the MT and MO. For wells without historical or Fall 2015 measured water level data, MTs were developed based on nearby wells with historical water level records (e.g., DWR WDL wells) or estimated from the Fall 2015 groundwater elevation contour map (see **Figure 4-30a**). In several ETSGSA monitoring program wells, the rate of change of available measured water levels were used to estimate Fall 2015 groundwater elevations (e.g., ETSGSA-09). MOs were based on either measured historic high groundwater levels, estimates from the Spring 1998 contour map (see **Figure 4-29**), or based on trends in available measured data extrapolated to Spring 1998. A summary of the MT/MO development method for each well in the monitoring network is provided in **Table 7-1**. Estimated MT and MO values may require adjustment when future groundwater elevation data are collected.

Static groundwater elevations will be measured twice a year in these monitoring network wells to represent seasonal high and seasonal low groundwater conditions.

As summarized on **Table 7-3**, there are SGMA monitoring wells in the Eastern Principal Aquifer that will be monitored on a semi-annual basis. Some of these are already outfitted with transducers for collecting water level data. Future water level data from these wells will be evaluated, and some of these wells, additional wells that are identified during future evaluations, or additional new monitoring wells may be added to the monitoring network during the GSP five-year update, if warranted. More SGMA monitoring wells may also be added when available.

7.1.2. Reduction of Groundwater in Storage

As described in **Section 6.4**, the sustainable management criteria for chronic lowering of groundwater levels will be used as a proxy for the reduction of groundwater in storage indicator. Accordingly, the monitoring network for the reduction of groundwater in storage is the same as the monitoring network for the chronic lowering of groundwater levels. This monitoring network is described above in **Section 7.1.1**, summarized in **Table 7-1**, and illustrated on **Figures 7-1, 7-2,** and **7-3**.

Static groundwater elevations will be measured twice a year in these monitoring network wells to represent seasonal high and low groundwater conditions.

In addition to the required reporting of groundwater levels over time, regulations also require that the GSP annual reports provide an annual estimation of the change in groundwater in storage (§354.34(c)(2)). As described in **Chapters 5** and **6**, the historical reduction of groundwater in storage is estimated at about 63,900 AFY. As discussed in **Section 6.4.1.3**, both the change in groundwater in storage and corresponding water levels in the Subbasin will be documented annually in the GSP annual reports. Collectively, these data will allow the connection between the reduction of groundwater in storage to Subbasin groundwater elevations to be documented on an annual basis, providing further justification for the use of a groundwater elevation proxy for this indicator.

7.1.3. Seawater Intrusion

As described in **Section 6.5**, the Turlock Subbasin GSAs found that seawater intrusion is not an applicable sustainability indicator for the Turlock Subbasin. Specifically, the GSAs determined that seawater intrusion is not present in the Turlock Subbasin and is not likely to occur in the future. Therefore, neither sustainable management criteria nor a monitoring network has been established for this sustainability indicator (§354.34(j)).

7.1.4. Degraded Water Quality

As summarized in **Section 6.6.1.3**, undesirable results for degraded water quality are defined as significant and unreasonable adverse impacts to groundwater quality caused by GSA projects, management actions, or other management of groundwater such that beneficial uses are affected and well owners experience an increase in operational costs. The MTs are set as a new exceedance of the maximum contaminant level (MCL) at a potable supply well for any of the six constituents of concern (COC): arsenic, nitrate, total dissolved solids (TDS), uranium, 1,2,3-trichloropropane (1,2,3-TCP), and tetrachloroethene (PCE).

The SWRCB and other agencies have the primary responsibility for water quality and the GSAs do not intend to duplicate this authority. Numerous regulated water quality monitoring programs exist in the Turlock Subbasin, providing the GSAs with data from hundreds of monitoring sites over time. Accordingly, the GSP monitoring network for this sustainability indicator will incorporate existing monitoring programs, all of which have been approved by the SWRCB or other water quality regulatory agency. The MTs will be quantitatively monitored by public agencies (and others) in representative monitoring wells in each Principal Aquifer in accordance with other water quality regulatory monitoring program requirements and using regulatory-approved sampling protocols. The GSAs will download water quality data from the State GeoTracker website each year and analyze any new exceedances of the six COCs in potable supply wells. New exceedances will be evaluated in relation to GSA management of water level and groundwater extractions, as well as GSA projects and management actions, to determine whether these exceedances were caused, or exacerbated, by the GSAs. This analysis will be included in the GSP annual reports. Measurable objectives will be tracked by analysis of increases in concentrations for the six COCs.

The monitoring network consists of drinking water supply wells, monitoring wells at regulated facilities, and monitoring sites associated with other regulatory water quality programs such as GAMA. Data from two specific regulatory water quality programs, CV-SALTS and the Nitrate Control Program (implemented by the Valley Water Collaborative – see **Section 2.4.4**), will be compiled separately if not already included in the GeoTracker data. These two programs are regulated through the CVRWQCB and provide water quality data for nitrate and total dissolved solids in groundwater throughout the Subbasin. Collectively, this dataset represents a comprehensive network for ongoing tracking and evaluation of water quality with respect to the sustainable management criteria.

The monitoring network may vary from year-to-year based on regulatory requirements for each water quality program. Water quality data collected in Subbasin wells from January 2020 to May 2021 for the COCs were downloaded from GeoTracker as an initial dataset. Initial water quality monitoring sites are represented on **Figure 7-4** and tabulated in **Appendix H**. During this time, water quality data were collected from over 300 wells in the Subbasin, including municipal and domestic drinking water wells and monitoring wells. Most of the data are from municipal drinking water systems and are therefore clustered in and around the municipalities, many of which include DAC areas (see **Figure 3-1**). Monitoring network wells are also located in areas where most domestic wells are located. As indicated on **Figure 7-4** and tabulated in **Appendix H**, there are more than 30 wells for each of the six COCs, providing sufficient data to track and characterize water quality COCs to meet beneficial uses across the Subbasin. More than 150 domestic wells are included in the network but have been sampled for nitrate only. The SWRCB is planning to expand domestic well sampling to include some of the Turlock Subbasin COCs as well as other constituents. These data will be used to supplement the water quality dataset in annual reports when available.

7.1.5. Land Subsidence

Although impacts from land subsidence have not been documented in the Turlock Subbasin, the potential for future land subsidence cannot be ruled out. Future land subsidence is most likely to occur as a result of the dewatering/depressurization of clays within and below the Corcoran Clay (based on land subsidence impacts in other parts of the San Joaquin Valley). As described in **Section 6.7**, the sustainable management criteria for chronic lowering of groundwater levels will be used as a proxy for land subsidence. Accordingly, the monitoring network for land subsidence is the same as the monitoring network for the chronic lowering of groundwater levels. This monitoring network is described above in **Section 7.1.1**, summarized in **Table 7-1**, and illustrated on **Figures 7-1, 7-2,** and **7-3**.

Static groundwater elevations will be measured twice a year in these network wells to represent seasonal high and seasonal low groundwater conditions.

Remote sensing data of ground surface elevations in the Turlock Subbasin will also be used as a screening tool to evaluate whether land subsidence might be occurring as a supplemental monitoring program, but MTs and MOs will not be assigned to these data. As summarized in **Section 4.3.6**, vertical displacement data has been collected using Interferometric Synthetic Aperture Radar (InSAR) since 2015 by TRE Altamira Inc., under contract with DWR. This data set is available on the SGMA Data Viewer (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub). Data collected from June 2015 to September 2019 in the Turlock Subbasin is illustrated on **Figure 4-61**. As shown on this figure, vertical displacement data covers the full extent of the Turlock Subbasin. Land subsidence will be monitored in the Subbasin by updating and evaluating this InSAR data on an annual basis. This evaluation will be included in the GSP annual reports.

7.1.6. Depletions of Interconnected Surface Water

The monitoring network for depletions of interconnected surface water, summarized in **Table 7-2** and presented on **Figure 7-5**, includes 12 wells along the San Joaquin River, Tuolumne River and Merced River. These wells are screened in the Western Upper Principal Aquifer and the Eastern Principal Aquifer. They include wells from CASGEM, the ETSGSA monitoring program, City of Ceres (1 well), and a future TSS well cluster location likely comprising 4 wells.

Groundwater data will be supplemented with surface water data monitored by others. Data include releases and diversions on the Tuolumne and Merced rivers, coupled with stream gauge data monitored by USGS. These data have been used in model calibration to analyze streamflow depletions in this GSP as documented in **Appendix D** (see **Sections 5.2.3** and **5.3.2** in **Appendix D**).

The wells in this monitoring network were chosen because they are relatively close to the rivers and are accessible for water level measurement into the future. The wells have known locations with screen intervals that should enable monitoring of the unconfined portions of these two aquifers adjacent to the river boundaries. Some of the wells, such as the CASGEM wells, have significant historical water level records.

The following summarizes the monitoring network wells along each of the rivers.

7.1.6.1. San Joaquin River

Three CASGEM wells are part of the monitoring network along the San Joaquin River. These wells are approximately 2 to 3.5 miles from the San Joaquin River and are the closest wells to the river screened in the Western Upper Principal Aquifer that are accessible for future monitoring. These wells have known construction, with discrete screen intervals from just below ground surface to between 71 and 195 ft bgs, within the Western Upper Principal Aquifer (**Table 7-2**). Each of these wells has historical water level data (hydrographs in **Appendix G**).

As shown on **Figure 7-5**, these three wells are relatively evenly spaced along the San Joaquin River. However, there is a gap in well coverage along the upstream reach of the San Joaquin River. This is consistent with the data gap in groundwater conditions along the river boundaries that was identified and described **Section 4.4**. The Subbasin GSAs are evaluating potential locations for constructing new monitoring wells along the San Joaquin River boundary. Specific locations for these future monitoring wells have not yet been chosen, but the GSAs intend to coordinate locations with well installations planned in the adjacent Delta-Mendota Subbasin. Construction of these monitoring wells will be funded by the Subbasin GSAs.

As described in **Section 6.8.2**, the MT for the San Joaquin River is defined as the low groundwater elevation observed in Fall 2015. The MO is the midpoint between the historical high groundwater elevation and the MT (**Table 7-2**). As noted on **Table 7-2**, the

MT and MO are close together (about 10 feet or less), providing relatively small amounts of operational flexibility; however, historical groundwater elevations in this part of the Subbasin have been shallow with relatively small fluctuations. The GSAs have developed an Implementation Support Activity (ISA 2) to allow for control of shallow groundwater to support land uses, as has been done historically in this area (see **Section 9.2.4.3**). The MTs and MOs at each of these wells is based on measured data, as shown on the hydrographs in **Appendix G**.

Static groundwater elevations will be measured twice a year, in spring and fall, to represent seasonal groundwater conditions.

7.1.6.2. Tuolumne River

Three wells are part of the monitoring network along the Tuolumne River. As shown on **Figure 7-5**, these include ETSGSA monitoring program wells to the east and west of Turlock Lake and one City of Ceres well. The ETSGSA monitoring program wells are approximately one mile, or less, from the Tuolumne River. The City of Ceres well is about 500 feet from the Tuolumne River. These wells were chosen for the monitoring network because they are close to the Tuolumne River and will be accessible for future water level monitoring.

ETSGSA-01 and ETSGSA-02 are screened at relatively similar intervals within the Eastern Principal Aquifer: ETSGSA-01 from 223 to 445 ft bgs and ETSGSA-02 from 250 to 350 ft bgs (**Table 7-2**). It is recognized that these screen intervals are relatively deep and measured vertical gradient data are not available, but groundwater elevations in these wells are representative of an unconfined aquifer system connected to shallow groundwater conditions and are likely influenced by surface water seepage. Both of these wells are outfitted with transducers. ETSGSA video logged and installed a transducer in ETSGSA-01, an inactive irrigation well, in October 2021. ETSGSA-02 is a little used domestic supply well installed in 2008. Water levels in ETSGSA-02 were measured in 2008 and have been recorded since October 2019 by transducer and semi-annual hand measurements in the fall and spring (see **Appendix G)**. Future data collection will help improve the understanding of the local conditions for surface water to groundwater interaction. Estimated MT and MO values may require adjustment when future groundwater elevation data are collected. Notwithstanding these limitations, ETSGSA-01 and ETSGSA-02 represent the best available wells for monitoring interconnected surface water along the upper reach of the Tuolumne River at this time.

The City of Ceres Well 36 is an inactive irrigation well near the eastern edge of the Corcoran Clay, screened both above and immediately below the Corcoran Clay. The Corcoran Clay in this area is thin (Wood Rodgers, Inc., 2010). Based on the well log, the clay thickness is 10 feet or less. Well logs from nearby wells across the river indicate thin or absent Corcoran Clay layers. Because this well is close to the thinning eastern extent of the Corcoran Clay and is also screened in the shallow Western Upper Principal Aquifer, the water levels are likely representative of the water table, making it a suitable well for monitoring interconnected surface water.

As shown on **Figure 7-5**, Ceres 36 is the only monitoring network well along the central and western reaches of the Tuolumne River. The Subbasin GSAs have identified groundwater conditions along the river boundaries as a data gap, as described in **Section 4.4**. The GSAs plan to install additional monitoring wells along the river boundaries during this and the following fiscal year. Three monitoring wells are planned along the central and downstream reaches of the Tuolumne River, but specific locations have not yet been chosen. The Turlock Subbasin GSAs intend to coordinate with the neighboring Modesto Subbasin GSAs to construct these shallow monitoring wells across the Tuolumne River from existing shallow monitoring wells in the Modesto Subbasin. In this manner, groundwater-surface water interaction can be more accurately monitored along the Tuolumne River.

As described in **Section 6.8.2**, the MT for the Tuolumne River is defined as the low groundwater elevation observed in Fall 2015. There is a lack of historical measured water level data at these wells, and therefore, the MTs are based on the Fall 2015 groundwater elevation at a nearby DWR WDL well (the method used for ETSGSA-01) and the minimum of recent measured data (the method used for ETSGSA-02). The MT for Ceres 36 is based on water levels in Fall 2015 at a nearby City of Ceres well with a similar screen interval. Estimated MT and MO values may require adjustment when future groundwater elevation data are collected.

Static groundwater elevations will be measured twice a year, in spring and fall, to represent seasonal high and low groundwater conditions.

Data gaps in the monitoring network will be addressed with an Implementation Support Activity (ISA 2) to improve future GSP monitoring (see **Section 9.2.2**).

7.1.6.3. Merced River

As shown on **Figure 7-5**, the monitoring network along the Merced River includes six locations: one CASGEM well, four ETSGSA monitoring program wells, and one future TSS monitoring well cluster location (TSS-4) with a target of 4 vertically discrete monitoring wells in the cluster. These wells were chosen for the monitoring network because they are close to the Merced River, have relatively shallow screen intervals, and will be accessible for future monitoring. Two of the wells, ETSGSA-14 and ETSGSA-21, are further from the Merced River and will provide information about the hydraulic gradient north of the Merced River. Well information is summarized in **Table 7-2**. Since TSS-4 well construction has not been determined yet, it is listed once on this table.

TID 303, ETSGSA-17 and ETSGSA-23 are within one mile of the Merced River and have known screen intervals. CASGEM well TID 303 is screened from 0.5 to 100 ft bgs in the Western Upper Principal Aquifer. ETSGSA-17 and ETSGSA-23 are in the Eastern Principal Aquifer and screened from 146 to 390 ft bgs and 132 to 212 ft bgs, respectively. ETSGSA-17 is a converted irrigation well used for monitoring only and ETSGSA-23 is an active domestic well. Both of these ETSGSA wells are outfitted with electronic pressure transducers to supplement hand measurements and have been recording water levels since October 2019. The future TSS-4 monitoring well cluster will be constructed within a quarter mile of the

Merced River and likely screened at four different intervals, with the shallowest well intended to represent the water table of the Eastern Principal Aquifer.

ETSGSA-14 and ETSGSA-21 are within three miles of the Merced River and screened from 187 to 685 ft bgs and 57 to 283 ft bgs, respectively. Both of these wells are inactive irrigation wells located close to active irrigation wells within the Eastern Principal Aquifer. They are outfitted with electronic pressure transducers to supplement hand-measured data that have been recording water levels since February 2020 (ETSGSA-14) and October 2019 (ETSGSA-21). Their proximity to active irrigation wells makes the electronic data collection extremely valuable in assessing static water levels in these areas further from the Merced River.

As shown on **Figure 7-5**, these wells are spaced apart along the Merced River. However, the locations of the ETSGSA monitoring program wells are limited to existing wells that may not be optimally sited, are screened well below the water table (without direct knowledge of vertical gradients) or have relatively long screen intervals. Notwithstanding these limitations, these wells represent the best available wells for monitoring interconnected surface water along the upper reach of the Merced River at this time. Nevertheless, as stated previously, groundwater conditions along the river boundaries were identified as a data gap in **Section 4.4** and future improvements to the monitoring network are described in an Implementation Support Activity (ISA 2) in **Chapter 9** (**Section 9.2.2**).

In 2003, USGS installed three clusters of monitoring wells (a total of 16 wells) close to TID 303 along a transect roughly oriented in the direction of groundwater flow toward the Merced River. USGS provided data and information on these wells in support of GSP development. The USGS wells have not been routinely monitored and access has not yet been secured to monitor these wells. Discussions between the GSAs and the USGS to gain access to these wells and help address the above-described data gap are in progress. As described in **Section 9.2.4**, coordination between the GSAs and the USGS to gain access to these monitoring wells is an Implementation Support Activity.

All but one of the USGS wells is screened in the Western Upper Principal Aquifer, with one screened in the Western Lower Principal Aquifer. The well in the Western Lower Principal Aquifer (Blum 3-1) is part of the monitoring network for chronic lowering of groundwater levels, assuming that access will be secured (see **Figure 7-2** and **Table 7-1**). Recognizing that TID 303 provides a reasonable monitoring site for this reach in the Western Upper Principal Aquifer, the GSAs intend to continue to explore access for the shallow USGS clusters and will monitor these clusters as additional SGMA monitoring wells, when available (**Table 7-3** and **Figure 7-6**). USGS wells screened in the Western Upper Principal Aquifer will be added to the monitoring network as data are collected and better understood in the context of interconnected surface water.

As described in **Section 6.8.2**, the MT for the Merced River is defined as the groundwater elevation observed in Spring 2014. The MT at TID 303 is the estimated Spring 2014 groundwater elevation, based on the trend of measured data dating back to the earliest measurement in November 2014. The MTs at the ETSGSA wells are based on Spring 2014 measured data at the well (ETSGSA-21), Spring 2014 measured data at a nearby DWR WDL well (ETSGSA-14), and recent (Spring 2021) measured water levels (ETSGSA-17 and ETSGSA-23). Hydrographs with MTs and MOs are in **Appendix G**. Estimated MT and MO values may require adjustment when future groundwater elevation data are collected.

Static groundwater elevations will be measured twice a year, in spring and fall, to represent seasonal high and low groundwater conditions.

7.1.7. Monitoring Network Summary

The monitoring network is composed of 52 representative monitoring wells and 52 SGMA monitoring wells. These well locations are shown on **Figure 7-6**. This figure includes the representative monitoring wells that are summarized on **Tables 7-1** and **7-2**, and illustrated on **Figures 7-1, 7-2, 7-3** and **7-5**, and the SGMA monitoring wells that are summarized in **Table 7-3**.

7.2. Protocols for Data Collection and Monitoring

As required by the GSP regulations, protocols are provided for groundwater elevation monitoring in the representative monitoring wells in the monitoring network. Monitoring protocols considered DWR's best management practices (BMP) and have incorporated applicable portions of the BMP (DWR, 2016b). As required by the regulations, monitoring protocols will be reviewed at least every five years as part of the periodic evaluation of the GSP, and modified as necessary.

Protocols are focused on groundwater elevation monitoring standards because that is the only monitoring method applicable to the monitoring network for the Turlock Subbasin. The justification and rationale for the use of groundwater elevations for applicable sustainability indicators are described in **Chapter 6** (see **Section 6.3.2.2** and **Table 6-4**). As stated above, groundwater elevation monitoring will follow DWR's BMP. If the GSAs develop standard operating procedures (SOPs) for groundwater elevation monitoring in the future, they will be documented in annual reports and incorporated into the five-year updates. As discussed in **Section 7.1.4.**, water quality monitoring will be conducted by others, and therefore water quality sampling protocols are not included in this section.

This section describes general procedures for documenting wells in the monitoring program and for collecting consistent high-quality groundwater elevation data. In general, the methods for establishing location coordinates (and reference point elevations) follow the data and reporting standards described in the GSP Regulations (§352.4) and the guidelines presented by USGS Groundwater Technical Procedures. These procedures are summarized below.

7.2.1. Field Methods for Monitoring Well Surveying

As described previously, new monitoring wells are planned for construction and will be incorporated into the monitoring network. To date, additional new wells have been planned as part of the current Proposition 68 grant, the DWR TSS program, and implementation funding by the GSAs for construction during fiscal years 2021-2022 and 2022-2023. Protocols for these new wells will incorporate GSP requirements, including locational information and survey procedures as follows:

- Pursuant to §8726 of the California Business and Professions code, establishment, reestablishment, or transformation of any surveyed location or elevation data shall be performed by, or under the responsible charge of an individual authorized to perform Land Surveying in the State of California.
- Horizontal positions of new monitoring wells shall be established. Positions so established shall be expressed in latitude and longitude in degrees and decimal degrees to a minimum positional accuracy of 0.5 feet, referenced to NAD83(2011).
- Monitoring well reference point orthometric heights shall be established. Orthometric heights so established shall be expressed in feet and decimals of a foot to a minimum positional accuracy of 0.5 feet, referenced to NAVD88.

7.2.2. Additional Well Standards

Additional standards and information applicable to new and existing wells are also incorporated into the monitoring network as required by the GSP regulations. This information is summarized on **Tables 7-1** and **7-2** and includes the following:

- CASGEM Well ID (as applicable),
- Well location, ground surface elevation and reference point elevation,
- Description of the well use and status (e.g., active drainage well, active irrigation well, monitoring well, etc.),
- Well depth and screen interval depth, and
- Principal Aquifer that is being monitored.

Additional information will be provided on the DWR templates for wells and water levels. For example, well completion report number, well construction diagram and geophysical log will be provided, if available. Additional well details such as boring total depth and well casing diameter, if available, will also be provided on the DWR templates.

The well depths and screen interval depths are known for all of the existing representative wells in the monitoring network (**Tables 7-1** and **7-2**). There is one SGMA monitoring well (ETSGSA-19, in the Eastern Principal Aquifer) for which the screen interval depths are unknown at this time (**Table 7-3**).

7.2.3. Field Methods for Groundwater Elevation Monitoring

Field methods for collecting depth to water measurements at representative monitoring wells in the Turlock Subbasin GSP monitoring network are described below. Groundwater elevations will be monitored by the GSA in which the well is located.

- Active production wells are required to be off when collecting a depth to water measurement.
- The approximate period of time that a well needs to be off before a static measurement is taken is 48 hours; field personnel will attempt to verify the time that the pump last ran and record that time in the field notes.
- To verify that the wells are ready for measurement, the GSAs will coordinate with well operators and/or owners as necessary.
- Each well has a unique manner to access the well bore (e.g., inspection port, sounding tube, hole drilled into the side of the casing).
- Depth to groundwater will be measured relative to the established reference point elevation, which will be marked with a marker or notch in the top of the well casing, sounding tube or access port. In the absence of a mark or notch, the groundwater elevation will be measured from the north side of the well casing and then marked for future measurements.
- If a pressure release is observed when the well cap or sounding port plug is removed, the water level will be allowed to stabilize for a short period of time before the depth to groundwater measurement is taken.
- Depth to groundwater measurements will be collected by electric sounding tape or by steel tape methods. The depth to water measurement methods described in DWR's Groundwater Elevation Monitoring Guidelines will apply to the Turlock Subbasin monitoring network for wells monitored with electric sounding tape or a steel tape (DWR, 2010).
- Most of the ETSGSA monitoring program wells in the monitoring network have electronic pressure transducers. ETSGSA will maintain and periodically download water level data from the transducers. ETSGSA will also measure water levels semi-annually by hand, using either an electric sounding tape or steel tape, and will compare these hand measurements to the electronic water level data.
- Depth to groundwater will be measured and reported in feet to the nearest 0.01 foot relative to the reference point.
- The measurement will be recorded on a field sheet with the date and time the measurement was made. Any factor that may influence the depth to water measurement will be noted, such as well condition or local flooding.
- Where necessary, the well cap or sounding port cap will be placed back on the well, and the well will be secured and locked.

7.2.4. Frequency and Timing of Groundwater Elevation Monitoring

- Semi-annual monitoring is determined to be appropriate to capture the seasonal high and low groundwater elevations associated with the irrigation pumping cycle.

- Groundwater elevations will be measured in monitoring network wells within as short a time as possible, preferably within a 1 to 2 week period (DWR, 2016b), in order to:
    - provide a snapshot of elevations in time to support mapping and management;
    - capture the seasonal high and low elevations in the Subbasin; and
    - meet reporting requirements for semi-annual monitoring data as required by DWR.
- Based on historical data and current land uses in the Turlock Subbasin, the following measurement time intervals are established:
    - Seasonal high: February 1 through April 15 for reporting to DWR by July 1.
    - Seasonal low: October 1 through November 15 for reporting to DWR by January 1. Depending on the hydrology, agricultural fields may be irrigated through early November in the Turlock Subbasin.
- Water level measurement may be adjusted within the time intervals based on hydrologic and land use conditions at that time. The timing for the monitoring events will be coordinated among the GSAs.

7.3. ASSESSMENT AND IMPROVEMENT OF MONITORING NETWORK

As described in **Section 4.4**, data gaps have been identified for groundwater elevations in the Western Lower Principal Aquifer and along the river boundaries. These data gaps are consistent with the gaps in well coverage in the monitoring networks and availability of historical data described in **Section 7.1**. The following specific data gaps have been identified for the GSP monitoring network, by each sustainability indicator:

- Chronic Lowering of Groundwater Levels: Number and location of accessible and representative wells screened in the Western Lower Principal Aquifer and in the northwest region of the Eastern Principal Aquifer. Lack of historical data for establishment of MTs.
- Reduction of Groundwater in Storage: Number and location of accessible and representative wells screened in the Western Lower Principal Aquifer and northwest region of the Eastern Principal Aquifer. Lack of historical data for establishment of MTs.
- Seawater Intrusion: Not applicable.
- Degraded Water Quality: No data gaps (GSAs will rely on a robust water quality monitoring network that combines numerous ongoing monitoring programs conducted by others – see **Section 7.1.4** and **Figure 7-4**).

- Land Subsidence: Number and location of accessible and representative wells screened in the Western Lower Principal Aquifer and northwest region of the Eastern Principal Aquifer. Lack of historical data for establishment of MTs.
- Depletions of Interconnected Surface Water: Number and location of appropriately constructed and accessible wells along various segments of the three river boundaries to measure the water table in the Western Upper Principal Aquifer and Eastern Principal Aquifer. Lack of historical data for establishment of MTs.

The GSAs have adopted an Implementation Support Activity (ISA 2) to evaluate and improve the current wells available for the GSP monitoring network (see **Section 9.2**). A schedule for addressing many of these data gaps has already been developed, and new wells are already planned as summarized below:

- Seven new monitoring wells at five locations with Proposition 68 grant funding. Well construction has begun and will be complete in Winter 2022. Specific locations have been chosen and associated Principal Aquifers have been targeted; well locations are illustrated on **Figures 7-1, 7-2**, and **7-3.**
- Monitoring wells at four locations in ETSGSA will be drilled by the DWR TSS program. These will be multi-completion well clusters in the Eastern Principal Aquifer, with one location next to the Merced River (TSS-4). These wells will likely be constructed in calendar years 2022 and 2023. Specific locations have been chosen and are illustrated on **Figures 7-3** and **7-5**.
- WTSGSA and ETSGSA have plans to site and construct shallow monitoring wells along the rivers to fill data gaps, as discussed in **Section 9.2**
- WTSGSA has plans to construct multi-completion wells in the Western Upper Principal Aquifer and Western Lower Principal Aquifer, and a well in the northwestern region of the Eastern Principal Aquifer. Specific locations for these monitoring wells have not yet been developed.

Collection of data from the current monitoring network wells and SGMA monitoring wells will provide additional data to inform the need for and locations of future wells to fill recognizable data gaps. Improvements to the monitoring network are planned in the first five years of GSP implementation as mentioned above and further described in an Implementation Support Activity (ISA 2) in **Chapter 9** (**Section 9.2)**. Furthermore, the representative monitoring network will be reviewed and evaluated in each five-year assessment in compliance with GSP regulations (§354.38). Estimated MT and MO values may require adjustment when future groundwater elevation data are collected.

7.4. DATA MANAGEMENT SYSTEM

Groundwater elevation data measured in the representative monitoring wells and the additional SGMA wells will be recorded in the data management system (DMS) developed for the GSP, which is described as an Implementation Support Activity (ISA 7) in **Section 9.7**.

The data collected for the GSP from the GSA member agencies, and other sources, currently resides in relational databases, which consist of an Access database, GIS geodatabase, and Excel workbooks. Future upgrades to this DMS are being considered by the GSAs. The DMS will be updated with the monitoring data annually and provided in the GSP annual reports. The data will also be submitted to DWR electronically.

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Table 7-1: Summary of Monitoring Network, Chronic Lowering of Groundwater Levels

Program	Well ID	Existing Well (Y/N)	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	WTSGSA	ETSGSA	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet)	Reference Point Elevation (feet)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT)	Measurable Objective (MO)	MT/MO Note	Interim Milestone (IM)
CASGEM	TID 010	Y	05S10E04D001M	6516	active drainage well	Western Upper	x		37.53658	-120.88476	99	100.79	45	0.5-25	63	69	based on measured data at the well	53
CASGEM	TID 018	Y	04S10E21E001M	3763	active drainage well	Western Upper	x		37.57460	-120.88350	104.38	104.38	250	0.5-110	44	65	based on measured data at the well	--
CASGEM	TID 022	Y	04S09E36E001M	3031	active drainage well	Western Upper	x		37.54393	-120.93413	86	88.69	49	0.5-27	52	64	based on measured data at the well	--
CASGEM	TID 048	Y	05S09E04C001M	4930	active irrigation well	Western Upper	x		37.53660	-120.98520	67.43	67.43	110	0.5-87	36	47	based on measured data at the well	--
CASGEM	TID 061A	Y	05S09E33R001M	5643	active drainage well	Western Upper	x		37.45272	-120.97657	63	64.61	225	0.5-195	40	49	based on measured data at the well	--
CASGEM	TID 063	Y	05S09E07B001M	4935	active drainage well	Western Upper	x		37.52240	-121.01960	56.41	56.41	110	0.5-71	37	45	based on measured data at the well	--
CASGEM	TID 083	Y	--	48497	active drainage well	Western Upper	x		37.43053	-120.93104	71	74.56	155	50-145	62	64	based on measured data at the well	--
CASGEM	TID 085B	Y	06S11E17C001M	28534	active drainage well	Western Upper	x		37.41791	-120.78794	104	109.08	172	0.5-80	85	93	based on measured data at the well	--
CASGEM	TID 106	Y	05S09E21B001M	5630	active drainage well	Western Upper	x		37.48910	-120.98100	64.37	64.37	157	0.5-100	49	54	based on measured data at the well	--
CASGEM	TID 111	Y	04S08E27H001M	2176	active irrigation well	Western Upper	x		37.56113	-121.06675	57	60.1	212	0.5-164	26	36	based on measured data at the well	--
CASGEM	TID 113A	Y	06S10E15F002M	6602	active drainage well	Western Upper	x		37.41447	-120.86036	91	92.04	136	0.5-136	81	84	based on measured data at the well	76
CASGEM	TID 118	Y	06S10E08H001M	5909	active drainage well	Western Upper	x		37.42986	-120.89066	81	81.29	242	0.5-105	65	69	based on measured data at the well	--
CASGEM	TID 136A	Y	05S11E33N003M	27312	active drainage well	Western Upper	x		37.45070	-120.77410	117.32	117.32	115	0.5-43	79	88	based on measured data at the well	76
CASGEM	TID 139	Y	04S09E19A001M	2877	active drainage well	Western Upper	x		37.57960	-121.01240	74.42	74.42	280	0.5-64, 78-189	40	53	based on measured data at the well	--
CASGEM	TID 175	Y	04S11E21D001M	5396	active drainage well	Eastern	x		37.57740	-120.77020	151.4	151.4	180	36-120	36	56	based on measured data at the well	31
CASGEM	TID 191	Y	04S09E24G001M	26403	active drainage well	Western Upper	x		37.57310	-120.92678	93	93.67	245	0.5-192	53	60	based on measured data at the well	--
CASGEM	TID 199A	Y	05S10E35Q001M	7237	active drainage well	Western Upper	x		37.44930	-120.83540	97.3	98.3	60	40-52	88	92	based on measured data at the well	--
Multi-Completion	Smyrna Park 4/233	Y	--	not applicable	monitoring well	Western Lower	x		37.59878	-120.94534	95.13	97.93	233	218-228	20	30	MT: based on October 2015 groundwater elevation contour map, Western Lower Principal Aquifer; MO: based on historic high of available data (not including 2012 water level - shortly after well construction)	10
Multi-Completion	Denair NW-11 287	Y	--	not applicable	monitoring well	Western Lower	x		37.51456	-120.80738	116.72	116.72	287	257-287	21	29	MT: based on October 2015 groundwater elevation contour map, Western Lower Principal Aquifer - based on elevation at nearby Tur-24; MO: based on 2021 groundwater elevation (no groundwater elevations during study period)	--
Multi-Completion	Ferreira Ranch Park MW-347	Y	--	not applicable	monitoring well	Western Lower	x		37.53495	-120.85554	106	106	347	332-342	20	29	MT: based on October 2015 groundwater elevation contour map, Western Lower Principal Aquifer; MO: based on 2012 water level (high level)	--
Multi-Completion	SWW Reservoir MW-335	Y	--	not applicable	monitoring well	Western Lower	x		37.48876	-120.87563	89	89	335	320-330	20	27	MT: based on October 2015 groundwater elevation contour map, Western Lower Principal Aquifer; MO: based on 2017 water level (only water level during study period)	--

Table 7-1: Summary of Monitoring Network, Chronic Lowering of Groundwater Levels (continued)

Program	Well ID	Existing Well (Y/N)	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	WTSGSA	ETSGSA	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet)	Reference Point Elevation (feet)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT)	Measurable Objective (MO)	MT/MO Note	Interim Milestone (IM)
Multi-Completion	NE Storm Basin MW-340	Y	--	not applicable	monitoring well	Eastern	x		37.53633	-120.82609	116.0	116.0	340	325-335	45	70	MT: estimated based on October 2015 groundwater elevation contour map; MO: historic high estimated based on March/April 1998 groundwater elevation contour map	20
USGS	Blum 3-1	Y	006S011E30B008M	not applicable	monitoring well	Western Lower	x		37.38773	-120.80275	90.6	90.6	185	170-180	55	65	MT: based on fall 2015 model contours (layer 2); MO: average of historic high (of available measured data) and MT	--
ETSGSA monitoring program	ETSGSA-01	Y	03S12E33N001M	not applicable	inactive pumping well	Eastern		x	37.623844	-120.664164	210.0	199.0	445	223-445	60	86	nearby DWR WDL well 04S12E03G001M - MT: estimated fall 2015 value; MO: based on historic high	38
ETSGSA monitoring program	ETSGSA-02	Y	04S13E03D002M	not applicable	active domestic well	Eastern		x	37.62142	-120.53216	261.0	262.0	350	250-310, 330-350	148	153	no nearby wells, MT: minimum of measured data (fall 2020), MO: historic high of measured data	138
ETSGSA monitoring program	ETSGSA-04	Y	04S12E19P001M	not applicable	non-pumping irrigation well	Eastern		x	37.56813	-120.69452	255.0	258.8	370	90-370	5	29	based on measured data at the well	-7
ETSGSA monitoring program	ETSGSA-05	Y	05S11E01Q001M	not applicable	active domestic well	Eastern		x	37.52200	-120.70766	195.0	196.0	375	275-375	-5	24	based on nearby voluntary well 05S11E01G001M, MT: October 2015 water level, which is similar to April 2021 level at this well (-3 ft msl), MO: based on historic high in March 2006	-17
ETSGSA monitoring program	ETSGSA-06	Y	04S12E07J001M	not applicable	non-pumping irrigation well	Eastern		x	37.60089	-120.68618	194.0	195.9	375	120-244	30	56	no water level data between 2014 and 2019, MT based on Oct 2015 contour map, MO based on historic high	11
ETSGSA monitoring program	ETSGSA-08	Y	04S12E26M001M	not applicable	active pumping fertigation well	Eastern		x	37.55470	-120.62733	272.0	274.0	658	188-474	18	43	nearby CASGEM 04S12E35C001M (EWD 13, old EWD-01): MT: 2015 non-pumping low, MO: historic high	8
ETSGSA monitoring program	ETSGSA-09	Y	04S13E20N001M	not applicable	non-pumping irrigation well	Eastern		x	37.56555	-120.57218	304.0	308.2	334	180-330	44	77	no nearby wells, MT: extrapolate to fall 2015 based on rate of change from fall 2019 to fall 2020 (2 ft/yr), MO: 1998 contour map	19
ETSGSA monitoring program	ETSGSA-12	Y	04S14E31N001M	not applicable	non-pumping irrigation well	Eastern		x	37.53633	-120.47958	296.0	299.4	435	250-430	155	160	MT: based on water level trend between 1975 and 2019, estimated in 2015; MO: based on water level trend between 1975 and 2019, estimated in 1998	86
ETSGSA monitoring program	ETSGSA-13	Y	05S11E22M001M	not applicable	non-pumping irrigation well	Eastern		x	37.48154	-120.75372	178.0	183.7	600	300-600	30	47	nearby DWR WDL well 05S11E22B001M, MT: 2015 low, MO: based on historic high	26
ETSGSA monitoring program	ETSGSA-14	Y	05S12E22F001M	not applicable	non-pumping irrigation well	Eastern		x	37.48497	-120.64256	222.0	225.8	685	187-598, 602-685	14	47	nearby DWR WDL well 05S12E22H001M, MT: 2015 low, MO: based on historic high	-6
ETSGSA monitoring program	ETSGSA-20	Y	05S13E03B001M	not applicable	non-pumping irrigation well	Eastern		x	37.53593	-120.52823	202.0	205.7	580	125-580	55	97	MT: fall 2015 level estimated based on rate of water level decline (3.3 ft/yr) from fall 2017 (48 ft) to fall 2020 (38 ft) ; MO: based on 1998 water level in DWR WDL 4S13E28Q001M (on 1998 contour map)	14
ETSGSA monitoring program	ETSGSA-21	Y	05S13E12D001M	not applicable	non-pumping irrigation well	Eastern		x	37.52058	-120.49899	308.0	312.2	283	57-283	140	180	MT: estimated from available water level data at this well. Note: water levels higher than at nearby ETSGSA wells; based on operational range (~40 ft) between MT and MO at ETSGSA-20	96

Table 7-1: Summary of Monitoring Network, Chronic Lowering of Groundwater Levels

Program	Well ID	Existing Well (Y/N)	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	WTSGSA	ETSGSA	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet)	Reference Point Elevation (feet)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT)	Measurable Objective (MO)	MT/MO Note	Interim Milestone (IM)
ETSGSA monitoring program	EW3	Y	05S12E19N001M	not applicable	monitoring well	Eastern		x	37.47757	-120.70297	161.6	164.1	170	130-170	10	37	close to DWR WDL well 05S11E25A001M (water level data from 1990-Nov 2011). MT: based on Oct 2015 contour map, between 0 and 20 ft contours; MO: based on historic high at DWR WDL well	-1
ETSGSA monitoring program	Olam R2-4	Y	04S13E11N001M	not applicable	currently an active irrigation well, won't pump in future	Eastern		x	37.59695	-120.51389	255.0	256.0	1680	445-930, 1459-1680	79	114	close to Olam R2-2 (water level data from 11/2006 - 11/2017 provided by Wood Rodgers for GSP); MT: 2015 low (on 2015 contour map), MO: historic high of available data	--
Prop 68	MW-68A	Y	--	not applicable	monitoring well	Western Lower		x	37.44997	-120.72205	150.0	150.0	160	148-158	-	-	will be developed once water level data are collected	--
Prop 68	MW-68B	N	--	not applicable	monitoring well	Eastern		x	37.59467	-120.64586	198.0	198.0	395	370-390	-	-	will be developed once well is constructed and water level data are collected	--
Prop 68	MW-68C	Y	--	not applicable	monitoring well	Eastern		x	37.53927	-120.52199	199.0	199.0	195	180-190	-	-	will be developed once water level data are collected	--
Prop 68	WTS-1 Shallow	Y	--	not applicable	monitoring well	Western Upper	x		37.46297	-120.93019	79.0	79.0	185	160-180	-	-	will be developed once water level data are collected	--
Prop 68	WTS-1 Deep	Y	--	not applicable	monitoring well	Western Lower	x		37.46297	-120.93025	79.0	79.0	340	315-335	-	-	will be developed once water level data are collected	--
Prop 68	WTS-2 Shallow	Y	--	not applicable	monitoring well	Western Upper	x		37.39738	-120.90442	81.0	81.0	145	120-140	-	-	will be developed once water level data are collected	--
Prop 68	WTS-2 Deep	Y	--	not applicable	monitoring well	Western Lower	x		37.39737	-120.90457	81.0	81.0	295	280-290	-	-	will be developed once water level data are collected	--
TSS	TSS-1	N	--	not applicable	monitoring well	Eastern		x	37.60248	-120.70003	-	-	-	-	30	54	MT: estimated from 2015 contour map; MO: based on historic high, estimated from 1998 contour map	--
TSS	TSS-2	N	--	not applicable	monitoring well	Eastern		x	37.49778	-120.64988	-	-	-	-	-5	34	close to DWR WDL 05S12E16R001M (data from 1990 - Nov 2010). MT: estimated based on 2015 contour map; MO: based on historic high at DWR WDL well	--
TSS	TSS-3	N	--	not applicable	monitoring well	Eastern		x	37.55358	-120.46714	-	-	-	-	155	160	close to ETSGSA-12, use same MT/MO (no additional information in this area of the Subbasin)	--

Notes: The field program for the construction of the Proposition 68 (Prop 68) program wells is underway in Winter 2021/2022. MTs/MOs for these wells will be developed once the field program is complete and water levels are measured and analyzed.
Wells being funded by the DWR Technical Support Services (TSS) program are not yet drilled at the time of this GSP. MTs/MOs for the future TSS wells were estimated based on best available data.
IMs were developed for wells in areas where water levels may continue to decline while projects are being brought online.
IMs were not assigned to wells with current water levels consistent with established MTs and MOs.
IMs provided on this table represent 5-year IMs (2027), as described in Section 7.1. The 10-year IMs (2032) are the MTs and the 15-year IMs (2037) are the midpoint between the MT and the MO (see Section 7.1).

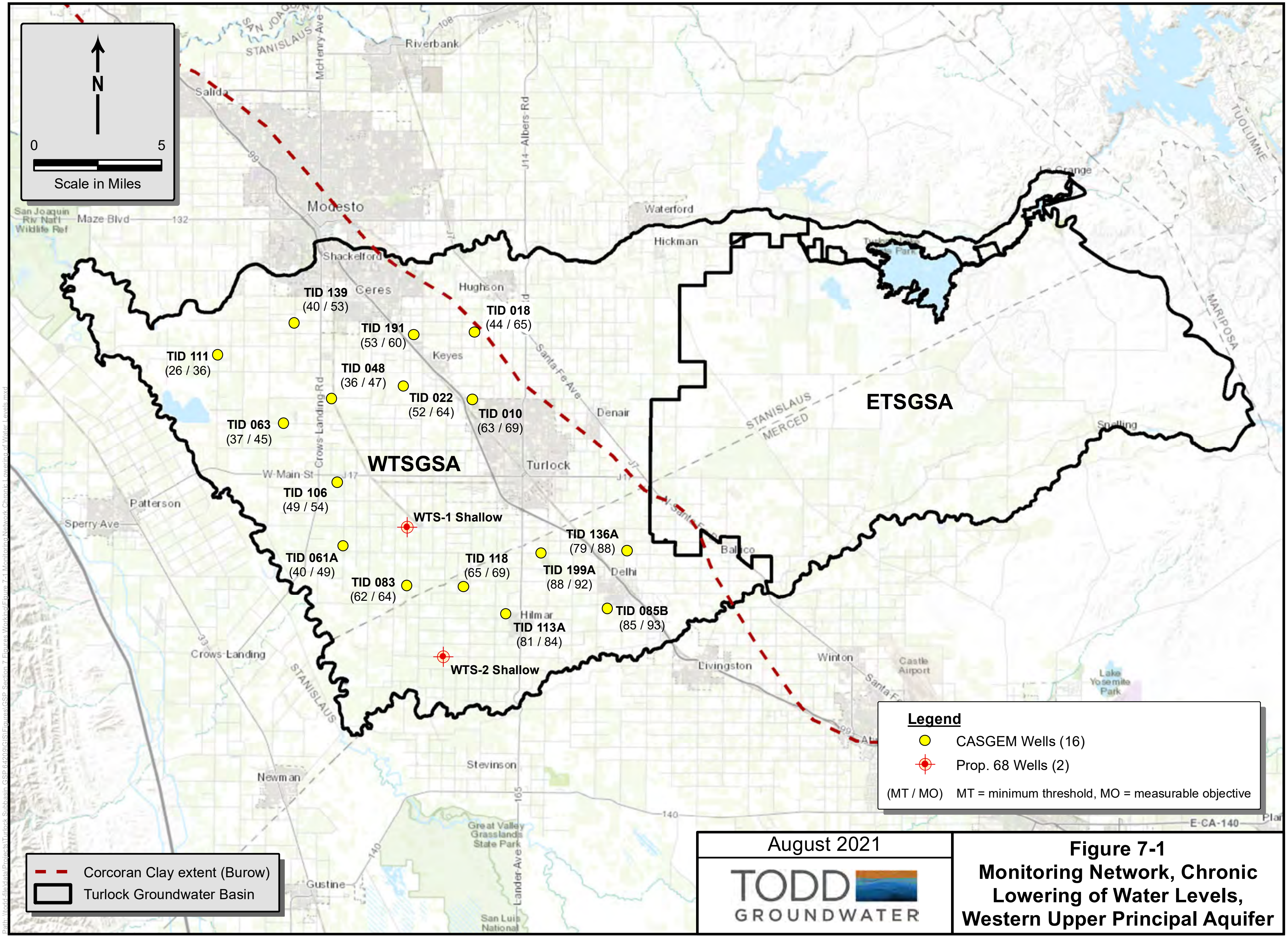
Table 7-2: Summary of Monitoring Network, Interconnected Surface Water

Program	Well ID	Existing Well (Y/N)	State Well Number	CASGEM Identification Number	Well Use / Status	Principal Aquifer	WTSGSA	ETSGSA	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet)	Reference Point Elevation (feet)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)	Minimum Threshold (MT)	Measurable Objective (MO)	MT/MO Note	Interim Milestone (IM)
San Joaquin River																		
CASGEM	TID 061A	Y	05S09E33R001M	5643	active drainage well	Western Upper	x		37.45272	-120.97657	63.0	64.6	225	0.5-195	40	49	based on measured data at the well	--
CASGEM	TID 063	Y	05S09E07B001M	4935	active drainage well	Western Upper	x		37.52240	-121.01960	56.4	56.4	110	0.5-71	37	45	based on measured data at the well	--
CASGEM	TID 111	Y	04S08E27H001M	2176	active drainage well	Western Upper	x		37.56113	-121.06675	57.0	60.1	212	0.5-164	26	36	based on measured data at the well	--
Tuolumne River																		
City of Ceres	Ceres 36	Y	--	not applicable	non-pumping irrigation well	Western Upper	x		37.62084	-120.96167	88.5	--	230	120-140, 170-230	31	36	MT: Fall 2015 water level at adjacent Ceres Well 34 (similar screened interval); MO: based on measured data	26
ETSGSA monitoring program	ETSGSA-01	Y	03S12E33N001M	not applicable	inactive pumping well	Eastern		x	37.623844	-120.664164	210.0	199.0	445	223-445	60	86	nearby DWR WDL well 04S12E03G001M - MT: estimated fall 2015 value; MO: based on historic high	38
ETSGSA monitoring program	ETSGSA-02	Y	04S13E03D002M	not applicable	active domestic well	Eastern		x	37.62142	-120.53216	261.0	262.0	350	250-310, 330-350	148	153	no nearby wells, MT: minimum of measured data (fall 2020), MO: historic high of measured data	138
Merced River																		
CASGEM	TID 303	Y	05S10E34J001M	48499	active irrigation well	Western Upper	x		37.39668	-120.81349	102.0	99.3	317	0.5-100	85	89	MT: 1 foot below November 2014 (based on data trend); MO: based on historic high	--
ETSGSA monitoring program	ETGSA-14	Y	05S12E22F001M	not applicable	non-pumping irrigation well	Eastern		x	37.48497	-120.64256	222.0	225.8	685	187-598, 602-685	14	47	nearby DWR WDL well 05S12E22H001M, MT: spring 2014, MO: based on historic high	-6
ETSGSA monitoring program	ETSGSA-17	Y	05S12E25H001M	not applicable	non-pumping irrigation well	Eastern		x	37.47300	-120.59615	217.0	221.1	390	146-178, 182-390	96	100	MT: spring 2021 water level; MO: based on measured historic high	86
ETSGSA monitoring program	ETSGSA-21	Y	05S13E12D001M	not applicable	non-pumping irrigation well	Eastern		x	37.52058	-120.49899	308.0	312.2	283	57-283	144	184	MT: estimated from available water level data at this well in spring 2014. Note: water levels higher than at nearby ETSGSA wells; based on operational range (~40 ft) between MT and MO at ETSGSA-20	96
ETSGSA monitoring program	ETSGSA-23	Y	06S12E04G001M	not applicable	active pumping well - home and field	Eastern		x	37.44169	-120.65617	175.0	178.1	228	132-212	71	78	MT: spring 2021 measurement; MO: based on historic high at nearby DWR WDL well 05S12E33N001M	61
TSS	TSS-4	N	05S13E21R001M	not applicable	monitoring well	Eastern		x	37.47941	-120.54404	-	-	-	-	86	100	estimated based on two wells near river and downstream of this location: ETSGSA-17 and DWR WDL 05S12E26N001M. Assumed difference (13 ft) in MT (spring 2014) and MO (1998) between ETSGSA-17 and 05S12E26N001M is same as between ETSGSA-17 and TSS-4	--

Notes: Wells being funded by the DWR Technical Support Services (TSS) program are not yet drilled at the time of this GSP. MTs/MOs for the future TSS wells were estimated based on best available data.
IMs were developed for wells in areas where water levels may continue to decline while projects are being brought online.
IMs were not assigned to wells with current water levels consistent with established MTs and MOs.
IMs provided on this table represent 5-year IMs (2027), as described in Section 7.1. The 10-year IMs (2032) are the MTs and the 15-year IMs (2037) are the midpoint between the MT and the MO (see Section 7.1).

Table 7-3: Summary of SGMA Monitoring Wells

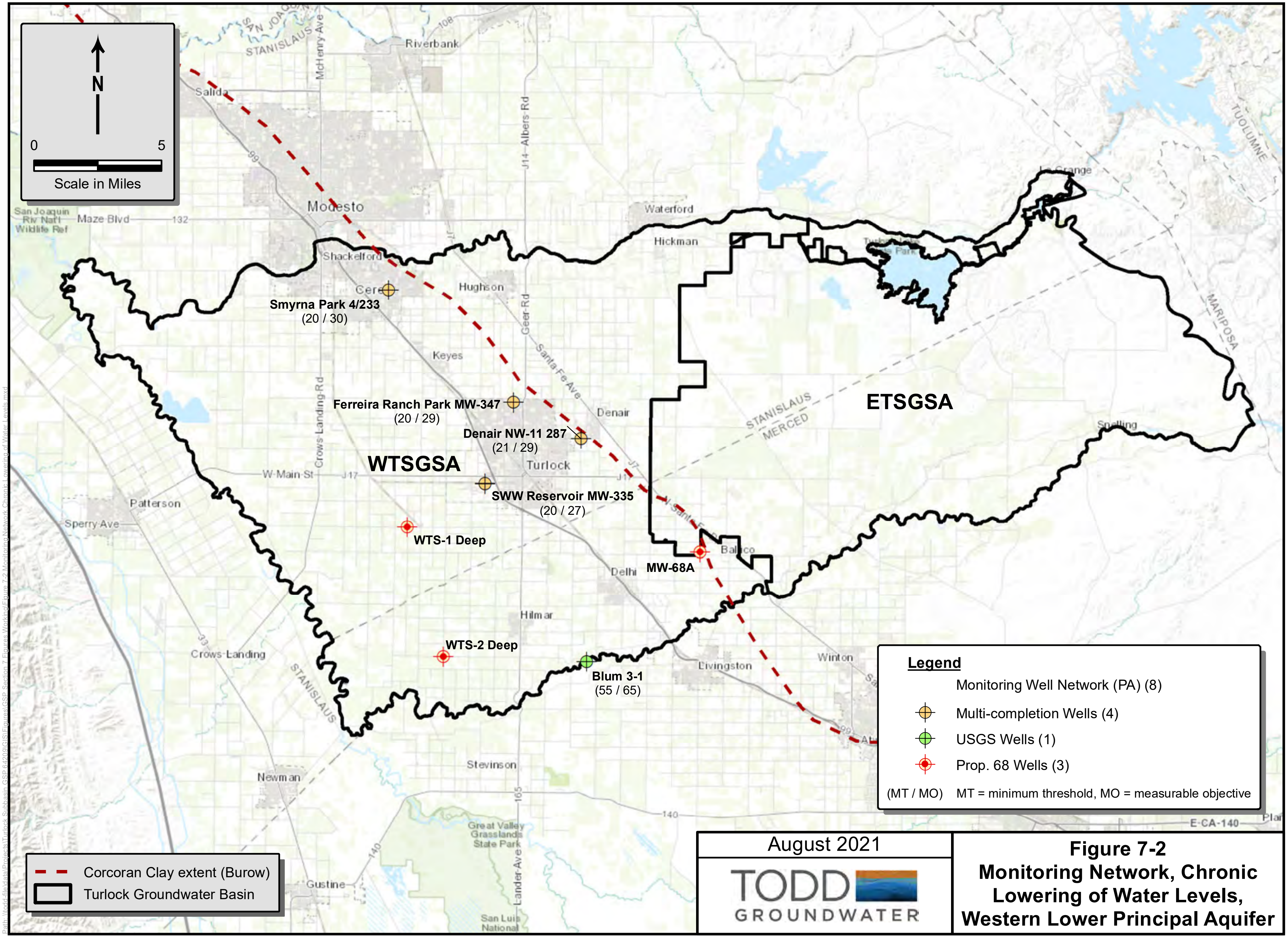
Program	Well ID	Existing Well (Y/N)	State Well Number	CASGEM Identification Number	Principal Aquifer	WTSGSA	ETSGSA	Latitude (NAD 83)	Longitude (NAD 83)	Ground Surface Elevation (feet)	Reference Point Elevation (feet)	Total Well Depth (feet bgs)	Screen Interval Depths (feet bgs)
CASGEM	TID 034	Yes	04S09E30Q001M	26548	Western Upper	x		37.55153	-121.01763	68	69.7	88	0.5-76
CASGEM	TID 082	Yes	05S09E23K001M	5632	Western Upper	x		37.48448	-120.94471	73	73.55	126	0.5-79
CASGEM	TID 92	Yes	04S08E13P001M	2161	Western Upper	x		37.58060	-121.04374	68	69.44	122	32-97
CASGEM	TID 186A	Yes	04S10E21R002M	3764	Western Upper	x		37.56630	-120.86790	111.37	111.37	253	62-172
CASGEM	TID 189	Yes	04S11E32P001M	5403	Eastern	x		37.53678	-120.78475	132	133.96	266	21-168
CASGEM	EWD-01 (identified as EWD-13 in ETSGSA)	Yes	04S12E35C001M	6837	Eastern		x	37.54770	-120.61820	263	264	600	400-600
CASGEM	EWD 03 (identified as EWD-05 in ETSGSA)	Yes	05S12E08K001M	50447	Eastern		x	37.51360	-120.67390	216	217	700	360-700
CASGEM	EWD 04	Yes	05S12E27A001M	9603	Eastern		x	37.47410	-120.63430	192.5	194	581	208-340, 344-581
CASGEM	EWD 05	Yes	05S13E06P001M	50448	Eastern		x	37.52162	-120.58842	202	203	513	135-423, 483-513
Multi-Completion	Smyrna Park 3/275	yes	--	not applicable	Western Lower	x		37.59878	-120.94534	95.13	97.83	275	260-270
Multi-Completion	Smyrna Park 2/293	yes	--	not applicable	Western Lower	x		37.59878	-120.94534	95.13	--	297	288-293
Multi-Completion	Smyrna Park 1/335	yes	--	not applicable	Western Lower	x		37.59878	-120.94534	95.13	97.63	335	320-330
Multi-Completion	Denair NW-11 443	yes	--	not applicable	Western Lower	x		37.51456	-120.80738	116.72	116.72	443	408-443
Multi-Completion	Denair NW-11 605	yes	--	not applicable	Western Lower	x		37.51456	-120.80738	116.72	116.72	605	540-605
Multi-Completion	Ferreira Ranch Park MW-210	yes	--	not applicable	Western Lower	x		37.53495	-120.85554	106.0	106.0	210	195-205
Multi-Completion	Ferreira Ranch Park MW-443	yes	--	not applicable	Western Lower	x		37.53495	-120.85554	106	106	443	428-438
Multi-Completion	Ferreira Ranch Park MW-535	yes	--	not applicable	Western Lower	x		37.53495	-120.85554	106	106	535	520-530
Multi-Completion	SWW Reservoir MW-235	yes	--	not applicable	Western Lower	x		37.48876	-120.87563	89	89	235	220-230
Multi-Completion	SWW Reservoir MW-417	yes	--	not applicable	Western Lower	x		37.48876	-120.87563	89	89	417	402-412
Multi-Completion	NE Storm Basin MW-280	yes	--	not applicable	Eastern		x	37.53633	-120.82609	116	116	280	265-275
Multi-Completion	NE Storm Basin MW-505	yes	--	not applicable	Eastern		x	37.53633	-120.82609	116	116	505	490-500
USGS	Blum 1-4	yes	006S011E30B005M	not applicable	Western Upper	x		37.38777	-120.80273	90.1	--	17	12-14
USGS	Blum 3-2	yes	006S011E30B009M	not applicable	Western Upper	x		37.38777	-120.80273	90.6	--	25	15-20
USGS	Blum 2-2	yes	006S011E30B007M	not applicable	Western Upper	x		37.38777	-120.80273	91.2	--	33	28-30
USGS	Blum 1-3	yes	006S011E30B004M	not applicable	Western Upper	x		37.38777	-120.80273	90.1	--	54	49-51
USGS	Blum 2-1	yes	006S011E30B006M	not applicable	Western Upper	x		37.38774	-120.80280	91.2	--	58	53-55
USGS	Blum 1-2	yes	006S011E30B003M	not applicable	Western Upper	x		37.38774	-120.80280	90.1	--	86	81-83
USGS	Blum 1-1	yes	006S011E30B002M	not applicable	Western Upper	x		37.38773	-120.80275	90.1	--	99	94-96
USGS	Stav 4	yes	006S011E19Q004M	not applicable	Western Upper	x		37.39232	-120.80131	98.8	--	25	15-20
USGS	Stav 3	yes	006S011E19Q003M	not applicable	Western Upper	x		37.39232	-120.80131	98.8	--	47	42-44
USGS	Stav 2	yes	006S011E19Q002M	not applicable	Western Upper	x		37.39232	-120.80131	98.8	--	66	61-63
USGS	Stav 1	yes	006S011E19Q001M	not applicable	Western Upper	x		37.39232	-120.80131	98.8	--	86	81-83
USGS	Balv 4	yes	006S011E19H006M	not applicable	Western Upper	x		37.39737	-120.80035	110.0	--	30	20-25
USGS	Balv 3	yes	006S011E19H005M	not applicable	Western Upper	x		37.39737	-120.80035	110.0	--	50	45-47
USGS	Balv 2	yes	006S011E19H004M	not applicable	Western Upper	x		37.39737	-120.80035	110.0	--	70	65-67
USGS	Balv 1	yes	006S011E19H003M	not applicable	Western Upper	x		37.39737	-120.80035	110.0	--	92	87-89
ETSGSA monitoring program	ETSGSA-03	Yes	04S11E14P001M	not applicable	Eastern		x	37.583721	-120.73011	189.4	190.4	527	197-500
ETSGSA monitoring program	ETSGSA-07	Yes	04S12E21R001M	not applicable	Eastern		x	37.56750	-120.65042	247	249.66	615	335-615
ETSGSA monitoring program	ETSGSA-10	Yes	04S13E35B001M	not applicable	Eastern		x	37.54721	-120.50448	283.0	287.6	550	285-545
ETSGSA monitoring program	ETSGSA-11	Yes	04S14E21P001M	not applicable	Eastern		x	37.56532	-120.43571	268.0	272.1	525	156-192, 227-512
ETSGSA monitoring program	ETSGSA-15	Yes	05S11E11P002M	not applicable	Eastern		x	37.51036	-120.73290	207	207	682	362-482, 602-682
ETSGSA monitoring program	ETSGSA-16	Yes	05S12E10N001M	not applicable	Eastern		x	37.506028	-120.647583	193	195.3	167	157-167
ETSGSA monitoring program	ETSGSA-18	Yes	05S13E08C001M	not applicable	Eastern		x	37.51963	-120.57024	208	209.83	453	213-453
ETSGSA monitoring program	ETSGSA-19	Yes	05S11E27A001M	not applicable	Eastern		x	37.476617	-120.740219	170.6	144	151	-
ETSGSA monitoring program	ETSGSA-22	Yes	04S12E31A001M	not applicable	Eastern		x	37.547466	-120.68668	229.4	230.4	494	296-388, 398-477
ETSGSA monitoring program	ETSGSA-24	Yes	05S11E35R001M	not applicable	Eastern		x	37.450151	-120.72206	147.60000	148.0	464.0	300-452
ETSGSA monitoring program	Turlock Airport Well	Yes	05S12E19P001M	not applicable	Eastern		x	37.48249	-120.69792	158.0	157.0	160	120-160
ETSGSA monitoring program	EW2	Yes	05S12E19E001M	not applicable	Eastern		x	37.48553	-120.70307	164.0	167.0	170	130-170
ETSGSA monitoring program	Olam R3-4	Yes	04S13E24P001M	not applicable	Eastern		x	37.571437	-120.49910	239.00000	240.0	655.0	239-339, 469-509, 519-599, 606-646
ETSGSA monitoring program	Olam R2-6	Yes	04S13E14E001M	not applicable	Eastern		x	37.589167	-120.51728	289.00000	290.0	452.0	285-335, 342-382, 402-442
ETSGSA monitoring program	Olam R3-5	Yes	04S13E24D001M	not applicable	Eastern		x	37.577285	-120.49690	263.00000	264.0	562.0	212-292, 463-483, 497-557
ETSGSA monitoring program	Olam R2-7	Yes	04S13E10B001M	not applicable	Eastern		x	37.608422	-120.52277	239.00000	240.0	310.0	178-258, 285-300



August 2021

TODD GROUNDWATER

Figure 7-1
Monitoring Network, Chronic Lowering of Water Levels, Western Upper Principal Aquifer



August 2021

TODD GROUNDWATER

Figure 7-2
Monitoring Network, Chronic Lowering of Water Levels, Western Lower Principal Aquifer

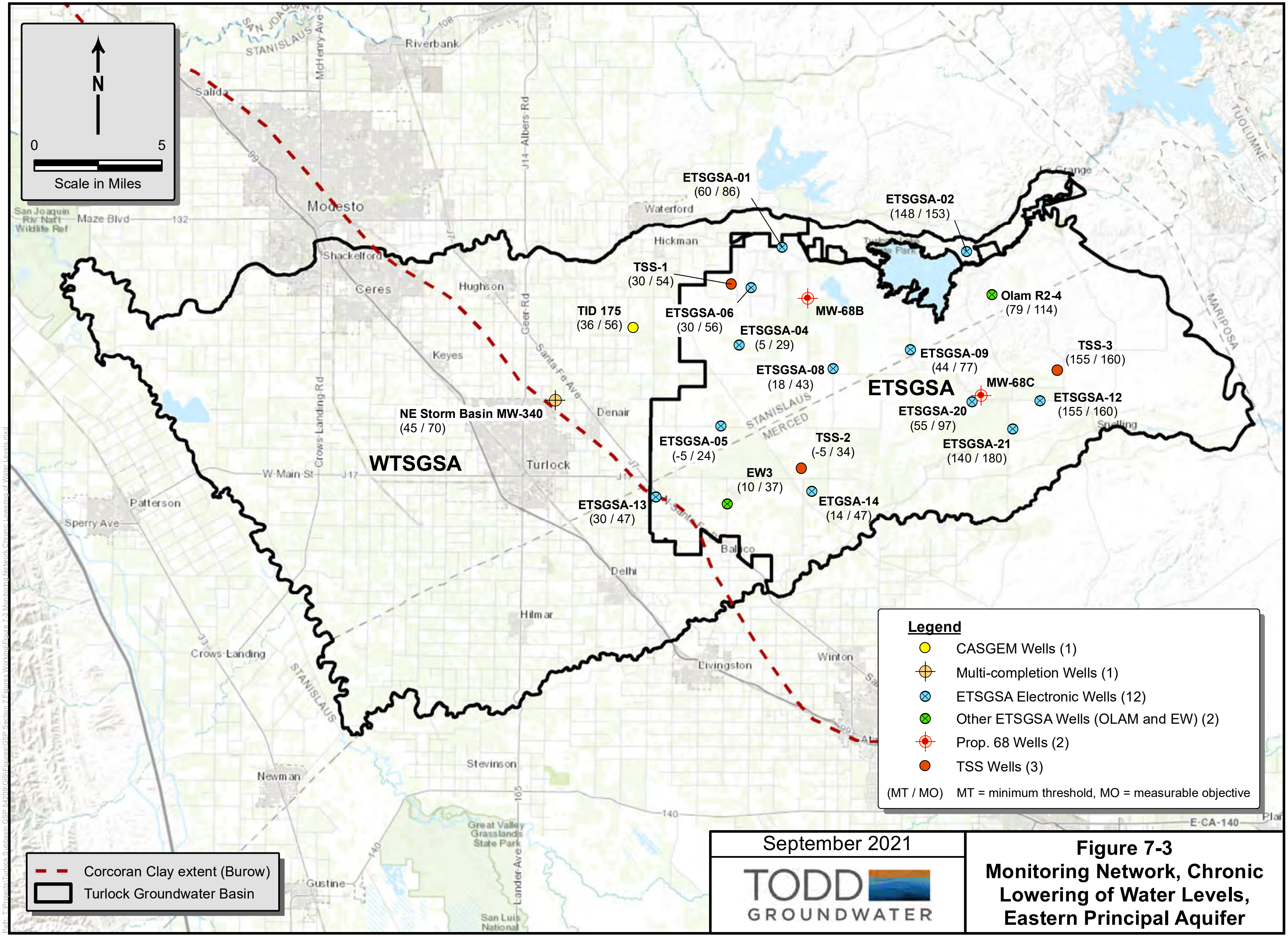
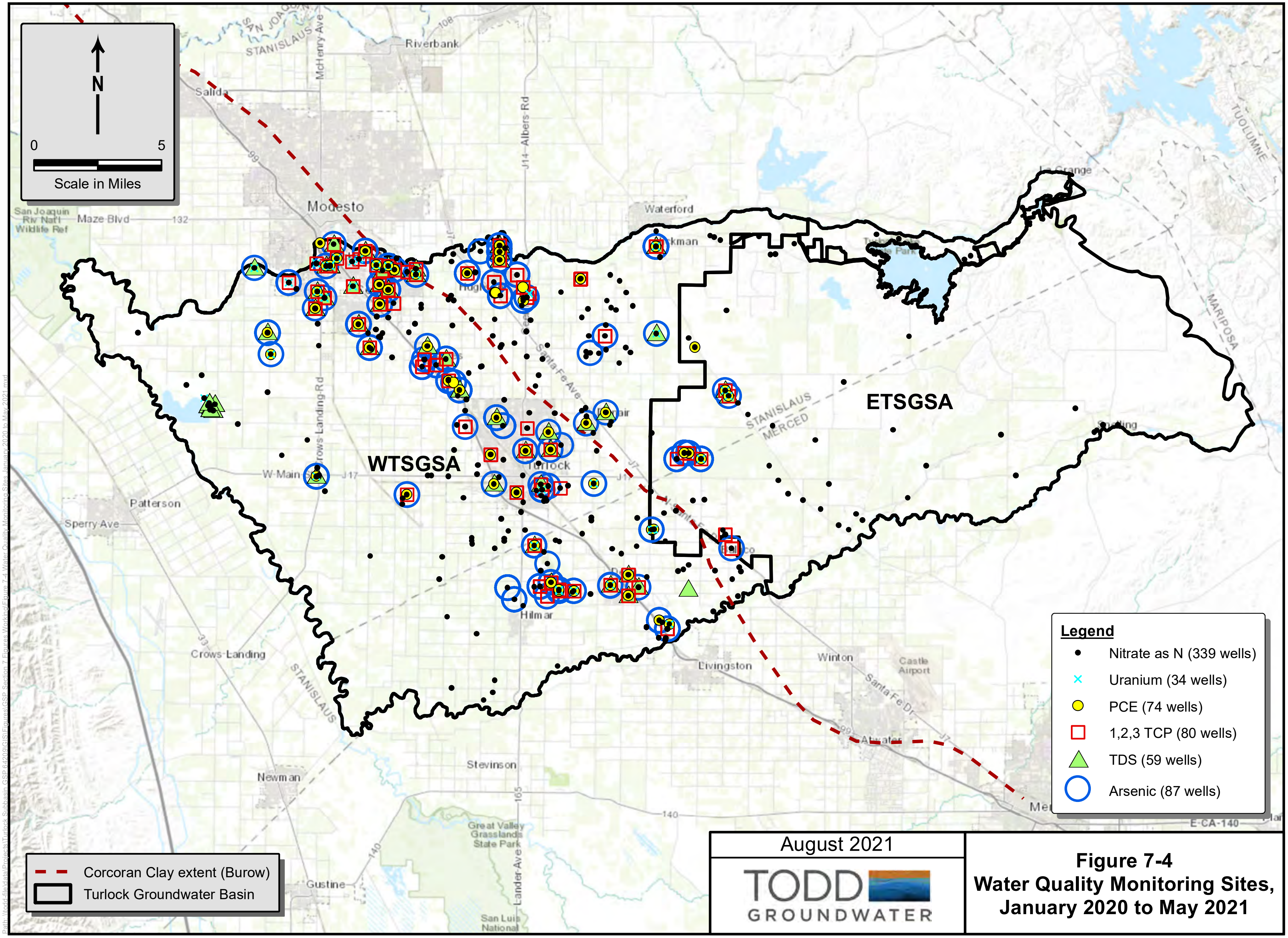


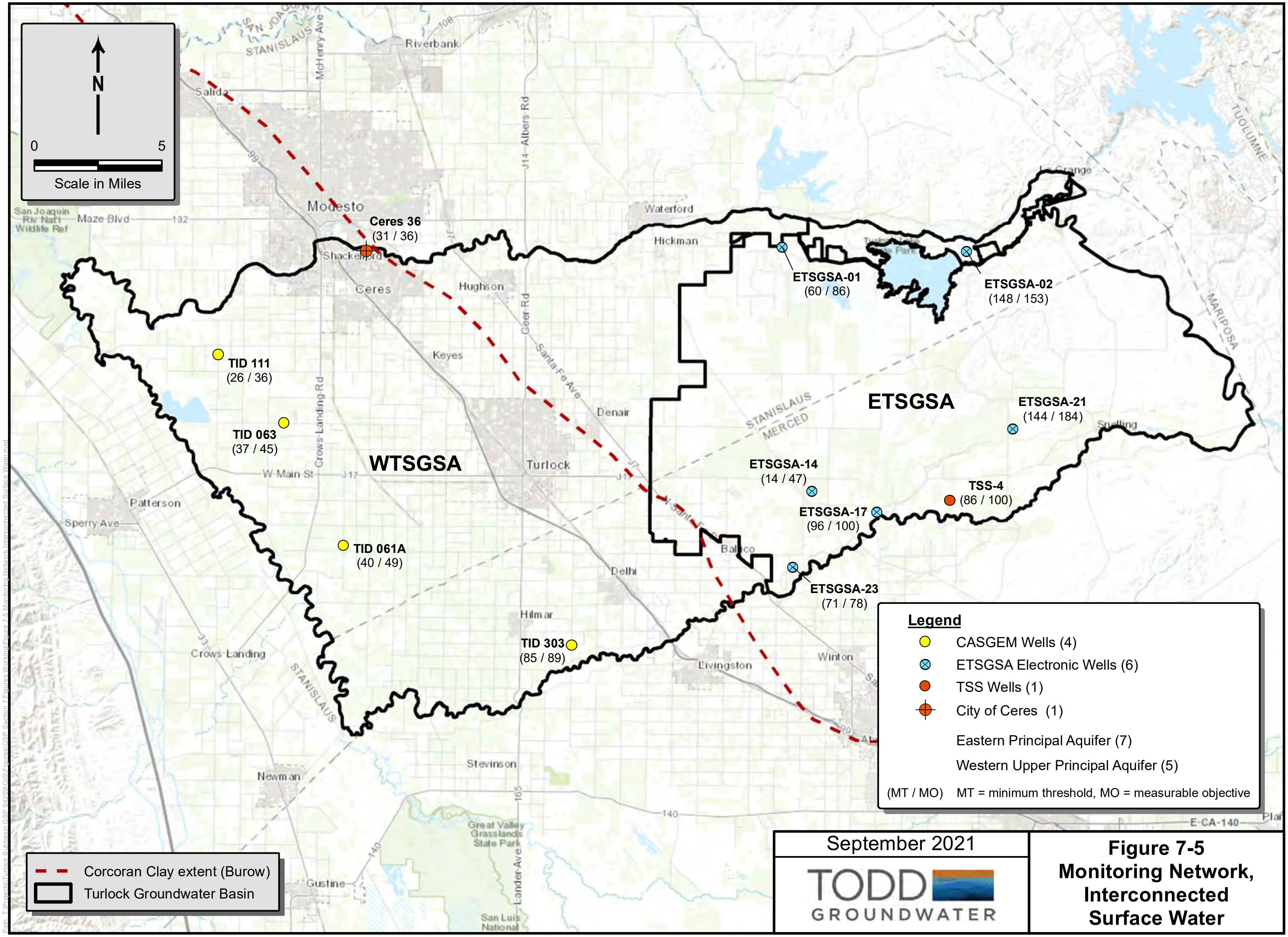
Figure 7-3
Monitoring Network, Chronic Lowering of Water Levels, Eastern Principal Aquifer



August 2021

TODD GROUNDWATER

Figure 7-4
Water Quality Monitoring Sites, January 2020 to May 2021



September 2021

TODD GROUNDWATER

Figure 7-5
Monitoring Network, Interconnected Surface Water

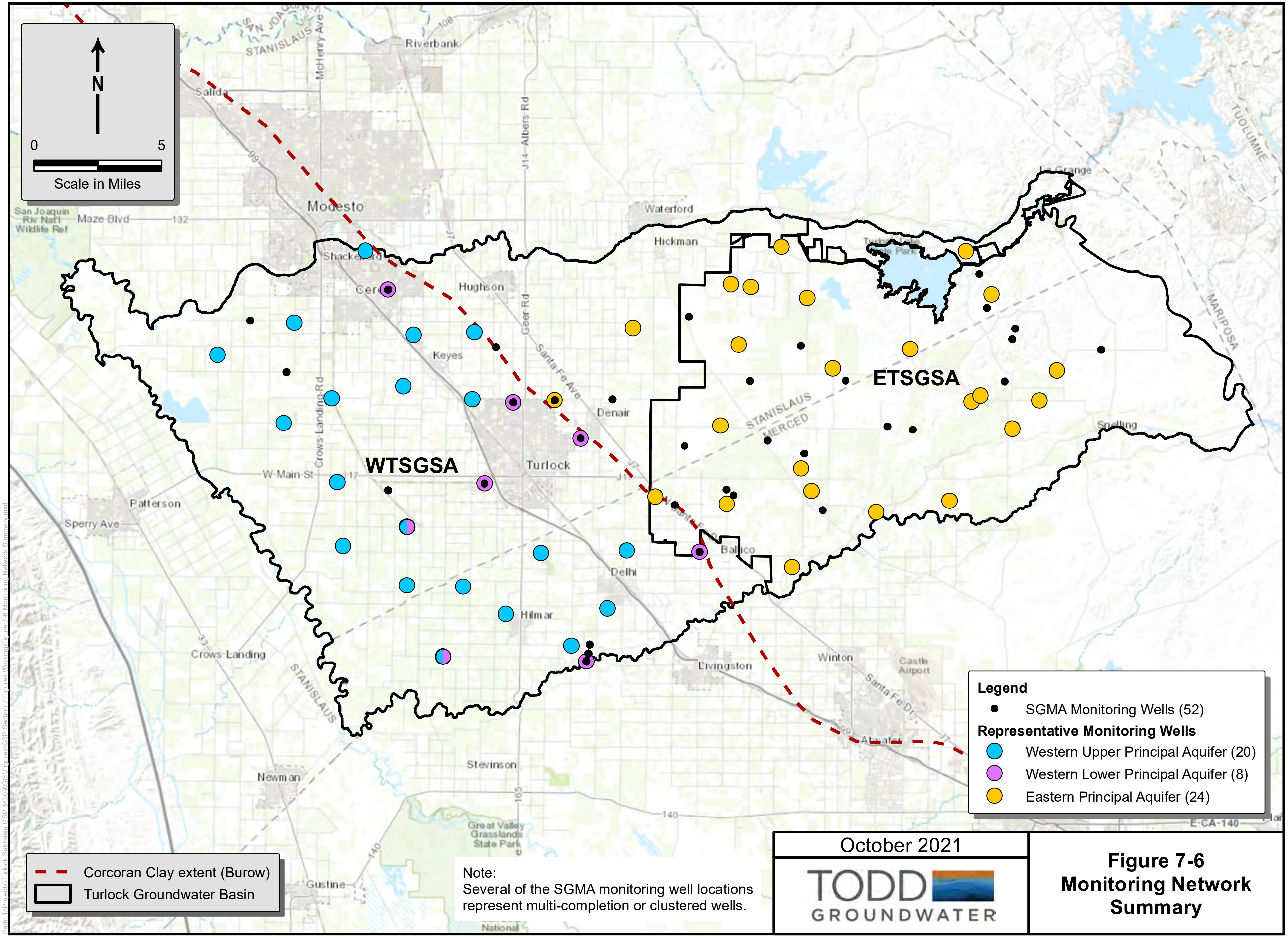


Figure 7-6
Monitoring Network Summary

8. PROJECTS AND MANAGEMENT ACTIONS

To achieve the sustainability goals for the Turlock Subbasin by 2042, and to avoid undesirable results over the remainder of a 50-year planning horizon, as required by SGMA regulations, multiple Projects and Management Actions (PMAs) have been identified and considered by the Turlock Subbasin Groundwater Sustainability Agencies (GSAs) in this Groundwater Sustainability Plan (GSP).

A description of PMAs that will contribute to the achievement of sustainability goals in the Turlock Subbasin is provided herein. PMAs are described in accordance with §354.42 and §354.44 of the SGMA regulations. An evaluation of the benefits and/or impacts of various planned projects on groundwater levels and storage volumes is also provided.

“Projects” generally refer to physically constructed (structural) features whereas “Management Actions” generally refer to the non-structural programs or policies designed to incentivize actions that result in improvements in sustainability of the Subbasin, including reductions in groundwater pumping or optimization of management of groundwater. The PMAs discussed in this Chapter are intended to help the GSAs progress toward meeting the sustainability goals and Measurable Objectives (MOs), as well as avoid violation of MTs and causing undesirable results as identified for the Subbasin in **Chapter 6**, Sustainable Management Criteria. Plans for implementation of the PMAs and implementing the GSP are discussed in **Chapter 9**, Implementation Support Activities.

Recognizing the GSP data gaps and uncertainties in the Basin Setting (per §354.44(d)), development and implementation of PMAs in the Turlock Subbasin utilizes an adaptive management approach informed by continued monitoring of the groundwater conditions throughout the Subbasin and over time. This adaptive approach includes two categories:

1. **PMAs developed for near-term implementation** that would help to achieve and maintain groundwater sustainability while supporting other local goals. These PMAs include:
    - PMAs that are in place and will continue to be implemented by project proponents and partners that will support groundwater management and GSP implementation.
    - PMAs that are currently in planning stage and will be developed and implemented by project proponents and partners, and which will contribute to attainment of the Subbasin sustainability goals and will support the GSP implementation
2. **Other PMAs to be implemented as needed** to gather and evaluate monitoring and investigation data as well as achieve and maintain long-term sustainable groundwater management across the Turlock Subbasin. These potential PMAs will be managed adaptively with further evaluation during GSP implementation if respective GSAs find that established Interim Milestones (IMs) or MOs cannot be achieved and/or if MTs are being approached.

A range of PMAs is presented to allow both the ETSGSA and the WTSGSA flexibility in their response to changing groundwater conditions and as new and better information becomes available. However, it is anticipated that not all the PMAs will need to be implemented, or that some PMAs will be implemented by one GSA and not the other. Adaptive implementation of PMAs will be informed by ongoing monitoring of groundwater conditions using the monitoring network and methods described in the GSP (**Chapter 7**). Any adverse groundwater conditions or challenges in maintaining groundwater sustainability will be addressed by scaling and implementing PMAs in a targeted and proportional manner, consistent with conditions observed in the Subbasin.

Implementation and operation of PMAs will be periodically assessed during the GSP implementation period. As planning is at varying early stages of development, complete information on construction requirements, operations, costs, schedule, permitting requirements, and other details are not uniformly available for all the PMAs. Schedule, cost, and funding opportunities for each PMA are provided under each PMA when available. Other implementation and funding efforts will be determined and reported if/when the PMA is evaluated and selected for implementation. This information will be reported in GSP Annual Reports and Five-Year Assessment Reports. For more detailed information regarding the funding of GSP implementation activities, refer to **Chapter 9**: Implementation Support Activities.

8.1. PROJECTS OVERVIEW

This section describes the Projects that are in place, planned, or may be considered for implementation in the Turlock Subbasin. In accordance with 23 CCR §354.44, Projects were developed to help achieve and maintain the Subbasin sustainability goal by 2042 and avoid undesirable results over the GSP planning and implementation period. Broadly, Projects provide tools that can be used to achieve and maintain groundwater sustainability.

Projects were developed, where possible, to be aligned with State grant program preferences and the Governor's Water Action Plan, by providing multiple benefits, embracing innovation and new technologies, and benefitting disadvantaged communities (DACs) and environmental water users. This Plan prioritizes Projects that contain multi-benefit approaches that address multiple needs and stress the utilization of natural infrastructure, including the basin itself for storage and the natural waterways and floodplains as recharge areas. Additionally, the Plan emphasizes coordination among users, the GSAs within the Subbasin, and neighboring basins to improve the region's groundwater condition and achieve sustainability.

Projects were identified in the Turlock Subbasin through several months of collaborative effort between the Turlock Subbasin GSP Ad-Hoc Committee, the Turlock Subbasin Technical Advisory Committee, Board of Directors of each GSA, and technical consultants to the GSAs. Project information was provided by the GSAs and proponent agencies (which are generally member agencies of the GSAs) and compiled into a draft list. The initial set of projects was reviewed further, and a final list of 24 possible projects was identified for inclusion in the GSP, representing a variety of project types including direct and in-lieu recharge, water recycling, and advancements to metering infrastructure. Projects are classified into three groups based on project status: Group 1, Group 2, and Group 3, as defined below.

- Group 1 – Projects that are in place and will continue to be implemented by specific participating agencies within the Turlock Subbasin to support groundwater management and GSP implementation.
- Group 2 – Projects that are currently planned and will be implemented by specific participating agencies within the Turlock Subbasin which will contribute to attainment of SMC and will support GSP implementation.
- Group 3 – Projects which have been identified and may occur in the Turlock Subbasin in the future, would provide benefits in contributing to the attainment of the sustainability goal and SMC, and would otherwise support GSP implementation.

Group 1 and Group 2 Projects are summarized in **Section 8.2**: Projects Developed for Near-Term Implementation. These Projects were analyzed as part of scenarios using the C2VSimTM model to estimate their benefit to the groundwater system over the projected planning period. The results of the model scenarios are discussed in **Section 8.5**: Plan for Achieving Sustainability.

Group 3 Projects are summarized in **Section 8.3:** Other Projects to be Implemented as Needed. Group 3 Projects are currently not evaluated in detail, and are described at a more general level, reflecting their conceptual nature and planning status at this time. Additional feasibility studies and details for these Projects will be developed in the future, as needed.

The proposed Projects identified in this Chapter will be either directly funded and implemented by GSAs of the Turlock Subbasin, the respective project proponents with coordination with the GSAs, or will be subject of grant funding requests through state and federal funding opportunities. Project proponents are listed in **Table 8-1**.

Each individual Project proponent will manage the permitting and other specific implementation oversight for its own Projects. It is the intent of the GSAs that projects and actions implemented by project proponents and/or GSAs will benefit those project proponents and/or GSAs. An accounting mechanism will be developed, as described under Implementation Support Activities (**Chapter 9**) that will dictate how the water within the subbasin will be shared and allocated moving forward. This will inform the implementation, needs, and responsibilities of PMAs in the future. In addition, pursuant to the Memorandum of Agreement between the GSAs, specific Project Agreements may be used to assist with implementation of joint projects in the future

Inclusion of Projects in this GSP does not forego any obligations regarding individual project implementation under local, state, or federal regulatory programs. While the GSAs do have an obligation to oversee progress towards groundwater sustainability, they are not the primary regulator of land use, water quality, or environmental project compliance. It is the responsibility of the implementing agencies of planned Projects to ensure that they are collaborating with outside entities and responsible regulatory agencies to ensure their Projects comply with all applicable laws and permitting requirements.

To facilitate the efficient environmental review of Projects under the California Environmental Quality Act (CEQA), a Programmatic Environmental Impact Report (PEIR) is being prepared as a joint Implementation Support Activity as described in **Chapter 9**.

The GSAs will collaborate with project proponents and project partners to track progress and support project implementation. The implementation of PMAs will be enhanced by the development of clear policy and guidance by the GSAs that lay out applicable sustainable management criteria (SMC, as described in **Chapter 6**: Sustainable Management Criteria) as well as PMA-specific monitoring and reporting frameworks to facilitate adaptive management toward Subbasin protection and sustainability. The GSP implementation will include guidelines and protocols to coordinate implementation of Projects in such a way that the Subbasin sustainability is achieved in a coordinated environment among the GSAs, the Project proponents and sponsors, and other stakeholders.

Table 8-1 shows the Group 1 and 2 Projects with their respective groups. **Table 8-2** shows the Group 3 Projects with their respective groups. Together, these lists represent an initial list of Projects that will be further refined as additional Projects are identified during GSP implementation, with updates included in Annual Reports and the GSP updates, as appropriate. A description of each Project in more detail is provided in **Sections 8.2** [Projects Developed for Near-Term Implementation (Groups 1 and 2)] and **8.3** [Other Projects to be Implemented As Needed (Group 3)].

Table 8-1 and **Table 8-2** provide a snapshot of Projects as required by 23 CCR §354.44(b). However, Implementation Support Activity 11 (see **Section 9.11**) proposes to expand the existing East Stanislaus IRWM Region Opti Database to include PMAs listed in this GSP. The database is already used by both the Turlock and Modesto Subbasins to store a living list of projects for the IRWM as well as the Stanislaus Multi-Agency Regional Storm Water Resource Plan. The database will be maintained and updated as a living list of GSP PMAs, reflecting the current status of each Project and continually adjusting as needed to meet changing basin conditions. The database would represent an extension of the DMS specifically as it relates to containing a list of the GSP's PMAs. When revised, the PMA list will be approved by the Turlock Subbasin GSAs or other body, as appropriate, following updating. As such, the list of PMAs maintained in the database is considered to be the official Turlock GSP PMA list; no formal GSP adoption or re-adoption will be required for PMA list updating.

Table 8-1: List of Projects (Group 1 and Group 2)

Number	Proponent(s)	Project Name	Primary Mechanism(s)[1,2]	Partner(s)	Group	Included in Modeling Scenarios
WTSGSA – Urban and Municipal Projects						
1	Cities of Turlock and Ceres	Regional Surface Water Supply Project	In-lieu Groundwater Recharge	Turlock Irrigation District	1	×
2	Community of Hickman	Waterford/Hickman Surface Water Pump Station and Storage Tank	In-lieu Groundwater Recharge	City of Modesto, Modesto Irrigation District	2	×
3	City of Turlock	Dianne Storm Basin	Direct Groundwater Recharge	Turlock Irrigation District	2	×
4	California State University - Stanislaus	Stanislaus State Stormwater Recharge	Direct Groundwater Recharge	N/A	2	×
5	City of Modesto	Advanced Metering Infrastructure Project (AMI)	Water Conservation	N/A	2	×
WTSGSA – Agricultural Water Supply Projects						
6	Turlock Irrigation District	TID On-Farm Recharge Project (in WTSGSA)	Direct or In-lieu Groundwater Recharge	N/A	2	×
7	Turlock Irrigation District	Recycled Water from City of Turlock	In-lieu Groundwater Recharge	City of Turlock	2	×
8	Turlock Irrigation District	TID Ceres Main Regulating Reservoir	In-lieu Groundwater Recharge	N/A	2	×
ETSGSA - Agricultural Water Supply Projects						
9	Eastside Water District	Agricultural Recharge Project (in ETSGSA)	Direct or In-lieu Groundwater Recharge	Turlock Irrigation District	2	×
10	Eastside Water District	Mustang Creek Flood Control Recharge Project	Direct Groundwater Recharge	Stanislaus County	2	×
11	Eastside Water District	Upland Pipeline Project	Direct or In-lieu Groundwater Recharge	Merced Irrigation District	2	×

[1]The primary mechanism of the Project as conceptualized. Projects may be used for multiple functions to support groundwater sustainability and multiple other benefits during implementation.

[2] Demand Management is a category of Management Action strategies described in **Section 8.4**. This action will be implemented as needed, along with PMAs within each GSA to achieve sustainability.

Table 8-2: Projects (Group 3)

Number	Proponent(s)	Project Name	Primary Mechanism(s)[1]	Partner(s)
WTSGSA – Group 3 Urban and Municipal Water Supply Projects				
12	City of Modesto	San Joaquin River Flood Diversions	Direct or In-Lieu Groundwater Recharge	N/A
WTSGSA – Group 3 Agricultural Water Supply Projects				
13	Turlock Irrigation District	La Grange Recharge Project (Within TID Irrigation Service Area)	Direct Groundwater Recharge	N/A
14	Turlock Irrigation District	TID Lateral 5 ½ Regulating Reservoir	In-Lieu Groundwater Recharge	N/A
15	Turlock Irrigation District	Additional TID Regulating Reservoirs	Direct or In-Lieu Groundwater Recharge	N/A
16	Turlock Irrigation District	Recharge from TID Conveyance System	Direct Groundwater Recharge	N/A
17	Turlock Irrigation District	Intertie Projects	In-Lieu Groundwater Recharge	N/A
ETSGSA – Group 3 Agricultural Water Supply Projects				
18	Eastside Water District	Rouse Lake Pipeline Project	Direct and In-Lieu Groundwater Recharge	TBD
19	Eastside Water District	Sand Creek Watershed Runoff Recharge	Direct Groundwater Recharge	N/A
20	Eastside Water District	Conveyance Improvements Project	Direct or In-Lieu Groundwater Recharge	Merced ID
21	Eastside Water District	Development of Diffused Stormwater Project	Direct or In-Lieu Groundwater Recharge	TBD
22	Eastside Water District	Dry Creek Watershed Recharge	Direct Groundwater Recharge	N/A
23	Eastside Water District	Direct Recharge in Agriculture Areas	Direct Groundwater Recharge	TBD

[1]The primary mechanisms of the Project as conceptualized. Projects may be used to support groundwater sustainability and other benefits during implementation.

Figure 8-1 shows a map of approximate Group 1 and Group 2 project locations. **Figure 8-2** shows a map of approximate Group 3 project locations.

Figure 8-1: Group 1 and Group 2 Projects Location Map

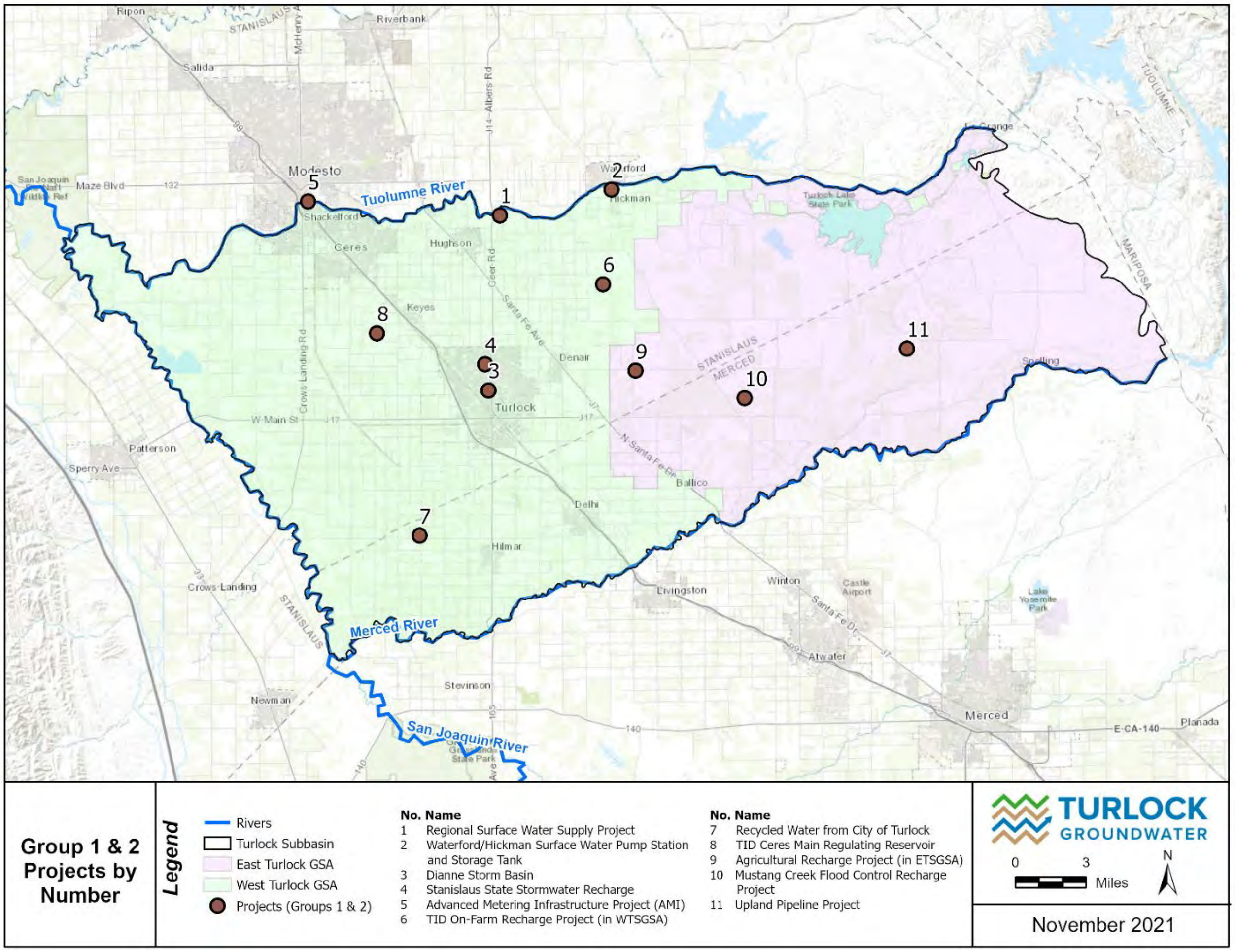
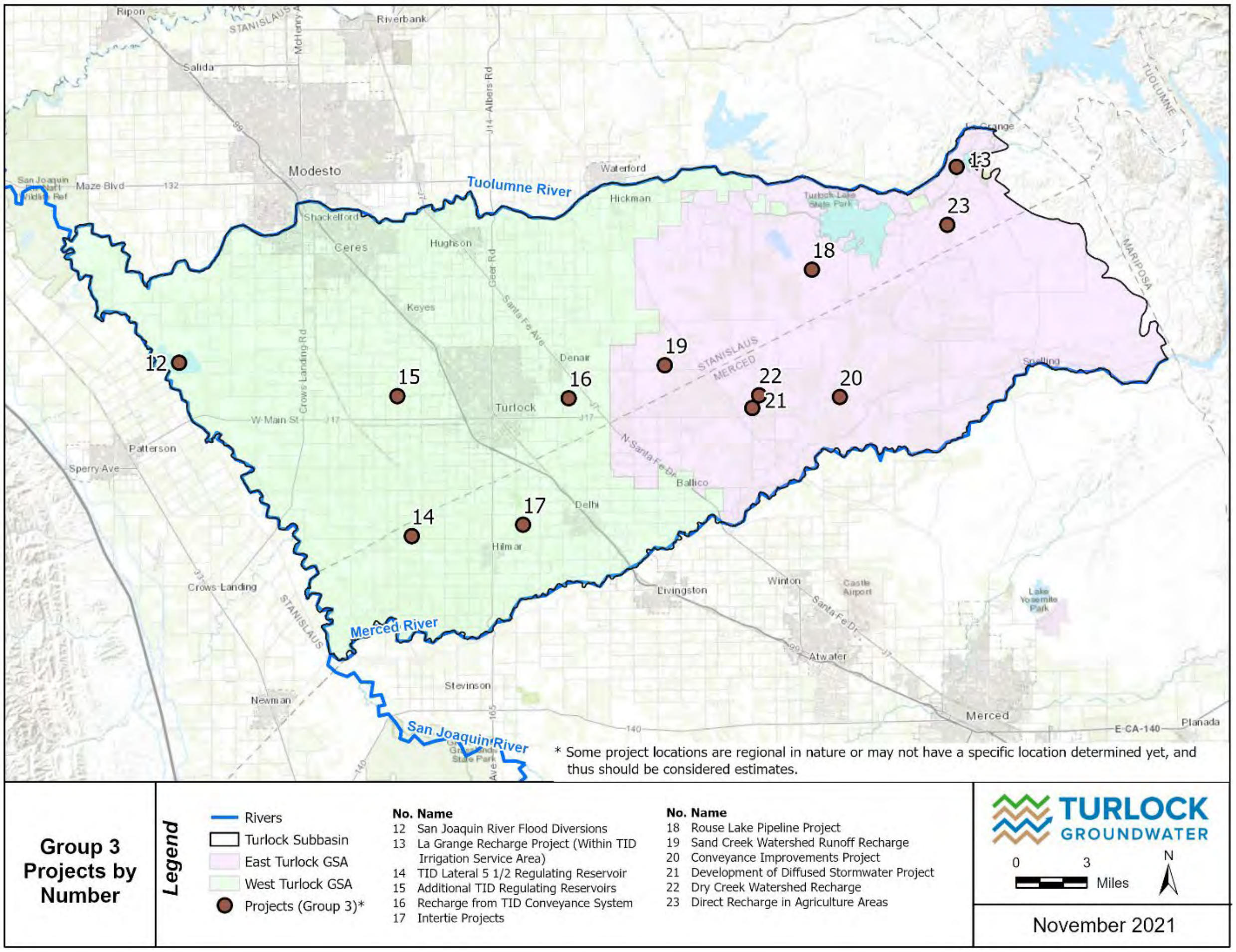


Figure 8-2: Group 3 Projects Location Map



In addition, there are existing projects that have been identified as part of the Integrated Regional Water Management Planning process and are included in the East Stanislaus IRWMP project database[1]. These are considered to be potential projects to support GSP implementation but represent alternative options that are not directly analyzed in this Chapter.

To facilitate implementation of the identified Group 2 and Group 3 Projects and develop other Projects for potential implementation, the GSAs are developing a Groundwater Recharge Assessment Tool (GRAT) for the Subbasin. The Turlock Subbasin GRAT will be used to help select optimal areas for recharge and assess their effectiveness and yield for Subbasin sustainability. Each GSA may develop additional project evaluation and prioritization tools as needed to progress projects through conceptual design and feasibility

[1] http://www.eaststanirwm.org/projects/

analysis, front-end engineering design, procurement of permits and entitlements, and construction.

8.2. Projects Developed for Near-Term Implementation (Groups 1 and 2)

This section describes the Projects that were developed for near-term implementation in the Turlock Subbasin, organized by proponent. This includes all Projects identified in **Table 8-1**. These Projects are either:

- Currently in place and will continue to be implemented by proponents and partner agencies, or are
- Currently planned and will be implemented or started by proponents and partner agencies in the next five years.

The Projects developed for near-term implementation were modeled using the C2VSimTM to estimate their potential benefit to the groundwater system over the projected conditions. Applicable assumptions used to model each Project are described in each Project description. The results of these model scenarios are discussed in **Section 8.5**: Plan for Achieving Sustainability.

Table 8-3 lists all Group 1 and Group 2 Projects described in the subsections that follow. Each Project description is organized to address the applicable regulatory requirements:

- **Project Description**: 23 CCR §354.44(b)
- **Public Notice**: 23 CCR §354.44(b)(1)(B)
- Permitting and Regulatory Process: 23 CCR §354.44(b)(3)
- **Expected Benefits**: 23 CCR §354.44(b)(4), §354.44(b)(5)
- **Implementation Criteria, Status, and Plan**: 23 CCR §354.44(b)(1)(A); §354.44(b)(4); §354.44(b)(6)
- Water Source and Reliability: 23 CCR §354.44(b)(6)
- **Legal Authority**: 23 CCR §354.44(b)(7)
- Estimated Costs and Funding Plan: 23 CCR §354.44(b)(8)
- Management of Groundwater Extractions and Recharge: 23 CCR §354.44(b)(9)

Summary of Criteria for Project Implementation (23 CCR §354.44(b)(1)(A))

As described above, the Group 1 and Group 2 Projects described in this section are either currently in place or are planned to be implemented prior to 2042. Those Projects that are currently in place will continue to be implemented over this same period.

Table 8-3: List of Projects Developed for Implementation in the Turlock Subbasin

Location (Proponent)	#	Project Name	Primary Mechanism(s)[1]
WTSGSA Urban and Municipal (Cities of Turlock and Ceres)	1	Regional Surface Water Supply Project	In-lieu Groundwater Recharge
WTSGSA Urban and Municipal (Community of Hickman)	2	Waterford/Hickman Surface Water Pump Station and Storage Tank	In-lieu Groundwater Recharge
WTSGSA Urban and Municipal (City of Turlock)	3	Dianne Storm Basin	Direct Groundwater Recharge
WTSGSA Urban and Municipal (California State University - Stanislaus)	4	Stanislaus State Stormwater Recharge	Direct Groundwater Recharge
WTSGSA Urban and Municipal (City of Modesto)	5	Advanced Metering Infrastructure Project (AMI)	Water Conservation
West Turlock Subbasin GSA (Turlock Irrigation District)	6	TID On-Farm Recharge Project (in WTSGSA)	Direct or In-Lieu Groundwater Recharge
	7	Recycled Water from City of Turlock	In-lieu Groundwater Recharge
	8	TID Ceres Main Regulating Reservoir	In-lieu Groundwater Recharge
East Turlock Subbasin GSA (Eastside Water District)	9	Agricultural Recharge Project (in ETSGSA)	Direct or In-Lieu Groundwater Recharge
	10	Mustang Creek Flood Control Recharge Project	Direct Groundwater Recharge
	11	Upland Pipeline Project	Direct and/or In-Lieu Groundwater Recharge

[1]The primary mechanism of the Project as conceptualized, although during implementation, Projects may be used for multiple purposes to support groundwater sustainability and provide multiple benefits beyond groundwater recharge.

8.2.1. Urban and Municipal Proponents (WTSGSA)

Projects developed for implementation by urban and municipal proponents in the Turlock Subbasin are summarized in the sections below.

8.2.1.1. Regional Surface Water Supply Project (Project 1)

8.2.1.1.1. Project Description

The Regional Surface Water Supply Project (Project) is an effort led by the Stanislaus Regional Water Authority (SRWA) to provide treated drinking water from the Tuolumne River to supplement both the City of Ceres and the City of Turlock's existing groundwater supplies.

The Project will divert surface water from the Tuolumne River through an existing river intake constructed in the early 2000s, a new raw water pump station, and new raw water pipeline. The raw water pump station includes a wet well element, constructed in early 2020. These elements of the Project are located adjacent to the Tuolumne River near Fox Grove Park just north of the intersection of Geer Road and Hatch Road.

Raw water from the pipelines will be treated to drinking water standards at a new water treatment plant, located just east of Fox Grove Park. The City of Ceres and City of Turlock will be required to integrate this new source of water into their existing drinking water distribution system. TID may also use the raw water facilities for emergency purposes or to deliver irrigation water to agricultural users after acquiring required environmental permits.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the Project.

8.2.1.1.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through SRWA outreach. SRWA hosts monthly Board meetings and Board meeting agendas and minutes are posted to their website (https://stanrwa.com/). The SRWA also provides regular construction updates and road closures through a webpage, interactive map, and email message for those that sign up for updates. The SRWA also provides frequent updates though social media (Facebook, Instagram, and Twitter), although these platforms are not used for official public noticing. Any other potential activities including planning, implementation, construction, and other actions will be posted on their website with a description of actions that will be taken.

Public and/or inter-agency noticing may be facilitated through SRWA board meetings, the SRWA and/or City of Turlock and City of Ceres websites, inter-basin coordination meetings, other public meetings hosted by the SRWA, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.1.3. Permitting and Regulatory Process

The SRWA has obtained CEQA clearance and has posted their Final Environmental Impact Report on January 2019 to their website. There are a range of additional specific permitting and regulatory processes that may potentially affect the construction of project-related infrastructure which include, but are not limited to:

- Electrical power service during construction and for constructed facilities (as applicable)
- Telephone and broadband internet service during construction and for constructed facilities (as applicable)
- County and City road right-of-way encroachment permit(s) (as applicable)
- Compliance with the California Building Standards Code, including applicable building, plumbing, mechanical, electrical and fire codes and applicable Fire Marshall approvals
- National Pollutant Discharge Elimination System (NPDES)/State Water Resources Control Board (SWRCB) storm water discharge permits (as applicable)
- Central Valley Regional Water Quality Control Board (RWQCB)/NPDES Permit and/or Waste Discharge Requirements for disposal of construction dewatering and acceptance test water
- SWRCB Division of Drinking Water (DDW) Domestic Water Supply Permit
- San Joaquin Valley Air Pollution Control District permits (as applicable)
- The Division of Occupational Safety and Health (Cal/OSHA) construction activity permits (as applicable)
- Material hauling and landfill disposal permits (as applicable)
- Risk Management and Prevention Programs (RMPPs)
- Compliance with federal and state Endangered Species Acts
- California Department of Fish and Wildlife Streambed Alteration Agreement
- Various pre-development and CEQA compliance/mitigation measures
- Burlington Northern Santa Fe Railroad encroachment permit
- California Wildlife Conservation Board/Stanislaus County Department of Parks and Recreation Fox Grove Park Access permit
- Central Valley Flood Protection Board encroachment permit

8.2.1.1.4. Expected Benefits

Benefits to Sustainability Indicators

The use of surface water for the City of Ceres and City of Turlock urban demands is expected to offset urban groundwater pumping demands, with in-lieu groundwater recharge benefits to the Subbasin. Beyond the existing scope of the Project, it could potentially provide water to other future regional participants, further reducing the need for groundwater. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, and interconnected surface water. All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The Project will provide several benefits to the City of Ceres and City of Turlock, which are both classified as DACs (Places, 2018). Both cities currently rely entirely on groundwater as their source of drinking water. Some of this groundwater contains contaminants that currently require or will require treatment processes to remove these impurities prior to consumption. Additionally, the existing groundwater supply is insufficient to meet future urban demands. The additional surface water supply through this Project allows the city to:

- Diversify their water supply portfolios
- Provide clean, safe, reliable drinking water
- Improve water quality of drinking water supplies (reduced hardness) and more-easily comply with drinking water quality regulations
- Increase municipal water supplies to meet increasing demands

In general, the majority of communities in the Turlock Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Benefits to Environmental Beneficial Uses

As documented in the Project's 2018 Draft Environmental Impact Report (DEIR), benefits to the environment have also been incorporated into the Project approach (Horizon, 2018). A key Project objective is listed as follows:

- Provide a benefit to Tuolumne River fish and other aquatic resources by increasing seasonal releases from La Grange Dam to accommodate proposed project diversions downstream at TID's infiltration gallery northeast of Hughson.

A specific study on the operational releases and diversions incorporated into the Project demonstrated these beneficial effects on aquatic resources. The Project allows water that would otherwise be diverted at the La Grange Dam to remain in the river for an additional 26 miles, thereby increasing flows and reducing water temperatures through salmon spawning areas. Downstream of the infiltration gallery diversions, FERC flows would continue to be met, habitat suitability would remain unchanged, and there would be no adverse effects (Horizon, 2018).

Further, an additional release of 24 cfs of cold water during Phase 1 of the Project could also benefit salmonid habitat conditions in the lower Tuolumne River. Although the effect would be minimal during high winter and spring flows, additional flows of 24 cfs during the summer and early fall low-flow conditions are predicted to beneficially decrease water temperatures (Horizon, 2018).

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

The Project is expected to provide up to 30 TAF/yr of surface water to the Subbasin (20 TAF/yr to the City of Turlock and 10 TAF/ty to the City of Ceres) during full allocation years, phased in over time. Surface water supplies will be reduced proportional to TID's allocation reduction in dry hydrologic years. While approximately 30 TAF/yr of surface water is anticipated to be utilized each year by completion of the Project, the precise availability may vary between days and years as municipal water use also varies.

Evaluation of benefits will be based on analysis of without-project and with-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling will be done with the C2VSimTM model used for GSP development.

8.2.1.1.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project will be implemented by SRWA. SRWA is a JPA between the City of Ceres and City of Turlock, in cooperation with TID.

The project implementation strategy and timeline are as follows:

Environmental Process and Planning

- 2016 – Planning; wet well design; funding strategy
- 2017 – Environmental; land acquisition; predesign; funding applications

Project Design

- 2018 – Environmental/permitting; procurement; land Acquisition; predesign; funding applications; wet well construction; water rights modification
- 2019 – Environmental/permitting; procurement; land Acquisition; water rights modification; funding applications; wet well construction; local facilities design
- 2020 – Procurement; financing; funding applications; water rights modification; permitting; design

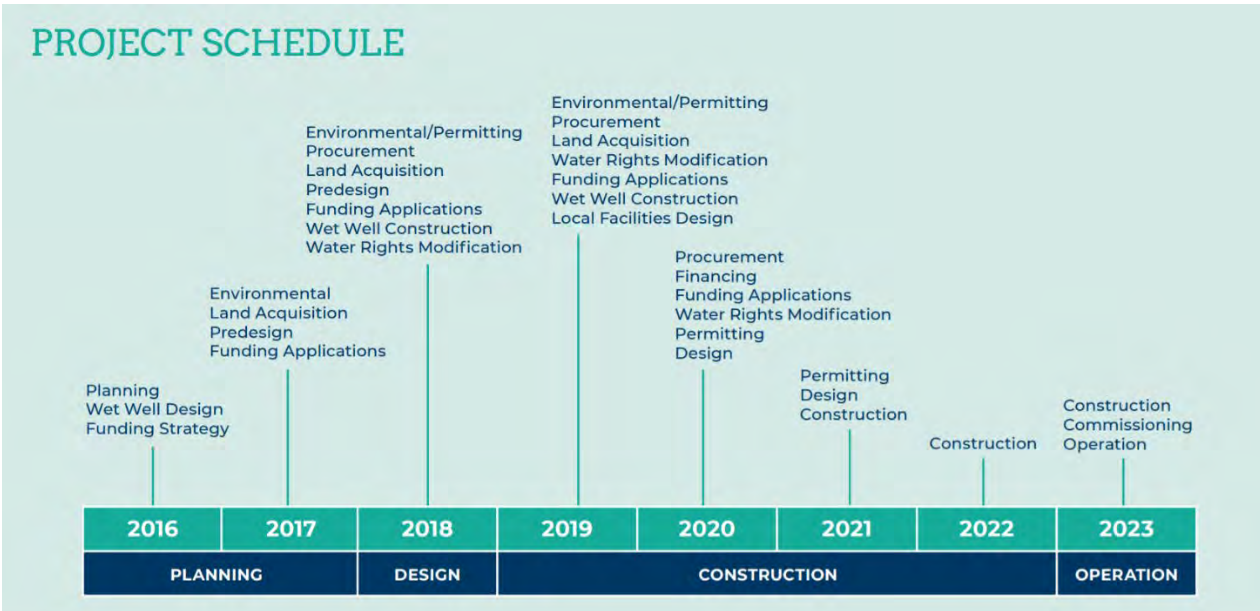
Project Construction

- 2021 – Permitting; design; construction
- 2022 – Construction
- 2023 – Construction; commissioning; operation

Project Implementation

The Project will achieve phases of surface water deliveries, delivering up to 17,375 AFY at the beginning of implementation (2023), up to 30,000 AFY of surface water at full operation (assumed to be 2035). **Figure 8-3** shows the project schedule (Stanislaus Regional Water Authority, n.d.).

Figure 8-3: Regional Surface Water Supply Project Schedule



Implementation Assumptions for Modeling

The Project has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Water source: Reservoir operations for the SRWA project were simulated using the Tuolumne Reservoir Simulation (TRS) model. Under this modeling scenario, the water supply is discharged from La Grange Dam into the Tuolumne River and then diverted from the river at the project site as illustrated in the project description.
- Volume of surface water deliveries:
    - The City of Turlock receives two-thirds, and the City of Ceres receives one-third of the total surface water deliveries.

Simulation Years	Surface Water Provided
1-7	0 AFY
8-10	Up to 17,375 AFY
11-19	Up to 20,160 AFY
20-50	Up to 30,000 AFY

- Offset pumping: Offset pumping is water that is pumped by the City of Turlock and City of Ceres in years of water allocation reduction to provide to TID for irrigation demands.[1]
- Based on TID's operations modeling, it is anticipated that agricultural surface water deliveries will be reduced by an average of 3,600 AFY over the 50-year simulation period. This volume will be counterbalanced by municipal offset pumping as described above, and the Recycled Water from City of Turlock Project (Project 7).

8.2.1.1.6. Water Source and Reliability

The Project will use surface water diverted from the Tuolumne River. SRWA will obtain the water supply from TID, as detailed in the Water Sales Agreement (TID, 2015). A combination of existing TID infrastructure and newly-constructed intake structure, pump stations, pipelines, and a water treatment plant will reliably deliver drinking water to the City of Turlock and City of Ceres. Surface water is expected to be available for this Project in all water year types, with potential reductions in dry and critical hydrologic years. Tuolumne River releases from New Don Pedro Dam will be reoperated as to provide surface water to both existing TID customers and the Project. In approximately half of the years since the construction of New Don Pedro Dam, the Tuolumne River watershed has produced more water than can be stored or beneficially used by existing customers. Recognizing that water supply availability could be impacted by climate change or regulatory requirements, the Project will be implemented using adaptive management.

8.2.1.1.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies. TID has the authority to sell surface water to the SRWA.

[1] The 2,000 AF of recycled water from the City of Turlock to TID that is included in the Offset water outlined in the Water Sales Agreement is modeled and described separately in **Section 8.2.2.2** (Recycled Water from City of Turlock (Project 7))

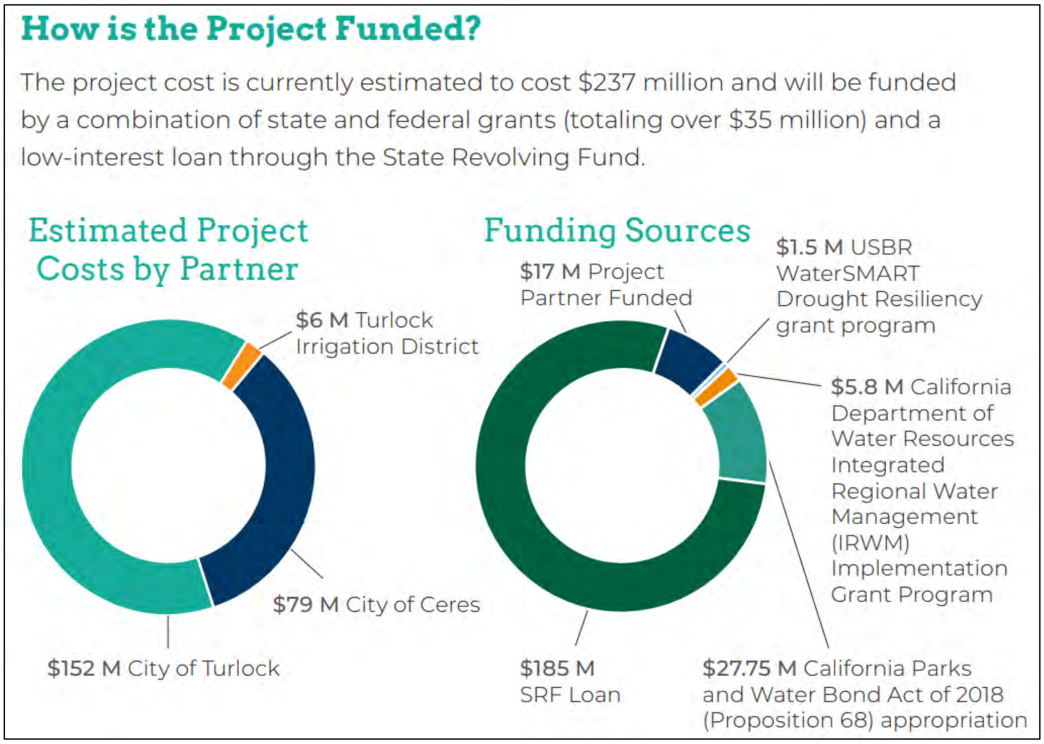
8.2.1.1.8. Estimated Costs and Funding Plan

Currently, the Project is estimated to cost $237 million, which includes the design and construction of the Project facilities and local improvements required by both Cities to integrate this new supply into their existing water systems. Ceres' portion of this cost is approximately $79 million, and Turlock's portion is approximately $152 million. An additional $6 million will be contributed by the TID for its portion of the Project.

In late 2017, the Cities of Ceres and Turlock both increased water rates to pay for the construction and ongoing operation of the Project and other water system needs. Those rates are intended to collect the necessary revenue to pay for debt service on borrowed money and for annual operational costs. The SRWA secured a grant for $750,000 towards the Ceres Finished Water Transmission Main and was recently awarded an additional $750,000 towards the Turlock Finished Water Transmission Main. The Project is also slated to receive an almost $28 million grant from Proposition 68, the Parks, Environment, and Water Bond. The SRWA has applied to other funding programs and continues to seek other sources of funding to reduce the Project's impacts on the ratepayers. These efforts include both State and federal grants and low-interest loans. The SRWA also sought and received legislative approval to utilize the Design-Build method to maximize the efficiencies of the design and construction process to ensure the most cost-effective process for completing the Project.

Figure 8-4 outlines the project costs and funding sources of the Project (Stanislaus Regional Water Authority, n.d.).

Figure 8-4: Regional Surface Water Supply Project Funding



8.2.1.1.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all projects developed for implementation are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, in-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies, helping to offset any potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.1.2. Waterford/Hickman Surface Water Pump Station and Storage Tank (Project 2)

8.2.1.2.1. Project Description

The Waterford/Hickman Surface Water Pump Station and Storage Tank (Project) entails connecting the City of Waterford (Waterford) and Hickman to Modesto Irrigation District's (Modesto ID) surface water supply. The Project includes several components, described in order of the flow of the surface water. Surface water will be diverted from Modesto ID's distribution network at a pipeline turn-out located at the corner of Tim Bell and Vineyard Road, northeast of the Waterford. The surface water will be piped into a one-million-gallon storage tank that will be constructed at this intersection. A pump station at this location and transmission line will also be constructed that transports the water to Yosemite Boulevard in Waterford.

As part of a separate project, the Waterford and Hickman systems are in the process of being connected and should be completed by the end of 2023. Once the two water systems are connected and the surface water conveyance, storage, and pump station are complete, then Hickman, located in the Subbasin, can utilize surface water from Modesto ID through existing transmission lines.

8.2.1.2.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the WTSGSA board meetings and/or TID board meetings, the Turlock Subbasin and/or TID website(s), the TID newsletter, inter-basin coordination meetings, other public meetings hosted by the WTSGSA and/or TID, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.2.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County of Stanislaus, and CARB. Specific permitting and regulatory processes that may potentially affect the construction of project-related infrastructure include, but are not limited to:

- USACE Section 404 Permits (potential exemption under Section 404(f)(1)(C) of Clean Water Act)
- RWQCB Section 401 Water Quality Certification (not required if exempt from USACE Section 404)
- SWRCB Construction General Permit and Storm Water Pollution Prevention Plan (SWPPP)
- State Historic Preservation Office (SHPO) and National Historic Preservation Act (NHPA) Section 106 Coordination
- CEQA Environmental Review Process
- California Endangered Species Act (CESA) Consultation

- Endangered Species Act (ESA) Compliance
- National Environmental Policy Act (NEPA) Compliance (expected to require either an Environmental Impact Report and Negative Declaration or Mitigated Negative Declaration)

8.2.1.2.4. Expected Benefits

Benefits to Sustainability Indicators

Utilization of surface water for urban water demands in Hickman is expected to offset groundwater pumping demands, with in-lieu groundwater recharge benefits to the Subbasin. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, interconnected surface water, and possibly land subsidence. All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The Waterford/Hickman Surface Water Pump Station and Storage Tank Project directly benefits Waterford and Hickman, both classified as a DACs, by supplementing and diversifying their drinking water supply. This Project will provide an alternate drinking water source in case of infrastructure or contamination concerns with the communities' groundwater production wells. The additional surface water supply will also reduce groundwater pumping and increase groundwater levels near the communities which can reduce pumping costs and potentially mitigate some groundwater quality concerns. Additionally, benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Waterford/Hickman Surface Water Pump Station and Storage Tank was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

It is assumed that Modesto ID will provide up to 900 AF/year to Waterford and Hickman, except for critical years which will provide a partial allotment (approximately 750 AF/year in critical years). The impact of this project on the Turlock Subbasin alone would be of 100 AF/year on average over the 50-year simulation period.

Evaluation of benefits will be based on analysis of without-project and with-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling will be done with the C2VSimTM model used for GSP development.

8.2.1.2.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The Waterford/Hickman Surface Water Pump Station and Storage Tank will be implemented by the City of Waterford. Waterford will oversee the Project financing and funding, permitting, and construction. The Project will require an agreement between Modesto ID and the City of Modesto to purchase treated surface water. Negotiations are underway for the water sales agreement but have not been concluded. Once negotiations are finalized and financing is secured, then design and subsequent construction will begin. This PMA is currently in the early conceptual stage. Thus, the start and completion dates for this PMA have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Current estimates are that the initial portion of the project to install a pipeline between Waterford and Hickman will be completed within 2 years while the next portion of the project to install a pump station and storage tank for surface water deliveries would be completed within 5 years.

Once the Project construction is complete, it is expected that Modesto ID would provide 900 AF/year to Waterford and Hickman in all water years except critical years which will provide a partial allocation.

Implementation Assumptions for Modeling

The Waterford/Hickman Surface Water Pump Station and Storage Tank has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Estimated volume of surface water deliveries: Proportional to the Modesto ID irrigation water allotment based on water year type, not to exceed 900 AF/yr. The surface water deliveries are distributed throughout the months proportional to monthly urban demands.
- Area receiving surface water deliveries: Surface water is delivered to the jurisdictional extent of the Hickman and Waterford communities, consistent with the extent in the historical C2VSimTM model. Surface water is distributed between Waterford and Hickman proportional to urban demands.
- Water source: It is assumed that all surface water is diverted from Modesto ID's distribution system, with no adjustment to modeled Modesto ID diversions, spillage, and seepage.
- Groundwater pumping: It is assumed that groundwater production is reduced by the volume of surface water deliveries which is distributed proportionally among all wells in Waterford and Hickman.

8.2.1.2.6. Water Source and Reliability

The Waterford/Hickman Surface Water Pump Station and Storage Tank will use water diverted from Modesto ID's surface water distribution network. Modesto ID has existing water rights on the Tuolumne River and existing storage and conveyance facilities. Surface water is expected to be available for this Project in all hydrologic years, proportional to Modesto ID irrigation allotment, while still meeting the demand of existing Modesto ID customers and City of Modesto.

8.2.1.2.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies, after addressing required regulations. Modesto ID and the City of Modesto have the authority to sell surface water to the City of Waterford.

8.2.1.2.8. Estimated Costs and Funding Plan

Costs of this Project include right of way purchase, environmental permitting, design, construction, and project management costs. The initial portion of the project to install a pipeline between Waterford and Hickman is estimated at $1 million, while the next portion of the project to install a pump station and storage tank for surface water deliveries is estimated at approximately $4 million. The total estimated cost at this time is $5 million. However, this Project is currently in the early conceptual stage and a more refined cost can be reported in GSP Annual Reports and Five-Year Assessment Reports when known. It is anticipated that Waterford would identify grant funding sources to cover project costs as part of project development.

8.2.1.2.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, in-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies, helping to offset any potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.1.3. Dianne Storm Basin (Project 3)

8.2.1.3.1. Project Description

This Project will recharge water into the existing Dianne Storm Drain basin. The Dianne Storm Drain basin is located on the western edge of the City of Turlock, north of the Turlock wastewater treatment plant, on West Canal Drive. The basin is 26 acres and can hold 105 AF of water.

The Dianne Storm Drain basin receives storm water from Fulkerth Road which includes roughly a third of the storm water captured in the City of Turlock. There is potential to supplement the water in the basin with surface water in TID's distribution network for additional aquifer recharge.

Once the basin reaches approximately 75% to 80% of capacity, it is pumped out of the basin into TID's Lateral #4 for conveyance to the river. This Project could upgrade the Dianne Storm Drain basin to expand the capacity of the basin and/or install ASR wells. Both approaches would enhance the volume of water that can recharge into the aquifer. Additionally, it could alleviate stress on the storm drain system.

8.2.1.3.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the WTSGSA board meetings and/or City of Turlock Council meetings, the WTSGSA and/or City of Turlock website(s), inter-basin coordination meetings, other public meetings hosted by the WTSGSA, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.3.3. Permitting and Regulatory Process

Required permitting and regulatory review is being initiated through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to: DWR, SWRCB, the California Department of Fish and Wildlife (CDFW), the Central Valley Flood Protection Board (Flood Board), RWQCBs, the United States Bureau of Reclamation (Reclamation or USBR), the United States Army Corps of Engineers (USACE), the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), Local Agency Formation Commissions (LAFCO), the County of Stanislaus, and the California Air Resources Board (CARB).

8.2.1.3.4. Expected Benefits

Benefits to Sustainability Indicators

The Dianne Storm Drain project would supply direct groundwater recharge to the Subbasin by enhancing infiltration and impoundment of storm water in dry wells. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, and interconnected surface water. All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

This Project would increase groundwater levels near the City of Turlock, which is classified as a DAC (2018 Places). Additionally, it would relieve stress on the storm drain system, mitigate flood potential, and reduce storm loads to the wastewater treatment plant.

The majority of communities in the Turlock Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Dianne Storm Drain project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

On average, the Project is expected to provide five million gallons of recharged water per storm event, which averages to approximately 22.5 AF/yr of recharged water in the Turlock Subbasin. These benefits are expected to occur during storm events which are more frequent during wet and above normal hydrologic conditions. Additional recharge could occur in the basin if it was supplemented with surface water from TID’s system, however that was not included in this analysis and will be evaluated in future reports.

Evaluation of benefits will be based on analysis of without-project and with-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling will be done with the C2VSimTM model used for GSP development.

8.2.1.3.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project would be implemented by the City of Turlock. The Project would enhance the Dianne Storm Drain basin through expansion and/or installation of ASR wells. On average, it is expected that five million gallons of water can be captured and recharged per storm event. If TID provides supplemental water to recharge in the basin, an agreement with TID would be necessary.

This PMA is currently in the early planning stage. Thus, the start and completion dates for this PMA have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. However, once project implementation begins, it is expected that the City of Turlock would recharge storm water during all years in which water is available from storm events, tentatively assumed to be all years. The City of Turlock hopes to complete the project in the next five years (by 2027), contingent upon grant funding for implementation.

Implementation Assumptions for Modeling

The Dianne Storm Drain project has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Estimated volume of recharged water: five million gallons per storm event, or 22.5 AFY, distributed between November and April of each year recharged at the existing Dianne Storm Drain basin.
- Source of water: Recharged storm water from the City of Turlock. TID deliveries are unaffected.

8.2.1.3.6. Water Source and Reliability

This Project would use storm water captured from the City of Turlock. The intensity and frequency of storm water events fluctuate by water year type. It is assumed that five million gallons can be recharged per storm event which occur in the winter and spring months. The exact volume of recharge capacity will be refined during future project development and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.

8.2.1.3.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies.

8.2.1.3.8. Estimated Costs and Funding Plan

Potential costs of this Project include enhancement of the basin and potentially purchase or exchange of water from TID. This PMA is currently in the early conceptual stage. Thus, the anticipated costs have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Early high-level estimates are approximately $5 million. It is anticipated that the City of Turlock would identify funding sources to cover project costs as part of project development. These may include grants (e.g., Prop 1, Prop 68, NRCS), fees, local cost share, loans, and other assessments.

8.2.1.3.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, direct recharge benefits of this Project are expected to increase the use and recharge of storm water, helping to offset any declines in groundwater levels from groundwater pumping during drought when surface water supplies are limited.

8.2.1.4. Stanislaus State Stormwater Recharge (Project 4)

8.2.1.4.1. Project Description

The Stanislaus State Stormwater Recharge project (Project) entails constructing French drains or other recharge basins/infrastructure to recharge storm water runoff on the California State University (CSU) Stanislaus campus. Currently, storm water runoff in excess of the on-campus ponds is released into an irrigation pipe which then flows to a canal and is typically discharged in the river. This Project aims to capture most of the storm water runoff for groundwater recharge.

8.2.1.4.2. Public Noticing

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the WTSGSA board meetings, the WTSGSA website, inter-basin coordination meetings, other public meetings hosted by the WTSGSA, GSP annual reports and five-year updates, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.1.4.3. Permitting and Regulatory Process

Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to: DWR, SWRCB, the California Department of Fish and Wildlife (CDFW), the Central Valley Flood Protection Board (Flood Board), RWQCBs, the United States Bureau of Reclamation (Reclamation or USBR), the United States Army Corps of Engineers (USACE), the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), Local Agency Formation Commissions (LAFCO), the County of Stanislaus, and the California Air Resources Board (CARB).

8.2.1.4.4. Expected Benefits

Benefits to Sustainability Indicators

The Stanislaus State Stormwater Recharge project would supply direct groundwater recharge to the Subbasin by enhancing infiltration and impoundment of storm water in French drains or other recharge basins/infrastructure. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, and interconnected surface water. All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

This Project would increase groundwater levels near the City of Turlock and the CSU Stanislaus campus, which are classified as a DAC (2018 Places). Additionally, it would potentially mitigate flooding on the campus and connected canal distribution system in DAC areas.

The majority of communities in the Turlock Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Stanislaus State Stormwater Recharge project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

On average, the Project is expected to provide 460 AFY of recharged storm water from the CSU Stanislaus campus occurring between November and April each year.

Evaluation of benefits will be based on analysis of without-project and with-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined. Modeling will be done with the C2VSimTM model used for GSP development.

8.2.1.4.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project would be implemented by CSU Stanislaus. The Project would enhance recharge from storm water collected on the CSU Stanislaus campus through French drains and/or other recharge infrastructure. On average, it is expected that 460 AFY can be captured and recharged.

Research and design, including a survey, soil test, and percolation test, are being conducted in 2021 and 2022. Since this Project is still early in the planning stage, the timeline of project design completion, funding acquisition, construction, and implementation are yet to be determined. The project proponent is currently actively pursuing grant funding, and contingent upon funding, plans to construct the project within 3 years (by 2025). Updates will be provided in GSP annual reports and five-year updates when known. However, once project implementation begins, it is expected that CSU Stanislaus would recharge storm water during all years in which water is available from storm events, tentatively assumed to be all years.

Implementation Assumptions for Modeling

The Stanislaus State Stormwater Recharge project has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Estimated volume of recharged water: 460 AFY distributed between November and April of each year recharged on the CSU Stanislaus campus.
- Source of water: Recharged storm water from the CSU Stanislaus campus.

8.2.1.4.6. Water Source and Reliability

This Project would use storm water captured from the CSU Stanislaus campus. The intensity and frequency of storm water events fluctuate by water year type. It is assumed that 460 AFY of storm water can be collected and captured between November and April each year. The exact volume of recharge capacity will be refined during future project development and will be reported in GSP annual reports and five-year updates when known.

8.2.1.4.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies.

8.2.1.4.8. Estimated Costs and Funding Plan

Potential costs of this Project include initial research, design, and testing and construction and materials for installing the French drains/recharge infrastructure. The preliminary research is estimated to cost approximately $90,000 and the total Project approximately $1.5 million. The Project is still under development, so the anticipated costs may change and would be updated in GSP annual reports and five-year updates. Potential funding and grants are yet to be determined.

8.2.1.4.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, direct recharge benefits of this Project are expected to increase the use and recharge of storm water, helping to offset any declines in groundwater levels from groundwater pumping during drought when surface water supplies are limited.

8.2.1.5. Advanced Metering Infrastructure Project (AMI) (Project 5)

8.2.1.5.1. Project Description

The City of Modesto is planning on upgrading 75,000 meters to AMI smart meters to support water reduction goals. Smart meters will assist the City in providing analytical tools to manage water usage better, such as identifying leaks sooner and providing customers more usable and user friendly data to manage their water usage. Examples include the City being able to notify customers of leaking pipes.

8.2.1.5.2. Public Noticing

Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.

8.2.1.5.3. Permitting and Regulatory Process

Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County of Stanislaus, and CARB.

8.2.1.5.4. Expected Benefits

Benefits to Sustainability Indicators

The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water.

Benefits to Disadvantaged Communities

This Project would apply to and benefit all water customers in the City of Modesto, most of which is considered a DAC or SDAC.

Volumetric Benefits to the Subbasin Groundwater System

This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. However, the Project is expected to reduce water use in the City of Modesto to meet future water use mandates and conservation goals.

Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project is evaluated as part of a scenario and the C2VSimTM is used to assess the benefits and impacts on the Subbasin sustainability.

8.2.1.5.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

Project planning is expected to occur in 2022 and 2023, with implementation expected from 2024 to 2026. Additional updates on the project schedule will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in all years beginning the first year of project implementation.

Implementation Assumptions for Modeling

The Advanced Metering Infrastructure Project has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Modeled as part of scenario of ongoing conservation efforts within the City of Modesto. Simulated change includes the reduction of urban water demand from 228 gallons per person per day (GPCD) (2015 City of Modesto UWMP) to 175 GPCD (2020 City of Modesto UWMP).

8.2.1.5.6. Water Source and Reliability

This Project would not directly use a water source but would help to manage and enhance use of existing water City of Modesto water supplies.

8.2.1.5.7. Legal Authority

The GSA, Districts, and individual project proponents have the authority to plan and implement projects.

8.2.1.5.8. Estimated Costs and Funding Plan

This Project is currently in the early conceptual stage but an initial estimate for the total cost is $20 million. Updated cost estimates will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.2.1.5.9. Management of Groundwater Extractions and Recharge

This Project would not directly use a water source (e.g., no groundwater extraction or recharge is involved) but would help to manage and enhance use of existing water City of Modesto water supplies.

8.2.2. West Turlock Subbasin GSA - Agriculture

Agricultural Projects developed for implementation in the West Turlock Subbasin GSA (WTSGSA) are summarized in the sections below.

8.2.2.1. TID On-Farm Recharge Project (in WTSGSA) (Project 6)

8.2.2.1.1. Project Description

In the Turlock Irrigation District (TID) On-Farm Recharge Project (in WTSGSA) Project (Project), TID will work with growers within its irrigation service area to identify parcels that would be willing to participate in the On-Farm Recharge Project and have suitable conditions to support recharge. TID plans to utilize the Groundwater Recharge Assessment Tool (GRAT) to identify areas and fields within TID that are suitable for on-farm recharge projects, as determined based on cropping, soil characteristics, and other pertinent parameters considered in the GRAT.

For purposes of analysis and GSP development, it is assumed that participating fields will comprise 25 percent of non-permanent crop lands within TID's existing irrigation service area along canals and laterals downstream of Turlock Lake in the eastern portion of the WTSGSA where the recharge potential is highest (including the Main Canal, Highline Canal, Turlock Main Canal, Upper Laterals, and Upper Stevinson). It is expected that on-farm recharge will apply, on average, approximately 2 AF per acre each year that the Project occurs, and that sufficient water will be available for this Project only in wet and above normal hydrologic years (approximately 50 percent of years historically). Subsequent analysis of water availability, actual annual application rates, application timing, and extent of participating lands will be necessary as Project development continues and implementation begins.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the TID on-farm recharge project.

8.2.2.1.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the WTSGSA board meetings and/or TID board meetings, the WTSGSA and/or TID website(s), the TID newsletter, inter-basin coordination meetings, other public meetings hosted by the WTSGSA and/or TID, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.2.1.3. Permitting and Regulatory Process

Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Surface water would be diverted for this Project by TID through existing water rights. Governing agencies that may be consulted for this Project include, but are not limited to: the SWRCB, the County(ies) of Stanislaus and/or Merced, and DWR.

If necessary for field flooding, the project proponent will obtain land grading permits from the County(ies).

Recharge projects may also require an environmental review process under CEQA. A Programmatic Environmental Impact Report will be prepared for this GSP which will assist in meeting this requirement.

8.2.2.1.4. Expected Benefits

Benefits to Sustainability Indicators

Surface water deliveries during the non-irrigation season are expected to provide direct groundwater recharge to the Subbasin. For fields that are irrigated using groundwater, surface water deliveries during the irrigation season are expected to offset groundwater demand and provide in-lieu groundwater recharge benefits. In both cases, the sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The TID on-farm recharge project is expected to provide direct or in-lieu recharge within the existing TID irrigation service area. The majority of communities in the Turlock Subbasin, particularly the TID irrigation service area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive surface water deliveries, this Project may directly benefit specific DACs in the TID irrigation service area. In addition, maintenance or improvement of groundwater levels may help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the TID on-farm recharge project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

On average across all years, the TID on-farm recharge project is expected to provide approximately 4,000 AF/yr of recharge benefit to the Turlock Subbasin. These benefits would accrue in years with wet or above normal hydrologic conditions when sufficient water is expected to be available for on-farm recharge (approximately 50 percent of years historically). In those years, approximately 8,000 AF/yr of groundwater recharge is expected to occur.

Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project is evaluated as part of a scenario and the C2VSimTM is used to assess the benefits and impacts on the Subbasin sustainability.

8.2.2.1.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The TID on-farm recharge project would be implemented by TID using existing TID surface water supplies and infrastructure to support on-farm recharge on fields within the existing TID irrigation service area. At the initiation of this Project and on an ongoing basis, TID plans to identify fields that are most suitable for groundwater recharge using the GRAT. It is expected that fields with non-permanent crops, permeable soils, and existing flood irrigation infrastructure will be most suitable for project participation.

This PMA is currently in the early conceptual stage. Thus, the start and completion dates for this PMA have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Current estimates are that the pilot program would be developed by the 2023 irrigation season followed by a build to full implementation within five years.

However, once project implementation begins, it is expected that TID would deliver surface water for on-farm recharge during wet and above normal hydrologic years (approximately 50 percent of years historically) when sufficient water is available for field flooding and on-farm recharge. TID would deliver surface water to participating fields found to be suitable for recharge in the GRAT, and irrigators would use that water to flood their fields for recharge. It is expected that approximately 2 AF per acre of water would be applied to participating fields, on average, during years when on-farm recharge occurs. Subsequent analysis of projected water availability, actual annual application rates, and extent of participating lands will be necessary as project development continues and implementation begins. While GSP modeling (described below) focuses on deliveries for this purpose between January and February, as the program is further developed it may include additional deliveries for on-farm recharge during the irrigation season.

Implementation Assumptions for Modeling

The TID on-farm recharge project has been modeled in the C2VSimTM model and will be modeled in the GRAT. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Estimated volume of on-farm recharge deliveries: Applied 8,000 AFY (during January and February) to participating areas in years with wet or above-normal hydrologic conditions, averaging 3,800 AFY over the simulation period.
- Area receiving on-farm recharge deliveries: Applied water to areas that are primarily represented by non-permanent crops within the north-eastern portion of the existing TID irrigation service area along the Main Canal, Highline Canal, Turlock Main Canal, Upper Laterals, and Upper Stevinson. Sufficient area was simulated to apply the full estimated volume of on-farm recharge deliveries (approximately 4,000 acres, resulting in approximately 2 AF per acre).
- Implementation of this project is anticipated to increase canal seepage by 2,950 AFY in wet and above normal years, averaging to 1,400 AFY over the simulation period. The additional recharge is due to operational seepage losses in the TID conveyance network, which are not managed at this level in winter months.
- Assumed that all surface water is diverted from the Tuolumne River and conveyed through the existing TID distribution system, with adjustment to modeled TID diversions, seepage in winter months, and Tuolumne River stream flows, including flood flows and other releases from Don Pedro Reservoir, as applicable.

8.2.2.1.6. Water Source and Reliability

The TID on-farm recharge project would use water diverted from the Tuolumne River. TID has existing water rights on the Tuolumne River. TID also has existing storage and conveyance facilities to reliably deliver replenishment water to participating parcels. Surface water is expected to be available for this Project in wet and above normal hydrologic years. In approximately half of the years since the construction of New Don Pedro Dam, the Tuolumne River watershed has produced more water than can be stored or beneficially used by existing customers. Recognizing that water supply availability could be impacted by climate change or regulatory requirements, the project will be implemented using adaptive management.

8.2.2.1.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies.

8.2.2.1.8. Estimated Costs and Funding Plan

Potential costs of this Project may include: project coordination and administration, financial, or other incentives to encourage on-farm recharge, field preparation to enhance flooding, and other potential on-field monitoring equipment. Costs per site may vary depending on changes in project implementation and incentives. Slightly higher costs per site would likely be incurred in the first year an irrigator participates, as more coordination and site preparation may be required. The total costs of the Project will vary over time, depending on the number of sites receiving water, the extent to which irrigators require coordination and support, and any applicable Project incentives.

This Project is currently in the early conceptual stage. Thus, the anticipated costs have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. However, high-level initial estimates are on the order of $160,000 per year for years that are hydrologically wet or above normal. It is anticipated that TID would identify funding sources to cover project costs as part of project development. These may include grants (e.g., Prop 1, Prop 68, NRCS, others), fees, and loans.

8.2.2.1.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, in-lieu and direct recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.2.2. Recycled Water from City of Turlock (Project 7)

8.2.2.2.1. Project Description

This Project will divert recycled water from the City of Turlock to the TID irrigation conveyance system and deliver that water to irrigated fields in the western portion of the TID irrigation service area. The recycled water supplies will be blended with existing supplies in the canal and used to offset existing groundwater pumping demand, providing in-lieu recharge benefits to the Turlock Subbasin. It is expected that approximately 2,000 AF/yr of recycled water will be available, or approximately two million gallons per day (MGD), during the irrigation season.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the Project for Recycled Water from City of Turlock.

8.2.2.2.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the WTSGSA board meetings and/or TID board meetings, the Turlock Subbasin and/or TID website(s), the TID newsletter, inter-basin coordination meetings, other public meetings hosted by the WTSGSA and/or TID, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.2.2.3. Permitting and Regulatory Process

The RWQCB approved the discharge of the City of Turlock's recycled water into TID's canal system, contingent upon the approval of the TID Board of Directors and the RWQCB's Executive Director. Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Counties of Merced and/or Stanislaus, and CARB. Specific permitting and regulatory processes that may potentially affect the construction of project-related infrastructure include, but are not limited to:

- USACE Section 404 Permits (potential exemption under Section 404(f)(1)(C) of Clean Water Act)
- SWRCB Wastewater Change Petition under CWC §1211: Change in Point of Discharge, Place of Use or Purpose of Use
- Modification of City of Turlock's wastewater NPDES permit
- RWQCB Section 401 Water Quality Certification (not required if exempt from USACE Section 404)
- SWRCB Construction General Permit and Storm Water Pollution Prevention Plan (SWPPP)
- State Historic Preservation Office (SHPO) and National Historic Preservation Act (NHPA) Section 106 Coordination
- CEQA Environmental Review Process
- California Endangered Species Act (CESA) Consultation
- Endangered Species Act (ESA) Compliance
- National Environmental Policy Act (NEPA) Compliance (expected to require either an Environmental Impact Report and Negative Declaration or Mitigated Negative Declaration)

Additionally, the RWQCBs regulate the production and use of recycled water in a manner that protects public health and the environment. Project implementation will comply with all applicable state regulations for recycled water use, and any necessary permits required to use treated municipal wastewater for non-potable uses (e.g., water reclamation requirements) will be obtained.

8.2.2.2.4. Expected Benefits

Benefits to Sustainability Indicators

Utilization of recycled water for irrigation in the western portion of the TID irrigation service area is expected to offset groundwater pumping demands, with in-lieu groundwater recharge benefits to the Subbasin. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

TID's use of recycled water from the City of Turlock is expected to provide in-lieu recharge benefits directly within the western portion of the TID irrigation service area. The majority of communities in the Turlock Subbasin, particularly the TID irrigation service area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). This Project is expected to directly benefit those communities in the TID irrigation service area. Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the recycled water from City of Turlock Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

On average across all years, the recycled water from City of Turlock Project is expected to provide approximately 2,000 AF/yr of benefit to the Turlock Subbasin. Benefits are expected to accrue in all years recycled water is used in available following project initiation, tentatively assumed to be every year. While approximately two MGD of recycled water is anticipated to be available each day during the irrigation season, the precise availability may fluctuate slightly as municipal water use also varies.

Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project is evaluated as part of a scenario and the C2VSimTM is used to assess the benefits and impacts on the Subbasin sustainability.

8.2.2.2.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project would be implemented by TID through a partnership with the City of Turlock. The Project would divert recycled water from facilities operated by the City of Turlock into the existing TID conveyance system, and deliver the recycled water, comingled with other irrigation water within the canal system, to irrigated fields in the western portion of the TID irrigation service area. On average, it is expected that approximately 2,000 AF of recycled water will be available in all years, or approximately two million gallons per day (MGD) during the irrigation season. Deliveries of recycled water during the irrigation season would be used to irrigate crops, offsetting groundwater pumping demand.

This PMA is currently in the early planning stage. Thus, the start and completion dates for this PMA have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Based on an assumption that recycled water permitting will be the schedule driver, the project is estimated to be completed by December 2026. However, once project implementation begins, it is expected that TID would deliver recycled water for in-lieu recharge during all years when water is available from the City of Turlock, tentatively assumed to be all years.

Implementation Assumptions for Modeling

The recycled water from City of Turlock Project has been modeled in the C2VSimTM model. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Estimated volume of recycled water deliveries: 2,000 AFY will be made available in all year types throughout the simulation period. The recycled water is delivered in conjunction with TID surface water as to offset some of the agricultural water supply impacts from the Regional Surface Water Supply Project (Project 1).
- Area receiving recycled water deliveries: Applied water to areas in the western portion of the existing TID irrigation service area.

8.2.2.2.6. Water Source and Reliability

This Project would use available recycled water from the City of Turlock. Municipal water supply and demand are considered to be reliable and are expected to reliably provide 2,000 AF/yr of recycled water for this Project. The precise reliability of available recycled water would be refined during future project development and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.

8.2.2.2.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies. The City of Turlock has the authority to supply recycled water to TID and TID has the authority to deliver recycled water to its customers, subject to certain regulatory and permitting requirements.

8.2.2.2.8. Estimated Costs and Funding Plan

This PMA is currently in the early conceptual stage. However, a high-level cost of the project has been estimated at $50,000. More detailed costs will be reported in GSP Annual Reports and Five-Year Assessment Reports when confirmed. It is anticipated that TID would identify funding sources to cover project costs as part of project development. These may include grants (e.g., Prop 1, Prop 68, NRCS), fees, local cost share, loans, and other assessments.

8.2.2.2.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, in-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years and reduce groundwater pumping in the lower portions of TID's distribution system, helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.2.3. TID Ceres Main Regulating Reservoir (Project 8)

8.2.2.3.1. Project Description

In this Project, TID will construct a new regulating reservoir in the TID distribution system, located along the Ceres Main Canal near the head of Lower Lateral 3. The reservoir would absorb operational fluctuations in the Ceres Main Canal caused by upstream flow adjustments and would maintain a constant pool elevation upstream of the drop where it is constructed. This reservoir is expected to provide numerous benefits to the operation of TID's distribution system and to the level of service offered to TID's irrigation customers, with cascading benefits to the Turlock Subbasin.

The proposed reservoir design would have an operational storage capacity of approximately 220 AF, a maximum storage capacity of 253 AF, and a design inflow/outflow capacity of 100 cubic feet per second (CFS). To facilitate reservoir operation, four existing in-canal level control structures, known as drop structures, would be modified and automated with new flume gates and telemetry.

The location of the new reservoir along the Ceres Main Canal is strategically positioned to capture and store a large portion of the operational fluctuations in the canal system downstream of its location. By capturing and allowing later use of water that would have otherwise spilled from the canal system, the Ceres Main regulating reservoir conserves surface water supplies for irrigation and provides in-lieu recharge benefits to the Subbasin.

The location of the new reservoir along the Ceres Main Canal also affords WDOs greater flexibility in delivering surface water to customers while also reducing unexpected lower than ordered flows at the bottom ends of the canal system below the reservoir. This reduces the need for supplemental local groundwater pumping to maintain required irrigation flow rates in the canals below the reservoir. The TID distribution system was constructed to supply higher-volume (15-20 CFS) deliveries for flood irrigation; however, the increased use of drip and micro sprinkler irrigation systems in recent years has increased demand for "microhead" deliveries with lower, varying flow rates and longer durations. Accommodating these microheads is challenging for WDOs due to their varying flow rates, start times, and end times. The added challenges of these microheads result in greater difficulty for WDOs to "level" demands by arranging the sequence of deliveries. The Ceres Main regulating reservoir will support WDOs in responding to these challenges and maintain high levels of irrigation service to customers. These features are expected to encourage continued use of surface water for irrigation and conserves surface water supplies, both of which would provide in-lieu recharge benefits to the Subbasin.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the TID Ceres Main regulating reservoir Project.

8.2.2.3.2. Public Notice

The public and other agencies will continue to be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing may be facilitated through the WTSGSA board meetings and/or TID board meetings, the Turlock Subbasin and/or TID website(s), the TID newsletter, inter-basin coordination meetings, other public meetings hosted by the WTSGSA and/or TID, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and/or environmental/regulatory permitting notification processes.

8.2.2.3.3. Permitting and Regulatory Process

Required permitting and regulatory review has been initiated through consultation with applicable governing agencies. TID has already initiated environmental permitting and regulatory processes. As of fall 2021, TID has prepared an Initial Study in accordance with the California Environmental Quality Act (CEQA) and has completed a Mitigated Negative Declaration for CEQA compliance. TID will continue consultation and initiation of any remaining permitting and regulatory processes through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to: the SWRCB, the County(ies) of Stanislaus and/or Merced, and DWR.

8.2.2.3.4. Expected Benefits

Benefits to Sustainability Indicators

As described in the Project Description section, the TID Ceres Main regulating reservoir is expected to support TID's WDOs in maintaining high levels of irrigation service and delivery flexibility to customers. The reservoir is also expected to conserve surface water supplies that may have otherwise spilled and make that water available for irrigation. Both features are expected to provide in-lieu groundwater recharge benefits to the Subbasin by enhancing the availability of surface water for irrigation instead of groundwater. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, interconnected surface water, and land subsidence (depending on where recharge occurs).

This Project may also benefit water quality, to the extent that surface water is used for irrigation and percolates to the groundwater system. The surface water supply for TID originates as snowmelt from the Sierra Nevada Mountains and is of very high quality,[1] with lower TDS relative to groundwater.

All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The TID Ceres Main regulating reservoir is expected to provide in-lieu recharge benefits throughout the TID irrigation service area. The majority of communities in the Turlock Subbasin, particularly the TID irrigation service area, are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). This Project is expected to directly benefit those communities in the TID irrigation service area. Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin

Volumetric Benefits to the Subbasin Groundwater System

The expected benefit of the TID Ceres Main regulating reservoir to the Turlock Subbasin was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

On average across all years, the TID Ceres Main regulating reservoir Project is expected to:

- Reduce spillage losses from the TID distribution system by an average of approximately 10,000 AFY (net volume conserved would be held in Don Pedro Reservoir for future beneficial use in TID), and
- Reduce groundwater pumping along Lower Lateral 3 by approximately 575 AFY (deliveries previously met by groundwater pumping would instead be met by surface water stored in the Ceres Main regulating reservoir).

Benefits are expected to accrue throughout the irrigation season in all years following construction. The precise benefits will vary between years as the volume of surface water

[1] Water quality is regularly tested at Turlock Lake as part of TID's Ag Suitability monitoring program. Results of these tests show that source water diverted from the Tuolumne River has an average TDS of 38 parts per million (ppm), nitrate concentration of less than 2 ppm, phosphorus concentration of less than 0.04 ppm, and potassium concentration of less than 2 ppm. (TID, 2021)

supplies and deliveries varies with water availability, hydrologic conditions, and irrigation demand.

Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project is evaluated as part of a scenario and the C2VSimTM is used to assess the benefits and impacts on the Subbasin sustainability.

8.2.2.3.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

This Project is currently planned for construction and implementation in the near future, pending funding, and would be implemented by TID. As of fall 2021, TID has acquired land at the head of Lower Lateral 3 for the proposed regulating reservoir. TID has also prepared an Initial Study in accordance with CEQA and has completed a mitigated negative declaration for CEQA compliance. As part of this process, TID has completed reservoir design and is currently seeking grant funding to support project construction.

The proposed reservoir would be constructed on a 38-acre parcel owned by TID, located approximately a quarter of a mile south of Keyes Road and a half mile west of Prairie Flower Road, east of the Township of Keyes in Stanislaus County, California. The reservoir design would have an operational storage capacity of approximately 220 AF, a maximum storage capacity of 253 AF, and a design inflow/outflow capacity of 100 CFS. Inflows to the reservoir would be conveyed through a reinforced concrete inlet pipe on the Ceres Main Canal, and outflows from the reservoir would be conveyed back to the Ceres Main through four steel and PVC pump lines and to LL3 (below Drop 1) through a separate steel and PVC pump line. The inlet/outlet structure on the Ceres Main Canal includes a broad crested spillway capable of passing 100 CFS from the reservoir to the Ceres Main Canal if design water storage levels are exceeded by more than 1 foot.

The timing of construction is uncertain and will depend on funding. The completion date for this PMA is estimated to be February 2023, contingent on grant funding, and will be updated in GSP Annual Reports and Five-Year Assessment Reports when confirmed. Once construction is complete, it is expected that TID would operate this reservoir in all years over the GSP implementation and planning horizon, up to the 50-year expected life of the reservoir components.

Implementation Assumptions for Modeling

The TID Ceres Main regulating reservoir Project has been modeled in the C2VSimTM model and will be modeled in the GRAT. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

The following general information and assumptions were used to simulate implementation of the Project:

- Volume of spillage reduction: Reduced spillage by an average of 10,000 AFY, distributed across the following sites: Faith Home (along the Ceres Main Canal), Hodges (along the Ceres Main Canal), Lateral 1, Lower Lateral 2, Lower Lateral 2 ½, Lower Lateral 3, Lower Lateral 4, and Lateral 4 ½.
- Volume of groundwater pumping reduction: Reduced groundwater pumping by TID-operated pumps along Lower Lateral 3 by 575 AFY.
- Assumed that the net volume of spillage reduction conserved by the reservoir may instead be stored in Don Pedro Reservoir for future beneficial use by TID.

8.2.2.3.6. Water Source and Reliability

The TID Ceres Main regulating reservoir project would conserve surface water diverted from the Tuolumne River. TID has existing water rights on the Tuolumne River. This Project will support ongoing management of these supplies to benefit groundwater sustainability in the Turlock Subbasin; however, this Project will not directly use additional surface water supplies.

8.2.2.3.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies. TID has the authority to construct and operate a regulating reservoir in its irrigation distribution system, subject to applicable regulatory requirements.

8.2.2.3.8. Estimated Costs and Funding Plan

This Project has gone through the preliminary planning and design stage, and TID is currently seeking grant funding to support construction. Total estimated project costs as of September 2021 are approximately $8,800,000. These costs include reservoir construction costs and indirect permitting costs. Initial project implementation cost estimates developed in February 2019 estimate the annual reservoir operating costs as approximately $32,000 per year. The precise costs of this Project will be refined through additional project development. Updated costs will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. TID is identifying potential funding sources to cover project costs as part of project development. These may include grants (e.g., Prop 1, Prop 68, WaterSMART), fees, local cost share, loans, and other assessments. As of fall 2021, TID is actively applying to grant opportunities to fund this Project.

8.2.2.3.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, this conservation and conjunctive use project is expected to increase the use and recharge of available surface water supplies during wetter years (in-lieu recharge), helping to offset potential increases in groundwater pumping during drought when surface water supplies are limited.

8.2.3. East Turlock Subbasin GSA - Agriculture

Projects developed for implementation in the East Turlock Subbasin GSA (ETSGSA) are summarized in the sections below.

8.2.3.1. Agricultural Recharge Project (in ETSGSA) (Project 9)

8.2.3.1.1. Project Description

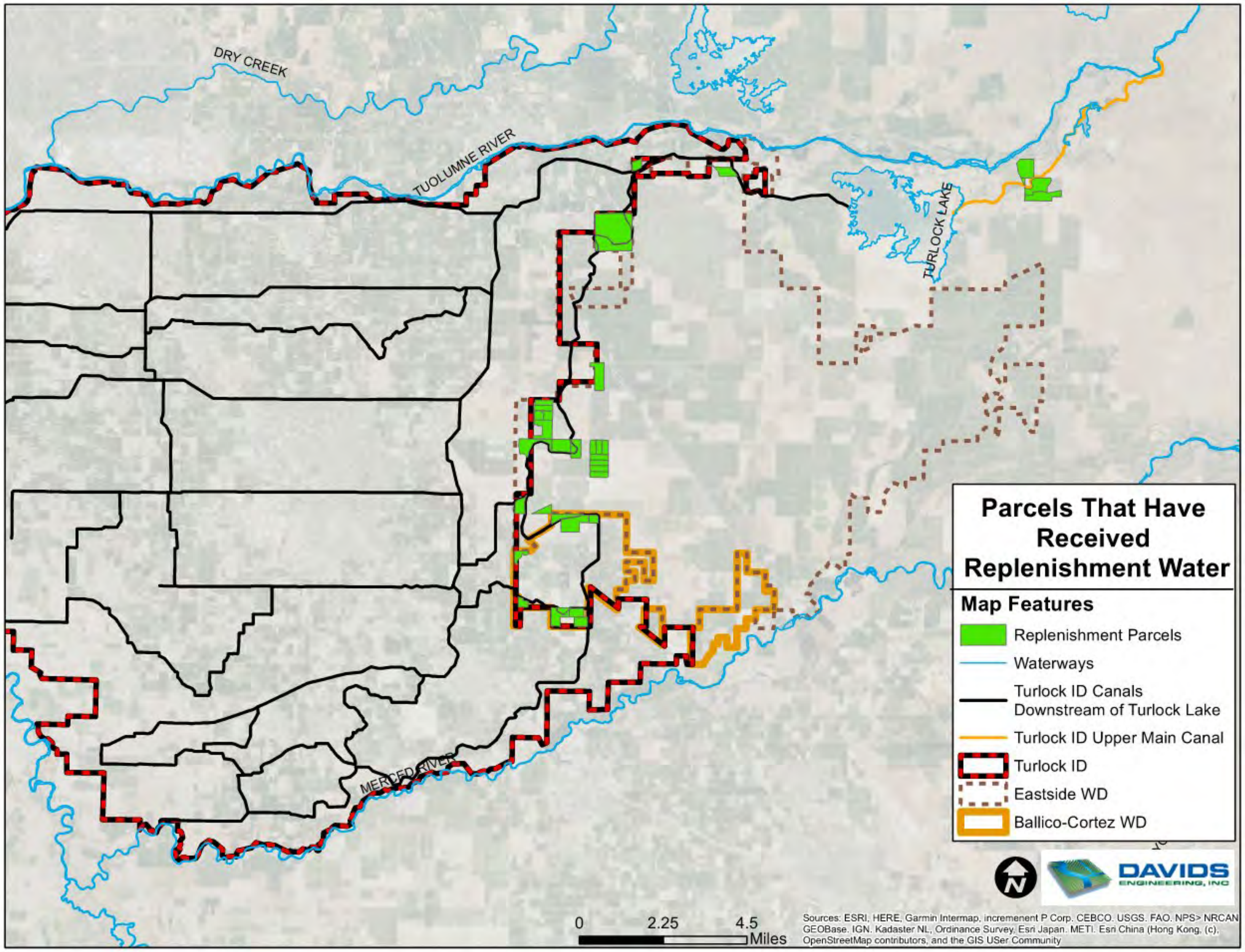
In certain wet years when sufficient surface water is available, Turlock Irrigation District (TID) promotes direct and in-lieu recharge through the provision of “replenishment water” to irrigators outside of, but adjacent to TID’s irrigation service area. Historically, the bulk of the replenishment water sales have gone to irrigators east of TID’s irrigation service area as a substitute for groundwater pumping or in-lieu groundwater recharge.

The Agricultural Recharge Project (in ETSGSA) (Project) would continue and potentially expand upon these replenishment water deliveries through a partnership between Eastside Water District (EWD) and TID. In this Project, TID would deliver water to land within EWD and the East Turlock Subbasin Groundwater Sustainability Agency (ETSGSA) in years when sufficient water supplies exist. Annual operation of this Project would be informed by the Tuolumne Reservoir Simulation (TRS) model, which TID currently uses to estimate the volume of surface water available each year.

Replenishment water deliveries will help maximize the utility of available water supplies to support groundwater sustainability in the Turlock Subbasin. During the irrigation season, replenishment water delivered through this Project would be used to offset demand for groundwater pumping and provide in-lieu recharge benefits to the Subbasin. During the non-irrigation season, water delivered through this Project would be used for field flooding to provide direct recharge benefits to the Subbasin.

This Project is expected to begin with deliveries during the irrigation season to parcels that have received replenishment water in the past and may expand deliveries to those same parcels during the non-irrigation season months depending on surface water availability. Additional parcels may be considered in the future to expand the recharge capacity of the Project when water is available.

Figure 8-5: Parcels Outside the TID Irrigation Service Area that Have Received Replenishment Water Deliveries (1995-2019)



This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the Agricultural Recharge Project.

8.2.3.1.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.

8.2.3.1.3. Permitting and Regulatory Process

Water would be diverted for this Project by TID through conservation and/or existing water rights. Required permitting and regulatory review would be initiated through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to, the SWRCB and the County(ies) of Stanislaus and/or Merced.

If necessary for field flooding or the development of new delivery infrastructure, the project proponent will obtain land grading and construction permits from the County(ies). Recharge projects that expand water delivery to new locations may also require an environmental review process under CEQA.

8.2.3.1.4. Expected Benefits

Benefits to Sustainability Indicators

This Project would deliver water to lands outside the TID irrigation service area that have historically used groundwater for irrigation. Water deliveries during the irrigation season are expected to offset groundwater demand and provide in-lieu groundwater recharge benefits. Water deliveries during the non-irrigation season are expected to provide direct groundwater recharge to the Subbasin. In both cases, the sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The majority of communities in the Turlock Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Depending on which specific parcels receive replenishment water deliveries, this Project may directly benefit specific DACs located in EWD and the ETSGSA along the TID irrigation service area boundary.[1] In addition, maintenance or improvement of groundwater levels may help to protect beneficial groundwater use by rural domestic

[1] Specific DACs in EWD and the ETSGSA along the TID service area boundary include census block groups (2018) 060990036044 and 060470002011, and 060470002012, and census tract group (2018) 06047000201.

wells from potential adverse impacts related to chronic groundwater level decline. Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Project was estimated by simulating two implementation phases for this Project in the C2VSimTM model:

1. Irrigation season deliveries to parcels in EWD and the ETSGSA that have historically received replenishment water deliveries, and
2. Non-irrigation season deliveries to parcels in EWD and the ETSGSA that have historically received replenishment water deliveries.

General information and assumptions used to simulate these two implementation phases are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability. The expected yield of each phase is summarized in **Table 8-4.**

On average, irrigation season deliveries to parcels in the ETSGSA that have historically received replenishment water is expected to provide 3,400 AFY of benefit to the Turlock Subbasin. These benefits are expected to accrue in years with wet or above normal hydrologic conditions when the TID Board of Directors allows deliveries to these areas.

Non-irrigation season replenishment water deliveries are expected to provide an average of 1,600 AFY of additional benefit to the Turlock Subbasin. If and when this phase of Project implementation occurs, these benefits are also expected to accrue in years with wet or above normal hydrologic conditions when the TID Board of Directors allows the delivery of replenishment water.

Evaluation of benefits will be based on analysis of without-project and with-project measurements potentially supported by modeling as needed. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined.

Table 8-4: Estimated Average Annual Benefits of the Agricultural Recharge Project by Project Implementation Phase

Project Implementation Phase	Estimated Yield, Projected Future Water Budget (AFY)
Irrigation season deliveries to parcels in EWD and the ETSGSA that have historically received replenishment water deliveries	3,400
Non-irrigation season deliveries to parcels in EWD and the ETSGSA that have historically received replenishment water deliveries	1,600

8.2.3.1.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The Project would be implemented through a partnership between EWD and TID. In this Project, TID would deliver water to land within EWD and the ETSGSA in years when sufficient water supplies exist. Annual operation of this Project would be informed by the TRS model, which TID uses to estimate the volume of water available each year.

Three implementation phases of this Project are being considered:

1. Existing and expanded irrigation season deliveries to parcels in EWD and the ETSGSA that have historically received replenishment water deliveries,
2. Non-irrigation season deliveries to parcels in EWD and the ETSGSA that have historically received replenishment water deliveries, and
3. Future recruitment of additional parcels into the Project to increase recharge capacity when water is available.

Other than existing irrigation season deliveries that have historically taken place, future phases are currently in the early conceptual stage. Thus, the start and completion dates for those phases have yet to be determined but will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. The Project is expected to expand within the next five years. Any future changes in project implementation will be communicated with the public and other agencies and will be documented in GSP Annual Reports and Five-Year Assessment Reports.

Implementation Assumptions for Modeling

All phases of the Project have been modeled in the C2VSimTM model and will be modeled in the GRAT. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

In general, information and assumptions used to simulate implementation of the three Project phases include:

- Estimated volume of deliveries:
- Phase 1, Irrigation season deliveries: The volume of deliveries was estimated as the required volume needed during the irrigation season to satisfy all irrigation water demands of parcels in the potential area receiving deliveries (below). Based on preliminary analysis, this project can supply up to 8,800 AFY of in-lieu recharge, averaging 3,400 AFY over the 50-year planning horizon.
- Phase 2, Non-irrigation season deliveries: The volume of deliveries was estimated at up to 3,000 acre-feet per month in January and February when flood flows were available from Don Pedro Reservoir, a long-term average of 1,600 AFY. This volumetric capacity of this project was estimated assuming 2 AF per acre and a 50 percent participation rate across the potential area receiving deliveries (below).
- Phase 3, Recruitment of Additional Parcels: The recruitment of additional parcels to increase the recharge capacity of the Project is anticipated in the future, but the implementation schedule

and capacity changes are uncertain. Therefore, this phase has not been evaluated in the modeling analysis.

- Potential area receiving deliveries: All parcels that have historically received replenishment water deliveries (**Table 8-4**).
- Assumed that all replenishment water is diverted from the Tuolumne River and conveyed through the existing TID distribution system. It is anticipated that in-lieu recharge during the irrigation season will have minimal effect on the simulated operations. Deliveries outside of the irrigation season for direct recharge, were limited by water availability and conveyance seepage is assumed to be in the total diversion amount and is included in the recharge.

8.2.3.1.6. Water Source and Reliability

The Project would use water diverted from the Tuolumne River and/or other supplies available to TID. TID has existing water rights on the Tuolumne River. TID also has existing storage and conveyance facilities to reliably deliver replenishment water to participating parcels. Water is expected to be available for this Project in wet and above normal hydrologic years. In approximately half of the years since the construction of New Don Pedro Dam, the Tuolumne River watershed has produced more water than can be stored or beneficially used by existing customers. Up to 6,000 AFY is anticipated to be available and able to be delivered using TID infrastructure; however, at this time, it is assumed that the Project capacity during Phase 1 and 2 will be limited to 4,000 AFY during above normal and wet years. Up to 2,000 AFY of additional water during above normal and wet years may be made available if Project capacity is expanded during Phase 3. Recognizing that water supply availability could be impacted by climate change or regulatory requirements, the project will be implemented using adaptive management.

8.2.3.1.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies.

8.2.3.1.8. Estimated Costs and Funding Plan

Potential costs of this Project may include project coordination and administration, financial incentives to encourage use of replenishment water, purchase of surplus water, field preparation to enhance flooding, and other potential on-field monitoring equipment. Costs per site may vary depending on changes in Project implementation and incentives. The total costs of the Project will likely vary over time, depending on the number of parcels receiving water from year to year and the extent of any applicable project incentives. Additional costs may apply in the case of a FloodMAR-type project related to potential expansion of laterals and delivery systems; these costs are not known at this time and will be developed and reported when known.

Costs of phase 1 are not reported at this time but are expected to be relatively modest. Phase 2 of this Project is currently in the planning stage. Thus, the anticipated costs have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Project proponents in the ETSGSA will identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS), fees, local cost share, loans, and other assessments.

8.2.3.1.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, in-lieu and direct recharge benefits of this Project are expected to increase water recharge during wetter years, helping to offset the impact of groundwater pumping during drought when surface water supplies are limited.

8.2.3.2. Mustang Creek Flood Control Recharge Project (Project 10)

8.2.3.2.1. Project Description

Flood water from the Mustang Creek watershed is currently held in a primary detention basin that was constructed in 1973 and is located northeast of the intersection of Oakdale Road and East Avenue in Merced County. The primary detention basin has a total flood water impoundment area of approximately 170 acres and a maximum rated flood control capacity of 650 AF. EWD is exploring opportunities to enhance recharge in the primary detention basin by overcoming the near surface low permeability layers and increasing the impoundment water storage.

The Mustang Creek Flood Control Recharge Project (Project) would recharge flood water from the primary detention basin through seven new dry wells within the flood footprint of the primary detention basin. These dry wells would be installed approximately 250 feet apart, varying in depth from approximately 65 feet to 110 feet. Three dry wells were installed recently as part of a pilot project and have a recharge capacity of approximately 1 AF per day per well. The new wells would likely have a similar recharge capacity.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the Mustang Creek Flood Control Recharge Project.

8.2.3.2.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.

8.2.3.2.3. Permitting and Regulatory Process

Required permitting and regulatory review is being initiated through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to: DWR, SWRCB, the California Department of Fish and Wildlife (CDFW), the Central Valley Flood Protection Board (Flood Board), RWQCBs, the United States Bureau of Reclamation (Reclamation or USBR), the United States Army Corps of Engineers (USACE), the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), Local Agency Formation Commissions (LAFCO), the County of Stanislaus and/or Merced, and the California Air Resources Board (CARB). Specific permitting and regulatory processes that may potentially affect the construction of project-related infrastructure include, but are not limited to:

- USACE Section 404 Permits (potential exemption under Section 404(f)(1)(C) of Clean Water Act)
- RWQCB Section 401 Water Quality Certification (not required if exempt from USACE Section 404)
- SWRCB Water Rights Petition
- SWRCB Construction General Permit and Storm Water Pollution Prevention Plan (SWPPP)
- State Historic Preservation Office (SHPO) and National Historic Preservation Act (NHPA) Section 106 Coordination
- CEQA Environmental Review Process
- California Endangered Species Act (CESA) Consultation
- Endangered Species Act (ESA) Compliance
- National Environmental Policy Act (NEPA) Compliance (expected to require either an Environmental Impact Report and Negative Declaration or Mitigated Negative Declaration)

8.2.3.2.4. Expected Benefits

Benefits to Sustainability Indicators

This Project would supply direct groundwater recharge to the Subbasin by enhancing infiltration and impoundment of storm water in dry wells. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, and interconnected surface water. All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The majority of communities in the Turlock Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin. In addition, maintenance or improvement of groundwater levels may help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Project was estimated by simulating the Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

On average, the Project is expected to provide approximately 600 AF/yr of benefit to the Turlock Subbasin. These benefits are expected to accrue in years with wet or above normal hydrologic conditions when flood flows occur along Mustang Creek.

Evaluation of benefits will be based on analysis of without-project and with-project measurements supported by modeling as needed. Measured parameters will include surface water deliveries, groundwater levels, and other parameters to be determined.

8.2.3.2.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The Project would be implemented by EWD in partnership with Stanislaus County. Other potential project partners would be determined during later project development and implementation, as applicable.

Seven new Dry Wells are scheduled to be installed in 2024. Additional details will be provided in Annual Reports when known.

Implementation Assumptions for Modeling

The Project has been modeled in the C2VSimTM model and will be modeled in the GRAT. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

- Estimated volume of recharge: volumetric supply of recharge water was estimated based on the water year index, distributed on a monthly-timestep based on local precipitation.

	Wet	Above Normal	Below Normal	Dry	Critical	Average
Mustang Creek	980	600	495	325	265	583

- Area receiving recharge: recharge is anticipated to occur at the project location as described above.

8.2.3.2.6. Water Source and Reliability

This Project would enhance recharge of flood water in the Mustang Creek watershed and could also capture and recharge agricultural return flows. Flood water is available for this Project during flood events, typically in wet and above normal hydrologic years, and agricultural return flows are available seasonally during the irrigation season. The precise reliability and return period of available water would be refined during future project development and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.

8.2.3.2.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies, following the applicable permitting and regulatory processes described above.

8.2.3.2.8. Estimated Costs and Funding Plan

There are seven new Dry Wells scheduled to be installed on the property after the completion of the current pilot monitoring studies. Each well has an estimated cost of $50,000 for a total project cost of $350,000.

EWD will be working to identify funding sources to cover project costs as part of continued project development. These may include grants (e.g., Prop 1, Prop 68, NRCS), fees, local cost share, loans, and other assessments.

8.2.3.2.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, direct recharge benefits of this Project are expected to increase the recharge of available surface water supplies during wetter years.

8.2.3.3. Upland Pipeline Project (Project 11)

8.2.3.3.1. Project Description

The Upland Pipeline Project (Project) will install a new piped conveyance system to supply water to EWD from Merced Irrigation District (Merced ID). Water would be diverted from the Merced ID Northside Canal to a stock pond on lands adjoining the Northside Canal at Keyes Road just east of Fields Road. From that point water would flow down the southernmost branch of Dry Creek, providing ambient recharge in the streambed (expected to be 9 cubic feet per second, prior to enhancement). The Project involves constructing a new upland pipeline intake off Dry Creek and into a portion of the Mustang Creek watershed. This movement of the supplied water from Merced ID then enables diverting water for:

- in-lieu recharge via surface water deliveries to irrigated parcels from the pipeline intake off Dry Creek to the Mustang Creek primary floodwater detention basin constructed by the USDA Soil Conservation Service and operated by EWD,
- direct recharge in dry wells constructed in the primary floodwater detention basin, and
- direct recharge at a secondary detention basin along Mustang Creek by the Turlock Municipal Airport, designed and constructed by the U.S. Army Corps of Engineers with controlled inflow and outflow.

Fundamentally, this Project allows for the conveyance of surface water from Merced ID to either:

- ambient recharge via the Dry Creek streambed,
- the direct-recharge in existing Mustang Creek detention basin and off-stream sumps and/or,
- in-lieu recharge along the Upland Pipeline alignment from Dry Creek to the primary detention basin on Mustang Creek.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of the Upland Pipeline Project.

8.2.3.3.2. Public Notice

The public and other agencies will be notified of the planned or ongoing implementation of PMA activities through the outreach and communication channels identified in the GSP, during the preparation process of the PEIR, and during updates presented at regularly scheduled GSA meetings. Noticing will occur as potential activities are being considered for implementation, and as ongoing and planned activities are implemented. Noticing will inform the public and other agencies that the proponent is considering or will be implementing the PMA and will provide a description of the actions that will be taken.

Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.

8.2.3.3.3. Permitting and Regulatory Process

Required permitting and regulatory review is being initiated through consultation with applicable governing agencies. Governing agencies that may be consulted for this Project include, but are not limited to: DWR, SWRCB, CDFW, the Flood Board, RWQCBs, USBR, USACE, USFWS, NMFS, LAFCO, the County of Stanislaus and/or Merced, and CARB. Specific permitting and regulatory processes that may potentially affect the construction of project-related infrastructure include, but are not limited to:

- USACE Section 404 Permits (potential exemption under Section 404(f)(1)(C) of Clean Water Act)
- RWQCB Section 401 Water Quality Certification (not required if exempt from USACE Section 404)
- SWRCB Water Rights Petition as required
- SWRCB Construction General Permit and Storm Water Pollution Prevention Plan (SWPPP)
- State Historic Preservation Office (SHPO) and National Historic Preservation Act (NHPA) Section 106 Coordination
- CEQA Environmental Review Process
- California Endangered Species Act (CESA) Consultation
- Endangered Species Act (ESA) Compliance
- National Environmental Policy Act (NEPA) Compliance (expected to require either an Environmental Impact Report and Negative Declaration or Mitigated Negative Declaration)

8.2.3.3.4. Expected Benefits

Benefits to Sustainability Indicators

This Project would supply direct and in-lieu groundwater recharge to the Subbasin by importing additional surface water from Merced ID for irrigation and recharge. The sustainability indicators expected to benefit from this Project are groundwater levels, groundwater storage, interconnected surface water, and land subsidence (depending on where recharge occurs). All benefits to sustainability indicators in the Turlock Subbasin will be evaluated through groundwater monitoring at nearby monitoring sites, identified in the GSP.

Benefits to Disadvantaged Communities

The majority of communities in the Turlock Subbasin are classified as DACs, SDACs, or EDAs (according to 2018 census data, evaluated by place, tract, and block group). Benefits to groundwater conditions in the Turlock Subbasin are also expected to broadly benefit all DACs, SDACs, and EDAs in the Turlock Subbasin. In addition, maintenance or improvement of groundwater levels may help to protect beneficial groundwater use by rural domestic wells from potential adverse impacts related to chronic groundwater level decline.

Volumetric Benefits to the Subbasin Groundwater System

The expected yield of the Project was estimated by simulating this Project in the C2VSimTM model. General information and assumptions used to simulate this Project are summarized in the Implementation section below. Additional information is provided in **Section 8.5**: Plan for Achieving Sustainability.

The Project is expected to provide up to 1,770 AF/yr of Merced River water for direct recharge during non-irrigation season in wet and above normal years. Additional water can potentially be available depending on the water availability from the Merced River and Merced Irrigation District.

Evaluation of benefits will be based on analysis of the Project water supplies using the C2VSimTM model.

8.2.3.3.5. Implementation Criteria, Status, and Strategy

Implementation Strategy and Timeline

The Project would be implemented by EWD in partnership with Merced ID. This Project has gone through the preliminary planning and design stage, and EWD is currently seeking bids for construction. The precise start and completion dates for this Project have yet to be determined but will be provided in Annual Reports when known. The current estimated schedule of activities over 2-3 years is:

- Year 1 – Acquiring easements from landowners and necessary permitting
- Year 2 – Construction
- Year 3 – Operational with existing water supply available from Merced ID

Implementation Assumptions for Modeling

The Project has been modeled in the C2VSimTM model and will be modeled in the GRAT to optimize water distribution. Additional information about project-related modeling is described in **Section 8.5**: Plan for Achieving Sustainability.

- Estimated volume of recharge: volumetric supply of recharge water was estimated based on the water year index, distributed on a monthly-timestep based on local precipitation.

	Wet	Above Normal	Below Normal	Dry	Critical	Average
Upland Pipeline Project	1,770	1,770	900	400	400	1,098

- Area receiving recharge: recharge is anticipated to occur at the project location as described above.

8.2.3.3.6. Water Source and Reliability

This Project would utilize Merced River water purchased from the Merced I, as may be made available. Water would potentially be available for this Project seasonally during the irrigation season. The precise reliability and return period of available water would be refined during future project development.

Note from Merced ID: Local project sponsor, Eastside Water District, anticipates that surface water sourced from the Merced ID may be available through water purchase and sale agreements and may serve as a water supply for the project(s). It is understood that the Board of Directors for the Merced ID has and shall retain full and absolute discretion regarding whether and when it will enter into water purchase and sale agreement(s), if any, and further, nothing contained in this document creates in any party or parties any right to water controlled by the Merced ID, whether it be surface or groundwater. Any transfer made available by Merced ID shall be limited by the terms and conditions contained in any respective water purchase and sale agreement.

8.2.3.3.7. Legal Authority

GSAs, Districts, and individual project proponents have the authority to plan and implement projects through consultation with applicable governing agencies.

8.2.3.3.8. Estimated Costs and Funding Plan

This Project has completed the preliminary planning and design stage, and EWD is currently seeking bids for construction. A $2.5 million construction proposal has been made at the time of GSP development. The precise costs of this Project have yet to be determined but will be refined through additional project development. Updated costs will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. It is anticipated that EWD would identify funding sources to cover Project costs as part of Project development. These may include grants (e.g., Prop 1, Prop 68, NRCS), fees, local cost share, loans, and other assessments.

8.2.3.3.9. Management of Groundwater Extractions and Recharge

Per 23 CCR § 354.44(b)(9), all Projects developed for implementation are targeted to maintain the balance of groundwater extractions and recharge to help ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels and storage in other years.

In particular, direct recharge and in-lieu recharge benefits of this Project are expected to increase the use and recharge of available surface water supplies during wetter years, helping to offset groundwater pumping.

8.3. OTHER PROJECTS TO BE IMPLEMENTED AS NEEDED (GROUP 3)

This section describes potential Projects that would be implemented where determined to be necessary to decrease the need for pumping reduction or address future conditions in the Turlock Subbasin. These Projects include all Group 3 Projects identified in **Table 8-2**Error! Reference source not found. that have been identified and may occur in the Turlock Subbasin in the future. While these Projects would also contribute to attainment of the sustainability goal and support GSP implementation, these Projects are at the conceptual or early planning stage at this time, with no specific implementation timeline established.

To the extent that future monitoring indicates the occurrence of undesirable results in the Subbasin, additional Projects will be implemented to address these changing conditions. Each GSA will develop processes and procedures as needed to identify and progress projects through the feasibility study phase, through planning and front-end engineering design, and to permitting, procurement of entitlements, and construction. As additional project development occurs for the projects included in **Table 8-5** or other projects identified in the future, updates will be documented and reported in subsequent GSP Annual Reports and Five-Year Assessment Reports. **Table 8-5** lists the potential Projects described in the subsections that follow, organized by both the GSA and the proponent.

Summary of Criteria for Project Implementation (23 CCR §354.44(b)(1)(A))

As described above, the Projects described in this section are either in the early planning stage or in the concept development stage. These potential Projects could be implemented, as needed, to achieve and maintain long-term sustainable groundwater management. The potential for implementing Projects would also be evaluated alongside potential Management Actions if, based on data gathered during GSP implementation, the GSAs find that established IMs and MOs cannot be maintained and/or if MTs are being approached. This adaptive approach of executing PMAs will be informed by monitoring groundwater conditions using the monitoring network and methods described in the GSP. This initial list of Projects will likely be supplemented with additional projects as they are identified and would be described and reported through Annual Reports and Five-Year Assessment Reports of the GSP.

Table 8-5: List of Other Projects to be Implemented as Needed in the Turlock Subbasin

Location (Proponent)	#	Project Name	Primary Mechanism(s)[1]
WTSGSA Urban and Municipal (City of Modesto)	12	San Joaquin River Flood Diversions	Direct or In-Lieu Groundwater Recharge
West Turlock Subbasin GSA (Turlock Irrigation District) – Agriculture	13	La Grange Recharge Project (Within TID Irrigation Service Area)	Direct Groundwater Recharge
	14	TID Lateral 5 1/2 Regulating Reservoir	In-Lieu Groundwater Recharge
	15	Additional TID Regulating Reservoirs	Direct or In-Lieu Groundwater Recharge
	16	Recharge from TID Conveyance System	Direct Groundwater Recharge
	17	Intertie Projects	In-Lieu Groundwater Recharge
East Turlock Subbasin GSA (Eastside Water District) - Agriculture	18	Rouse Lake Pipeline Project	Direct or In-Lieu Groundwater Recharge
	19	Sand Creek Runoff Recharge	Direct Groundwater Recharge
	20	Conveyance Improvements Project	Direct or In-Lieu Groundwater Recharge
	21	Development of Diffused Stormwater Project	Direct or In-Lieu Groundwater Recharge
	22	Dry Creek Watershed Recharge	Direct Groundwater Recharge
	23	Direct Recharge in Agricultural Areas	Direct Groundwater Recharge

[1]The primary mechanism of the Project as conceptualized, although during implementation Projects may be used for multiple functions to support groundwater sustainability and multiple other benefits.

8.3.1. Group 3 Urban and Municipal Proponents (WTSGSA)

Other potential Projects that would be implemented by urban and municipal proponents, as needed, are summarized below.

8.3.1.1. San Joaquin River Flood Diversions (Project 12)

This Project is proposed by the City of Modesto and would divert flood water from the San Joaquin River into storage ponds for use in the Turlock Subbasin. The City of Modesto has storage ponds located at 7001 Jennings Road, Modesto, CA, that hold up to 7,830 AF of water. These ponds have been underutilized since the City of Modesto moved to tertiary treatment of the wastewater and began selling the recycled wastewater to the Del Puerto Water District. It is expected that these storage ponds are partially available to capture and store urban storm water and flood flows from the San Joaquin River, although the exact amount of storage available and period of availability has yet to be determined. The current project is focused on analyzing flood flows from the San Joaquin River but could be expanded to include to storage and use of urban storm water. The occurrence and volume of flows available for diversion into the ponds would also need to be determined. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. This information will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.

Water stored in the ponds could be used to irrigate 2,530 acres of ranch owned by the City of Modesto. The majority of the infrastructure necessary to store and deliver water to the ranch land already exists (including the storage ponds, pipes, pumps, a reservoir, and valves for conveyance). The remaining infrastructure that would need to be constructed is a conduit to divert water from the San Joaquin River into the storage ponds. The ponds are in close proximity to the San Joaquin River, less than 600 feet away from some reaches. This Project would complete an on-site evaluation of the existing outfall and old pumps used for pumping irrigation water from the river, along with consideration of possible alternate methods.

A summary of the Projects is provided in **Table 8-6**.

Table 8-6: San Joaquin River Flood Diversions: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would divert flood water from the San Joaquin River into storage ponds for direct and in-lieu recharge in the Turlock Subbasin. The Project would utilize storage ponds owned by the City of Modesto, as well as other available infrastructure for conveying flood flows to irrigated ranch land. This Project would require construction or rehabilitation of infrastructure to convey flood water from the San Joaquin River to the ponds. This Project is proposed for implementation by the City of Modesto. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic years when flood water is available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use available flood water from the San Joaquin River. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. This information will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.2. WTSGSA – Group 3 Agricultural Water Supply Projects

Other potential Projects that would be implemented in the WTSGSA, as needed, are summarized below.

8.3.2.1. La Grange Recharge Project (Within TID Irrigation Service Area) (Project 13)

This Project would develop recharge opportunities in the La Grange area, upstream of Turlock Lake and within TID's existing irrigation service area. Recharge opportunities would focus on areas where the recharge potential is found to be high. On-farm flood irrigation in excess of crop water requirements would likely be done to purposefully recharge the aquifer.

A summary of the Project is provided in **Table 8-7**.

Table 8-7: La Grange Recharge Project (Within TID Irrigation Service Area): Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	The La Grange recharge project (within the TID irrigation service area) would develop recharge opportunities in the La Grange area, upstream of Turlock Lake and within TID's existing irrigation service area. Recharge opportunities would focus on areas where the recharge potential is found to be high. This Project is proposed for implementation by TID. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic years when sufficient water is available for on-farm recharge, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use water diverted by TID using existing water rights on the Tuolumne River. Surface water is expected to be available for this Project in wet and above normal hydrologic years. In approximately half of the years since the construction of New Don Pedro Dam, the Tuolumne River watershed has produced more water than can be stored, beneficially used by existing customers. This Project is currently in the early conceptual stage. Recognizing that water supply availability could be impacted by climate change or regulatory requirements, the Project will be implemented using adaptive management. The precise reliability of available water would be identified and reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes,	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will

Item in GSP Regulations	Description
and regulatory control (§354.44(b)(3); §354.44(b)(7))	be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County of Stanislaus, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Expected yield of the project will be determined as the project is further developed.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.2.2. TID Lateral 5 1/2 Regulating Reservoir (Project 14)

This Project would construct a new regulating reservoir on Lateral 5 1/2, with 140 AF of operating capacity. Water would be pumped to the reservoir from Harding Drain and would be pumped out to Lateral 5 1/2. The reservoir may be operated to reduce spillage and to supply deliveries and alleviate capacity constraints along Lateral 5 1/2, enhancing delivery service especially to customers along the lower reaches of Lateral 5 1/2. The reservoir may also help to reduce pumping along Lateral 5 1/2 that has historically occurred to compensate for limited surface water supplies stemming from capacity constraints. This Project may also benefit water quality, to the extent that surface water deliveries offset groundwater pumping requirements. The surface water supply for TID originates as snowmelt from the Sierra Nevada Mountains and is of very high quality with lower TDS relative to groundwater.

The reservoir would be designed to minimize excavation and off-haul of dirt over the Project area and would be constructed in close proximity to the City of Turlock's recycled water pipeline. TID would consider adding a connection to route 2,000 AF/yr of recycled water from the City of Turlock (uses same recycled water described in Project 7, described earlier in **Section 8.2.2.2**) into the Lateral 5 1/2 reservoir, providing additional water supplies to customers along Lateral 5 1/2.

As a secondary benefit of the reservoir, and pending the final design, in addition to site specific hydrogeology, the reservoir may also be able to be used to store storm water during the non-irrigation season for direct or in-lieu groundwater recharge purposes. The frequency and magnitude of storm water retention would require further analysis.

A summary of the Project is provided in **Table 8-8**.

Table 8-8: TID Lateral 5 ½ Regulating Reservoir: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would construct a new regulating reservoir on Lateral 5 1/2 with 140 AF of operating capacity. The reservoir would be operated to capture spillage, alleviate capacity constraints on Lateral 5 1/2, improve delivery service to customers, and potentially reduce groundwater pumping requirements along Lateral 5 1/2. The reservoir may also be constructed with a connection to the City of Turlock's recycled water pipeline to provide additional water supplies to customers along Lateral 5 1/2. This Project is proposed for implementation by TID. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. If sustainable levels are not reached following implementation of other PMAs, this project may be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue throughout the irrigation season in all years following construction. The precise benefits will vary between years as the volume of surface water supplies and deliveries varies with water availability, hydrologic conditions, and irrigation demand.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would primarily help to manage and enhance deliveries of surface water diverted from the Tuolumne River. TID has existing water rights on the Tuolumne River. The proposed reservoir may also store recycled water available from the City of Turlock. Municipal water supply and demand are considered to be reliable in all years. This Project is currently in the early conceptual stage. The precise reliability of water would be identified and reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes,	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable

Item in GSP Regulations	Description
and regulatory control (§354.44(b)(3); §354.44(b)(7))	governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County of Stanislaus, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.2.3. Additional TID Regulating Reservoirs (Project 15)

This Project would construct new regulating reservoirs in the TID conveyance system to better manage mismatches in supply and demand, improve customer response time, and decrease existing groundwater pumping downstream of the reservoirs. As a secondary benefit of the reservoirs and pending the final design of each reservoir in addition to site specific hydrogeology, the reservoirs may also be able to be used to store storm water during the non-irrigation season for direct or in-lieu groundwater recharge purposes. The frequency and magnitude of storm water retention would require further analysis.

A summary of the Project is provided in **Table 8-9**.

Table 8-9: Additional TID Regulating Reservoirs: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would construct new regulating reservoirs in the TID conveyance system, primarily to improve system operation and enhance surface water deliveries. The reservoirs would help to better manage mismatches in supply and demand, improve customer response time, and decrease existing groundwater pumping downstream of the reservoirs. Pending further analysis, the reservoirs may also be used to store storm water during the non-irrigation season for direct or in-lieu groundwater recharge purposes. This Project is proposed for implementation by TID. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. If sustainable levels are not reached following implementation of other PMAs, this Project may be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits of improved system operation and enhanced surface water deliveries are expected to accrue throughout the irrigation season in all years following construction. Potential benefits of storm flow capture are also expected to accrue in wet and above normal hydrologic years when storm flows occur. The precise benefits will vary between years as the volume of surface water supplies and deliveries varies with water availability, hydrologic conditions, and irrigation demand.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would primarily help to manage and enhance deliveries of surface water diverted from the Tuolumne River. TID has existing water rights on the Tuolumne River. This Project is currently in the early conceptual stage. The precise reliability of water would be identified and reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes,	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will

Item in GSP Regulations	Description
and regulatory control (§354.44(b)(3); §354.44(b)(7))	be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.2.4. Recharge from TID Conveyance System (Project 16)

This Project would develop new recharge opportunities downstream of Turlock Lake where the recharge potential is found to be high. This Project is envisioned to occur in areas downstream of Turlock Lake, potentially within or outside the existing TID irrigation service area that can be served by existing TID facilities.

As one potential option, water could be diverted into existing open channels in the eastern portion of TID to facilitate direct recharge during the non-irrigation season. Subsequent analysis is necessary as project development continues to identify potential infiltration rates and to identify additional recharge opportunities (recharge basins, aquifer storage and recovery (ASR), dry wells, expansion of on-farm recharge, etc.).

A summary of the Project is provided in **Table 8-10**.

Table 8-10: Recharge from TID Conveyance System: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would develop new recharge opportunities downstream of Turlock Lake in areas that can be served by existing TID facilities, potentially within or outside the existing TID irrigation service area. Recharge opportunities would focus on areas where the recharge potential is found to be high. This Project is proposed for implementation by TID. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. If sustainable levels are not reached following implementation of other PMAs, this project may be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue primarily in wet and above normal hydrologic years when sufficient water is available to facilitate direct recharge, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use water diverted by TID using existing water rights on the Tuolumne River. Surface water is expected to be available for this Project in wet and above normal hydrologic years. In approximately half of the years since the construction of New Don Pedro Dam, the Tuolumne River watershed has produced more water than can be stored or beneficially used by existing customers. Recognizing that water supply availability could be impacted by climate change or regulatory requirements, the Project will be implemented using adaptive management. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified and reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes,	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable

Item in GSP Regulations	Description
and regulatory control (§354.44(b)(3); §354.44(b)(7))	governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.2.5. Intertie Projects (Project 17)

Intertie projects (Project) are proposed to connect various canal segments in the TID conveyance system, particularly from canals with sufficient capacity to other canal segments downstream of capacity constraints that otherwise limit surface water deliveries. Interties would benefit the Subbasin by potentially reducing the need for groundwater pumping along capacity-constrained canals, resulting in in-lieu recharge benefits and improved water quality. Intertie projects may also be coupled with future regulating reservoirs (Project 15), when appropriate, to further improve operational flexibility and expand water conservation and in-lieu recharge opportunities. This Project is currently conceptual in nature and would require further development and analysis to identify specific intertie projects of interest. Additional information on specific Intertie projects would be included in GSP Annual Reports and Five-Year Assessment Reports as information becomes available.

A summary of the Project is provided in **Table 8-11**.

Table 8-11: Intertie Projects: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would identify and construct interties to connect various canal segments in the TID conveyance system, particularly between canals with sufficient capacity and other canal segments downstream of capacity constraints that otherwise limit surface water deliveries. This Project is proposed for implementation by TID. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. If sustainable levels are not reached following implementation of other PMAs, this project may be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits of improved system operation and enhanced surface water deliveries are expected to accrue throughout the irrigation season in all years following construction. The precise benefits will vary between years as the volume of surface water supplies and deliveries varies with water availability, hydrologic conditions, and irrigation demand.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would primarily help to manage and enhance deliveries of surface water diverted from the Tuolumne River. TID has existing water rights on the Tuolumne River. However, this Project will not directly use additional surface water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. Each project may be evaluated as part of a scenario and the C2VSimTM would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.3. ETSGSA – Group 3 Agricultural Water Supply Projects

Other potential Projects that would be implemented in the ETSGSA, as needed, are summarized below.

8.3.3.1. Rouse Lake Pipeline Project (Project 18)

The Rouse Lake Pipeline Project would install a new piped conveyance system that connects through the area of Rouse Lake into other portions of the ETSGSA. The pipe would extend into the Rouse Lake and Mustang Creek watersheds. Water could be taken directly onto irrigated parcels adjoining the Rouse Lake Pipeline to develop in-lieu recharge during the irrigation season as well as to direct recharge water in the off-season to facilities such as drywells and possibly Ag-ASR wells. In addition, water could be conveyed into the watercourse of Mustang Creek with the principal goal of direct recharge using drywells constructed in those watersheds for Mustang Creek Flood Control Recharge Project (Project 10). A subsequent phase of this Project that conveys water to the west would enable in-lieu recharge and direct recharge to adjoining parcels and into the Sand Creek watercourse where drywells or other direct surface water recharge enhancements might be constructed as part of Sand Creek Watershed Runoff Recharge (Project 19).

A summary of the Project is provided in **Table 8-12**.

Table 8-12: Rouse Lake Pipeline Project: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	The Rouse Lake Pipeline Project would install a new piped conveyance system around Rouse Lake, and into the Sand Creek and Mustang Creek watersheds with the goal of conveying flood and/or surface water from Rouse Lake for direct and in-lieu recharge. This Project is proposed for implementation by EWD. The Project would be monitored and quantified with respect to groundwater conditions, as needed. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic years when flood water and/or sufficient surface water is available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use available flood and/or surface water from Rouse Lake. This Project is currently in the conceptual stage. The precise reliability of available water would be identified if/when the project is evaluated and selected for implementation. This information will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. C2VSimTM or another suitable assessment tool would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.3.2. Sand Creek Watershed Runoff Recharge (Project 19)

This Project would capture available storm water runoff from the Sand Creek watershed for direct recharge. Recharge could be done directly in the Sand Creek channel or by other means on land adjacent to the creek. This is a conceptual project, and a feasibility analysis is the next step.

A summary of the Project is provided in **Table 8-13**.

Table 8-13: Sand Creek Watershed Runoff Recharge: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	The Sand Creek Watershed Runoff Recharge project would capture available storm water runoff from the Sand Creek watershed for direct recharge. This Project is proposed for implementation by EWD. The Project will be implemented, and would be monitored, and quantified with respect to groundwater conditions, as needed. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status	This Project is currently in the conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic

Item in GSP Regulations	Description
(§354.44(b)(4))	years when runoff is available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use available runoff from the Sand Creek watershed. This Project is currently in the conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. Those will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. C2VSimTM or another suitable assessment tool would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.3.3. Conveyance Improvements Project (Project 20)

In the Conveyance Improvements Project (Project), Merced ID and other conveyance and delivery infrastructure would be improved and/or constructed to serve areas within the ETSGSA. This Project would increase the capacity and/or construct conveyance facilities for delivering excess flows, particularly during flood flow events, and otherwise within the Merced ID water rights purview. The Project would also support direct and in-lieu recharge in EWD. This Project is currently being analyzed by the responsible agencies and will be further developed over time.

A summary of the Project is provided in **Table 8-14**.

Table 8-14: Conveyance Improvements Project: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	The Conveyance Improvements Project would improve and construct conveyance and delivery infrastructure to serve areas within the ETSGSA. This Project would increase the capacity and/or construct conveyance facilities for delivering excess flows, particularly during flood flow events. The Project would also support direct and in-lieu recharge in ETSGSA. This Project is proposed for implementation by EWD, through potential partnership with Merced ID. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early planning stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic years when excess flows are available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use excess flows, particularly flood flows, in the Merced ID conveyance system. This Project is currently in the early planning stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. Those will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.

Item in GSP Regulations	Description
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early planning stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. C2VSimTM or another suitable analysis tool would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early planning stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.3.4. Development of Diffused Stormwater Project (Project 21)

This Project would support the development of direct recharge, in-lieu recharge, and flood managed aquifer recharge (FloodMAR) activities in locations in the ETSGSA where storm flows are available, or where existing surface water facilities can be utilized to direct and control surface water for various beneficial uses. Components of this Project would be developed privately or as coordinated district efforts. Necessary infrastructure would be installed to connect existing delivery systems to newly developed direct recharge, in-lieu recharge, and FloodMAR activities. This is a conceptual project and has not benefited from a feasibility analysis or any subsequent design.

A summary of the Project is provided in **Table 8-15**.

Table 8-15: Development of Diffused Stormwater Project: Summary (23 CCR §354.44(b)).

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would support the development of direct recharge, in-lieu recharge, and flood managed aquifer recharge (FloodMAR) activities in locations in and surrounding EWD where storm water flows are available, or where existing surface water facilities can be utilized to direct and control surface water for various beneficial uses. This Project is proposed for implementation by ETSGSA, through potential partnerships with other districts. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic years when storm flows or other excess flows are available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project is currently in the early conceptual stage. The precise source and reliability of storm flows or other excess flows would be identified if/when the Project is evaluated and selected for implementation. Those will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. C2VSimTM or another suitable tool would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.3.5. Dry Creek Watershed Recharge (Project 22)

This Project would develop recharge opportunities and capabilities along Dry Creek in areas where there is favorable recharge potential. The Project would capture runoff from the Dry Creek watershed. Recharge could be done directly in the Dry Creek channel or by other means on land adjacent to the creek. This is a conceptual project and has not benefited from a feasibility analysis or any subsequent design.

A summary of the Project is provided in **Table 8-16**.

Table 8-16: Dry Creek Watershed Recharge: Summary (23 CCR §354.44(b)).

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	This Project would develop recharge opportunities and capabilities along Dry Creek in areas where there is favorable recharge potential. This Project is proposed for implementation by EWD. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status (§354.44(b)(4))	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Benefits are expected to accrue in wet and above normal hydrologic years when runoff is available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project would use available runoff from the Dry Creek watershed. This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. Those will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and/or Merced, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP

Item in GSP Regulations	Description
	Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. C2VSimTM or another suitable assessment tool would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.3.3.6. Direct Recharge in Agriculture Areas (Project 23)

The Direct Recharge in Agriculture Areas project (Project) would develop recharge capabilities on land within the ETSGSA in areas where there is good recharge potential, sufficient storage capacity in the aquifer, and to which water can be conveyed from the La Grange area for underground storage. This is a preliminary conceptual project, and a feasibility analysis will need to be developed.

A summary of the Project is provided in **Table 8-17**.

Table 8-17: Direct Recharge in Agriculture Areas: Summary (23 CCR §354.44(b))

Item in GSP Regulations	Description
Implementation Strategy and Criteria (§354.44(b)(1)(A); §354.44(b)(6))	The Direct Recharge in Agriculture Areas project would develop recharge facilities on agricultural land where there is good recharge potential and adequate underground storage capacity. Existing water conveyance facilities may be used such as canals and outlet gates; however, new conveyance and recharge infrastructure is envisioned in the project concepts. This Project is proposed for implementation by ETSGSA. The Project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed. This will be done in the context of SMC to ensure sustainable operation of the Turlock Subbasin.
Timeline and Implementation Status	This Project is currently in the early conceptual stage. Thus, the start and completion dates for this Project have yet to be determined and will be provided in GSP Annual Reports and Five-Year Assessment Reports when

Item in GSP Regulations	Description
(§354.44(b)(4))	known. Benefits are expected to accrue in wet and above normal hydrologic years when runoff is available for use, potentially beginning the first year of project implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or inter-agency noticing will be facilitated through GSA and/or district board meetings, GSA and/or district website(s), GSA and/or district newsletters, inter-basin coordination meetings, GSP Annual Reports and Five-Year Assessment Reports, public scoping meetings, and environmental/regulatory permitting notification processes.
Water source & reliability (§354.44(b)(6))	This Project is currently in the early conceptual stage. The precise reliability of available water would be identified if/when the Project is evaluated and selected for implementation. Those will be reported in GSP Annual Reports and Five-Year Assessment Reports when known.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, County(ies) of Stanislaus and Merced, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage. There may be a benefit to the sustainability indicator for, and depletion of interconnected surface water. This Project is currently in the early conceptual stage. Thus, the expected yield of this Project has yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. Evaluation of benefits will be based on analysis of without-project and with-project effects on the SGMA sustainability indicators. C2VSimTM or another suitable assessment tool would be used to assess the benefits and impacts on the Subbasin sustainability.
Costs (§354.44(b)(8))	This Project is currently in the early conceptual stage. Thus, the anticipated costs of this Project have yet to be determined and will be reported in GSP Annual Reports and Five-Year Assessment Reports when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

8.4. MANAGEMENT ACTIONS

This Section identifies and describes proposed Management Actions that may be undertaken by the Turlock Subbasin GSAs as an element of GSP implementation. Management Actions generally refer to non-structural programs or policies designed to incentivize actions and strategies to support the sustainability of the groundwater Subbasin, including reductions in groundwater pumping and optimization of groundwater use in the Subbasin. This includes required actions as well as incentivization of voluntary actions.

Table 8-18 shows a list of the seven Management Actions organized into three categories:

1. Demand Reduction Strategies (**Section 8.4.1**)
2. Pumping Management Framework (**Section 8.4.2**)
3. Domestic Well Mitigation Program (**Section 8.4.3**)

Demand Reduction Strategies are a broad and strategic set of actions intended to reduce water demand, some of which may be incentivized by State programs or policies, or by Management Actions in the Pumping Management Framework. The Pumping Management Framework provides a suite of administrative procedures, programs, and policies that describe how the GSAs plan to manage and monitor groundwater extractions.

As described in **Section 6.3.1,** the Subbasin has experienced overdraft conditions. Per § 354.44(b)(2), the GSP must describe Projects or Management Actions, including a quantification of demand reduction or other methods, for mitigation of overdraft. Several Projects identified earlier in this Chapter would increase the available water in the Subbasin through increased recharge or use of alternate supplies, but they are not expected to reduce the groundwater deficit sufficiently to achieve the Subbasin's sustainability goal. Additional projects (identified as Group 3 projects) will be implemented to further decrease this deficit, but Management Actions are expected to be necessary to mitigate overdraft and achieve the sustainability goal. A modeling analysis to assess the effectiveness of the current Group 1 and Group 2 projects (**Section 8.5**) and the need for additional demand reduction indicates up to an additional 25% reduction in net groundwater use may be required after these projects are implemented.

It is understood that the projections of future groundwater conditions using the C2VSimTM model are based on the current understanding of the Subbasin, which can be further refined as more information becomes available. The 50-year projection of groundwater conditions using C2VSimTM is based on assumptions that has uncertainties in hydrologic and climatic conditions, agricultural crop mix and patterns, irrigation practices, population growth patterns and urban development trends, land use plans, and environmental regulations. However, the C2VSimTM is currently the best available analysis tool to assist in evaluation of project benefits and impacts, not in an absolute sense, but in a relative scale. The use of C2VSimTM is intended to compare benefits and impacts of a group of projects relative to a "No-Project" or "No-Action" Baseline condition. The results of this analysis are then compared to MTs to estimate the approximate amount of additional net demand reduction that will be needed to meet the sustainability goal of the Subbasin. This gap in net demand reduction can be met through the implementation of additional projects or through management actions to promote water conservation or require pumping reduction.

The C2VSimTM model is therefore used for assessment of the scenarios which include Group 1 and 2 projects, as well as the remaining gap which is currently assumed to be met by demand reduction after implementation of these projects. Group 3 projects and voluntary demand reduction management actions are not assessed using the model due to significant uncertainties in the scale and definition of these projects and actions. The extent and effectiveness of the Group 3 projects that will be implemented in the future, and of the water conservation management actions described in **Section 8.4.1** is not yet known. Modeling analyses were performed with a number of scenarios to assess options to evaluate the potential need for demand reduction within the Subbasin. Given the modelled projections of the benefits of project Groups 1 and 2, a 25% net demand reduction gap in the ETSGSA is estimated on a preliminary basis and used for planning purposes to meet the sustainability goals of the Subbasin and address the key sustainability indicators. As discussed previously, this modeling analysis is subject to inherent uncertainties and may be refined as more reliable information and data become available. In addition, it is anticipated that when Group 3 projects and demand reduction Management Actions are developed at a level to be evaluated and implemented, the scale of the net demand reduction that remains to be met will be reduced. The GSAs therefore intend to implement demand reduction using the adaptive management approach as discussed in **Section 8.4.2**.

This section describes potential Management Actions that could be implemented in the Subbasin. While the tools described in this section will be available for implementation at the Subbasin level, implementation will be determined based upon need within each GSA separately, and in a coordinated manner to ensure that the Subbasin sustainability goals are achieved within the scheduled timeframe. PMAs implemented in one GSA represent that GSA's contributions to Subbasin sustainability and, as such, it is anticipated that each GSA will implement PMAs in proportion to its need to address overdraft and comply with SMC within its jurisdiction.

A range of Management Actions is presented to allow the GSAs flexibility in their response to changing groundwater conditions and as data gaps and uncertainties are addressed during GSP implementation. However, it is anticipated that not all Management Actions will need to be implemented, or that individual Management Actions may be implemented by one GSA but not by the other. In addition, implementation of Management Actions will be based on adaptive management strategies informed by ongoing monitoring of groundwater conditions using the monitoring network and methods described in the GSP. A key component of this strategy is a Management Action for pumping reduction, which will be implemented by each GSA as necessary to mitigate overdraft or other issues effecting the ability to meet sustainability goals. Monitoring data will be used to assess the need for PMAs in the Subbasin as a whole, in the individual GSAs, and at particular locations. This will occur incrementally as monitoring data become available, the effectiveness of prior PMAs is established, and knowledge of the Subbasin improves over time. The advent or threat of undesirable results and the performance or failure of the Subbasin to meet IMs or MOs will serve as triggers for scaling and implementing both PMAs in a targeted and proportional manner, consistent with conditions observed in the Subbasin. At this time, it is anticipated that the Demand Reduction Strategies Management Actions will need to be implemented in the ETSGSA; however, future changes in supplies or conditions may necessitate additional projects or programs in the WTSGSA to ensure sustainability goals are met. Thus, tools need to be available basin wide, with the ability to implement them adaptively as needed. Current plans for implementation of Management Actions within each GSA are described in this Section and will be updated within Annual Reports and Five-Year Assessment Reports of the GSP.

Table 8-18 lists the Management Actions described in the subsections that follow. Each Management Action description is organized to address the applicable regulatory requirements:

- **Management Action Description:** 23 CCR §354.44(b)
- **Public Notice:** 23 CCR §354.44(b)(1)(B)

  Permitting and Regulatory Process: 23 CCR §354.44(b)(3)

- **Expected Benefits:** 23 CCR §354.44(b)(4), §354.44(b)(5)
- **Implementation Criteria, Status, and Plan:** 23 CCR §354.44(b)(1)(A); §354.44(b)(4); §354.44(b)(6)

  How the Management Action will be Accomplished: 23 CCR §354.44(b)(6)

- **Legal Authority:** 23 CCR §354.44(b)(7)
- Estimated Costs and Funding Plan: 23 CCR §354.44(b)(8)
- Management of Groundwater Extractions and Recharge: 23 CCR §354.44(b)(9)

Summary of Criteria for Project Implementation (23 CCR §354.44(b)(1)(A))

Most of the Management Actions described in this section are presented as frameworks and will be fully developed into implementation plans during the first years of GSP implementation as indicated in the subsequent sections. These potential Management Actions will be implemented by each GSA as needed to achieve and maintain long-term sustainable groundwater management within their respective jurisdictions and subsequently across the Turlock Subbasin. They would be evaluated and selected for implementation if, based on data gathered during GSP implementation, the GSAs find that established IMs and MOs cannot be maintained and/or if MTs are being approached. This adaptive approach will be informed by continued monitoring of groundwater conditions, using the monitoring network and methods described in the GSP.

Table 8-18: List of Management Actions

Category	Number	Proponent[2]	Management Action	Primary Mechanism(s)[1]
Demand Reduction Strategies	1	WTSGSA and/or ETSGSA	Voluntary Conservation and/or Land Fallowing	Conservation/ Land Fallowing
	2	WTSGSA and/or ETSGSA	Conservation Practices	Conservation
Pumping Management Framework	3	WTSGSA and/or ETSGSA	Groundwater Extraction Reporting Program	Pumping Reduction
	4	WTSGSA and/or ETSGSA	Groundwater Allocation and Pumping Management Program	Pumping Reduction
	5	WTSGSA and/or ETSGSA	Groundwater Extraction Fee	Pumping Reduction
	6	WTSGSA and/or ETSGSA	Groundwater Pumping Credit Market and Trading Program	Pumping Reduction
Domestic Well Mitigation	7	WTSGSA and/or ETSGSA	Domestic Well Mitigation Program	(multiple)

[1]The primary mechanism of the Management Action as conceptualized. Management Actions may support groundwater sustainability through multiple mechanisms during implementation.

[2] It is anticipated that Management Actions will be implemented by each GSA as needed to mitigate overdraft within their jurisdictional areas and assure that the SMC adopted in **Chapter 6** are met.

8.4.1. Demand Reduction Strategies

Several demand reduction strategies will be developed to decrease agricultural and urban water demands in the Subbasin. These strategies would be implemented as needed in conjunction with projects to decrease the Subbasin's projected groundwater storage deficit. They could be implemented in the form of voluntary conservation and/or land fallowing (see **Section 8.4.1.1**) or other urban and agricultural conservation practices (see **Section 8.4.1.2**). While conservation practices are well established and expected to be implemented consistent with state law throughout the Subbasin, the Voluntary Conservation and/or Land Fallowing program is in preliminary stages of development. Since current modeling suggests demand management within the ETSGSA will be needed to achieve sustainability goals, it is anticipated that ETSGSA will implement Management Action 1. WTSGSA may decide to pursue this Management Action in the future if needed to address conditions within its jurisdiction.

8.4.1.1. Voluntary Conservation and/or Land Fallowing (Management Action 1)

8.4.1.1.1. Management Action Description

Voluntary Conservation and/or Land Fallowing covers several strategies that can be designed to achieve both temporary and permanent water demand reduction. Should one or both of the Turlock Subbasin GSAs decide that pursuing such strategies is necessary to achieve the Subbasin sustainability goals within their jurisdiction, this Management Action would assess options and develop a program to enact voluntary conservation and/or fallowing strategies in close coordination and collaboration with the landowners within their jurisdiction. Examples of this strategy could include repurposing of lands growing lower value crops to be dry farmed, fallowed in rotation, or used for recreation, habitat restoration, groundwater recharge, solar power generation, or other uses.

Public programs to assist landowners to participate in such programs are available. Assembly Bill (AB) 252 is a good example that can provide support for such program implementation. AB 252 establishes the Multi-benefit Land Repurposing Program to assist GSAs in critically overdrafted basins in achieving their groundwater sustainability goal by providing grants to public and private agencies and entities for projects and programs that reduce groundwater use. Projects and programs supported by AB 252 may create incentives to repurpose, or convert, irrigated agricultural land to new uses that both reduce groundwater demand and provide some other measurable benefits to the environment or broader community. Although the Turlock Subbasin is not critically overdrafted, the Turlock Subbasin may be eligible to benefit from future similar programs.

Temporary or permanent land fallowing could also be combined with recharge projects through the application of surplus surface water supplies to the fallowed lands.

8.4.1.1.2. Public Notice

A successful Voluntary Conservation and/or Land Fallowing program will require a comprehensive and strategic outreach effort, including multiple public workshops and meetings, potential website and/or email announcements, along with other public notices for the workshops. The outreach will be targeted to both potential participants of the program (landowners) as well as other stakeholders who may be impacted by changes to land and water use.

8.4.1.1.3. Permitting and Regulatory Process

Preparation of a CEQA evaluation for a fallowing program will identify potential environmental impacts and identify feasible alternatives or feasible mitigation measures. Establishment of a voluntary land fallowing program is expressly authorized under SGMA (CWC, §10726.2(c)). The fallowing program, including program standards, will be developed and undergo CEQA review as necessary.

8.4.1.1.4. Expected Benefits

Benefits to Sustainability Indicators

Sustainability indicators that could benefit from Voluntary Conservation and/or Land Fallowing include:

- Chronic lowering of groundwater levels – By reducing groundwater demand, this Management Action would reduce pumping and pumping-related contributions to chronic lowering of groundwater levels.
- Reduction of groundwater storage – Reduced pumping throughout the Subbasin contributes to a smaller rate of reduction in groundwater storage.
- Degraded water quality – Fallowing of crop lands can reduce agricultural water use and associated nutrient loading, thereby improving groundwater quality.
- Land subsidence – Depending on the location of land fallowing or conservation, reduced pumping stress on local aquifer(s) will reduce the potential for subsidence.
- Depletion of interconnected surface water – Voluntary conservation and/or land fallowing in areas reliant upon groundwater can reduce groundwater pumping. In areas where groundwater demand may be depleting interconnected surface water, such an action can reduce impacts to interconnected surface water.

Benefits to Disadvantaged Communities

Benefits to disadvantaged communities overlap with the benefits described above for sustainability indicators. Land repurposing can also provide other ancillary benefits to local communities, such as recreation.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system would depend on the extent to which a Voluntary Conservation and/or Land Fallowing program is adopted and would be further studied when the program is implemented by the GSAs.

8.4.1.1.5. Implementation Criteria, Status, and Plan

Temporary fallowing is a quick way to reduce demand with no capital costs or infrastructure needed. Because it can be relatively inexpensive, it can be implemented earlier and quicker while other long-term solutions like land repurposing are investigated. The Turlock Subbasin GSAs may explore options for encouraging voluntary and temporary fallowing during GSP implementation as necessary while developing a more structured program and exploring funding opportunities.

The Voluntary Conservation and/or Land Fallowing program is in preliminary stages of development. Should either of the Turlock Subbasin GSAs decide to pursue a program in the future, the program would be further developed and implemented as necessary in a targeted and proportional manner consistent with conditions observed in the Subbasin and within their respective jurisdictional boundaries. It is anticipated that, if implemented, a program would be developed by ETSGSA within the first five years of GSP implementation. An actual implementation timeline has yet to be determined but would be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Any future changes in implementation would be communicated with the public and other agencies and would be documented in GSP Annual Reports and Five-Year Assessment Reports.

8.4.1.1.6. How the Management Action will be Accomplished

This Management Action does not rely on the availability of water supplies because it is a planning effort that will result in conservation. It will be implemented through landowner and stakeholder outreach and voluntary participation and supported through organized implementation and incentives. It will support overall supply reliability by reducing overdraft in the Subbasin and moving the Subbasin towards sustainability.

8.4.1.1.7. Legal Authority

It is the established policy of the State of California "to facilitate the voluntary transfer of water and water rights where consistent with the public welfare" (CWC, §109(a)). "The Legislature hereby finds and declares that voluntary water transfers between water users can result in a more efficient use of water, benefitting both the buyer and the seller" (CWC, §475).

In addition, each of the members of the GSA has independent legal authority to implement water transfer programs in their respective jurisdictions under existing law. Under SGMA, the GSA has authority to "authorize temporary and permanent transfers of groundwater extraction allocations within the [GSA's] boundaries, if the total quantity of groundwater extracted in any water year is consistent with the provisions of the [GSP]" CWC, §10726.4(a)(3). The GSA also has authority to "provide for a program of voluntary fallowing of agricultural lands or validate an existing program" (CWC, §10726.2(c)).

This Management Action carries forward the policy of the state and satisfies SGMA requirements by establishing a voluntary program that encourages water within the Subbasin to be transferred to beneficial uses of water in a manner designed to achieve the sustainability goals and to protect against undesirable results.

8.4.1.1.8. Estimated Costs and Funding Plan

The Voluntary Conservation and/or Land Fallowing program is in preliminary stages of development. Therefore, no costs have been estimated for its development and implementation. Such costs would be developed should the Turlock Subbasin GSAs decide to pursue a program in the future. Separately, multiple potential funding programs and mechanisms exist as a potential source of revenue for individual landowners looking at options for voluntary land repurposing, including (EDF, 2021):

- Mitigation or Conservation Banks
- Conservation Easements
- Solar Rental Agreements
- Grazing Leases
- Converting to Low Water Intensity Crops
- Federal and State Grant Funding Programs

8.4.1.1.9. Management of Groundwater Extractions and Recharge

This Management Action encourages the conservation of water and does not directly involve management of groundwater extraction or recharge. The measure will be applicable during both drought and non-drought conditions.

8.4.1.2. Conservation Practices (Management Action 2)

8.4.1.2.1. Management Action Description

This Management Action would create a program to support the use of conservation practices in both urban and agricultural sectors. This program would be implemented within each GSA as necessary to address overdraft within its jurisdiction or to ensure the sustainability goals are met.

Urban water suppliers are already obligated to consider demand reduction and conservation efforts during dry periods. These demand management actions are described in their respective Urban Water Management Plans (UWMPs). These include:

- City of Modesto Urban Water Management Plan

  https://www.modestogov.com/860/Urban-Water-Management-Plan

- City of Turlock Urban Water Management Plan

  https://www.cityofturlock.org/watersewergarbageservice/waterconservation/urbanwatermanagementplan.asp

- City of Ceres Urban Water Management Plan

  https://www.ci.ceres.ca.us/169/City-of-Ceres-Water-System-Historical-In

In addition, SB 606 and AB 1668, both signed into law in May 2018, are laws that introduce conservation mandates that cap indoor residential use and set a target for efficient outdoor landscape irrigation based on local climate and size of landscaped areas. Urban water suppliers will be required to report on progress to meeting urban water use objectives beginning in 2023 and comply with them beginning in 2028.

Agricultural water suppliers serving more than 25,000 irrigated acres must adopt an Agricultural Water Management Plan (AWMP) that includes reports on the implementation status of specific Efficient Water Management Practices required by the Water Conservation Act of 2009 (SB X7-7). Agencies that have developed AWMPs include:

- Turlock Irrigation District Agricultural Water Management Plan

  https://www.tid.org/irrigation/irrigation-information/ag-water-management-plan/

- Merced Irrigation District Agricultural Water Management Plan

  http://mercedid.org/index.cfm/water/ag-water-management-plan-awmp/

Under this Management Action, the Turlock Subbasin GSAs may choose to evaluate the existing UWMPs and AWMPs within their jurisdiction in the Subbasin and either expand upon minimum requirements to increase the impact of such programs or implement similar conservation practice programs in other areas of the Subbasin that may not be covered under an UWMP or AWMP.

Notably, conservation practices must be considered in the greater context of the Subbasin water budget, especially at the nexus between on-farm water use and groundwater sustainability. In areas where groundwater is the primary or sole water supply, conservation practices that reduce water demand also directly reduce groundwater consumption, but conservation practices in other areas have a more complex relationship with water conservation and sustainable groundwater management. Applying less water to an area and reducing the gap between irrigation and consumptive use also reduces deep percolation and seepage to the groundwater system in that area. The benefits and drawbacks of conservation will be evaluated as the program evolves. In areas with access to surface water where landowners have implemented more advanced irrigation practices (i.e., drip/micro irrigation) utilizing groundwater for convenience or to increase yields, programs may be developed to further conjunctive use programs by encouraging landowners to utilize surface water when available to reduce groundwater demand and increase recharge, while utilizing drip/micro in dry years when surface water supplies are limited. Other consequences may stem from behavioral responses and changes in irrigation resulting from these technologies and policies. If less water can be used to produce the same amount of a crop product, growers may be inclined to use the same amount of water and produce more (Lankford, et al., 2020). Additional considerations on the promises, pitfalls, and paradoxes of irrigation efficiency in water management planning are described by Lankford et al. (2020).

Further details on any expansion of the Conservation Practices program are preliminary as of the time of publishing and would need to be developed and refined further during GSP implementation.

8.4.1.2.2. Public Notice

The Turlock Subbasin GSAs anticipate that public outreach and education on the potential structure of the Conservation Practices program, as well as feasible monitoring and enforcement mechanisms, would be necessary to enable a successful program. Outreach may include public notices, meetings, potential website presence and email announcements. Initial program implementation will focus on voluntary compliance while the GSAs consider the necessary elements to begin enforcing the program by 2027 (five years after adopting and submitting the GSP).

8.4.1.2.3. Permitting and Regulatory Process

Development of a Conservation Practices program is not a project as defined by the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) and would therefore not trigger either.

8.4.1.2.4. Expected Benefits

Benefits to Sustainability Indicators

Sustainability indicators benefitting from Conservation Practices include:

- Chronic lowering of groundwater levels – By reducing groundwater demand, this Management Action would reduce pumping and pumping-related contributions to chronic lowering of groundwater levels.
- Reduction of groundwater storage – Reduced pumping throughout the Subbasin contributes to a smaller rate of reduction in groundwater storage.

- Degraded water quality – This Management Action does not address this sustainability indicator.
- Land subsidence – Depending on the location of Conservation Practices, reduced pumping stress on local aquifer(s) will reduce the potential for subsidence.
- Depletion of interconnected surface water – Conservation in areas reliant upon groundwater would reduce groundwater pumping. To the extent that the groundwater pumping may be impacting interconnected surface water, conservation practices may reduce that impact.

Benefits to Disadvantaged Communities

Benefits to disadvantaged communities overlap with the benefits described above for sustainability indicators. Depending on how they're structured, urban conservation programs may also provide a financial benefit to individual users who reduce their water consumption, either via a lower water bill or reduced demand on a domestic well.

Volumetric Benefits to Subbasin Groundwater System

The volumetric benefit to the groundwater system will depend on the extent to which a Conservation Practices program is implemented and will be further studied when the program is developed by the GSAs.

8.4.1.2.5. Implementation Criteria, Status, and Plan

The Conservation Practices Management Action is expected to commence shortly after the adoption of the GSP and a formal program is expected to be developed and implemented during the first five years of GSP implementation and to continue in an ongoing fashion throughout the implementation of the GSP. The implementation timeline has yet to be determined but would be provided in GSP Annual Reports and Five-Year Assessment Reports when known. Any future changes in implementation would be communicated with the public and other agencies and would be documented in GSP Annual Reports and Five-Year Assessment Reports.

8.4.1.2.6. How the Management Action will be Accomplished

This Management Action does not rely on water supplies because it is a planning effort that will result in conservation benefits. It will be implemented through irrigation district, landowner and stakeholder outreach and voluntary planning and participation initially. A formal program is expected to be developed and implemented within the first five years of GSP implementation. It will support overall supply reliability by reducing groundwater demand in the Subbasin and moving the Subbasin towards sustainability.

8.4.1.2.7. Legal Authority

The Turlock Subbasin GSAs have the authority to develop a Conservation Practices program and may perform implementation and enforcement of practices, if deemed to be warranted, via implementation of fees for noncompliance or through metering or other methods to quantify groundwater use. If deemed necessary, mechanisms for enforcement would be outlined in the Conservation Practices program once developed and are expected to be enforced by the Turlock Subbasin GSAs and/or member agencies.

8.4.1.2.8. Estimated Costs and Funding Plan

Costs for UWMP and AWMP report preparation and submittals are ongoing for urban and agricultural water suppliers, respectively. Any future costs related to additional programming or program enforcement are not yet developed. Such costs will be dependent on the scope of the program and will be reported in future GSP updates or Annual Reports.

8.4.1.2.9. Management of Groundwater Extractions and Recharge

This Management Action encourages the conservation of water; which may result in decreased groundwater extraction. This will be applicable during both wet and dry conditions.

8.4.2. Pumping Management Framework

The Pumping Management Framework consists of four Management Actions that will be implemented in an adaptive manner as determined by the Turlock Subbasin GSAs to meet the Subbasin's sustainability goal. Not all Management Actions may be needed or may not be implemented by each GSA depending on their assessment of conditions and strategy effectiveness within their jurisdictional boundaries in the Subbasin. The Pumping Management Framework includes the following Management Actions:

1. Groundwater Extraction Reporting Program (Management Action 3) – see **Section 8.4.2.1**
    - To facilitate implementation of pumping management, a reporting program is needed first. Based on experience in other San Joaquin Valley subbasins, a voluntary program is likely to achieve significant response. Therefore, the reporting will be initially implemented on a voluntary basis and then a decision will be made how best to expand the program either through mandatory reporting or by supplementation using consumptive use data derived from analysis of remote sensing data.
2. Groundwater Allocation and Pumping Management Program (Management Action 4) – see **Section 8.4.2.2**
    - Either GSA may implement pumping management within their jurisdictions. Different categories of pumping management will be defined and allocated to pumpers, including the following:
        - Sustainable Pumping (pumping within a parcel's assigned share of the designated sustainable yield)
        - Unsustainable Pumping (pumping in excess of a parcel's share of the designated sustainable yield, to be phased out over time to achieve the sustainability goal of the Subbasin)
        - Carry-Over Pumping (pumping in excess of the sustainable yield that is carried over from pumping below the sustainable yield in prior years or offset by pumping below the sustainable yield in subsequent years).
    - Pumping reduction would be implemented in phases to provide the aquifer response necessary to address the net groundwater deficit remaining after implementation of feasible projects and water conservation measures. Pumping reduction would be

increased incrementally in response to monitoring data to meet the IMs and MOs established in **Chapter 6**.

3. Groundwater Extraction Fee Program (Management Action 5) – see **Section 8.4.2.3**

    - Either GSA may decide to implement a tiered groundwater extraction fee program for Unsustainable Pumping and/or Carry-Over Pumping that is not offset. Fees assessed under this program could be used to fund projects or the procurement of replenishment water.

4. Groundwater Pumping Credit Market and Trading Program (Management Action 6) – see **Section 8.4.2.4**

    - Either GSA may decide to implement a program that allows trading or sale of unused Sustainable Pumping or Carry-Over Pumping credits in order to allow operational flexibility and apply market forces and opportunities as Unsustainable Pumping allocations are scaled back.

The figures below illustrate how the Pumping Management Framework would function.

Figure 8-6 illustrates conceptually how average Sustainable Pumping and Unsustainable Pumping will be managed over time to achieve groundwater management within the sustainable yield over time. The values shown present percent estimates of sustainable yield that are not certain or absolute because of limitations and uncertainties in the 50-year projection, including the hydrologic and climatologic conditions, land and water use conditions, water supplies, population growth and development trends, as well as uncertainties in the C2VSimTM model. These uncertainties can be decreased as more data and information become available through monitoring and addressing data gaps. Although the projected project benefits, project impacts, and demand reduction are consistent with the best available estimates at this time, they are presented as conceptual values for the purposes of this graph. It should also be noted that the actual values will vary from year to year based on hydrologic and climatic conditions, varying surface water availability, and varying crop water demands and irrigation decisions. The long-term averages are shown for illustrative purposes. **Figure 8-6** shows the following implementation phases for the Groundwater Allocation and Pumping Management Program (Management Action 4):

- Phase 1 (GSP Implementation Years 1 to 5) - During the first Phase of the Pumping Management Program, information will be gathered to better assess Subbasin trends, water budget information, and the Subbasin response to hydrologic and climatic conditions and projects. In addition, projects will begin to be implemented and will offset a portion of the Unsustainable Pumping. The amount of the offset is dependent on the yield of the individual projects and their effectiveness to mitigate overdraft in different portions of the Subbasin. This information would be assessed to develop a Pumping Management Plan based on an adaptive management approach to phase in pumping reductions sequentially as needed to address overdraft and achieve sustainability goals. In **Figure 1-4**, only the Group 1 and Group 2 projects discussed earlier in this section are assumed to be implemented. The GSAs may choose to begin implementation of pumping reduction during the latter part of this period.

- Phase 2 (GSP Implementation Years 6 to 10) - During this period, pumping reductions would begin to be phased in or would be escalated based on comparison of monitoring data to the IMs established in **Chapter 6**. The Subbasin response to project, climatic, and pumping conditions would continue to be monitored and adjustments would be made to the pumping reduction strategy as needed.

- Phase 3 (GSP Implementation Years 11 to 15) - At this point, the projects are assumed to be fully phased in, and the Demand Management Plan would be updated to include the final pumping reductions needed to maintain pumping within the sustainable yield of the Subbasin by the end of the period. The Subbasin response to project, climatic, and pumping conditions would continue to be monitored and adjustments would be made to the pumping reduction strategy as needed.

- Phase 4 (GSP Implementation Years 16 to 20) - The Subbasin would be operated within its long-term average sustainable yield. The groundwater level response to project, climatic, and pumping conditions would continue to be monitored and adjustments would be made to the pumping reduction strategy as needed.

Figure 8-7 shows the same general phases as **Figure 8-6**; however, it includes the conceptual effects of implementing Group 3 projects and the Demand Reduction Strategies Management Actions discussed in **Section 8.4.1** (Management Actions 1 and 2). As illustrated in **Figure 8-7**, the implementation of these additional recharge and water conservation measures could have a substantial impact in terms of reducing the amount of pumping reduction needed to achieve sustainable management. As the increased effectiveness of the additional collective PMAs is realized and confirmed by monitoring, adaptive management would decrease pumping reduction in response to the effectiveness of these measures. The actual yield and effect of the projects and Demand Reduction Strategies Management Actions are not known at this time; however, it is expected to be measurable and significant as illustrated in the conceptual graph and would be confirmed by monitoring.

Figure 8-8 shows the conceptual application of Carry-Over Pumping, pumping credit markets and trading, and fees for Unsustainable Pumping. These are described below:

- **Carry-Over Pumping** – **Figures 8-6** and **8-7** show long-term average pumping rates, but SGMA recognizes that sustainable pumping is the result of average demands over a period of years, including both wet and dry periods. In addition, due to climatic variability and other factors, the amount of irrigation demand of an agricultural operation will vary from year to year. Carry-Over Pumping is intended to allow groundwater pumpers operational flexibility to respond to these changes and would allow pumping in excess of the designated sustainable yield as long as it is offset by pumping less groundwater in prior or subsequent years. This concept is in the early development stages and would begin with the adoption of Carry-Over Pumping rules adapted to best serve the management of the Subbasin. For example, Carry-Over Pumping could be balanced over a period of two year or three years, or Carry-Over Pumping in excess of sustainable yield could be allowed for a percentage of the offset pumping.

- **Recharge Credits** - A program could be implemented to provide pumping credits to property owners that implement recharge projects on their land. These credits could be utilized on the property or sold or traded on the water markets discussed below.

- **Unsustainable Pumping Fees** - A fee structure could be applied to pumping over the sustainable yield or carry-over pumping that is not offset. Charging fees for Unsustainable Pumping would provide an incentive to pump less groundwater and the funds obtained could be used to fund additional projects or procure replenishment water for recharge.

- **Markets and Trading** - Markets and platforms could be established for trading, exchange, or sale of pumping allocations and credits to provide additional incentives for pumpers to decrease their groundwater demand, while providing operational flexibility to obtain additional pumping allocations when needed. Market forces would have a mediating effect on the reduction of Unsustainable Pumping over time.

The process of providing annual reports to DWR and five-year GSP updates will allow GSAs to update the Pumping Management Framework and adjust the implementation course as needed based on changing conditions.

Figure 8-6: Implementation of Pumping Reduction Framework: Adaptive Management with Implementation of Group 1 and 2 Projects