5.4.5 Water Budget Definitions and Assumptions

The spreadsheet model simulates the major hydrologic processes that affect the flow of surface water and groundwater within the Northern and Central Delta-Mendota Regions. The primary components of the land surface budget and groundwater budget are presented in **Table 5-12** and **Table 5-13**, respectively.

Table 5-12. Land Surface Budget Category Definitions

Water Budget Flow Category	Definition
Inflow	*Includes volumes that are applied to the land surface within the defined budget area.*
Precipitation	Total atmospheric precipitation that occurs onto the defined budget area.
Pumping	Total volume of water applied to the defined budget area from production wells within the defined budget area.
Tile Drainage	Total volume of water applied to the defined budget area from tile drains within the defined budget area.
Surface Water Deliveries	Total volume of water delivered to the defined budget area from diversions off the San Joaquin River, Delta-Mendota Canal, California Aqueduct, and other local surface water sources.
Outflow	*Includes volumes that flow out of the land surface within the defined budget area. This includes flows to the aquifer and to other land surface budget areas.*
Deep Percolation	Total volume of water that seeps past the root zone and into the groundwater aquifer. This includes applied water seepage, as well as stream seepage (from the San Joaquin River, Delta-Mendota Canal, and California Aqueduct) and delivery losses.
Runoff	Total volume of water that leaves the defined budget area through surface runoff. This does not include river flows but is a portion of applied water and precipitation.
Evapotranspiration	Total volume of water that returns to the atmosphere through either evaporation or through transpiration.

Note: Surface water flows are not directly tabulated in the water budgets, but river seepage is accounted for in the Deep Percolation category. This limitation is discussed in **Appendix D** *Water Budgets Model Development Technical Memorandum*.

Table 5-13. Groundwater Budget Category Definitions

Water Budget Flow Category	Definition
Inflow	*Includes volumes that flow into the groundwater aquifer within the defined budget area. This includes volumes coming from the surface water budget and from adjacent budget areas.*
Deep Percolation	Total volume of water that seeps past the root zone and into the groundwater aquifer. This includes applied water seepage, as well as stream seepage (from the San Joaquin River, Delta-Mendota Canal, and California Aqueduct) and delivery losses.
Upper Aquifer Underflows	Groundwater inflows into the defined budget area in the Upper Aquifer from adjacent water budgets.
Lower Aquifer Underflows	Groundwater inflows into the defined budget area in the Lower Aquifer from adjacent water budgets.
Outflow	*Includes volumes that flow out of the groundwater aquifer within the defined budget area. This includes volumes pumped to the surface and flows to adjacent budget areas.*
Pumping	Total volume of water extracted from the defined budget area from production wells within the defined budget area.
Tile Drainage	Total volume of water removed from the defined budget area from tile drains within the defined budget area.
Upper Aquifer Underflows	Groundwater flows out of the defined budget area in the Upper Aquifer into adjacent water budgets.
Lower Aquifer Underflows	Groundwater flows out of the defined budget area in the Lower Aquifer into adjacent water budgets.
Change in Storage	*Includes volumetric differences of storage in the aquifer as compared to the previous water year. In an ideal case, volumes should sum to be equal to inflows minus outflows.*
Upper Aquifer Change in Storage	Change in storage in the Upper Aquifer compared to prior the water year. This is not a total storage amount.
Lower Aquifer Change in Storage	Change in storage in the Lower Aquifer compared to prior the water year. This is not a total storage amount.

Note: Surface water flows are not directly tabulated in the budgets, but river seepage is accounted for in the Deep Percolation category. This limitation is discussed in **Appendix D** *Water Budgets Model Development Technical Memorandum*.

Historic and Current Water Budget Assumptions

The historic and current water budgets are presented side-by-side and operate under the same assumptions and with the same data sources. Assumptions and sources for each of the budget flow categories are listed in **Table 5-14** and **Table 5-15**.

Table 5-14. Historic and Current Land Surface Budget Assumptions

Water Budget Flow Category	Data Source	Data Assumptions
Precipitation	Various CIMIS stations	CIMIS data was applied across the Plan area so that the nearest or most representative station's data were applied to each GSA member agency. The monthly precipitation data were then used to calculate yearly precipitation volumes.
Pumping	GSA member agencies historic agricultural pumping, and urban pumping historic data	Agricultural pumping was combined with urban pumping volumes.
Tile Drainage	GSA member agencies tile drainage historic data	All reported tile drainage was reapplied and treated as another applied water source.
Surface Water Deliveries	GSA member agencies surface water delivery and diversion historic data	All reported surface water delivery data counted as a source for applied water. The differences between diversions and deliveries (where available) were used to quality check calculated Deep Percolation rates.
Deep Percolation	Calculated from other applied water volumes	CVHM2 trends were aggregated and trends in applied water and precipitation proportions becoming deep percolation were used for the Historic & Current Period. Since Deep Percolation in CVHM2 accounts for Delta-Mendota Canal, California Aqueduct, and San Joaquin River seepage, these rates implicitly account for stream seepage volumes.
Runoff	Calculated from other applied water volumes	CVHM2 trends were aggregated based on Water Year Types during the Historic & Current period. Trends in applied water and precipitation proportions becoming runoff were used.
Evapotranspiration	Various CIMIS Stations ET_0 data, Cal Poly ITRC Crop Coefficient data, GSA member agencies historic land use data	CIMIS data was applied across the Plan area so that the nearest or most representative station's data were applied to each GSA member agency. The monthly ET_0 data were then used with observed seasonal land use trends, and crop coefficients (for each crop type from the Cal Poly Crop Coefficients) to calculate evapotranspiration volumes.

Table 5-15. Historic and Current Groundwater Budget Assumptions

Water Budget Flow Category	Data Source	Data Assumptions
Deep Percolation	See **Table 5-14**	See **Table 5-14**
Upper Aquifer Underflows	GSA member agencies observation well data, CASGEM observation well data, Westside Subbasin's Groundwater Model results, SJREC transmissivity data	Hydrographs were created and considered with transmissivity data to calculate intra-subbasin underflows. The Westside Subbasin's Groundwater Model results were used on the southern Subbasin boundary with the Westside Subbasin to determine underflows. Hydrographs were also developed to evaluate underflows to Tracy, Modesto, Turlock, and Kings Subbasins.
Lower Aquifer Underflows	Calculated from Upper Aquifer Underflows	Lower Aquifer Underflows were assumed to be a portion of Upper Aquifer Underflows. The proportion utilized was the same as the proportion of pumping volumes from the Upper Aquifer versus the Lower Aquifer.
Pumping	See **Table 5-14**	See **Table 5-14**
Upper Aquifer Change in Storage	GSA member agencies observation well data, CASGEM observation well data, CVHM2 storativity data	Hydrographs were grouped spatially into designated zones in the Plan area for the calculation of change in storage on a sub-regional basis. Change in water surface elevations between water years were determined for each sub-regional zone. These data and local storativity values were combined to determine the change in storage for each sub-regional zone for each water year.
Lower Aquifer Change in Storage	Calculated from Upper Aquifer Change in Storage	Lower Aquifer Change in Storage was assumed to be a portion of Upper Aquifer Change in Storage. The proportion was based on professional judgment and local knowledge.

Projected Water Budget Data Sources

The results of the three projected water budgets are presented separately, but they operate under the same assumptions and with the same data sources. Assumptions and sources for the flow categories in the baseline projected water budget are listed in **Table 5-16** and **Table 5-17**. Differences in assumptions and sources between the three projected budgets are described in **Table 5-18**. To estimate future flows, historic data were applied according to the representative years selected for the projected budget timeline. Those years are specified in **Table 5-10**, and the assignment of the representative water years is discussed in **Section 5.4.3**.

Table 5-16. Projected Land Surface Budget Assumptions

Water Budget Flow Category	Data Source	Data Assumptions
Precipitation	Various CIMIS stations	CIMIS data were applied across the Plan area so that the nearest or most representative station's data were applied to each GSA area. The monthly precipitation data were then used to calculate yearly precipitation volumes.
Pumping	Calculated	For irrigated lands, precipitation and surface water (where available) were assumed to be used to meet crop demands with groundwater used to meet any remaining crop demand. Pumping was therefore calculated to meet the remaining agricultural demand after applied water, precipitation, and water losses were accounted for. Additional runoff and deep percolation were then accounted for after groundwater was 'applied'. Agricultural demands were calculated seasonally, by crop type, and by GSA member agencies operational patterns.
Tile Drainage	GSA member agencies tile drainage historic data	All reported tile drainage was assumed to be reapplied as irrigation and therefore was treated as another applied water source.
Surface Water Deliveries	GSA member agencies surface water delivery and diversion historic data	All reported surface water delivery data counted as a source for applied water. The differences between diversions and deliveries (where available) were used to quality check calculated deep percolation rates.
Deep Percolation	Calculated from other applied water volumes	CVHM2 trends were aggregated and trends in applied water and precipitation proportions becoming deep percolation were used for the Historic & Current Period and aggregated into trends by Water Year Type. Since Deep Percolation in CVHM2 accounts for Delta-Mendota Canal, California Aqueduct, and San Joaquin River seepage, these rates implicitly account for stream seepage volumes.
Runoff	Calculated from other applied water volumes	CVHM2 trends were aggregated and trends in applied water and precipitation proportions becoming runoff were used for the Historic & Current Period and aggregated by Water Year Type.
Evapotranspiration	Various CIMIS Stations ET_0 data, Cal Poly Crop Coefficient data, GSA member agencies historic land use data	CIMIS data were applied across the Plan area so that the nearest or most representative station's data were applied to each GSA area. The monthly ET_0 data were then used with observed seasonal land use trends and crop coefficients (for each crop type from the Cal Poly Crop Coefficients[1]) to calculate Evapotranspiration volumes.

[1] Cal Poly ITRC Crop Coefficient data for Zone 14, aggregated by irrigation type, water year type, and crop type.

Table 5-17. Projected Groundwater Budget Assumptions

Water Budget Flow Category	Data Sources	Data Assumptions
Deep Percolation	See **Table 5-16**	See **Table 5-16**
Upper Aquifer Underflows	See **Table 5-15**	Underflows were averaged from the historic period according to water year type and by principal aquifer. Underflows were adjusted in the two projected water budgets with CCF and P&MAs budgets to reflect changes in interactions with the land surface.
Lower Aquifer Underflows	See **Table 5-15**	
Pumping	See **Table 5-16**	See **Table 5-16**
Upper Aquifer Change in Storage	GSA member agencies observation well data, CASGEM observation well data, CVHM2 storativity data	Hydrographs were grouped spatially into sub-regional zones in the Plan area. Change in water surface elevations between water years were determined for each sub-regional zone. These data and local storativity data were combined to determine the change in storage for each sub-regional zone for each water year in the projected period. These changes were averaged by water year type and used for each projected year.
Lower Aquifer Change in Storage	Calculated from Upper Aquifer Change in Storage	Lower Aquifer Change in Storage was assumed to be a portion of Upper Aquifer Change in Storage. The proportion was based on professional judgment and local knowledge.

Table 5-18. Differences in Sources and Assumptions Between Projected Water Budgets

Water Budget Flow Category	Changes Made between the Baseline Projected Budget and Budget with CC	Changes Made between Budget with CC and the P&MAs Budget
Precipitation	Precipitation rates were adjusted according to multipliers from the VIC hydrological gridded data set.[1] Precipitation was scaled according to the spatial overlap of the gridded data set and the Plan area.	No additional changes were made.
Pumping	Additional estimated pumping volume is due to the changes in Precipitation and Evapotranspiration.	The decreased estimated pumping volume in the P&MAs budget is due to the effects of Projects & Management Actions on increased Surface Water Deliveries.
Tile Drainage	No changes were made.	No changes were made.
Surface Water Deliveries	No changes were made.[2]	Additional volume of surface water deliveries in the P&MAs budget is due to the effects of Projects & Management Actions. (which are anticipated to increase surface water deliveries to the GSP area)
Deep Percolation	Additional volume of deep percolation estimated is due to the changes in Precipitation and Evapotranspiration.	Additional volume of deep percolation in the P&MAs budget is due to the effects of anticipated increases in applied surface water resulting from the Projects & Management Actions
Runoff	Additional volume of runoff is due to the changes in Precipitation and Evapotranspiration.	Additional volume of percolation in the P&MAs budget is due to the effects of anticipated increases in applied surface water resulting from the Projects & Management Actions.
Evapotranspiration	ET_0 rates were adjusted according to multipliers from the VIC hydrological gridded data set.[1] ET_0 was scaled according to the spatial overlap of the VIC hydrological gridded data set* and the GSP Area.	No additional changes were made.
Upper Aquifer Underflows	No changes were made.[2]	No changes were made.
Lower Aquifer Underflows	No changes were made. [2]	No changes were made.
Upper Aquifer Change in Storage	Additional Pumping volumes were split between the Upper and Lower Aquifer Change in Storage volumes. Additional Deep Percolation volumes were applied to the Upper Aquifer Change in Storage volume.	Reduced Pumping volumes were split between the Upper and Lower Aquifer Change in Storage volumes. Additional Deep Percolation volumes were applied to the Upper Aquifer Change in Storage volume.
Lower Aquifer Change in Storage	Additional Pumping volumes were split between the Upper and Lower Aquifer Change in Storage volumes.	Reduced pumping volumes were split between the Upper and Lower Aquifer Change in Storage volumes. Reductions that were due to projects and management actions specifically targeted at Lower Aquifer Pumping rates were not split between the Aquifers but were attributed entirely to the Lower Aquifer Change in Storage volume.

[1] Gridded Statewide Precipitation and Evapotranspiration (ET) Change Factors were developed for the Water Storage Investment Program (WSIP), using the Variable Infiltration Capacity (VIC) Macroscale Hydrology Model. (CA DWR 2018).
[2] Projected surface water deliveries were based on volumes provided by the GSAs Member Agencies. These volumes represent their anticipated future supplies. Climate change factors provided by DWR were not applied to Historic and Current surface water deliveries as they are based on an outdated model. These climate change factors, when applied, result in projected future surface water deliveries that do not represent anticipated future conditions.

5.4.6 Subbasin-Wide Water Budget

The Delta-Mendota Subbasin water budgets, which combines the individual water budgets from the six Subbasin GSPs based on agreed-upon water budget categories, are presented in the *Common Chapter* (**Appendix B**). **Table 5-19** maps the water budget categories for the Northern & Central Delta-Mendota water budgets to the Subbasin-wide coordinated water budget categories presented in the *Common Chapter* (**Appendix B**) for the Subbasin-wide water budgets.

Table 5-19. Water Budget Category Cross Walk

<table>
<tr><th>Water Budget</th><th>Northern & Central Delta-Mendota Category</th><th>Has Project Effects</th><th>Subbasin-Wide Category</th></tr>
<tr><td rowspan="4">Land Surface Inflow</td><td>Surface Water Deliveries</td><td>✓</td><td>Applied Water - Surface Water</td></tr>
<tr><td>Pumping</td><td>✓</td><td rowspan="2">Applied Water - Groundwater</td></tr>
<tr><td>Tile Drainage</td><td></td></tr>
<tr><td>Precipitation</td><td></td><td>Precipitation</td></tr>
<tr><td rowspan="3">Land Surface Outflow</td><td>Runoff</td><td>✓</td><td>Runoff</td></tr>
<tr><td>Deep Percolation</td><td>✓</td><td>Deep Percolation</td></tr>
<tr><td>Evapotranspiration</td><td></td><td>Evapotranspiration</td></tr>
<tr><td rowspan="3">Groundwater Inflow</td><td>Deep Percolation</td><td>✓</td><td>Infiltration</td></tr>
<tr><td>Upper Aquifer Underflows</td><td></td><td>Lateral Subsurface Flow - Upper Aquifer</td></tr>
<tr><td>Lower Aquifer Underflows</td><td></td><td>Lateral Subsurface Flow - Lower Aquifer</td></tr>
<tr><td rowspan="4">Groundwater Outflow</td><td>Pumping</td><td>✓</td><td rowspan="2">Groundwater Extraction</td></tr>
<tr><td>Tile Drainage</td><td></td></tr>
<tr><td>Upper Aquifer Underflows</td><td></td><td>Lateral Subsurface Flow - Upper Aquifer</td></tr>
<tr><td>Lower Aquifer Underflows</td><td></td><td>Lateral Subsurface Flow - Lower Aquifer</td></tr>
</table>

5.4.7 Water Budget Estimates

Flow category definitions, data sources, and their assumptions are described in **Section 5.4.5**. The annual estimates for the historic, current, and projected water budgets are detailed in the following tables in acre-feet per year (AFY):

- Historic Water Budget
  - Land Surface Budget (**Table 5-20**)
  - Groundwater Budget (**Table 5-21**)
  - Change in Storage (**Table 5-22**)
- Current Water Budget
  - Land Surface Budget (**Table 5-23**)
  - Groundwater Budget (**Table 5-24**)
  - Change in Storage (**Table 5-25**)
- Baseline Projected Water Budget
  - Land Surface Budget (**Table 5-26**)
  - Groundwater Budget (**Table 5-27**)
  - Change in Storage (**Table 5-28**)
- Projected Water Budget with Climate Change
  - Land Surface Budget (**Table 5-29**)
  - Groundwater Budget (**Table 5-30**)

    - Change in Storage (**Table 5-31**)
- Projected Water Budget with Climate Change and Projects & Management Actions
    - Land Surface Budget (**Table 5-32**)
    - Groundwater Budget (**Table 5-33**)
    - Change in Storage (**Table 5-34**)

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Table 5-20. Land Surface Budget, Historic Water Budget (AFY)

Land Surface Budget														
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows									Outflows			
		Surface Water Deliveries				Groundwater Pumping		Tile Drainage	Precipitation	**Total Inflows**	Runoff [1]	Deep Percolation	Evapotranspiration	**Total Outflows**
		San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural							
2003	Average	78,000	365,000	4,000	0	3,000	92,000	30	200,000	**742,000**	63,000	66,000	606,000	**736,000**
2004	Dry	85,000	359,000	5,000	0	3,000	86,000	30	174,000	**711,000**	52,000	57,000	580,000	**688,000**
2005	Wet	79,000	347,000	4,000	0	4,000	102,000	30	312,000	**848,000**	62,000	75,000	662,000	**799,000**
2006	Wet	66,000	353,000	4,000	0	4,000	99,000	30	248,000	**774,000**	60,000	65,000	663,000	**788,000**
2007	Dry	93,000	344,000	4,000	0	4,000	97,000	30	114,000	**656,000**	33,000	47,000	560,000	**639,000**
2008	Dry	97,000	269,000	2,000	0	4,000	140,000	30	142,000	**654,000**	56,000	47,000	598,000	**700,000**
2009	Average	109,000	234,000	2,000	0	4,000	128,000	30	125,000	**602,000**	28,000	42,000	647,000	**717,000**
2010	Average	105,000	271,000	3,000	0	4,000	112,000	30	227,000	**721,000**	49,000	60,000	590,000	**699,000**
2011	Wet	104,000	356,000	3,000	0	4,000	76,000	30	258,000	**802,000**	60,000	68,000	682,000	**811,000**
2012	Dry	124,000	316,000	3,000	0	4,000	106,000	30	112,000	**665,000**	28,000	47,000	559,000	**634,000**
Historic Average		**94,000**	**322,000**	**3,000**	**0**	**4,000**	**104,000**	**30**	**191,000**	**718,000**	**49,000**	**58,000**	**615,000**	**722,000**

[1] Runoff includes return flows to all surface water sources leaving the Plan area. Return flows were not separated due to model limitations.

Table 5-21. Groundwater Budget, Historic Water Budget (AFY)

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Inflows**	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Outflows**
2003	Average	66,000	50,000	27,000	**143,000**	95,000	30	60,000	32,000	**186,000**
2004	Dry	57,000	56,000	29,000	**142,000**	89,000	30	65,000	34,000	**188,000**
2005	Wet	75,000	73,000	39,000	**187,000**	105,000	30	54,000	29,000	**188,000**
2006	Wet	65,000	61,000	32,000	**158,000**	103,000	30	54,000	29,000	**186,000**
2007	Dry	47,000	35,000	18,000	**100,000**	101,000	30	67,000	36,000	**204,000**
2008	Dry	47,000	40,000	21,000	**108,000**	144,000	30	76,000	40,000	**259,000**
2009	Average	42,000	36,000	19,000	**98,000**	132,000	30	67,000	35,000	**234,000**
2010	Average	60,000	56,000	30,000	**146,000**	115,000	30	60,000	32,000	**207,000**
2011	Wet	68,000	63,000	33,000	**164,000**	80,000	30	61,000	32,000	**173,000**
2012	Dry	47,000	38,000	20,000	**105,000**	110,000	30	66,000	35,000	**212,000**
Historic Average		**58,000**	**51,000**	**27,000**	**136,000**	**108,000**	**30**	**63,000**	**33,000**	**204,000**

Table 5-22. Change in Storage, Historic Water Budget (AFY)

Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage: Upper Aquifer	Change in Storage: Lower Aquifer	Total Change in Storage
2003	Average	94,000	19,000	**113,000**
2004	Dry	(67,000)	(13,000)	**(80,000)**
2005	Wet	123,000	25,000	**147,000**
2006	Wet	(67,000)	(13,000)	**(80,000)**
2007	Dry	(157,000)	(31,000)	**(188,000)**
2008	Dry	(211,000)	(42,000)	**(253,000)**
2009	Average	(45,000)	(9,000)	**(54,000)**
2010	Average	77,000	15,000	**92,000**
2011	Wet	(64,000)	(13,000)	**(76,000)**
2012	Dry	(105,000)	(21,000)	**(126,000)**
Historic Average		**(42,000)**	**(8,000)**	**(50,000)**

Table 5-23. Land Surface Budget, Current Water Budget (AFY)

Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows: Surface Water Deliveries: San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Groundwater Pumping: Municipal & Industrial	Agricultural	Tile Drainage	Precipitation	Total Inflows	Outflows: Runoff [1]	Deep Percolation	Evapotranspiration	Total Outflows
2013	Dry	127,000	283,000	3,000	0	4,000	119,000	30	149,000	**685,000**	51,000	50,000	568,000	**669,000**

[1] Runoff includes return flows to all surface water sources leaving the Plan area. Return flows were not separated due to model limitations.

Table 5-24. Groundwater Budget, Current Water Budget (AFY)

Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows: Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	Total Inflows	Outflows: Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	Total Outflows
2013	Dry	50,000	42,000	22,000	**114,000**	124,000	0	52,000	27,000	**203,000**

Table 5-25. Change in Storage, Current Water Budget (AFY)

Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage: Upper Aquifer	Lower Aquifer	Total Change in Storage
2013	Dry	(73,000)	(15,000)	**(88,000)**

Table 5-26. Land Surface Budget, Baseline Projected Water Budget (AFY)

Land Surface Budget														
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows									Outflows			
		Surface Water Deliveries				Groundwater Pumping		Tile Drainage	Precipitation	**Total Inflows**	Runoff [1]	Deep Percolation	Evapotranspiration	**Total Outflows**
		San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural							
2014	Shasta Critical	105,000	229,000	2,000	0	4,000	197,000	8,000	127,000	**671,000**	47,000	61,000	578,000	**686,000**
2015	Shasta Critical	60,000	210,000	1,000	0	4,000	198,000	8,000	134,000	**615,000**	38,000	48,000	542,000	**628,000**
2016	Dry	80,000	231,000	3,000	0	4,000	136,000	11,000	260,000	**724,000**	55,000	87,000	572,000	**714,000**
2017	Wet	74,000	303,000	3,000	0	4,000	123,000	12,000	264,000	**784,000**	65,000	90,000	648,000	**803,000**
2018	Average	60,000	320,000	2,000	0	4,000	121,000	10,000	196,000	**713,000**	51,000	74,000	585,000	**710,000**
2019	Wet	118,000	332,000	4,000	0	4,000	85,000	12,000	342,000	**897,000**	76,000	107,000	683,000	**867,000**
2020	Dry	141,000	272,000	3,000	0	5,000	115,000	11,000	211,000	**757,000**	50,000	67,000	584,000	**700,000**
2021	Wet	118,000	332,000	4,000	0	4,000	86,000	12,000	342,000	**898,000**	76,000	107,000	683,000	**867,000**
2022	Wet	118,000	332,000	4,000	0	5,000	79,000	12,000	410,000	**960,000**	81,000	114,000	697,000	**893,000**
2023	Average	126,000	310,000	3,000	0	5,000	109,000	10,000	327,000	**891,000**	66,000	93,000	617,000	**776,000**
2024	Dry	141,000	272,000	3,000	0	5,000	110,000	11,000	320,000	**863,000**	65,000	89,000	594,000	**748,000**
2025	Wet	118,000	332,000	4,000	0	5,000	80,000	12,000	461,000	**1,012,000**	87,000	120,000	695,000	**902,000**
2026	Dry	141,000	272,000	3,000	0	6,000	111,000	11,000	304,000	**848,000**	62,000	86,000	593,000	**741,000**
2027	Dry	141,000	272,000	3,000	0	6,000	110,000	11,000	336,000	**879,000**	67,000	92,000	585,000	**744,000**
2028	Dry	141,000	272,000	3,000	0	6,000	112,000	11,000	277,000	**823,000**	58,000	77,000	601,000	**735,000**
2029	Dry	141,000	272,000	3,000	0	6,000	115,000	11,000	217,000	**764,000**	49,000	64,000	575,000	**689,000**
2030	Shasta Critical	122,000	244,000	2,000	0	6,000	186,000	8,000	155,000	**722,000**	47,000	59,000	585,000	**691,000**
2031	Shasta Critical	122,000	244,000	2,000	0	6,000	186,000	8,000	165,000	**732,000**	48,000	63,000	582,000	**694,000**
2032	Wet	118,000	332,000	4,000	0	6,000	97,000	12,000	334,000	**903,000**	76,000	106,000	699,000	**881,000**
2033	Dry	141,000	272,000	3,000	0	6,000	116,000	11,000	189,000	**739,000**	48,000	63,000	564,000	**676,000**
2034	Wet	118,000	332,000	4,000	0	6,000	80,000	12,000	341,000	**893,000**	76,000	107,000	659,000	**842,000**
2035	Wet	118,000	332,000	4,000	0	6,000	91,000	12,000	332,000	**894,000**	74,000	101,000	695,000	**870,000**
2036	Wet	118,000	332,000	4,000	0	6,000	140,000	12,000	289,000	**900,000**	72,000	98,000	719,000	**889,000**
2037	Wet	118,000	332,000	4,000	0	6,000	83,000	12,000	393,000	**948,000**	85,000	127,000	653,000	**866,000**
2038	Average	126,000	310,000	3,000	0	6,000	152,000	10,000	196,000	**805,000**	59,000	84,000	593,000	**735,000**
2039	Average	126,000	310,000	3,000	0	6,000	167,000	10,000	177,000	**800,000**	55,000	72,000	615,000	**742,000**
2040	Dry	141,000	272,000	3,000	0	6,000	141,000	11,000	199,000	**773,000**	54,000	77,000	573,000	**704,000**
2041	Dry	141,000	272,000	3,000	0	7,000	153,000	11,000	152,000	**739,000**	48,000	62,000	571,000	**682,000**
2042	Average	126,000	310,000	3,000	0	6,000	153,000	10,000	200,000	**809,000**	58,000	81,000	606,000	**746,000**
2043	Dry	141,000	272,000	3,000	0	7,000	151,000	11,000	174,000	**759,000**	53,000	73,000	580,000	**706,000**
2044	Wet	118,000	332,000	4,000	0	6,000	110,000	12,000	312,000	**894,000**	75,000	105,000	662,000	**842,000**
2045	Wet	118,000	332,000	4,000	0	7,000	121,000	12,000	248,000	**841,000**	68,000	89,000	663,000	**820,000**

Land Surface Budget														
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows									Outflows			
		Surface Water Deliveries				Groundwater Pumping		Tile Drainage	Precipitation	**Total Inflows**	Runoff [1]	Deep Percolation	Evapotranspiration	**Total Outflows**
		San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural							
2046	Dry	141,000	272,000	3,000	0	7,000	156,000	11,000	114,000	**704,000**	44,000	52,000	560,000	**656,000**
2047	Dry	141,000	272,000	3,000	0	7,000	170,000	11,000	142,000	**746,000**	47,000	57,000	598,000	**702,000**
2048	Average	126,000	310,000	3,000	0	6,000	209,000	10,000	125,000	**790,000**	53,000	63,000	647,000	**762,000**
2049	Average	126,000	310,000	3,000	0	6,000	130,000	10,000	227,000	**814,000**	60,000	90,000	590,000	**740,000**
2050	Wet	118,000	332,000	4,000	0	7,000	124,000	12,000	258,000	**854,000**	66,000	84,000	682,000	**832,000**
2051	Dry	141,000	272,000	3,000	0	7,000	153,000	11,000	112,000	**699,000**	44,000	52,000	559,000	**654,000**
2052	Dry	141,000	272,000	3,000	0	7,000	143,000	11,000	149,000	**726,000**	47,000	57,000	568,000	**672,000**
2053	Shasta Critical	122,000	244,000	2,000	0	7,000	220,000	8,000	128,000	**729,000**	49,000	62,000	601,000	**711,000**
2054	Shasta Critical	122,000	244,000	2,000	0	7,000	216,000	8,000	138,000	**735,000**	40,000	48,000	562,000	**650,000**
2055	Dry	141,000	272,000	3,000	0	7,000	152,000	11,000	262,000	**848,000**	56,000	87,000	587,000	**730,000**
2056	Wet	118,000	332,000	4,000	0	7,000	156,000	12,000	275,000	**903,000**	68,000	91,000	696,000	**855,000**
2057	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	342,000	**911,000**	77,000	107,000	683,000	**868,000**
2058	Average	126,000	310,000	3,000	0	6,000	147,000	10,000	199,000	**803,000**	57,000	78,000	607,000	**741,000**
2059	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	342,000	**911,000**	77,000	107,000	683,000	**868,000**
2060	Dry	141,000	272,000	3,000	0	7,000	126,000	11,000	211,000	**770,000**	50,000	67,000	584,000	**701,000**
2061	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	342,000	**911,000**	77,000	107,000	683,000	**868,000**
2062	Average	126,000	310,000	3,000	0	6,000	147,000	10,000	199,000	**803,000**	57,000	78,000	607,000	**741,000**
2063	Average	126,000	310,000	3,000	0	6,000	147,000	10,000	199,000	**803,000**	57,000	78,000	607,000	**741,000**
2064	Dry	141,000	272,000	3,000	0	7,000	126,000	11,000	211,000	**770,000**	50,000	67,000	584,000	**701,000**
2065	Average	126,000	310,000	3,000	0	6,000	147,000	10,000	199,000	**803,000**	57,000	78,000	607,000	**741,000**
2066	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	342,000	**911,000**	77,000	107,000	683,000	**868,000**
2067	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	342,000	**911,000**	77,000	107,000	683,000	**868,000**
2068	Dry	141,000	272,000	3,000	0	7,000	126,000	11,000	211,000	**770,000**	50,000	67,000	584,000	**701,000**
2069	Dry	141,000	272,000	3,000	0	7,000	126,000	11,000	211,000	**770,000**	50,000	67,000	584,000	**701,000**
2070	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	342,000	**911,000**	77,000	107,000	683,000	**868,000**
Projected Average		**124,000**	**295,000**	**3,000**	**0**	**6,000**	**132,000**	**11,000**	**246,000**	**817,000**	**61,000**	**83,000**	**620,000**	**764,000**

[1] Runoff includes return flows to all surface water sources leaving the Plan area. Return flows were not separated due to model limitations.

Table 5-27. Groundwater Budget, Baseline Projected Water Budget (AFY)

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Inflows**	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Outflows**
2014	Shasta Critical	61,000	45,000	24,000	***131,000***	201,000	8,000	65,000	34,000	***308,000***
2015	Shasta Critical	48,000	45,000	24,000	***117,000***	203,000	8,000	65,000	34,000	***310,000***
2016	Dry	87,000	45,000	24,000	***157,000***	140,000	11,000	65,000	34,000	***251,000***
2017	Wet	90,000	73,000	38,000	***201,000***	127,000	12,000	56,000	30,000	***226,000***
2018	Average	74,000	51,000	27,000	***153,000***	125,000	10,000	62,000	33,000	***230,000***
2019	Wet	107,000	73,000	38,000	***219,000***	89,000	12,000	56,000	30,000	***188,000***
2020	Dry	67,000	45,000	24,000	***136,000***	119,000	11,000	65,000	34,000	***230,000***
2021	Wet	107,000	73,000	38,000	***219,000***	90,000	12,000	56,000	30,000	***189,000***
2022	Wet	114,000	73,000	38,000	***226,000***	84,000	12,000	56,000	30,000	***182,000***
2023	Average	93,000	51,000	27,000	***172,000***	114,000	10,000	62,000	33,000	***219,000***
2024	Dry	89,000	45,000	24,000	***158,000***	115,000	11,000	65,000	34,000	***226,000***
2025	Wet	120,000	73,000	38,000	***232,000***	85,000	12,000	56,000	30,000	***184,000***
2026	Dry	86,000	45,000	24,000	***155,000***	116,000	11,000	65,000	34,000	***227,000***
2027	Dry	92,000	45,000	24,000	***161,000***	116,000	11,000	65,000	34,000	***227,000***
2028	Dry	77,000	45,000	24,000	***146,000***	118,000	11,000	65,000	34,000	***229,000***
2029	Dry	64,000	45,000	24,000	***134,000***	121,000	11,000	65,000	34,000	***231,000***
2030	Shasta Critical	59,000	45,000	24,000	***128,000***	192,000	8,000	65,000	34,000	***299,000***
2031	Shasta Critical	63,000	45,000	24,000	***133,000***	192,000	8,000	65,000	34,000	***299,000***
2032	Wet	106,000	73,000	38,000	***218,000***	103,000	12,000	56,000	30,000	***202,000***
2033	Dry	63,000	45,000	24,000	***133,000***	122,000	11,000	65,000	34,000	***233,000***
2034	Wet	107,000	73,000	38,000	***219,000***	86,000	12,000	56,000	30,000	***185,000***
2035	Wet	101,000	73,000	38,000	***213,000***	97,000	12,000	56,000	30,000	***196,000***
2036	Wet	98,000	73,000	38,000	***209,000***	146,000	12,000	56,000	30,000	***244,000***
2037	Wet	127,000	73,000	38,000	***239,000***	89,000	12,000	56,000	30,000	***188,000***
2038	Average	84,000	51,000	27,000	***162,000***	158,000	10,000	62,000	33,000	***263,000***
2039	Average	72,000	51,000	27,000	***151,000***	173,000	10,000	62,000	33,000	***279,000***
2040	Dry	77,000	45,000	24,000	***146,000***	147,000	11,000	65,000	34,000	***258,000***
2041	Dry	62,000	45,000	24,000	***132,000***	159,000	11,000	65,000	34,000	***270,000***
2042	Average	81,000	51,000	27,000	***160,000***	159,000	10,000	62,000	33,000	***264,000***
2043	Dry	73,000	45,000	24,000	***143,000***	158,000	11,000	65,000	34,000	***269,000***
2044	Wet	105,000	73,000	38,000	***217,000***	116,000	12,000	56,000	30,000	***215,000***
2045	Wet	89,000	73,000	38,000	***201,000***	127,000	12,000	56,000	30,000	***226,000***
2046	Dry	52,000	45,000	24,000	***122,000***	163,000	11,000	65,000	34,000	***274,000***

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Inflows**	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Outflows**
2047	Dry	57,000	45,000	24,000	***127,000***	177,000	11,000	65,000	34,000	***288,000***
2048	Average	63,000	51,000	27,000	***142,000***	215,000	10,000	62,000	33,000	***321,000***
2049	Average	90,000	51,000	27,000	***169,000***	137,000	10,000	62,000	33,000	***242,000***
2050	Wet	84,000	73,000	38,000	***195,000***	130,000	12,000	56,000	30,000	***229,000***
2051	Dry	52,000	45,000	24,000	***121,000***	160,000	11,000	65,000	34,000	***271,000***
2052	Dry	57,000	45,000	24,000	***127,000***	150,000	11,000	65,000	34,000	***260,000***
2053	Shasta Critical	62,000	45,000	24,000	***131,000***	227,000	8,000	65,000	34,000	***334,000***
2054	Shasta Critical	48,000	45,000	24,000	***117,000***	223,000	8,000	65,000	34,000	***330,000***
2055	Dry	87,000	45,000	24,000	***156,000***	159,000	11,000	65,000	34,000	***270,000***
2056	Wet	91,000	73,000	38,000	***203,000***	162,000	12,000	56,000	30,000	***261,000***
2057	Wet	107,000	73,000	38,000	***219,000***	103,000	12,000	56,000	30,000	***202,000***
2058	Average	78,000	51,000	27,000	***156,000***	154,000	10,000	62,000	33,000	***259,000***
2059	Wet	107,000	73,000	38,000	***219,000***	103,000	12,000	56,000	30,000	***202,000***
2060	Dry	67,000	45,000	24,000	***136,000***	132,000	11,000	65,000	34,000	***243,000***
2061	Wet	107,000	73,000	38,000	***219,000***	103,000	12,000	56,000	30,000	***202,000***
2062	Average	78,000	51,000	27,000	***156,000***	154,000	10,000	62,000	33,000	***259,000***
2063	Average	78,000	51,000	27,000	***156,000***	154,000	10,000	62,000	33,000	***259,000***
2064	Dry	67,000	45,000	24,000	***136,000***	132,000	11,000	65,000	34,000	***243,000***
2065	Average	78,000	51,000	27,000	***156,000***	154,000	10,000	62,000	33,000	***259,000***
2066	Wet	107,000	73,000	38,000	***219,000***	103,000	12,000	56,000	30,000	***202,000***
2067	Wet	107,000	73,000	38,000	***219,000***	103,000	12,000	56,000	30,000	***202,000***
2068	Dry	67,000	45,000	24,000	***136,000***	132,000	11,000	65,000	34,000	***243,000***
2069	Dry	67,000	45,000	24,000	***136,000***	132,000	11,000	65,000	34,000	***243,000***
2070	Wet	107,000	73,000	38,000	***219,000***	103,000	12,000	56,000	30,000	***202,000***
Projected Average		**83,000**	**56,000**	**30,000**	**169,000**	**138,000**	**11,000**	**62,000**	**32,000**	**243,000**

Table 5-28. Change in Storage, Baseline Projected Water Budget (AFY)

Groundwater Budget				
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage		
		Upper Aquifer	Lower Aquifer	Total Change in Storage
2014	Shasta Critical	(128,000)	(28,000)	**(156,000)**
2015	Shasta Critical	(127,000)	(27,000)	**(154,000)**
2016	Dry	(102,000)	(14,000)	**(115,000)**
2017	Wet	(12,000)	(5,000)	**(17,000)**
2018	Average	41,000	8,000	**48,000**
2019	Wet	4,000	3,000	**7,000**
2020	Dry	(111,000)	(19,000)	**(130,000)**
2021	Wet	4,000	3,000	**7,000**
2022	Wet	18,000	10,000	**28,000**
2023	Average	67,000	22,000	**88,000**
2024	Dry	(89,000)	(7,000)	**(97,000)**
2025	Wet	28,000	15,000	**43,000**
2026	Dry	(93,000)	(9,000)	**(102,000)**
2027	Dry	(86,000)	(6,000)	**(92,000)**
2028	Dry	(98,000)	(12,000)	**(110,000)**
2029	Dry	(110,000)	(18,000)	**(128,000)**
2030	Shasta Critical	(123,000)	(25,000)	**(147,000)**
2031	Shasta Critical	(121,000)	(24,000)	**(144,000)**
2032	Wet	2,000	2,000	**4,000**
2033	Dry	(116,000)	(21,000)	**(137,000)**
2034	Wet	4,000	3,000	**6,000**
2035	Wet	2,000	2,000	**4,000**
2036	Wet	(7,000)	(3,000)	**(9,000)**
2037	Wet	14,000	8,000	**22,000**
2038	Average	41,000	8,000	**48,000**
2039	Average	37,000	6,000	**43,000**
2040	Dry	(114,000)	(20,000)	**(134,000)**
2041	Dry	(123,000)	(25,000)	**(148,000)**
2042	Average	41,000	8,000	**50,000**
2043	Dry	(119,000)	(23,000)	**(141,000)**
2044	Wet	(2,000)	0	**(2,000)**
2045	Wet	(15,000)	(7,000)	**(22,000)**
2046	Dry	(131,000)	(29,000)	**(160,000)**

Groundwater Budget				
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage		
		Upper Aquifer	Lower Aquifer	**Total Change in Storage**
2047	Dry	(125,000)	(26,000)	**(151,000)**
2048	Average	26,000	0	**27,000**
2049	Average	47,000	11,000	**58,000**
2050	Wet	(13,000)	(6,000)	**(19,000)**
2051	Dry	(131,000)	(29,000)	**(160,000)**
2052	Dry	(124,000)	(25,000)	**(149,000)**
2053	Shasta Critical	(128,000)	(27,000)	**(155,000)**
2054	Shasta Critical	(126,000)	(26,000)	**(152,000)**
2055	Dry	(101,000)	(13,000)	**(114,000)**
2056	Wet	(9,000)	(4,000)	**(14,000)**
2057	Wet	4,000	3,000	**7,000**
2058	Average	41,000	8,000	**49,000**
2059	Wet	4,000	3,000	**7,000**
2060	Dry	(111,000)	(19,000)	**(130,000)**
2061	Wet	4,000	3,000	**7,000**
2062	Average	41,000	8,000	**49,000**
2063	Average	41,000	8,000	**49,000**
2064	Dry	(111,000)	(19,000)	**(130,000)**
2065	Average	41,000	8,000	**49,000**
2066	Wet	4,000	3,000	**7,000**
2067	Wet	4,000	3,000	**7,000**
2068	Dry	(111,000)	(19,000)	**(130,000)**
2069	Dry	(111,000)	(19,000)	**(130,000)**
2070	Wet	4,000	3,000	**7,000**
Projected Average		**(43,000)**	**(7,000)**	**(50,000)**

Table 5-29. Land Surface Budget, Projected Water Budget with Climate Change (AFY)

Land Surface Budget														
		Inflows									Outflows			
		Surface Water Deliveries				Groundwater Pumping								
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural	Tile Drainage	Precipitation	**Total Inflows**	Runoff [1]	Deep Percolation	Evapotranspiration	**Total Outflows**
2014	Shasta Critical	105,000	229,000	2,000	0	4,000	208,000	8,000	131,000	**686,000**	48,000	63,000	598,000	**709,000**
2015	Shasta Critical	60,000	210,000	1,000	0	4,000	196,000	8,000	141,000	**620,000**	39,000	49,000	543,000	**631,000**
2016	Dry	80,000	231,000	3,000	0	4,000	130,000	11,000	280,000	**738,000**	57,000	93,000	574,000	**724,000**
2017	Wet	74,000	303,000	3,000	0	4,000	125,000	12,000	259,000	**781,000**	64,000	88,000	649,000	**801,000**
2018	Average	60,000	320,000	2,000	0	4,000	120,000	10,000	200,000	**717,000**	52,000	75,000	586,000	**712,000**
2019	Wet	118,000	332,000	4,000	0	4,000	84,000	12,000	347,000	**900,000**	76,000	109,000	684,000	**869,000**
2020	Dry	141,000	272,000	3,000	0	5,000	117,000	11,000	200,000	**749,000**	48,000	64,000	583,000	**695,000**
2021	Wet	118,000	332,000	4,000	0	4,000	83,000	12,000	351,000	**904,000**	76,000	109,000	685,000	**870,000**
2022	Wet	118,000	332,000	4,000	0	5,000	77,000	12,000	437,000	**984,000**	84,000	118,000	701,000	**902,000**
2023	Average	126,000	310,000	3,000	0	5,000	106,000	10,000	342,000	**903,000**	67,000	97,000	618,000	**783,000**
2024	Dry	141,000	272,000	3,000	0	5,000	109,000	11,000	325,000	**866,000**	65,000	89,000	596,000	**750,000**
2025	Wet	118,000	332,000	4,000	0	5,000	79,000	12,000	460,000	**1,010,000**	86,000	119,000	696,000	**901,000**
2026	Dry	141,000	272,000	3,000	0	6,000	108,000	11,000	315,000	**856,000**	63,000	88,000	595,000	**746,000**
2027	Dry	141,000	272,000	3,000	0	6,000	108,000	11,000	343,000	**884,000**	68,000	94,000	587,000	**748,000**
2028	Dry	141,000	272,000	3,000	0	6,000	110,000	11,000	296,000	**839,000**	60,000	80,000	604,000	**744,000**
2029	Dry	141,000	272,000	3,000	0	6,000	113,000	11,000	223,000	**768,000**	49,000	65,000	577,000	**691,000**
2030	Shasta Critical	122,000	244,000	2,000	0	6,000	185,000	8,000	156,000	**722,000**	46,000	59,000	586,000	**691,000**
2031	Shasta Critical	122,000	244,000	2,000	0	6,000	184,000	8,000	173,000	**738,000**	49,000	65,000	584,000	**697,000**
2032	Wet	118,000	332,000	4,000	0	6,000	93,000	12,000	347,000	**911,000**	77,000	109,000	699,000	**885,000**
2033	Dry	141,000	272,000	3,000	0	6,000	115,000	11,000	196,000	**743,000**	49,000	64,000	565,000	**679,000**
2034	Wet	118,000	332,000	4,000	0	6,000	79,000	12,000	345,000	**895,000**	76,000	108,000	660,000	**843,000**
2035	Wet	118,000	332,000	4,000	0	6,000	88,000	12,000	342,000	**901,000**	75,000	104,000	695,000	**874,000**
2036	Wet	118,000	332,000	4,000	0	6,000	128,000	12,000	337,000	**936,000**	78,000	110,000	719,000	**908,000**
2037	Wet	118,000	332,000	4,000	0	6,000	87,000	12,000	382,000	**940,000**	83,000	124,000	654,000	**861,000**
2038	Average	126,000	310,000	3,000	0	6,000	152,000	10,000	199,000	**806,000**	59,000	84,000	593,000	**736,000**
2039	Average	126,000	310,000	3,000	0	6,000	169,000	10,000	171,000	**796,000**	54,000	71,000	615,000	**740,000**
2040	Dry	141,000	272,000	3,000	0	6,000	139,000	11,000	204,000	**777,000**	54,000	77,000	574,000	**706,000**
2041	Dry	141,000	272,000	3,000	0	7,000	151,000	11,000	158,000	**743,000**	49,000	63,000	573,000	**685,000**
2042	Average	126,000	310,000	3,000	0	6,000	150,000	10,000	207,000	**813,000**	58,000	82,000	608,000	**748,000**
2043	Dry	141,000	272,000	3,000	0	7,000	146,000	11,000	197,000	**777,000**	55,000	80,000	582,000	**717,000**
2044	Wet	118,000	332,000	4,000	0	6,000	107,000	12,000	320,000	**900,000**	76,000	106,000	663,000	**846,000**
2045	Wet	118,000	332,000	4,000	0	7,000	123,000	12,000	241,000	**836,000**	67,000	86,000	665,000	**817,000**

Land Surface Budget														
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows									Outflows			
		Surface Water Deliveries				Groundwater Pumping		Tile Drainage	Precipitation	**Total Inflows**	Runoff [1]	Deep Percolation	Evapotranspiration	**Total Outflows**
		San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural							
2046	Dry	141,000	272,000	3,000	0	7,000	157,000	11,000	112,000	**703,000**	44,000	51,000	560,000	**655,000**
2047	Dry	141,000	272,000	3,000	0	7,000	167,000	11,000	158,000	**759,000**	48,000	60,000	601,000	**709,000**
2048	Average	126,000	310,000	3,000	0	6,000	210,000	10,000	119,000	**786,000**	52,000	61,000	648,000	**760,000**
2049	Average	126,000	310,000	3,000	0	6,000	127,000	10,000	238,000	**821,000**	61,000	92,000	591,000	**744,000**
2050	Wet	118,000	332,000	4,000	0	7,000	123,000	12,000	259,000	**854,000**	65,000	82,000	685,000	**832,000**
2051	Dry	141,000	272,000	3,000	0	7,000	153,000	11,000	112,000	**699,000**	44,000	51,000	560,000	**655,000**
2052	Dry	141,000	272,000	3,000	0	7,000	142,000	11,000	149,000	**726,000**	45,000	55,000	570,000	**671,000**
2053	Shasta Critical	122,000	244,000	2,000	0	7,000	222,000	8,000	121,000	**725,000**	48,000	59,000	600,000	**707,000**
2054	Shasta Critical	122,000	244,000	2,000	0	7,000	216,000	8,000	138,000	**735,000**	40,000	47,000	563,000	**650,000**
2055	Dry	141,000	272,000	3,000	0	7,000	155,000	11,000	252,000	**841,000**	54,000	82,000	590,000	**725,000**
2056	Wet	118,000	332,000	4,000	0	7,000	154,000	12,000	279,000	**905,000**	67,000	90,000	699,000	**856,000**
2057	Wet	118,000	332,000	4,000	0	7,000	97,000	12,000	339,000	**909,000**	75,000	104,000	687,000	**866,000**
2058	Average	126,000	310,000	3,000	0	6,000	149,000	10,000	193,000	**798,000**	55,000	74,000	609,000	**738,000**
2059	Wet	118,000	332,000	4,000	0	7,000	96,000	12,000	345,000	**913,000**	77,000	107,000	685,000	**869,000**
2060	Dry	141,000	272,000	3,000	0	7,000	130,000	11,000	198,000	**762,000**	49,000	63,000	584,000	**695,000**
2061	Wet	118,000	332,000	4,000	0	7,000	95,000	12,000	347,000	**913,000**	76,000	106,000	688,000	**869,000**
2062	Average	126,000	310,000	3,000	0	6,000	150,000	10,000	192,000	**798,000**	55,000	75,000	609,000	**739,000**
2063	Average	126,000	310,000	3,000	0	6,000	148,000	10,000	197,000	**801,000**	56,000	76,000	609,000	**740,000**
2064	Dry	141,000	272,000	3,000	0	7,000	127,000	11,000	211,000	**772,000**	50,000	65,000	585,000	**700,000**
2065	Average	126,000	310,000	3,000	0	6,000	145,000	10,000	206,000	**808,000**	57,000	78,000	609,000	**744,000**
2066	Wet	118,000	332,000	4,000	0	7,000	97,000	12,000	340,000	**909,000**	75,000	105,000	687,000	**867,000**
2067	Wet	118,000	332,000	4,000	0	7,000	94,000	12,000	349,000	**915,000**	76,000	107,000	687,000	**871,000**
2068	Dry	141,000	272,000	3,000	0	7,000	126,000	11,000	205,000	**765,000**	49,000	63,000	586,000	**698,000**
2069	Dry	141,000	272,000	3,000	0	7,000	125,000	11,000	210,000	**770,000**	50,000	65,000	586,000	**700,000**
2070	Wet	118,000	332,000	4,000	0	7,000	95,000	12,000	344,000	**911,000**	76,000	106,000	687,000	**868,000**
Projected Average		**124,000**	**295,000**	**3,000**	**0**	**6,000**	**131,000**	**11,000**	**250,000**	**820,000**	**60,000**	**83,000**	**622,000**	**765,000**

[1] Runoff includes return flows to all surface water sources leaving the Plan area. Return flows were not separated due to model limitations.

Table 5-30. Groundwater Surface Budget, Projected Water Budget with Climate Change (AFY)

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Inflows**	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Outflows**
2014	Shasta Critical	63,000	45,000	24,000	**132,000**	*212,000*	*8,000*	*65,000*	*34,000*	**319,000**
2015	Shasta Critical	49,000	45,000	24,000	**118,000**	*200,000*	*8,000*	*65,000*	*34,000*	**308,000**
2016	Dry	93,000	45,000	24,000	**162,000**	*134,000*	*11,000*	*65,000*	*34,000*	**244,000**
2017	Wet	88,000	73,000	38,000	**199,000**	*129,000*	*12,000*	*56,000*	*30,000*	**228,000**
2018	Average	75,000	51,000	27,000	**154,000**	*124,000*	*10,000*	*62,000*	*33,000*	**229,000**
2019	Wet	109,000	73,000	38,000	**220,000**	*88,000*	*12,000*	*56,000*	*30,000*	**186,000**
2020	Dry	64,000	45,000	24,000	**133,000**	*122,000*	*11,000*	*65,000*	*34,000*	**232,000**
2021	Wet	109,000	73,000	38,000	**221,000**	*87,000*	*12,000*	*56,000*	*30,000*	**186,000**
2022	Wet	118,000	73,000	38,000	**229,000**	*82,000*	*12,000*	*56,000*	*30,000*	**180,000**
2023	Average	97,000	51,000	27,000	**176,000**	*111,000*	*10,000*	*62,000*	*33,000*	**216,000**
2024	Dry	89,000	45,000	24,000	**159,000**	*115,000*	*11,000*	*65,000*	*34,000*	**225,000**
2025	Wet	119,000	73,000	38,000	**231,000**	*84,000*	*12,000*	*56,000*	*30,000*	**183,000**
2026	Dry	88,000	45,000	24,000	**157,000**	*113,000*	*11,000*	*65,000*	*34,000*	**224,000**
2027	Dry	94,000	45,000	24,000	**163,000**	*114,000*	*11,000*	*65,000*	*34,000*	**225,000**
2028	Dry	80,000	45,000	24,000	**149,000**	*116,000*	*11,000*	*65,000*	*34,000*	**227,000**
2029	Dry	65,000	45,000	24,000	**135,000**	*118,000*	*11,000*	*65,000*	*34,000*	**229,000**
2030	Shasta Critical	59,000	45,000	24,000	**128,000**	*191,000*	*8,000*	*65,000*	*34,000*	**298,000**
2031	Shasta Critical	65,000	45,000	24,000	**134,000**	*190,000*	*8,000*	*65,000*	*34,000*	**297,000**
2032	Wet	109,000	73,000	38,000	**221,000**	*98,000*	*12,000*	*56,000*	*30,000*	**197,000**
2033	Dry	64,000	45,000	24,000	**134,000**	*121,000*	*11,000*	*65,000*	*34,000*	**231,000**
2034	Wet	108,000	73,000	38,000	**219,000**	*84,000*	*12,000*	*56,000*	*30,000*	**183,000**
2035	Wet	104,000	73,000	38,000	**216,000**	*93,000*	*12,000*	*56,000*	*30,000*	**192,000**
2036	Wet	110,000	73,000	38,000	**222,000**	*134,000*	*12,000*	*56,000*	*30,000*	**232,000**
2037	Wet	124,000	73,000	38,000	**235,000**	*92,000*	*12,000*	*56,000*	*30,000*	**191,000**
2038	Average	84,000	51,000	27,000	**163,000**	*158,000*	*10,000*	*62,000*	*33,000*	**263,000**
2039	Average	71,000	51,000	27,000	**149,000**	*175,000*	*10,000*	*62,000*	*33,000*	**281,000**
2040	Dry	77,000	45,000	24,000	**147,000**	*146,000*	*11,000*	*65,000*	*34,000*	**256,000**
2041	Dry	63,000	45,000	24,000	**133,000**	*158,000*	*11,000*	*65,000*	*34,000*	**269,000**
2042	Average	82,000	51,000	27,000	**161,000**	*156,000*	*10,000*	*62,000*	*33,000*	**262,000**
2043	Dry	80,000	45,000	24,000	**149,000**	*153,000*	*11,000*	*65,000*	*34,000*	**263,000**
2044	Wet	106,000	73,000	38,000	**218,000**	*114,000*	*12,000*	*56,000*	*30,000*	**213,000**
2045	Wet	86,000	73,000	38,000	**197,000**	*129,000*	*12,000*	*56,000*	*30,000*	**228,000**
2046	Dry	51,000	45,000	24,000	**120,000**	*164,000*	*11,000*	*65,000*	*34,000*	**274,000**

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Inflows**	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Outflows**
2047	Dry	60,000	45,000	24,000	**129,000**	*174,000*	*11,000*	*65,000*	*34,000*	**284,000**
2048	Average	61,000	51,000	27,000	**140,000**	*217,000*	*10,000*	*62,000*	*33,000*	**322,000**
2049	Average	92,000	51,000	27,000	**171,000**	*133,000*	*10,000*	*62,000*	*33,000*	**238,000**
2050	Wet	82,000	73,000	38,000	**194,000**	*129,000*	*12,000*	*56,000*	*30,000*	**228,000**
2051	Dry	51,000	45,000	24,000	**120,000**	*160,000*	*11,000*	*65,000*	*34,000*	**270,000**
2052	Dry	55,000	45,000	24,000	**125,000**	*149,000*	*11,000*	*65,000*	*34,000*	**260,000**
2053	Shasta Critical	59,000	45,000	24,000	**129,000**	*229,000*	*8,000*	*65,000*	*34,000*	**336,000**
2054	Shasta Critical	47,000	45,000	24,000	**117,000**	*223,000*	*8,000*	*65,000*	*34,000*	**330,000**
2055	Dry	82,000	45,000	24,000	**151,000**	*161,000*	*11,000*	*65,000*	*34,000*	**272,000**
2056	Wet	90,000	73,000	38,000	**201,000**	*160,000*	*12,000*	*56,000*	*30,000*	**259,000**
2057	Wet	104,000	73,000	38,000	**216,000**	*104,000*	*12,000*	*56,000*	*30,000*	**202,000**
2058	Average	74,000	51,000	27,000	**153,000**	*156,000*	*10,000*	*62,000*	*33,000*	**261,000**
2059	Wet	107,000	73,000	38,000	**219,000**	*102,000*	*12,000*	*56,000*	*30,000*	**201,000**
2060	Dry	63,000	45,000	24,000	**132,000**	*137,000*	*11,000*	*65,000*	*34,000*	**247,000**
2061	Wet	106,000	73,000	38,000	**217,000**	*101,000*	*12,000*	*56,000*	*30,000*	**200,000**
2062	Average	75,000	51,000	27,000	**153,000**	*156,000*	*10,000*	*62,000*	*33,000*	**261,000**
2063	Average	76,000	51,000	27,000	**154,000**	*154,000*	*10,000*	*62,000*	*33,000*	**260,000**
2064	Dry	65,000	45,000	24,000	**135,000**	*134,000*	*11,000*	*65,000*	*34,000*	**244,000**
2065	Average	78,000	51,000	27,000	**157,000**	*152,000*	*10,000*	*62,000*	*33,000*	**257,000**
2066	Wet	105,000	73,000	38,000	**216,000**	*104,000*	*12,000*	*56,000*	*30,000*	**202,000**
2067	Wet	107,000	73,000	38,000	**218,000**	*101,000*	*12,000*	*56,000*	*30,000*	**199,000**
2068	Dry	63,000	45,000	24,000	**132,000**	*133,000*	*11,000*	*65,000*	*34,000*	**244,000**
2069	Dry	65,000	45,000	24,000	**135,000**	*132,000*	*11,000*	*65,000*	*34,000*	**243,000**
2070	Wet	106,000	73,000	38,000	**217,000**	*102,000*	*12,000*	*56,000*	*30,000*	**201,000**
Projected Average		**83,000**	**56,000**	**30,000**	**169,000**	**137,000**	**11,000**	**62,000**	**32,000**	**242,000**

Table 5-31. Change in Storage, Projected Water Budget with Climate Change (AFY)

Groundwater Budget				
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage		
		Upper Aquifer	Lower Aquifer	Total Change in Storage
2014	Shasta Critical	(135,000)	(29,000)	**(164,000)**
2015	Shasta Critical	(123,000)	(26,000)	**(148,000)**
2016	Dry	(87,000)	(10,000)	**(97,000)**
2017	Wet	(17,000)	(6,000)	**(23,000)**
2018	Average	43,000	8,000	**52,000**
2019	Wet	7,000	4,000	**11,000**
2020	Dry	(119,000)	(20,000)	**(139,000)**
2021	Wet	10,000	4,000	**14,000**
2022	Wet	28,000	13,000	**41,000**
2023	Average	76,000	24,000	**100,000**
2024	Dry	(88,000)	(7,000)	**(94,000)**
2025	Wet	28,000	15,000	**43,000**
2026	Dry	(86,000)	(7,000)	**(93,000)**
2027	Dry	(81,000)	(4,000)	**(85,000)**
2028	Dry	(90,000)	(9,000)	**(99,000)**
2029	Dry	(106,000)	(17,000)	**(123,000)**
2030	Shasta Critical	(121,000)	(24,000)	**(146,000)**
2031	Shasta Critical	(115,000)	(22,000)	**(138,000)**
2032	Wet	12,000	4,000	**16,000**
2033	Dry	(112,000)	(20,000)	**(132,000)**
2034	Wet	6,000	3,000	**10,000**
2035	Wet	10,000	4,000	**13,000**
2036	Wet	26,000	4,000	**30,000**
2037	Wet	5,000	7,000	**12,000**
2038	Average	42,000	8,000	**50,000**
2039	Average	33,000	5,000	**37,000**
2040	Dry	(111,000)	(19,000)	**(130,000)**
2041	Dry	(120,000)	(24,000)	**(144,000)**
2042	Average	46,000	9,000	**55,000**
2043	Dry	(103,000)	(19,000)	**(122,000)**
2044	Wet	3,000	1,000	**4,000**
2045	Wet	(22,000)	(8,000)	**(30,000)**
2046	Dry	(133,000)	(29,000)	**(162,000)**

Groundwater Budget				
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	**Change in Storage**		
		Upper Aquifer	Lower Aquifer	**Total Change in Storage**
2047	Dry	(116,000)	(24,000)	**(140,000)**
2048	Average	22,000	(1,000)	**21,000**
2049	Average	54,000	13,000	**67,000**
2050	Wet	(13,000)	(6,000)	**(19,000)**
2051	Dry	(132,000)	(29,000)	**(161,000)**
2052	Dry	(125,000)	(25,000)	**(150,000)**
2053	Shasta Critical	(133,000)	(28,000)	**(162,000)**
2054	Shasta Critical	(126,000)	(26,000)	**(153,000)**
2055	Dry	(110,000)	(15,000)	**(125,000)**
2056	Wet	(8,000)	(3,000)	**(12,000)**
2057	Wet	0	2,000	**2,000**
2058	Average	35,000	7,000	**42,000**
2059	Wet	5,000	3,000	**9,000**
2060	Dry	(122,000)	(21,000)	**(142,000)**
2061	Wet	5,000	4,000	**8,000**
2062	Average	35,000	7,000	**42,000**
2063	Average	38,000	8,000	**46,000**
2064	Dry	(114,000)	(19,000)	**(133,000)**
2065	Average	45,000	9,000	**54,000**
2066	Wet	0	3,000	**3,000**
2067	Wet	7,000	4,000	**11,000**
2068	Dry	(117,000)	(19,000)	**(137,000)**
2069	Dry	(113,000)	(19,000)	**(132,000)**
2070	Wet	3,000	3,000	**7,000**
Projected Average		**(42,000)**	**(6,000)**	**(48,000)**

Table 5-32. Land Surface Budget, Projected Water Budget with Climate Change and Projects & Management Actions (AFY)

Land Surface Budget														
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows									Outflows			
		Surface Water Deliveries [1]				Groundwater Pumping		Tile Drainage	Precipitation	**Total Inflows**	Runoff [2]	Deep Percolation	Evapotranspiration	**Total Outflows**
		San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural							
2014	Shasta Critical	105,000	229,000	2,000	0	4,000	208,000	8,000	131,000	**686,000**	48,000	63,000	598,000	**709,000**
2015	Shasta Critical	60,000	210,000	1,000	0	4,000	196,000	8,000	141,000	**620,000**	39,000	49,000	543,000	**631,000**
2016	Dry	80,000	231,000	3,000	0	4,000	130,000	11,000	280,000	**738,000**	57,000	93,000	574,000	**724,000**
2017	Wet	74,000	303,000	3,000	0	4,000	125,000	12,000	259,000	**781,000**	64,000	88,000	649,000	**801,000**
2018	Average	60,000	320,000	2,000	0	4,000	114,000	10,000	200,000	**710,000**	51,000	75,000	586,000	**712,000**
2019	Wet	118,000	332,000	4,000	2,000	4,000	76,000	12,000	347,000	**895,000**	76,000	108,000	684,000	**868,000**
2020	Dry	141,000	272,000	3,000	9,000	5,000	111,000	11,000	200,000	**752,000**	48,000	67,000	583,000	**698,000**
2021	Wet	118,000	332,000	4,000	7,000	4,000	76,000	12,000	351,000	**904,000**	76,000	119,000	685,000	**881,000**
2022	Wet	118,000	332,000	4,000	7,000	5,000	70,000	12,000	437,000	**984,000**	83,000	128,000	701,000	**912,000**
2023	Average	126,000	310,000	3,000	6,000	5,000	98,000	10,000	342,000	**901,000**	67,000	100,000	618,000	**785,000**
2024	Dry	141,000	272,000	3,000	6,000	5,000	106,000	11,000	325,000	**869,000**	65,000	92,000	596,000	**753,000**
2025	Wet	118,000	332,000	4,000	7,000	5,000	72,000	12,000	460,000	**1,010,000**	86,000	130,000	696,000	**912,000**
2026	Dry	141,000	272,000	3,000	52,000	6,000	64,000	11,000	315,000	**864,000**	63,000	94,000	595,000	**753,000**
2027	Dry	141,000	272,000	3,000	49,000	6,000	67,000	11,000	343,000	**893,000**	68,000	103,000	587,000	**758,000**
2028	Dry	141,000	272,000	3,000	50,000	6,000	69,000	11,000	296,000	**847,000**	60,000	89,000	604,000	**753,000**
2029	Dry	141,000	272,000	3,000	55,000	6,000	66,000	11,000	223,000	**778,000**	50,000	75,000	577,000	**701,000**
2030	Shasta Critical	122,000	244,000	2,000	49,000	6,000	138,000	8,000	156,000	**725,000**	46,000	68,000	586,000	**700,000**
2031	Shasta Critical	122,000	244,000	2,000	51,000	6,000	136,000	8,000	173,000	**741,000**	49,000	74,000	584,000	**706,000**
2032	Wet	118,000	332,000	4,000	46,000	6,000	62,000	12,000	347,000	**925,000**	78,000	131,000	699,000	**909,000**
2033	Dry	141,000	272,000	3,000	60,000	6,000	68,000	11,000	196,000	**757,000**	50,000	75,000	565,000	**690,000**
2034	Wet	118,000	332,000	4,000	47,000	6,000	49,000	12,000	345,000	**913,000**	77,000	130,000	660,000	**867,000**
2035	Wet	118,000	332,000	4,000	48,000	6,000	55,000	12,000	342,000	**917,000**	76,000	126,000	695,000	**898,000**
2036	Wet	118,000	332,000	4,000	50,000	6,000	97,000	12,000	337,000	**955,000**	79,000	133,000	719,000	**931,000**
2037	Wet	118,000	332,000	4,000	49,000	6,000	58,000	12,000	382,000	**961,000**	85,000	146,000	654,000	**885,000**
2038	Average	126,000	310,000	3,000	53,000	6,000	105,000	10,000	199,000	**812,000**	59,000	99,000	593,000	**751,000**
2039	Average	126,000	310,000	3,000	52,000	6,000	123,000	10,000	171,000	**801,000**	54,000	86,000	615,000	**756,000**
2040	Dry	141,000	272,000	3,000	66,000	6,000	94,000	11,000	204,000	**797,000**	55,000	88,000	574,000	**717,000**
2041	Dry	141,000	272,000	3,000	62,000	7,000	99,000	11,000	158,000	**753,000**	49,000	73,000	573,000	**695,000**
2042	Average	126,000	310,000	3,000	51,000	6,000	104,000	10,000	207,000	**819,000**	59,000	97,000	608,000	**763,000**
2043	Dry	141,000	272,000	3,000	68,000	7,000	98,000	11,000	197,000	**797,000**	57,000	90,000	582,000	**729,000**
2044	Wet	118,000	332,000	4,000	53,000	6,000	70,000	12,000	320,000	**916,000**	77,000	129,000	663,000	**870,000**
2045	Wet	118,000	332,000	4,000	53,000	7,000	78,000	12,000	241,000	**844,000**	67,000	108,000	665,000	**840,000**

Land Surface Budget														
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows									Outflows			
		Surface Water Deliveries [1]				Groundwater Pumping		Tile Drainage	Precipitation	**Total Inflows**	Runoff [2]	Deep Percolation	Evapotranspiration	**Total Outflows**
		San Joaquin River	Central Valley Project	State Water Project	Local Supplies	Municipal & Industrial	Agricultural							
2046	Dry	141,000	272,000	3,000	68,000	7,000	100,000	11,000	112,000	**714,000**	44,000	61,000	560,000	**666,000**
2047	Dry	141,000	272,000	3,000	64,000	7,000	111,000	11,000	158,000	**768,000**	48,000	70,000	601,000	**719,000**
2048	Average	126,000	310,000	3,000	49,000	6,000	161,000	10,000	119,000	**786,000**	52,000	75,000	648,000	**775,000**
2049	Average	126,000	310,000	3,000	62,000	6,000	98,000	10,000	238,000	**854,000**	63,000	108,000	591,000	**762,000**
2050	Wet	118,000	332,000	4,000	54,000	7,000	83,000	12,000	259,000	**869,000**	66,000	105,000	685,000	**856,000**
2051	Dry	141,000	272,000	3,000	69,000	7,000	102,000	11,000	112,000	**718,000**	45,000	61,000	560,000	**666,000**
2052	Dry	141,000	272,000	3,000	67,000	7,000	97,000	11,000	149,000	**747,000**	47,000	66,000	570,000	**682,000**
2053	Shasta Critical	122,000	244,000	2,000	47,000	7,000	178,000	8,000	121,000	**728,000**	48,000	68,000	600,000	**716,000**
2054	Shasta Critical	122,000	244,000	2,000	34,000	7,000	187,000	8,000	138,000	**740,000**	40,000	55,000	563,000	**658,000**
2055	Dry	141,000	272,000	3,000	49,000	7,000	115,000	11,000	252,000	**851,000**	54,000	91,000	590,000	**735,000**
2056	Wet	118,000	332,000	4,000	46,000	7,000	109,000	12,000	279,000	**906,000**	67,000	112,000	699,000	**878,000**
2057	Wet	118,000	332,000	4,000	55,000	7,000	63,000	12,000	339,000	**930,000**	77,000	127,000	687,000	**891,000**
2058	Average	126,000	310,000	3,000	54,000	6,000	100,000	10,000	193,000	**803,000**	55,000	90,000	609,000	**754,000**
2059	Wet	118,000	332,000	4,000	55,000	7,000	62,000	12,000	345,000	**935,000**	78,000	130,000	685,000	**893,000**
2060	Dry	141,000	272,000	3,000	69,000	7,000	78,000	11,000	198,000	**779,000**	50,000	73,000	584,000	**706,000**
2061	Wet	118,000	332,000	4,000	55,000	7,000	61,000	12,000	347,000	**936,000**	77,000	128,000	688,000	**894,000**
2062	Average	126,000	310,000	3,000	58,000	6,000	100,000	10,000	192,000	**806,000**	56,000	90,000	609,000	**755,000**
2063	Average	126,000	310,000	3,000	54,000	6,000	99,000	10,000	197,000	**806,000**	56,000	91,000	609,000	**756,000**
2064	Dry	141,000	272,000	3,000	70,000	7,000	77,000	11,000	211,000	**792,000**	51,000	76,000	585,000	**712,000**
2065	Average	126,000	310,000	3,000	58,000	6,000	98,000	10,000	206,000	**818,000**	57,000	94,000	609,000	**760,000**
2066	Wet	118,000	332,000	4,000	55,000	7,000	63,000	12,000	340,000	**931,000**	77,000	127,000	687,000	**891,000**
2067	Wet	118,000	332,000	4,000	55,000	7,000	61,000	12,000	349,000	**938,000**	78,000	130,000	687,000	**895,000**
2068	Dry	141,000	272,000	3,000	69,000	7,000	75,000	11,000	205,000	**782,000**	50,000	73,000	586,000	**709,000**
2069	Dry	141,000	272,000	3,000	66,000	7,000	75,000	11,000	210,000	**785,000**	50,000	75,000	586,000	**712,000**
2070	Wet	118,000	332,000	4,000	55,000	7,000	62,000	12,000	344,000	**933,000**	77,000	128,000	687,000	**892,000**
Projected Average		**124,000**	**295,000**	**3,000**	**45,000**	**6,000**	**96,000**	**11,000**	**250,000**	**830,000**	**61,000**	**95,000**	**622,000**	**778,000**

[1] Projects & Management Actions aim to increase the amount of Surface Water transfers between GSA Member Agencies by approximately 45,000 AFY. The source of these Surface Water volumes is yet to be determined. The total volume of these transfers will not exceed the cumulative volumes remaining after demands are met within each GSA Member Agency. For a more detailed explanation of these Projects & Management Actions, see **Section 7.1** of the *Sustainability Implementation* chapter.

[2] Runoff includes return flows to all surface water sources leaving the Plan area. Return flows were not separated due to model limitations.

Table 5-33. Groundwater Budget, Projected Water Budget with Climate Change and Projects & Management Actions (AFY)

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	Total Inflows	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	Total Outflows
2014	Shasta Critical	63,000	45,000	24,000	132,000	212,000	8,000	65,000	34,000	319,000
2015	Shasta Critical	49,000	45,000	24,000	118,000	200,000	8,000	65,000	34,000	308,000
2016	Dry	93,000	45,000	24,000	162,000	134,000	11,000	65,000	34,000	244,000
2017	Wet	88,000	73,000	38,000	199,000	129,000	12,000	56,000	30,000	228,000
2018	Average	75,000	51,000	27,000	153,000	118,000	10,000	62,000	33,000	223,000
2019	Wet	108,000	73,000	38,000	220,000	81,000	12,000	56,000	30,000	179,000
2020	Dry	67,000	45,000	24,000	136,000	115,000	11,000	65,000	34,000	226,000
2021	Wet	119,000	73,000	38,000	231,000	80,000	12,000	56,000	30,000	179,000
2022	Wet	128,000	73,000	38,000	239,000	75,000	12,000	56,000	30,000	173,000
2023	Average	100,000	51,000	27,000	179,000	103,000	10,000	62,000	33,000	208,000
2024	Dry	92,000	45,000	24,000	161,000	111,000	11,000	65,000	34,000	222,000
2025	Wet	130,000	73,000	38,000	241,000	78,000	12,000	56,000	30,000	176,000
2026	Dry	94,000	45,000	24,000	164,000	70,000	11,000	65,000	34,000	180,000
2027	Dry	103,000	45,000	24,000	172,000	73,000	11,000	65,000	34,000	183,000
2028	Dry	89,000	45,000	24,000	158,000	74,000	11,000	65,000	34,000	185,000
2029	Dry	75,000	45,000	24,000	144,000	72,000	11,000	65,000	34,000	183,000
2030	Shasta Critical	68,000	45,000	24,000	137,000	144,000	8,000	65,000	34,000	251,000
2031	Shasta Critical	74,000	45,000	24,000	143,000	142,000	8,000	65,000	34,000	249,000
2032	Wet	131,000	73,000	38,000	243,000	67,000	12,000	56,000	30,000	166,000
2033	Dry	75,000	45,000	24,000	144,000	74,000	11,000	65,000	34,000	185,000
2034	Wet	130,000	73,000	38,000	242,000	55,000	12,000	56,000	30,000	153,000
2035	Wet	126,000	73,000	38,000	238,000	61,000	12,000	56,000	30,000	160,000
2036	Wet	133,000	73,000	38,000	244,000	102,000	12,000	56,000	30,000	201,000
2037	Wet	146,000	73,000	38,000	258,000	64,000	12,000	56,000	30,000	163,000
2038	Average	99,000	51,000	27,000	178,000	111,000	10,000	62,000	33,000	216,000
2039	Average	86,000	51,000	27,000	164,000	129,000	10,000	62,000	33,000	234,000
2040	Dry	88,000	45,000	24,000	157,000	100,000	11,000	65,000	34,000	211,000
2041	Dry	73,000	45,000	24,000	143,000	106,000	11,000	65,000	34,000	216,000
2042	Average	97,000	51,000	27,000	176,000	110,000	10,000	62,000	33,000	216,000
2043	Dry	90,000	45,000	24,000	160,000	104,000	11,000	65,000	34,000	215,000
2044	Wet	129,000	73,000	38,000	241,000	77,000	12,000	56,000	30,000	176,000
2045	Wet	108,000	73,000	38,000	220,000	84,000	12,000	56,000	30,000	183,000
2046	Dry	61,000	45,000	24,000	131,000	107,000	11,000	65,000	34,000	218,000

Groundwater Budget										
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Inflows				Outflows				
		Deep Percolation	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Inflows**	Groundwater Pumping	Tile Drainage	Upper Aquifer Underflows	Lower Aquifer Underflows	**Total Outflows**
2047	Dry	70,000	*45,000*	*24,000*	**139,000**	*118,000*	*11,000*	*65,000*	*34,000*	**229,000**
2048	Average	75,000	*51,000*	*27,000*	**154,000**	*168,000*	*10,000*	*62,000*	*33,000*	**273,000**
2049	Average	108,000	*51,000*	*27,000*	**187,000**	*104,000*	*10,000*	*62,000*	*33,000*	**209,000**
2050	Wet	105,000	*73,000*	*38,000*	**216,000**	*90,000*	*12,000*	*56,000*	*30,000*	**189,000**
2051	Dry	61,000	*45,000*	*24,000*	**131,000**	*109,000*	*11,000*	*65,000*	*34,000*	**220,000**
2052	Dry	66,000	*45,000*	*24,000*	**135,000**	*104,000*	*11,000*	*65,000*	*34,000*	**214,000**
2053	Shasta Critical	68,000	*45,000*	*24,000*	**138,000**	*185,000*	*8,000*	*65,000*	*34,000*	**292,000**
2054	Shasta Critical	55,000	*45,000*	*24,000*	**125,000**	*194,000*	*8,000*	*65,000*	*34,000*	**301,000**
2055	Dry	91,000	*45,000*	*24,000*	**161,000**	*122,000*	*11,000*	*65,000*	*34,000*	**233,000**
2056	Wet	112,000	*73,000*	*38,000*	**223,000**	*116,000*	*12,000*	*56,000*	*30,000*	**215,000**
2057	Wet	127,000	*73,000*	*38,000*	**239,000**	*70,000*	*12,000*	*56,000*	*30,000*	**169,000**
2058	Average	90,000	*51,000*	*27,000*	**168,000**	*106,000*	*10,000*	*62,000*	*33,000*	**212,000**
2059	Wet	130,000	*73,000*	*38,000*	**242,000**	*69,000*	*12,000*	*56,000*	*30,000*	**167,000**
2060	Dry	73,000	*45,000*	*24,000*	**143,000**	*85,000*	*11,000*	*65,000*	*34,000*	**196,000**
2061	Wet	128,000	*73,000*	*38,000*	**240,000**	*68,000*	*12,000*	*56,000*	*30,000*	**167,000**
2062	Average	90,000	*51,000*	*27,000*	**169,000**	*106,000*	*10,000*	*62,000*	*33,000*	**212,000**
2063	Average	91,000	*51,000*	*27,000*	**169,000**	*105,000*	*10,000*	*62,000*	*33,000*	**210,000**
2064	Dry	76,000	*45,000*	*24,000*	**145,000**	*84,000*	*11,000*	*65,000*	*34,000*	**195,000**
2065	Average	94,000	*51,000*	*27,000*	**172,000**	*104,000*	*10,000*	*62,000*	*33,000*	**210,000**
2066	Wet	127,000	*73,000*	*38,000*	**239,000**	*70,000*	*12,000*	*56,000*	*30,000*	**169,000**
2067	Wet	130,000	*73,000*	*38,000*	**241,000**	*68,000*	*12,000*	*56,000*	*30,000*	**166,000**
2068	Dry	73,000	*45,000*	*24,000*	**143,000**	*82,000*	*11,000*	*65,000*	*34,000*	**192,000**
2069	Dry	75,000	*45,000*	*24,000*	**145,000**	*82,000*	*11,000*	*65,000*	*34,000*	**193,000**
2070	Wet	128,000	*73,000*	*38,000*	**240,000**	*68,000*	*12,000*	*56,000*	*30,000*	**167,000**
Projected Average		**95,000**	**56,000**	**30,000**	**181,000**	**102,000**	**11,000**	**62,000**	**32,000**	**207,000**

Table 5-34. Change in Storage, Projected Water Budget with Climate Change and Projects & Management Actions (AFY)

Groundwater Budget				
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage		
		Upper Aquifer	Lower Aquifer	**Total Change in Storage**
2014	Shasta Critical	(135,000)	(29,000)	**(164,000)**
2015	Shasta Critical	(123,000)	(26,000)	**(148,000)**
2016	Dry	(87,000)	(10,000)	**(97,000)**
2017	Wet	(17,000)	(6,000)	**(23,000)**
2018	Average	43,000	14,000	**57,000**
2019	Wet	9,000	9,000	**18,000**
2020	Dry	(112,000)	(17,000)	**(129,000)**
2021	Wet	22,000	10,000	**31,000**
2022	Wet	40,000	19,000	**58,000**
2023	Average	80,000	31,000	**110,000**
2024	Dry	(84,000)	(4,000)	**(88,000)**
2025	Wet	39,000	21,000	**60,000**
2026	Dry	(45,000)	2,000	**(43,000)**
2027	Dry	(39,000)	5,000	**(35,000)**
2028	Dry	(48,000)	0	**(48,000)**
2029	Dry	(60,000)	(7,000)	**(67,000)**
2030	Shasta Critical	(80,000)	(10,000)	**(90,000)**
2031	Shasta Critical	(73,000)	(8,000)	**(81,000)**
2032	Wet	57,000	12,000	**69,000**
2033	Dry	(63,000)	(13,000)	**(75,000)**
2034	Wet	52,000	10,000	**62,000**
2035	Wet	55,000	13,000	**68,000**
2036	Wet	65,000	18,000	**83,000**
2037	Wet	52,000	10,000	**63,000**
2038	Average	92,000	20,000	**112,000**
2039	Average	81,000	17,000	**99,000**
2040	Dry	(63,000)	(11,000)	**(74,000)**
2041	Dry	(68,000)	(13,000)	**(81,000)**
2042	Average	95,000	21,000	**116,000**
2043	Dry	(55,000)	(9,000)	**(63,000)**
2044	Wet	53,000	10,000	**64,000**
2045	Wet	31,000	6,000	**37,000**
2046	Dry	(79,000)	(16,000)	**(96,000)**

Groundwater Budget				
Simulated Water Year	Delta-Mendota Subbasin Water Year Type	Change in Storage		
		Upper Aquifer	Lower Aquifer	**Total Change in Storage**
2047	Dry	(63,000)	(11,000)	**(75,000)**
2048	Average	68,000	17,000	**85,000**
2049	Average	90,000	22,000	**112,000**
2050	Wet	37,000	6,000	**43,000**
2051	Dry	(82,000)	(17,000)	**(100,000)**
2052	Dry	(80,000)	(14,000)	**(94,000)**
2053	Shasta Critical	(94,000)	(15,000)	**(109,000)**
2054	Shasta Critical	(97,000)	(19,000)	**(116,000)**
2055	Dry	(69,000)	(7,000)	**(76,000)**
2056	Wet	43,000	11,000	**55,000**
2057	Wet	46,000	13,000	**59,000**
2058	Average	86,000	21,000	**107,000**
2059	Wet	51,000	13,000	**65,000**
2060	Dry	(71,000)	(10,000)	**(80,000)**
2061	Wet	51,000	14,000	**64,000**
2062	Average	86,000	21,000	**108,000**
2063	Average	89,000	22,000	**110,000**
2064	Dry	(64,000)	(8,000)	**(73,000)**
2065	Average	94,000	23,000	**117,000**
2066	Wet	46,000	13,000	**59,000**
2067	Wet	53,000	14,000	**67,000**
2068	Dry	(66,000)	(9,000)	**(75,000)**
2069	Dry	(63,000)	(8,000)	**(71,000)**
2070	Wet	50,000	13,000	**63,000**
Projected Average		**(4,000)**	**3,000**	**(1,000)**

5.4.8 Historic and Current Water Budgets

The historic water budget is a quantitative evaluation of historic hydrology, water supply, water demand, and land use information covering the 10-year period from WY2003 to WY2012. The current water budget (WY2013) quantifies the same information for current inflows and outflows for the Plan area using the most recent hydrology, water supply, water demand, and land use information. The goal of the water budget analysis is to characterize water supply and demand while summarizing hydrologic conditions and flows within the Plan area, including the movement of all primary sources of water such as rainfall, irrigation, streamflow, and subsurface flow.

Figure 5-122 and **Figure 5-123**, respectively, summarize the average annual historic and current land surface inflows and outflows in the Northern and Central Delta-Mendota Regions. **Figure 5-124** shows the annual time series of historic and current land surface inflows and outflows.

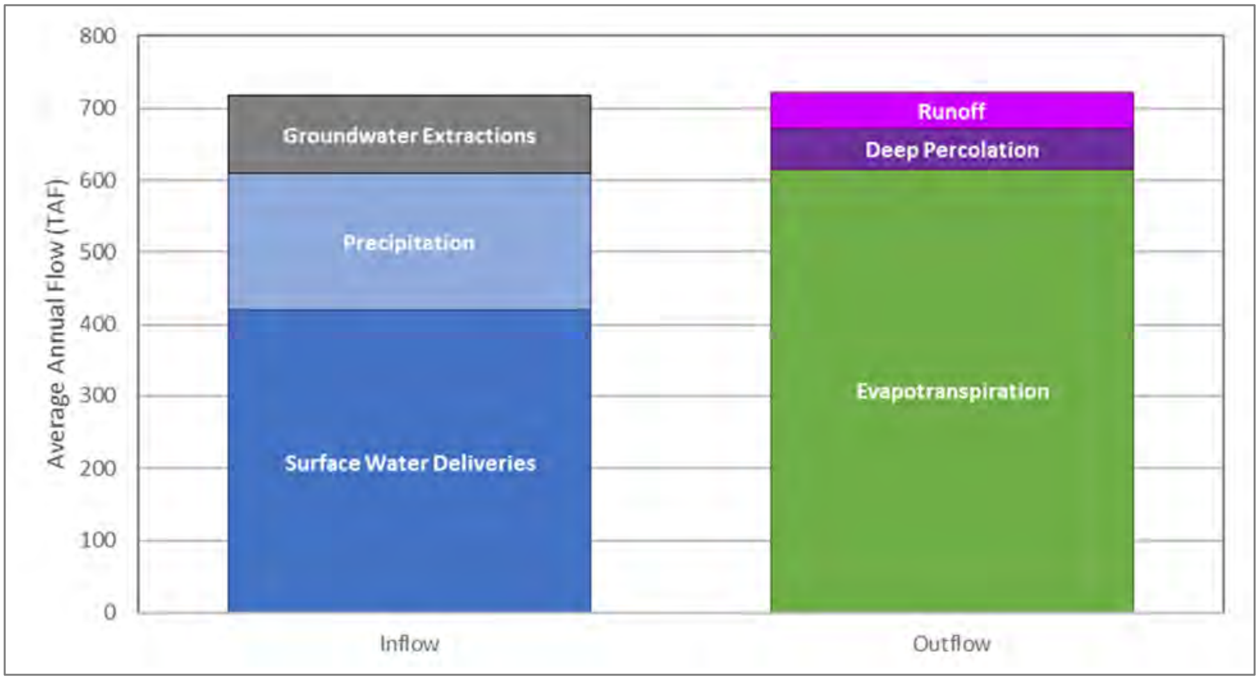

Figure 5-122. Average Historic Land Surface Budget (WY2003-2012)

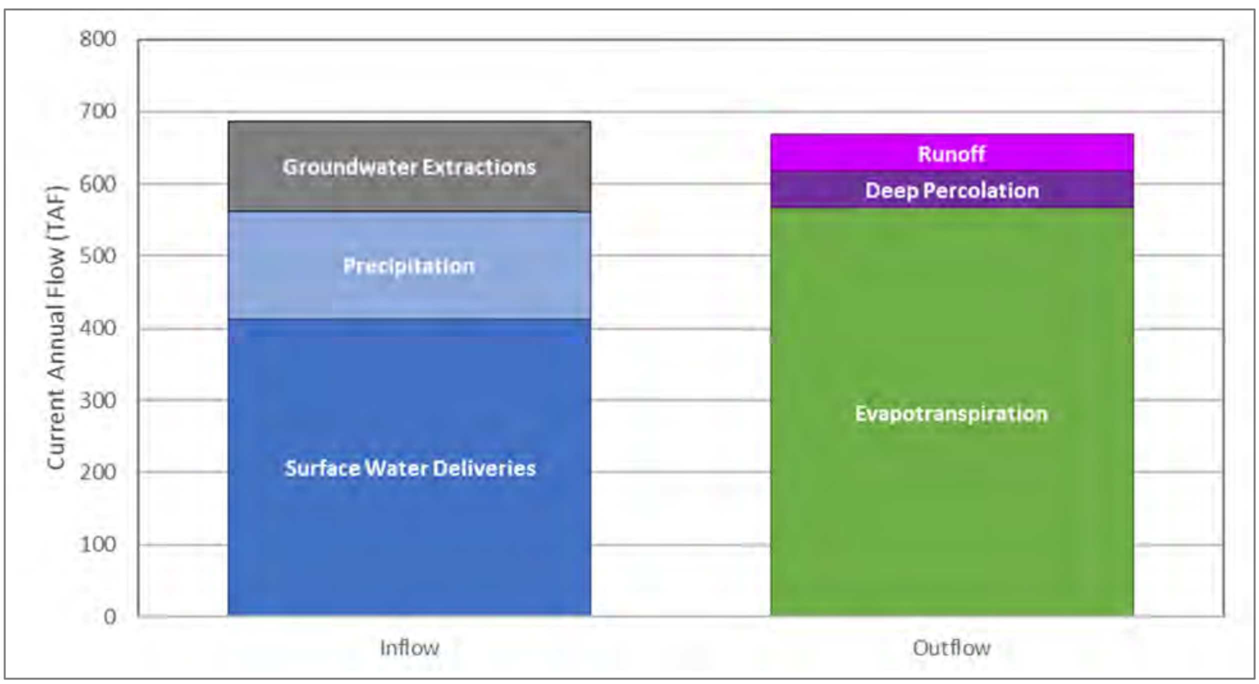

Figure 5-123. Current Land Surface Budget (WY2013)

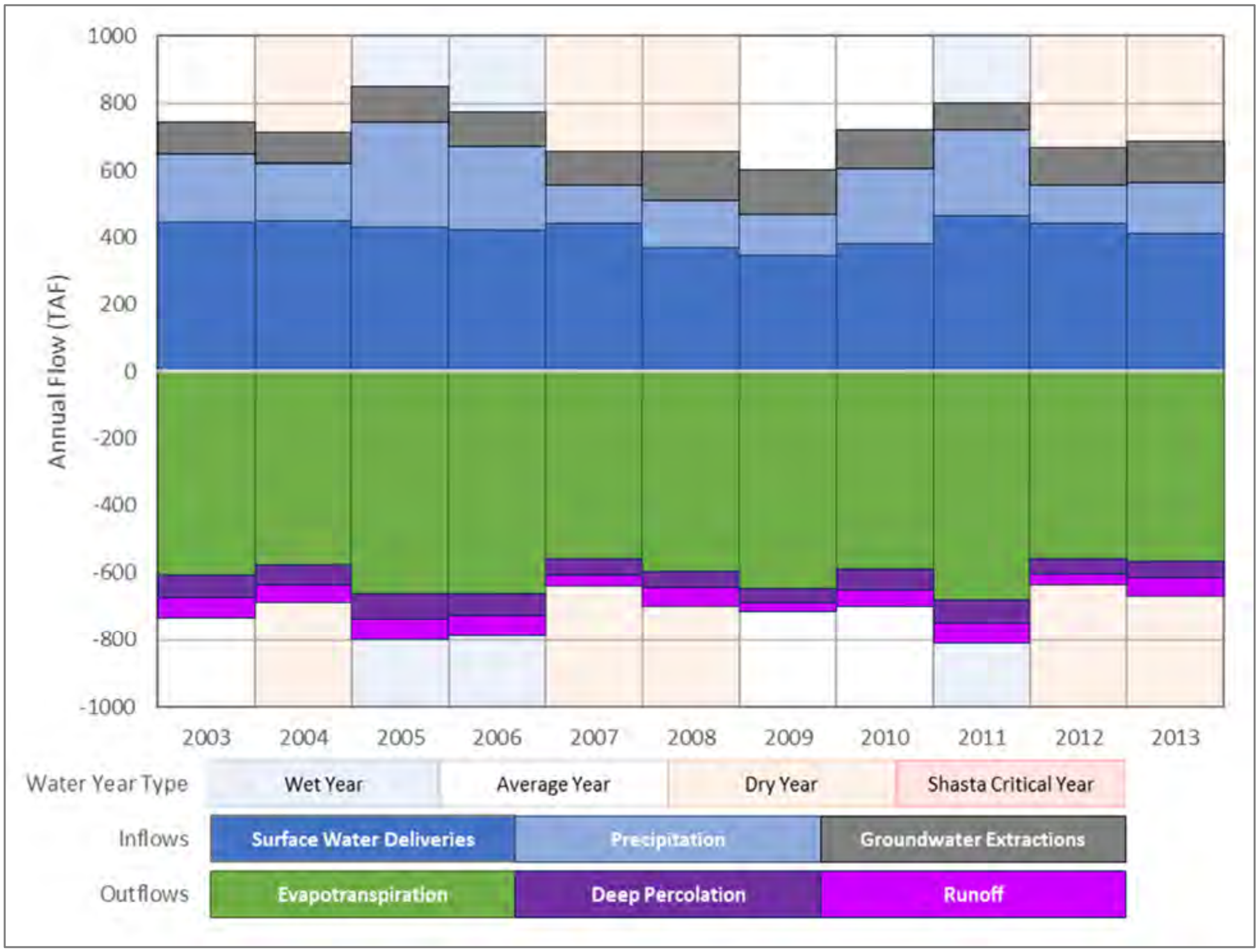

Figure 5-124. Annual Land Surface Budget Over Historic and Current Periods

The land surface budget estimated that the Northern and Central Delta-Mendota Regions experienced about 718,000 AFY of inflows on average between WY2003 and WY2012, including a combination of surface water deliveries (419,000 AFY), applied groundwater (pumped) (108,000 AFY), and precipitation (191,000 AFY) (**Figure 5-122**). Outflows from the land surface system were estimated to be similar in magnitude to inflows (722,000 AFY total) and are comprised of runoff (49,000 AFY), deep percolation (58,000 AFY), and evapotranspiration (615,000 AFY). Under current water year conditions (WY2013), total inflow to the land surface system was estimated to exceed outflows by approximately 16,000 acre-feet (AF) (685,000 AF and 669,000 AF, respectively) (**Figure 5-123**). During WY2013, inflows consisted of surface water deliveries (413,000 AF), applied groundwater (123,000 AF), and precipitation (149,000 AF), while outflows consisted of runoff (51,000 AF), deep percolation (50,000 AF) and evapotranspiration (568,000 AF).

Annual inflows and outflows in the land surface budget during the historic and current water budget period ranged from 602,000 AF (WY2009) to 848,000 AF (WY2005) and 634,000 AF (WY2012) to 811,000 AF (WY2011), respectively (**Figure 5-124**). The highest annual inflow and outflow were experienced during wet water years (WY2005, 2006, and 2011) when precipitation and surface water deliveries are highest. The least inflow and outflow from the land surface system was estimated to occur during dry years and years immediately following consecutive dry years as groundwater pumping increased but did not meet the entire surface water delivery deficit. Overall, inflows and outflows in the land surface budget were mostly balanced on an annual basis from WY2003 through WY2013.

Figure 5-125 and **Figure 5-126**, respectively, summarize the average annual historic and current groundwater inflows and outflows in the Northern and Central Delta-Mendota Regions. **Figure 5-127** shows the annual time series of historic and current groundwater inflows and outflows.

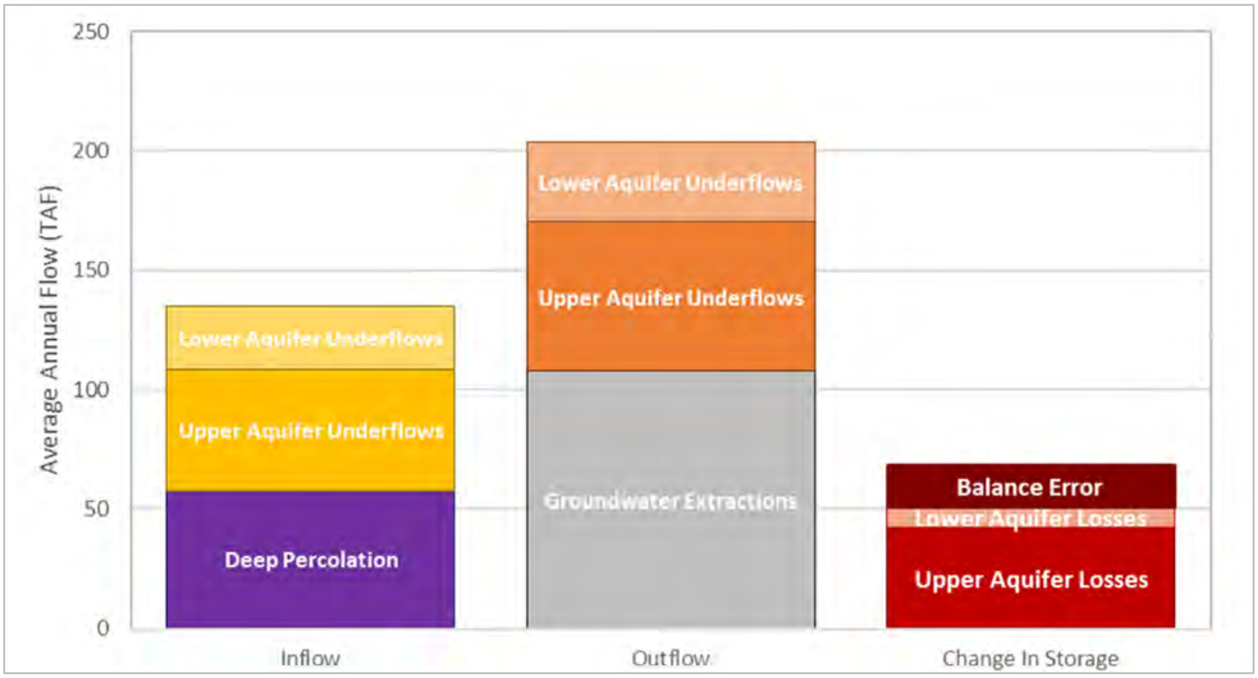

Figure 5-125. Average Historic Groundwater Budget (WY2003-2012)

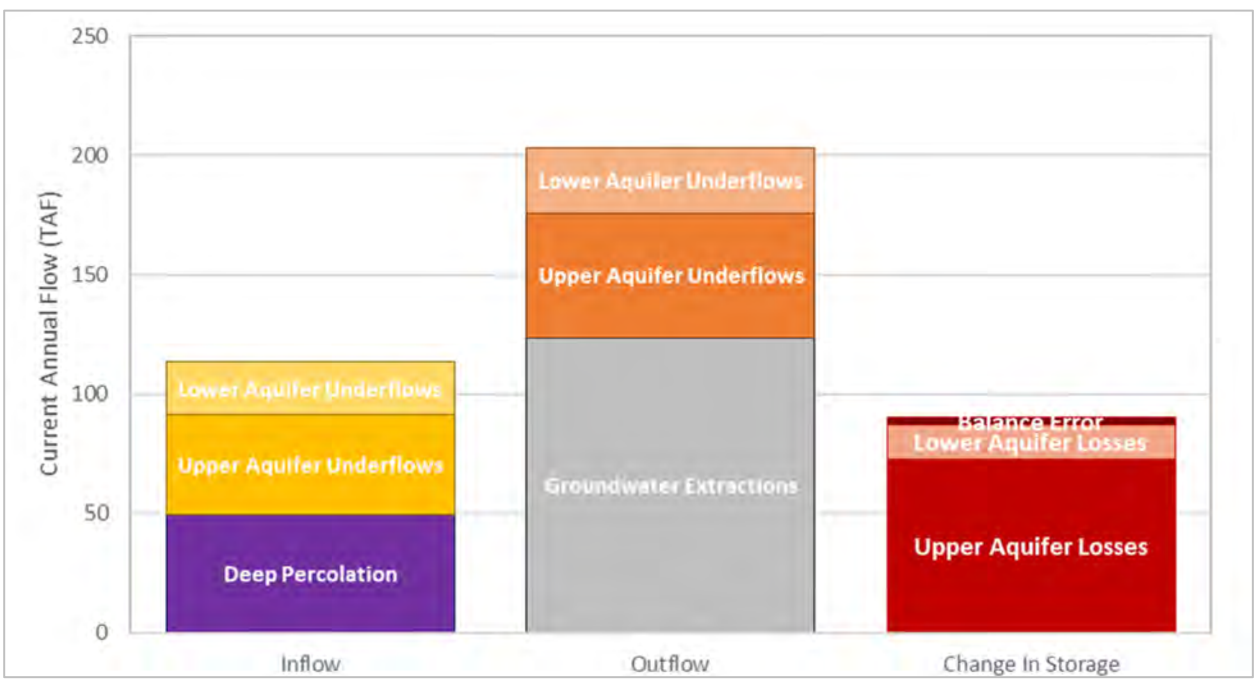

Figure 5-126. Current Groundwater Budget (WY2013)

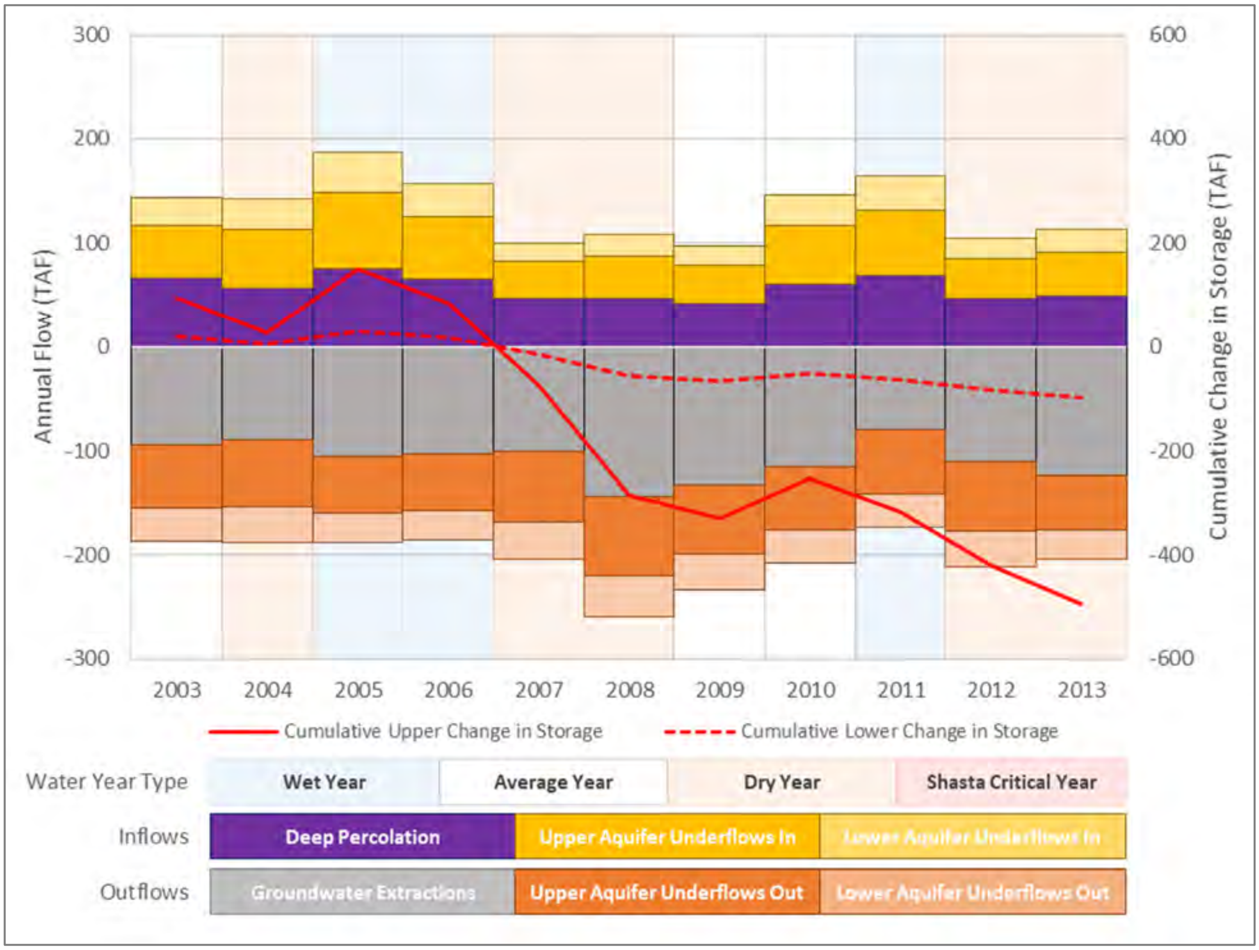

Figure 5-127. Historic and Current Annual Groundwater Budget

The groundwater budget estimated that the Northern and Central Delta-Mendota Regions experienced 136,000 AFY of total inflow on average during the historic water budget period, which includes 58,000 AFY of deep percolation, 51,000 AFY of Upper Aquifer underflows, and 27,000 AFY of Lower Aquifer underflows (**Figure 5-125**). Outflows from the groundwater system were estimated to be 204,000 AFY on average, which includes 108,000 AFY of groundwater pumping, 30 AFY of tile drainage, 63,000 AFY of Upper Aquifer underflows, and 33,000 AFY of Lower Aquifer underflow. In WY2013 (current condition), a total of 114,000 AF of inflow to the Northern and Central Delta-Mendota Regions was estimated to be comprised of 50,000 AF of deep percolation, 42,000 AF of Upper Aquifer underflows, and 22,000 AF of Lower Aquifer underflows (**Figure 5-126**). Estimated outflows from the groundwater system in WY2013 totaled 203,000 AF and was comprised of 124,000 AF of groundwater pumping, 30 AFY of tile drainage, 52,000 AF of Upper Aquifer underflows, and 27,000 AF of Lower Aquifer underflows. Overall, there is estimated to be 68,000 AFY and 89,000 AFY greater outflow than inflow under historic and current conditions, respectively. This includes balance error, Upper Aquifer losses, and Lower Aquifer losses.

On average, outflows were estimated to be greater than inflows throughout the historic and current water budget periods, meaning inflows did not meet the entire groundwater demand and resulted in decreased groundwater storage. This pattern is observed annually regardless of water year type, but the negative balance between inflows and outflows is less during wet years as compared to dry and normal years (**Figure 5-127**). Within the Northern and Central Delta-Mendota Regions, estimated average annual change in storage (i.e. overdraft) was -42,000 AFY in the Upper Aquifer and -8,000 AFY in the Lower Aquifer over the historic water budget period (50,000 AFY of total overdraft). During the current budget period, estimated Upper Aquifer storage decreased by 73,000 AF and Lower Aquifer storage decreased by 15,000 AF. Cumulative change in storage over the historic and current water budget periods in the Upper Aquifer and Lower Aquifer show overall downward trends (**Figure 5-127**). Between the beginning of WY2003 and WY2012, the estimated cumulative change in storage within the Upper Aquifer was -1.33 AF/acre, and -0.27 AF/acre in the Lower Aquifer (over the 316,000-acre Plan area). In WY2013, the estimated change in storage within the Upper Aquifer was -0.23 AF/acre and -0.05 AF/acre in the Lower Aquifer. Therefore, overdraft within the Northern and Central Delta-Mendota Regions is largely driven by conditions in the Upper Aquifer.

5.4.9 Projected Baseline Water Budget

The projected baseline water budget is used to estimate future (WY2014-2070) baseline conditions of supply, demand, and aquifer response to Plan implementation. More specifically, the baseline projected water budget was prepared to evaluate potential impacts from future changes in land use, cropping patterns, surface water supplies and groundwater demands, independent of climate change and mitigation measures (e.g. projects and management actions). Average annual historic hydrologic conditions were applied by water year type to each projected water year in correlation with the assigned representative water year.

Figure 5-128 summarizes the average annual projected baseline land surface inflows and outflows in the Northern and Central Delta-Mendota Regions. **Figure 5-129** shows the annual time series of projected baseline land surface inflows and outflows.

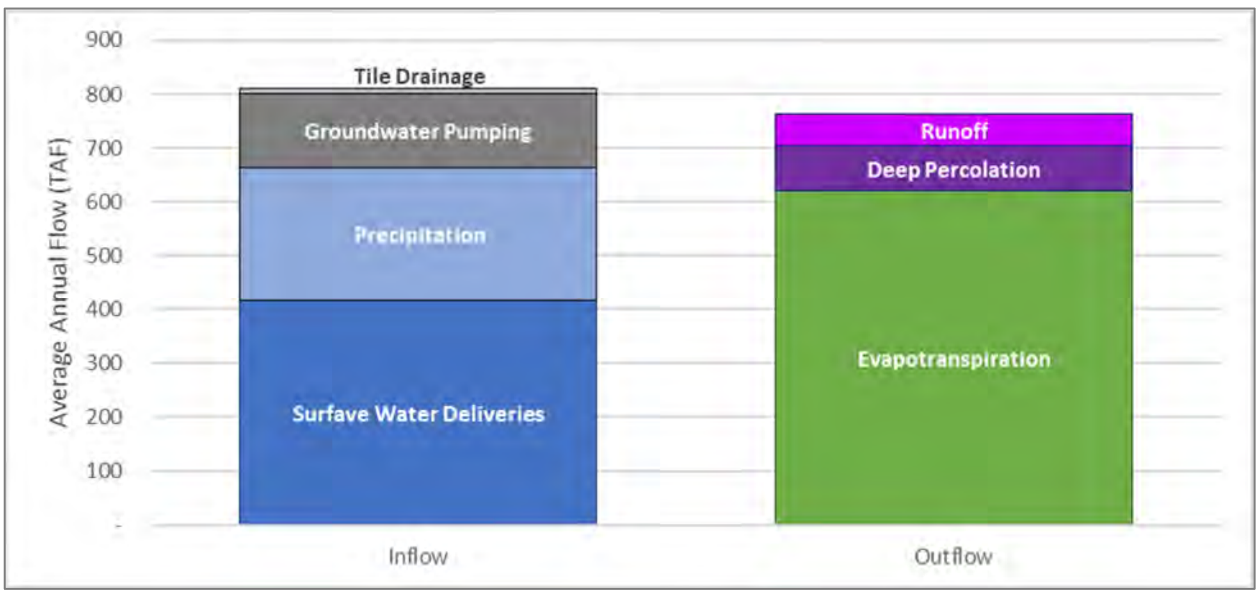

Figure 5-128. Projected Baseline Average Annual Land Surface Budget (WY2014-2070)

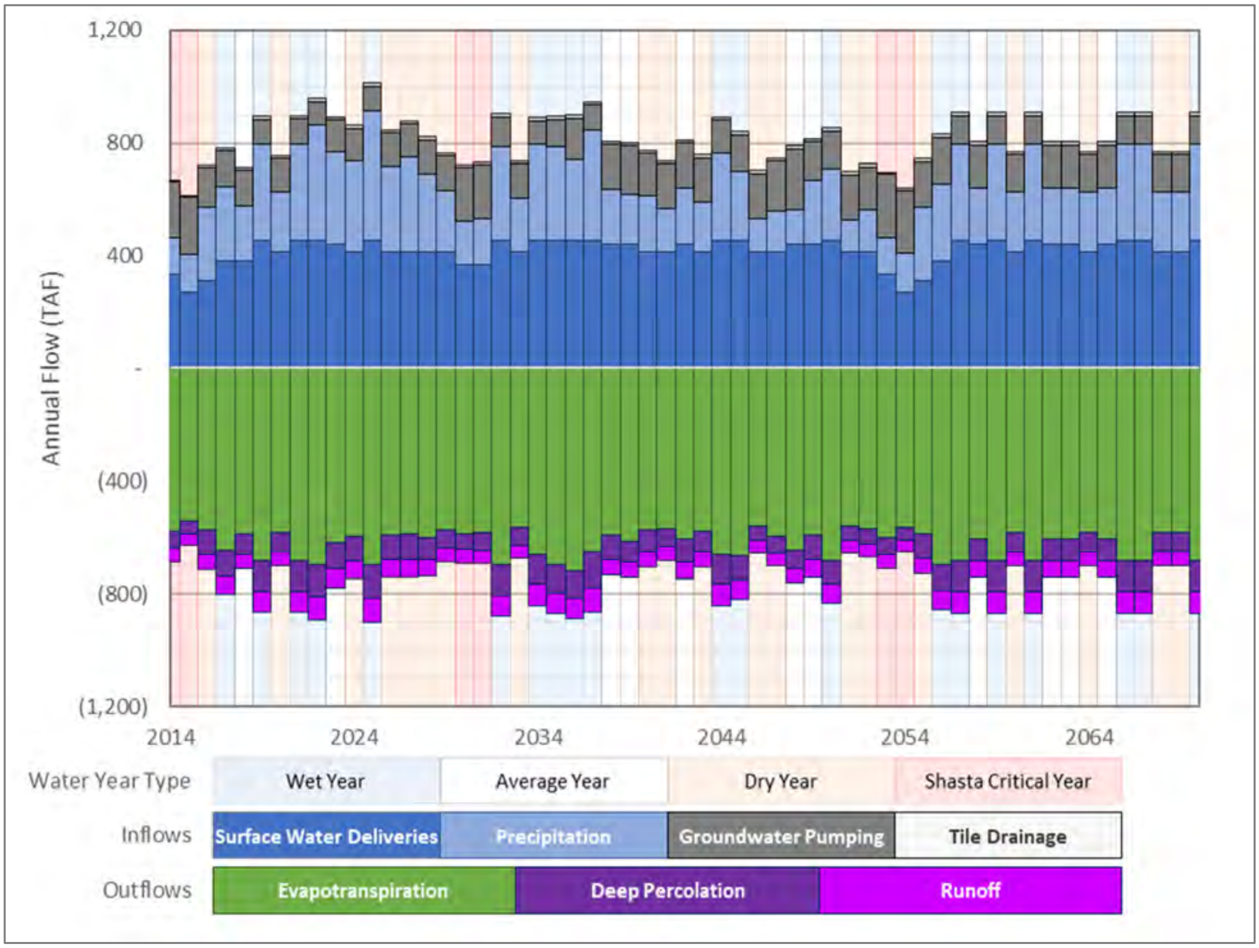

Figure 5-129. Projected Baseline Annual Land Surface Budget (WY2014-2070)

The land surface budget under projected baseline conditions shows inflows exceeding outflows on average by 53,000 AFY, where total average inflows and outflows are 817,000 AFY and 764,000 AFY, respectively (**Figure 5-128**). Inflows are comprised of surface water deliveries (422,000 AFY), applied groundwater (pumped) (138,000 AFY), tile drainage (11,000 AFY), and precipitation (246,000 AFY). Outflows are comprised of runoff (61,000 AFY), deep percolation (83,000 AFY), and evapotranspiration (620,000 AFY).

Annual inflows and outflows in the land surface budget during the projected baseline water budget period range from 615,000 AF (WY2015) to 1,012,000 AF (WY2025) and 628,000 AF (WY2015) to 902,000 AF (WY2025), respectively (**Figure 5-129**). Inflows and outflows from the land surface system are estimated to be largely balanced over the projected baseline water budget time period. Shasta Critical water years and dry water years preceding Shasta Critical water years show the least amount of inflow and outflow from the land surface system due to reduced surface water availability and precipitation. **Figure 5-130** summarizes the average annual projected baseline groundwater inflows and outflows in the Northern and Central Delta-Mendota Regions. **Figure 5-131** shows the annual time series of projected baseline inflows and outflows.

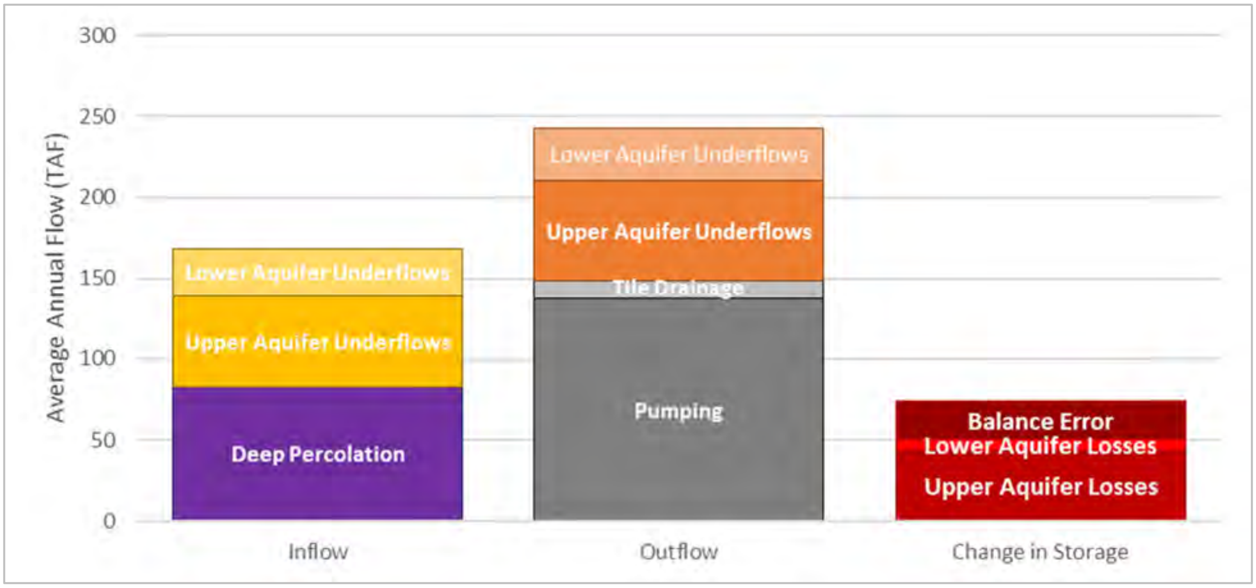

Figure 5-130. Projected Baseline Average Annual Groundwater Budget (WY2014-2070)

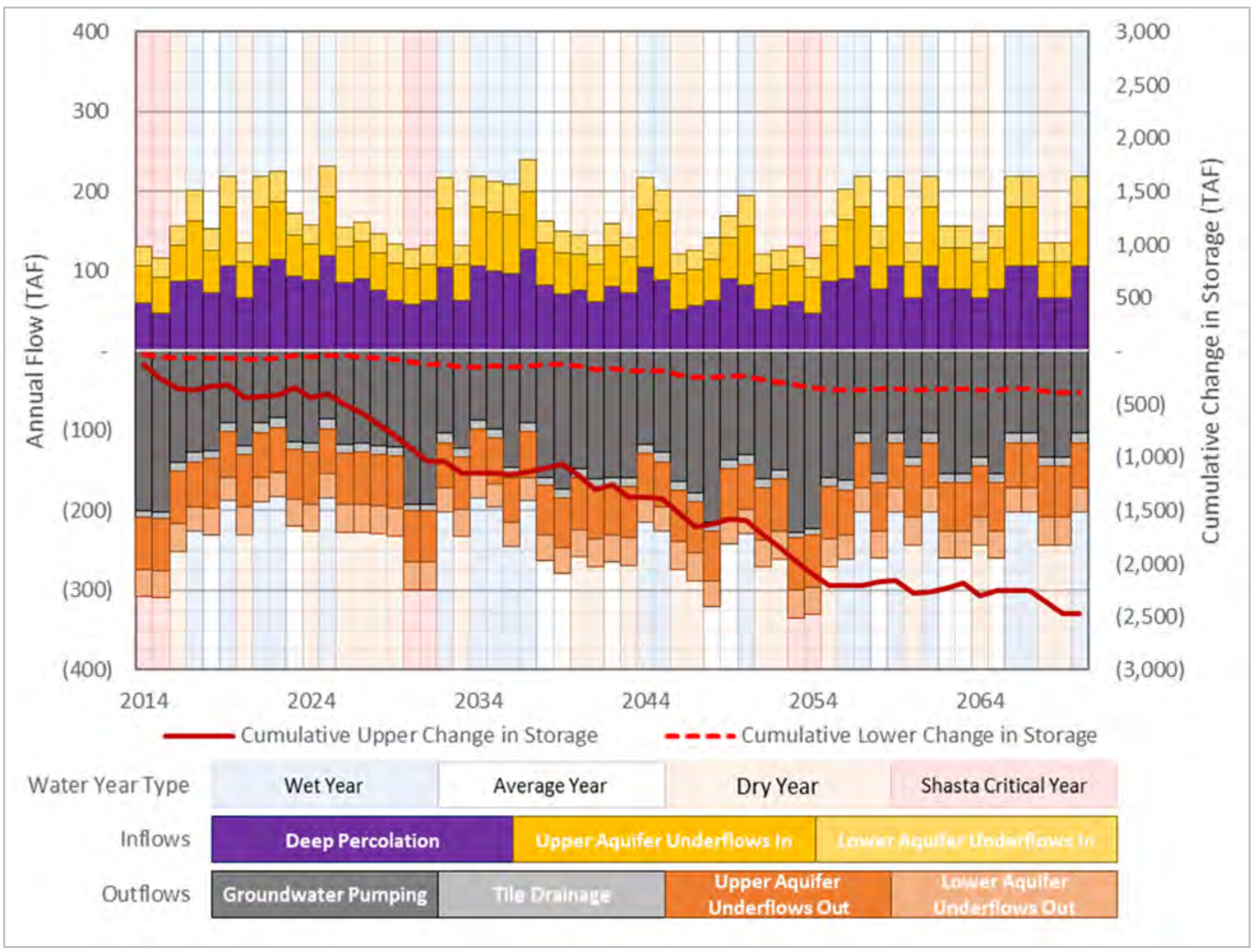

Figure 5-131. Projected Baseline Annual Groundwater Budget (WY2014-2070)

Under projected baseline conditions, the Northern and Central Delta-Mendota Regions are estimated to experience, on average, 169,000 AFY of inflow, of which 83,000 AFY is from deep percolation, 56,000 AFY is from Upper Aquifer underflows, and 30,000 AFY is from Lower Aquifer underflows (**Figure 5-130**). A total average annual outflow under the same conditions of 243,000 AFY consists of 138,000 AFY from groundwater pumping, 11,000 AFY from tile drainage, 62,000 AFY of Upper Aquifer underflows, and 32,000 AFY of Lower Aquifer underflows. Overall, there is 74,000 AFY greater outflow than inflow under projected baseline conditions that includes balance error, Upper Aquifer losses, and Lower Aquifer losses.

On average, outflows are estimated to be greater than inflows under projected baseline conditions, meaning continual declines in groundwater storage persist in the Northern and Central Delta-Mendota Regions. From WY2014 to WY2070, average annual change in storage is -43,000 AFY in the Upper Aquifer and -7,000 AFY in the Lower Aquifer (-50,000 AFY total). Cumulative change in storage in both the Upper and Lower Aquifer show overall declining trends over the baseline projected water budget period (**Figure 5-131**). By WY2070, cumulative change in storage in the Upper Aquifer and Lower Aquifer are -7.80 AF/acre and -1.24 AF/acre, respectively. Declines in groundwater storage in the Upper Aquifer continues to be dominant within the Northern and Central Delta-Mendota Regions over the projected baseline water budget period.

5.4.10 Projected Water Budget with Climate Change

The projected water budget with climate change is used to estimate future conditions of supply, demand, and aquifer response to Plan implementation without projects and management actions as precipitation, evapotranspiration, and streamflow patterns change. The projected water budget with CCF applied is used to evaluate projected baseline conditions with where applied climate change factors for precipitation and evapotranspiration provided by the California Department of Water Resources (DWR) (2018) and surface water delivery projections from local water purveyors were utilized from WY2014 through WY2070.

Figure 5-132 summarizes the average annual projected land surface inflows and outflows with CCF applied in the Northern and Central Delta-Mendota Regions. **Figure 5-133** shows the annual time series of projected land surface inflows and outflows with climate change.

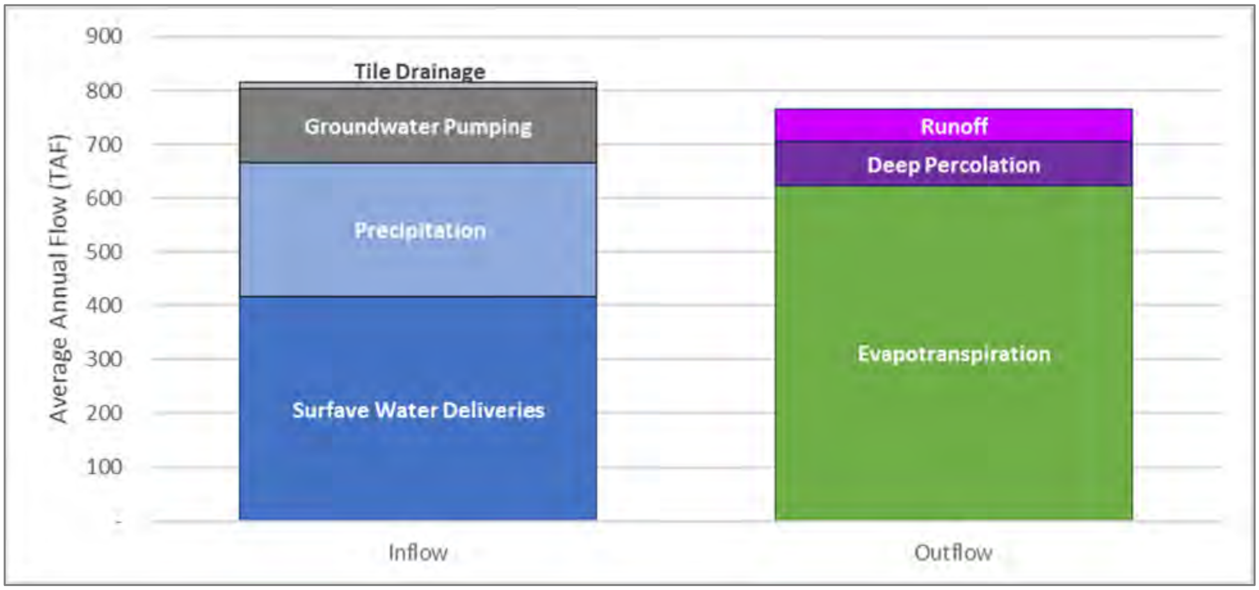

Figure 5-132. Projected Average Annual Land Surface Budget with Climate Change (WY2014-2070)

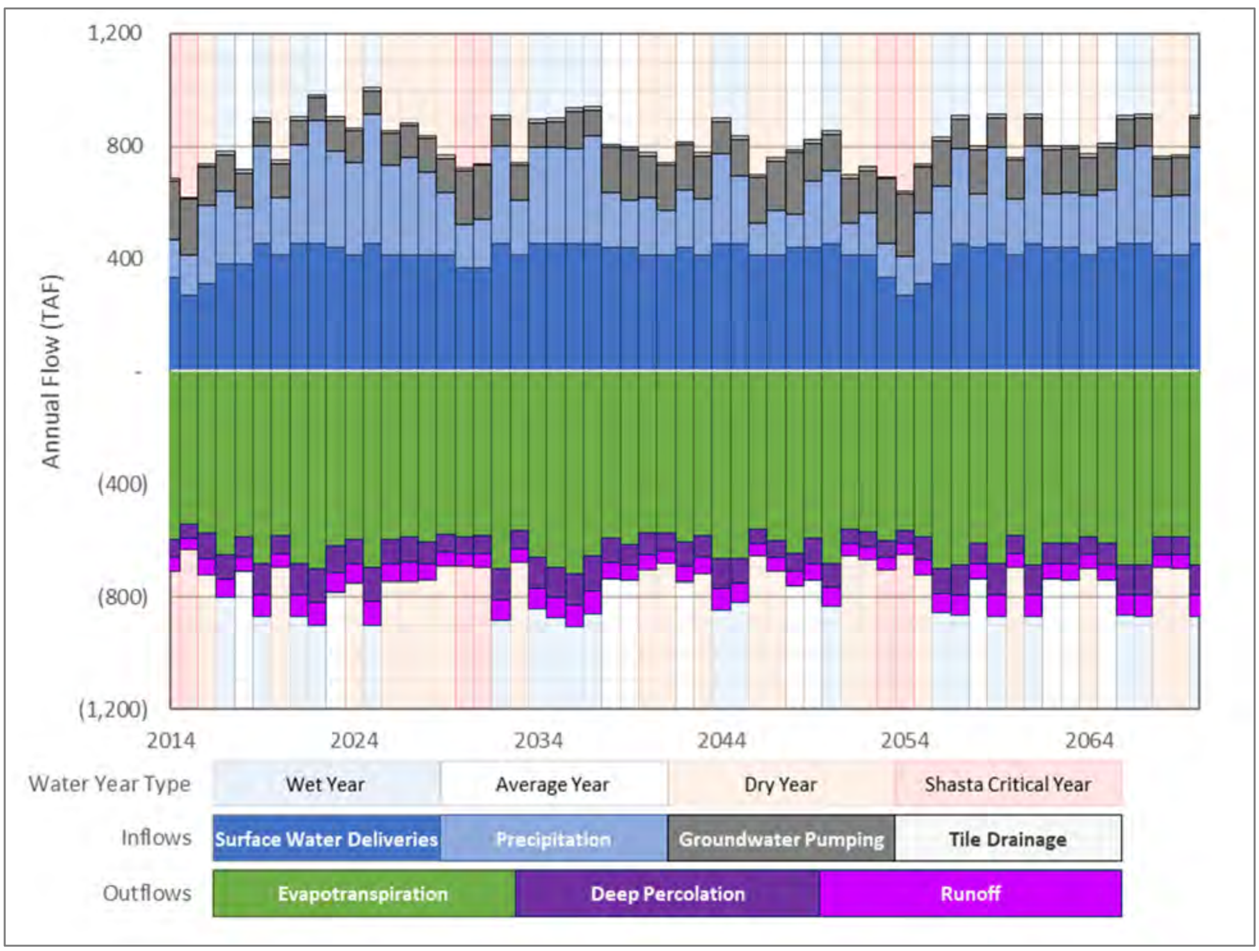

Figure 5-133. Projected Annual Land Surface Budget with Climate Change (WY2014-2070)

The land surface budget under projected conditions with climate change shows inflows exceeding outflows on average by 55,000 AFY, where total average inflows and outflows are 820,000 AFY and 765,000 AFY, respectively (**Figure 5-132**). Inflows are comprised of surface water deliveries (422,000 AFY), applied groundwater (pumped) (137,000 AFY), tile drainage (11,000 AFY), and precipitation (250,000 AFY). Outflows are comprised of runoff (60,000 AFY), deep percolation (83,000 AFY), and evapotranspiration (622,000 AFY).

Annual inflows and outflows in the land surface budget during the projected conditions with climate change water budget period range from 620,000 AF (WY2015) to 1,010,000 AF (WY2025) and 631,000 AF (WY 2015) to 908,000 AF (WY2036), respectively (**Figure 5-133**). Inflows and outflows from the land surface system are estimated to be largely balanced over the projected water budget time period under climate change. Shasta Critical water years and dry water years preceding Shasta Critical water years show the least amount of inflow and outflow from the land surface system due to reduced surface water availability.

Figure 5-134 summarizes the average annual projected conditions groundwater inflows and outflows with CCF applied in the Northern and Central Delta-Mendota Regions. **Figure 5-135** shows the annual time series of projected conditions inflows and outflows with climate change.

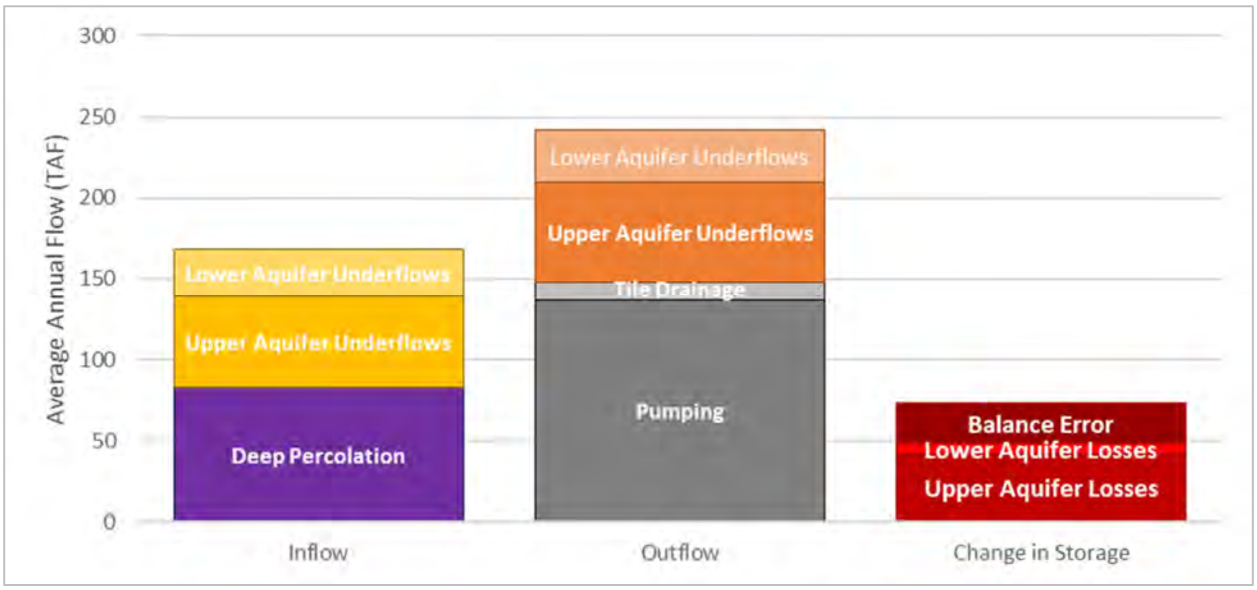

Figure 5-134. Projected Average Annual Groundwater Budget with Climate Change (WY2014-2070)

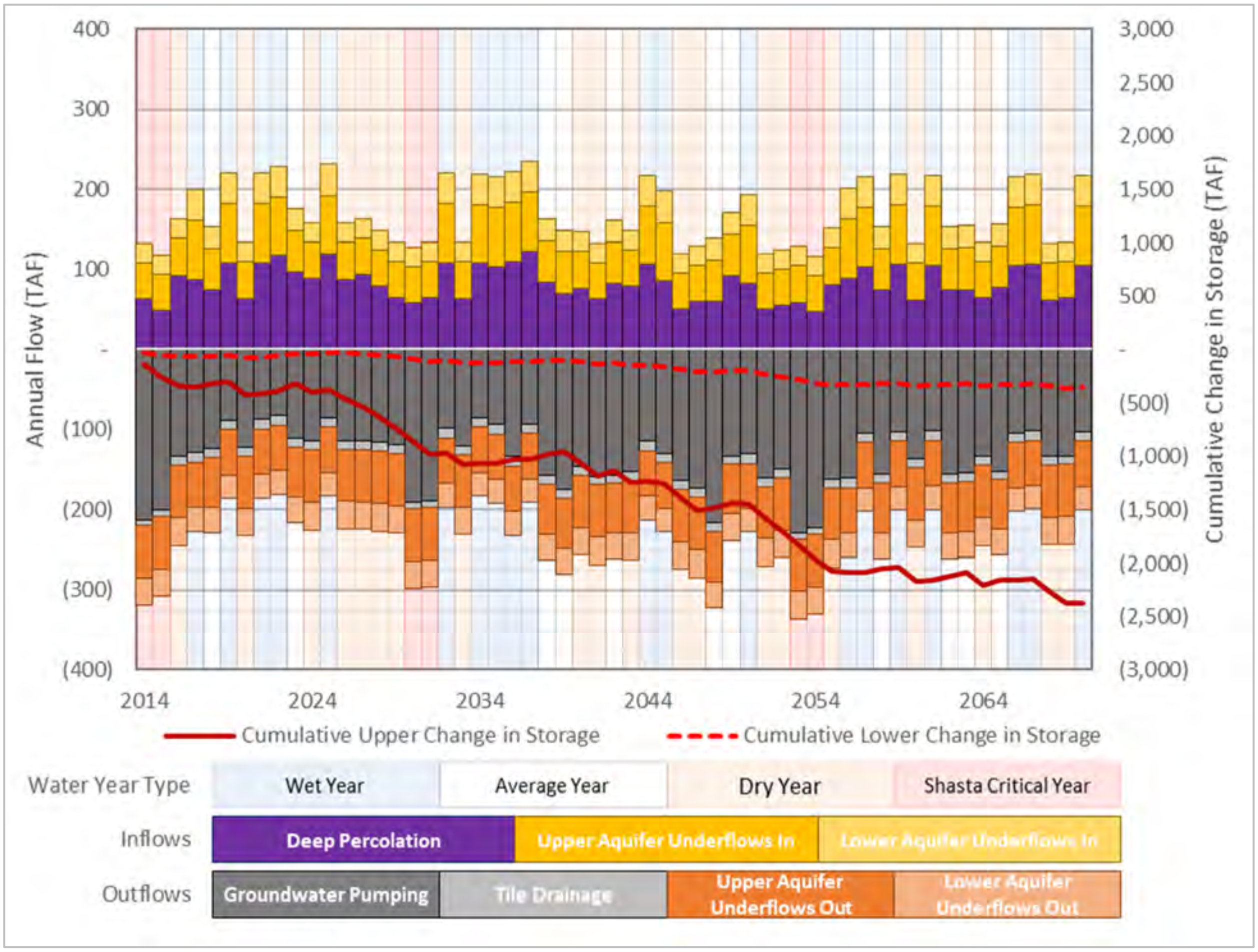

Figure 5-135. Projected Annual Groundwater Budget with Climate Change (WY2014-2070)

Under projected conditions with climate change, the Northern and Central Delta-Mendota Regions experiences, on average, 169,000 AFY of inflow of which 83,000 AFY is from deep percolation, 56,000 AFY is from Upper Aquifer underflows, and 30,000 AFY is from Lower Aquifer underflows (**Figure 5-134**). A total average annual outflow under the same conditions of 242,000 AFY consists of 137,000 AFY from groundwater pumping, 11,000 AFY from tile drainage, 62,000 AFY of Upper Aquifer underflows, and 32,000 AFY of Lower Aquifer underflows. Overall, there is 73,000 AFY greater outflow than inflow under projected conditions with climate change that includes balance error, Upper Aquifer losses, and Lower Aquifer losses.

On average, outflows are greater than inflows under projected conditions with climate change, meaning overdraft conditions persist in the Northern and Central Delta-Mendota Regions. From WY2014 to WY2070, average annual change in storage is -42,000 AFY in the Upper Aquifer and -6,000 AFY in the Lower Aquifer (-48,000 AFY total). Cumulative change in storage in both the Upper and Lower Aquifer show overall declining trends over the time period for the projected water budget with CCF applied (**Figure 5-135**). By WY2070, cumulative change in storage in the Upper Aquifer and Lower Aquifer are -7.51 AF/acre and -1.14 AF/acre, respectively. Compared to projected baseline conditions, cumulative change in storage under climate change conditions is 93,000 AF less in the Upper Aquifer and 33,000 AF less in the Lower Aquifer by WY2070. Overdraft in the Upper Aquifer continues to be the primary driver of overall overdraft within the Northern and Central Delta-Mendota Regions under projected conditions with climate change.

5.4.11 Projected Water Budget with Climate Change and Projects & Management Actions

The projected water budget with climate change is used to estimate future conditions of supply, demand, and aquifer response to Plan implementation as precipitation, evapotranspiration, and streamflow patterns change. The projected water budget with CCF applied and P&MAs is used to evaluate the projected baseline conditions with applied climate change factors provided by DWR from WY2014 through WY2070 as well as projects and management actions that will be implemented within the Plan area to help achieve sustainability by 2040. For more information regarding projects and management actions incorporated into this water budget, refer to **Chapter 7** *Sustainability Implementation*, **Section 7.1** *Projects & Management Actions*.

Figure 5-136 summarizes the average annual projected land surface inflows and outflows with CCF applied and P&MAs in the Northern and Central Delta-Mendota Regions. **Figure 5-137** shows the annual time series of projected land surface inflows and outflows with CCF applied and P&MAs.

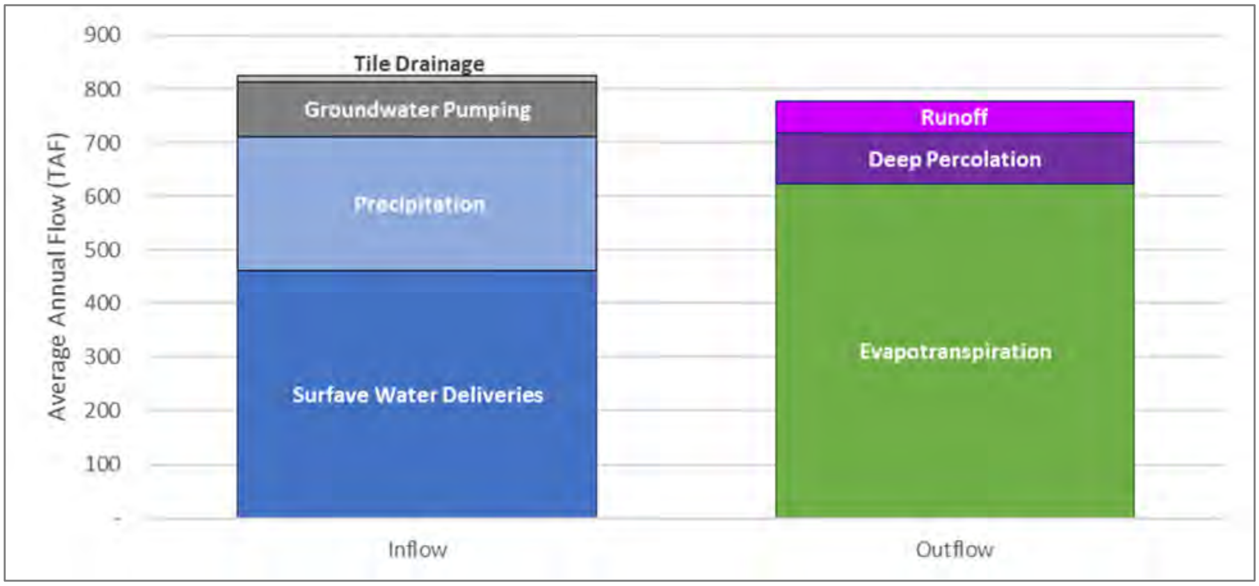

Figure 5-136. Projected Average Annual Land Surface Budget with Climate Change and Projects & Management Actions (WY2014-2070)

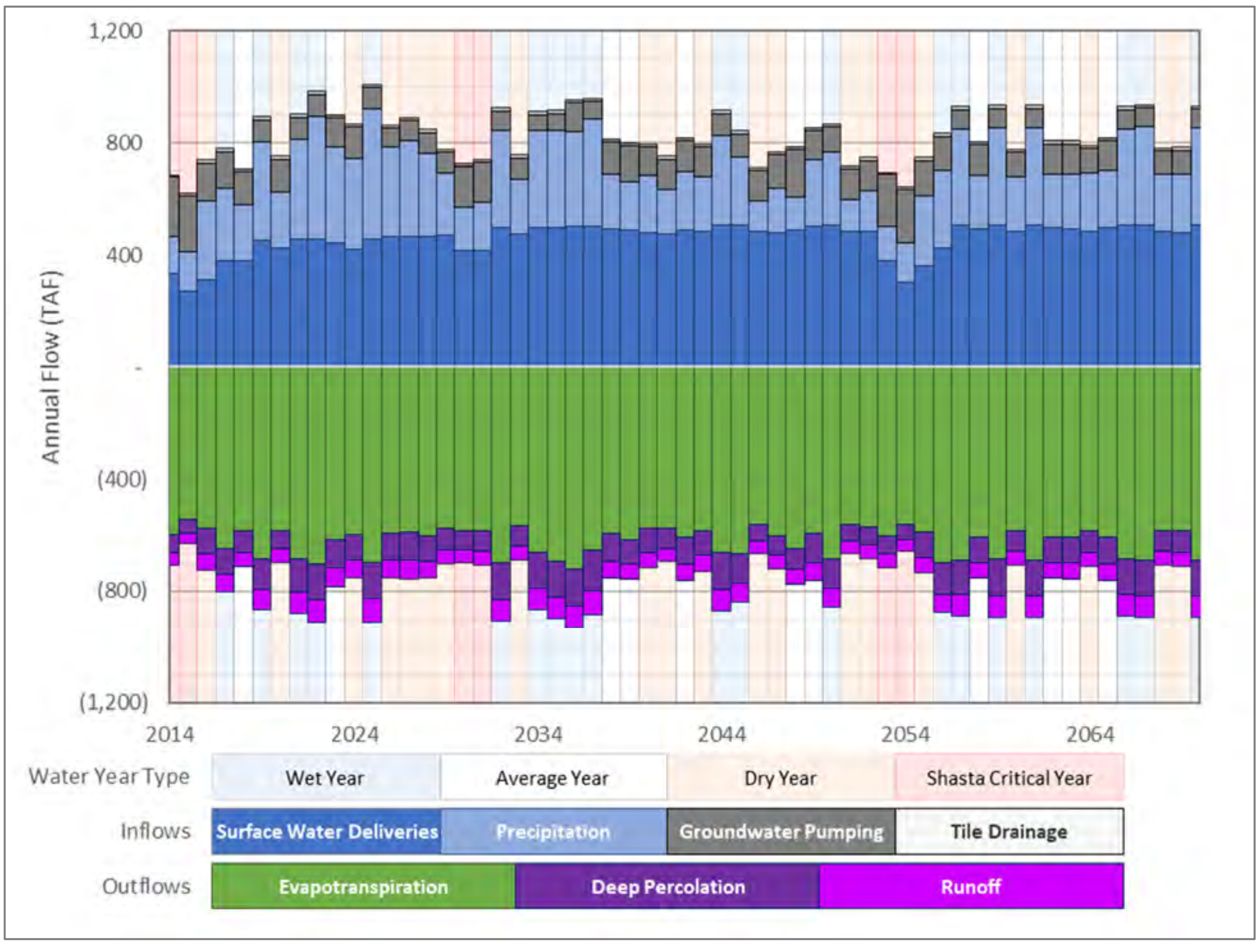

Figure 5-137. Projected Annual Land Surface Budget with Climate Change and Projects & Management Actions (WY2014-2070)

The land surface budget under projected conditions with CCF and P&MAs shows inflows exceeding outflows on average by 52,000 AFY, where total average inflows and outflows are 830,000 AFY and 778,000 AFY, respectively (**Figure 5-136**). Inflows are comprised of surface water deliveries (467,000 AFY), applied groundwater (pumped) (102,000 AFY), tile drainage (11,000 AFY), and precipitation (250,000 AFY). Outflows are comprised of runoff (61,000 AFY), deep percolation (95,000 AFY), and evapotranspiration (622,000 AFY).

Annual inflows and outflows in the land surface budget under projected conditions with CCF applied and P&MAs range from 620,000 AF (WY2015) to 1,010,000 AF (WY2025) and 631,000 AF (WY2015) to 931,000 AF (WY2036), respectively (**Figure 5-137**). Inflows and outflows from the land surface system are estimated to be largely balanced over the projected water budget with CCF applied and P&MAs time period. Shasta Critical water years and dry water years preceding Shasta Critical water years show the least amount of inflow and outflow from the land surface system due to reduced surface water availability and precipitation. **Figure 5-138** summarizes the average annual projected conditions groundwater inflows and outflows with CCF applied and P&MAs in the Northern and Central Delta-Mendota Regions. **Figure 5-139** shows the annual time series of projected conditions inflows and outflows with CCF applied and P&MAs.

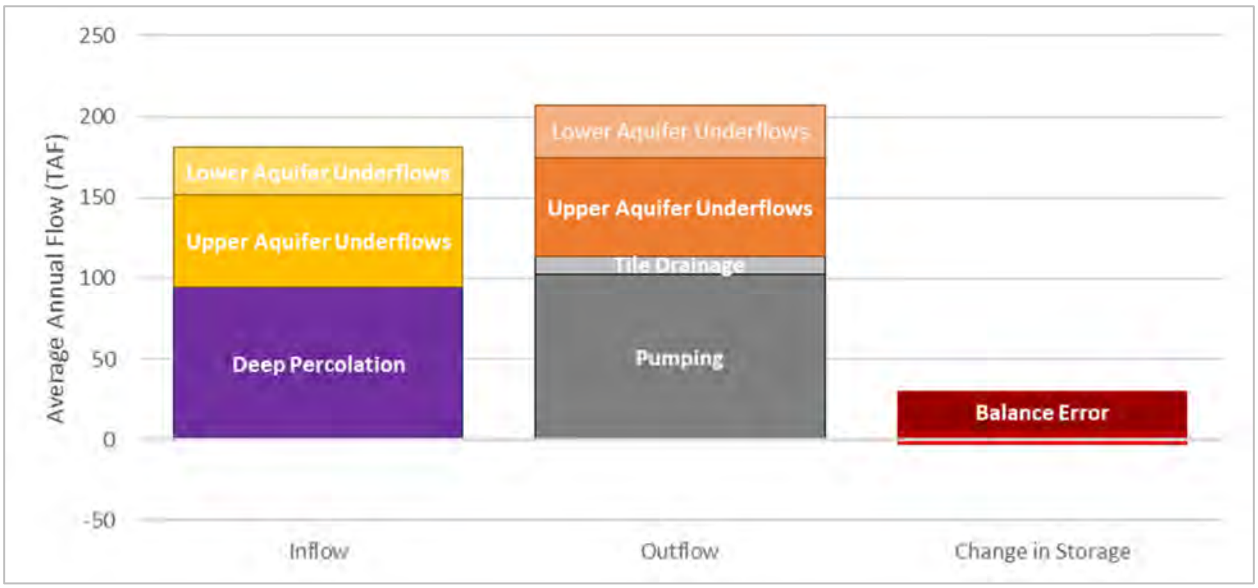

Figure 5-138. Projected Average Annual Groundwater Budget with Climate Change and Projects & Management Actions (WY2014-2070)

** Upper Aquifer Losses and Lower Aquifer Gains too small to label.*

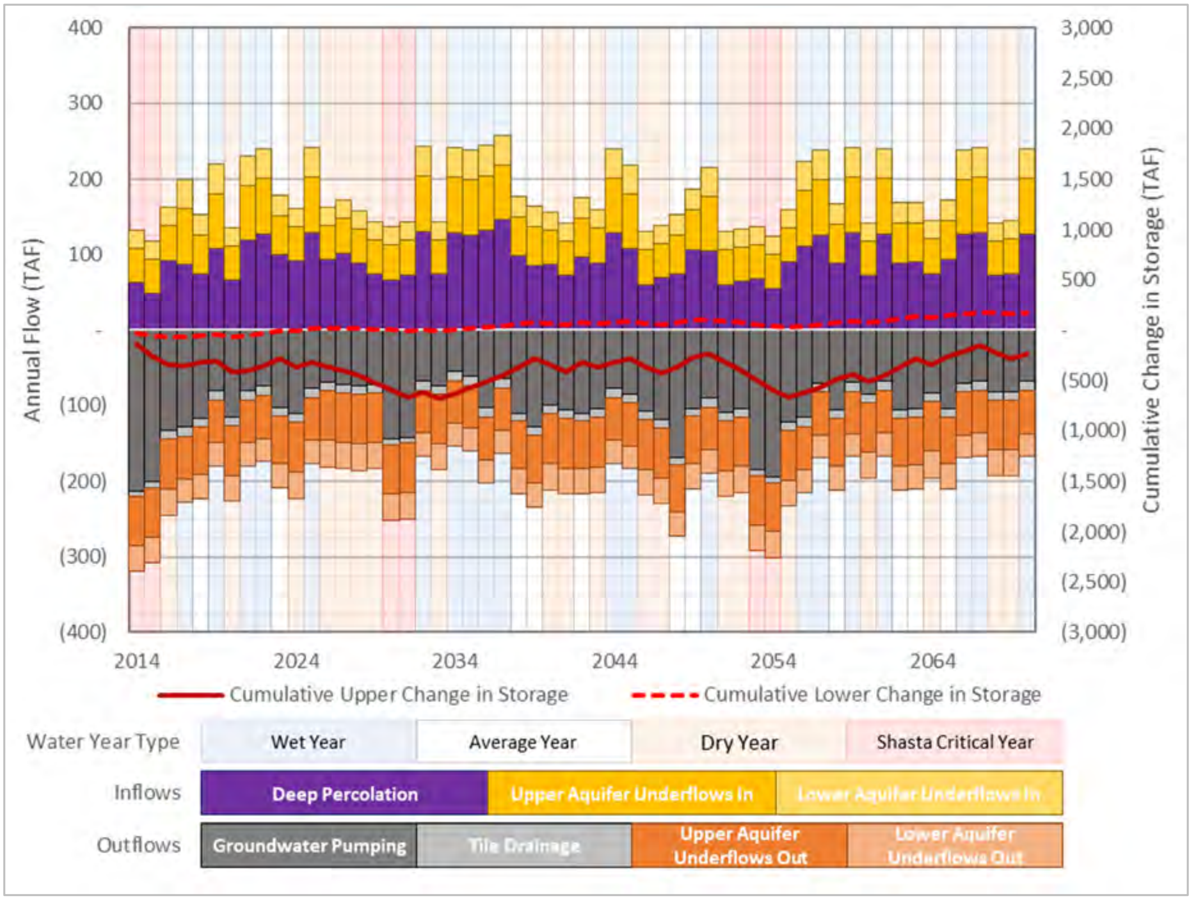

Figure 5-139. Projected Annual Groundwater Budget with Climate Change and Projects & Management Actions (WY2014-2070)

Under projected conditions with CCF and P&MAs, the Northern and Central Delta-Mendota Regions experience, on average, 181,000 AFY of inflow of which 95,000 AFY is from deep percolation, 56,000 AFY is from Upper Aquifer underflows, and 30,000 AFY is from Lower Aquifer underflows (**Figure 5-138**). A total average annual outflow under the same conditions of 207,000 AFY consists of 102,000 AFY from groundwater pumping, 11,000 AFY from tile drainage, 62,000 AFY of Upper Aquifer underflows, and 32,000 AFY of Lower Aquifer underflows. Overall, there is 26,000 AFY greater outflow than inflow under projected conditions with climate change factors applied and projects & management actions, including balance error, Upper Aquifer losses, and Lower Aquifer losses.

With the addition of CCF and P&MAs, projected long-term declines in groundwater storage are nearly reversed in both principal aquifers on an average annual basis in the Northern and Central Delta-Mendota Regions. From WY2014 to WY2070, average annual change in storage is -4,000 AFY in the Upper Aquifer and +3,000 AFY in the Lower Aquifer (-1,000 AFY total over the 316,000 acres comprising the Northern and Central Delta-Mendota Regions). From WY2034 onward, the Lower Aquifer no longer experiences overdraft conditions. Cumulative change in storage in both the Upper and Lower Aquifer show overall increasing trends over the projected water budget period with the addition of climate change and projects & management actions (**Figure 5-139**). By WY2070, cumulative change in storage in the Upper Aquifer and Lower Aquifer are -0.75 AF/acre and +0.55 AF/acre, respectively.

By WY2040, cumulative change in storage is -1.09 AF/acre in the Upper Aquifer and +0.22 AF/acre in the Lower Aquifer, for a total GSP-regional change in storage of approximately -0.87 AF/acre. By WY2040, the downward trend of cumulative change in storage has been corrected as compared to projected baseline conditions. However, these water budgets have been developed using approximate methodologies with a projected hydrology and land and water use patterns that are subject to change over the 20-year implementation period. It is anticipated that, as more data are collected and water budgets are refined, that projects and management actions will also be modified as needed to ensure that the sustainability goals for groundwater elevations and storage are achieved.

5.4.12 Sustainable Yield Estimates

Under SGMA, sustainable yield is defined as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (California Water Code [CWC] 10721(w)). Sustainable yield estimates for the Upper Aquifer and Lower Aquifer have been developed in a coordinated fashion for the entire Delta-Mendota Subbasin by Delta-Mendota Technical Working Group and approved by the Delta-Mendota Coordination Committee.

Upper Aquifer Sustainable Yield Estimate

Methodologies for calculating Upper Aquifer sustainable yield were discussed by both the Delta-Mendota Coordination Committee and Technical Working Group of the Coordination Committee. During a workshop dedicated to this effort, several basic concepts and principles were discussed to calculate the Upper Aquifer sustainable yield estimate. Consideration was given to several potential options with increasing detail, including some combination of the following: total Subbasin Upper Aquifer pumping volumes, total Subbasin Upper Aquifer change in storage, and Subbasin Upper Aquifer subsurface inflows and outflows. Inflow from certain neighboring subbasins, based on groundwater flow direction, as well as subsurface inflow from the Coast Range at existing gradients (as part of the inflow to the Northern & Central Delta-Mendota Region GSP area) was considered. Outflow to neighboring subbasins at existing gradients was also considered in certain applicable areas along the Delta-Mendota Subbasin boundary based on groundwater flow characteristics.

An overarching goal of the Delta-Mendota Subbasin is to maintain a balanced water budget by managing groundwater extractions (pumping). Therefore, the Upper Aquifer sustainable yield was estimated using the change in storage from the historic water budget (WY2003-2012). Based on these considerations, the following formula was selected for estimating Upper Aquifer sustainable yield utilizing the consolidated historic water budget components:

$$\text{Upper Aquifer Sustainable Yield} = (\text{Pumping} + \text{Change in Storage}) + (\text{Subsurface Outflow} - \text{Subsurface Inflow})$$

The formula for determining Upper Aquifer sustainable yield was applied to the following compiled Delta-Mendota Subbasin projected water budgets (WY2014-2070):

- *Projected Baseline values with Climate Change Factors*
- *Projected Baseline values with Climate Change Factors and Projects and Management Actions*

This analysis resulted in an Upper Aquifer Sustainable Yield estimate of 403,000 acre-feet for the Delta-Mendota Subbasin.

The Upper Aquifer sustainable yield value, derived from calculations using the best available but limited data, is considered to be a preliminary estimation only and will be updated to an anticipated higher level of accuracy in future GSP updates. The intention of the Delta-Mendota Subbasin GSAs, following GSP submission in 2020, is to increase Subbasin-wide data collection efforts. Improved data, modeling results, and understanding of subsurface flows will allow the GSAs and each GSP Group to improve estimated sustainable yield value for future GSP updates.

The Upper Aquifer sustainable yield reflects the principle that the GSAs within the Delta-Mendota Subbasin reserve the right to claim or retain some portion of subbasin outflow generated by the lowering of groundwater levels from neighboring subbasins and the equitable portion of sources of recharge shared between two subbasins, by physical or non-physical means, in the future if the Delta-Mendota Subbasin GSAs determine that doing so will improve Subbasin sustainability or will prevent undesirable results due to the chronic lowering of groundwater. Furthermore, intra-basin coordination during GSP development, followed by continuing inter-basin coordination discussions and data collection after GSP adoption, will allow the GSAs to further refine these determinations.

Lower Aquifer Sustainable Yield Estimate

Currently, within the Delta-Mendota Subbasin, the distribution of known Lower Aquifer water level data and extraction volume data are not sufficient to allow for an accurate calculation of Lower Aquifer sustainable yield utilizing the same methodology as for the Upper Aquifer. Following discussions by both the Coordination Committee and the Technical Working Group of the Coordination Committee, a consensus was reached to establish a Lower Aquifer sustainable yield estimate for the Subbasin based on a projection of existing subsidence rates as measured along the DMC with the minimum threshold established for inelastic land subsidence.

In the original 2020 submittal, the calculation for the Lower Aquifer sustainable yield was based on a recent study completed by the Westlands Water District (WWD) GSA using groundwater modeling, in conjunction with the Westside GSP development, to estimate sustainable yield for that subbasin. Based on an analysis of available data and an initial assumption of lower aquifer sustainable yield equivalent to approximately 0.35 acre-feet per acre within the Westside Subbasin (Westlands Water District GSA, Groundwater Management Strategy Concepts presentation to the WWD Board on October 16, 2018) the GSA estimates a sustainable yield of 230,000 to 250,000 AF, with historic conditions suggesting a range from 250,000 to 300,000 AF (Westlands Water District GSA, Westside Subbasin's Groundwater Model Forecast and Augmentation Strategies presentation to the WWD Board on April 3, 2019). Using Westlands Water District GSA's analysis, the Coordination Committee recommended a slightly more conservative sustainable yield value of one-third (0.33) an acre-foot per acre for the Delta-Mendota Subbasin. Using this more conservative value, the estimated sustainable yield is approximately 250,000 acre-feet per year over the approximately 750,000-acre subbasin. It should be noted that sustainable management of the Lower Aquifer is governed by significant and unreasonable subsidence rather than sustainable yield. Sustainable yield is not uniform throughout the Subbasin, and it will be the responsibility of each GSA in the Subbasin to manage Lower Aquifer pumping to prevent significant and unreasonable inelastic land subsidence.

Acknowledging that land subsidence is occurring at localized areas in the Subbasin, the Delta-Mendota Coordination Committee refined the Lower Aquifer sustainable yield calculation, adjusting the value from 250,000 to 101,000 AF, based on observed extractions from the Lower Aquifer during WY2015. This refinement is consistent with the common definitions established across the Subbasin for all sustainable management criteria. It is important to note that subsidence will be the primary factor influencing the allowable volume of groundwater that can be extracted from the Lower Aquifer without incurring significant and impacts on beneficial uses and users. As such, this number will be updated as data gaps are filled, particularly using the Proposition (Prop 68) grant-funded well inventory and subsidence study and the results of the Airborne Electromagnetic (AEM) survey recently completed by DWR. Furthermore, the Subbasin will investigate the feasibility to recharge the Lower Aquifer as a means of reducing subsidence and managing future Lower Aquifer sustainable yield.

The Lower Aquifer sustainable yield estimate will be refined in the future based on data collected and compiled for the Subbasin. This current sustainable yield approximation highlights the importance of an accepted Subbasin-level subsidence monitoring program concurrent with improved estimates of sub-Corcoran Clay groundwater extractions.

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Section 6

Sustainable Management Criteria

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6. SUSTAINABLE MANAGEMENT CRITERIA

This chapter describes sustainable management criteria defining undesirable results in the Northern and Central Regions of the Delta-Mendota Subbasin and establishing the objectives by which Subbasin Groundwater Sustainability Agencies (GSAs) will obtain sustainable use of groundwater in the Subbasin. Sustainability criteria defined herein include minimum thresholds and measurable objectives for each applicable sustainability indicator, pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations Article 5 *Plan Contents*, Subarticle 3 *Sustainable Management Criteria* (§ 354.22 through 354.30).

The following criteria for each sustainability indicator applicable to the Plan area are described herein:

- Sustainability Goal
- Undesirable Results
- Minimum Thresholds
- Measurable Objectives
- Interim Milestones

The Sustainable Groundwater Management Act (SGMA) defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (California Water Code Section 10721). Sustainable Groundwater Management Criteria, or SMC, were developed using information presented in **Chapter 5** *Basin Setting*. Input from Subbasin stakeholders was accepted and incorporated into the established SMC through discussion and presentation at public workshops and meetings of the following groups throughout the GSP development process: Northern and Central Delta-Mendota Technical Working Group, Northern and Central Delta-Mendota Region Management Committees, Delta-Mendota Subbasin Technical Working Group, and the Delta-Mendota Subbasin Coordination Committee.

The SMC developed for the Northern and Central Delta-Mendota Regions will be used to assess progress toward achieving the sustainability goal for the Delta-Mendota Subbasin. The Northern & Central Delta-Mendota Region GSP Group will continue to coordinate with the other GSP Groups in the Subbasin as each GSP is implemented to ensure actions of neighboring GSP Groups do not cause undesirable results for another GSP Group and that, collectively, progress is made towards achieving the Subbasin sustainability goal by 2040. Similarly, the Northern and Central Delta-Mendota Regions will continue to coordinate with adjacent subbasins (Tracy, Modesto, Turlock, Westside, and Kings) regarding SMC and ensuring activities within the Plan area do not cause undesirable results for adjacent subbasins.

6.1 USEFUL TERMS

A list and description of technical terms used throughout this section to discuss Sustainable Management Criteria are listed below. **Figure 6-1** shows a graphic demonstrating the relationship between the Sustainable Management Criteria terms using groundwater elevation as an example. The terms and their descriptions are identified here to guide readers through this section and are not a definitive definition of each term.

- **Undesirable Result** – Significant and unreasonable negative impacts associated with each sustainability indicator, avoidance of which is used to guide development of GSP components.
- **Minimum Threshold** – Quantitative threshold for each sustainability indicator used to define the point at which undesirable results may begin to occur.
- **Measurable Objective** – Quantitative target that establishes a point above the minimum threshold that allows for a range of active management in order to prevent undesirable results.

- **Interim Milestones –** Targets set in increments of five years over the implementation period of the GSP to put the basin on a path to sustainability.
- **Margin of Operational Flexibility –** The range of active management between the measurable objective and the minimum threshold.

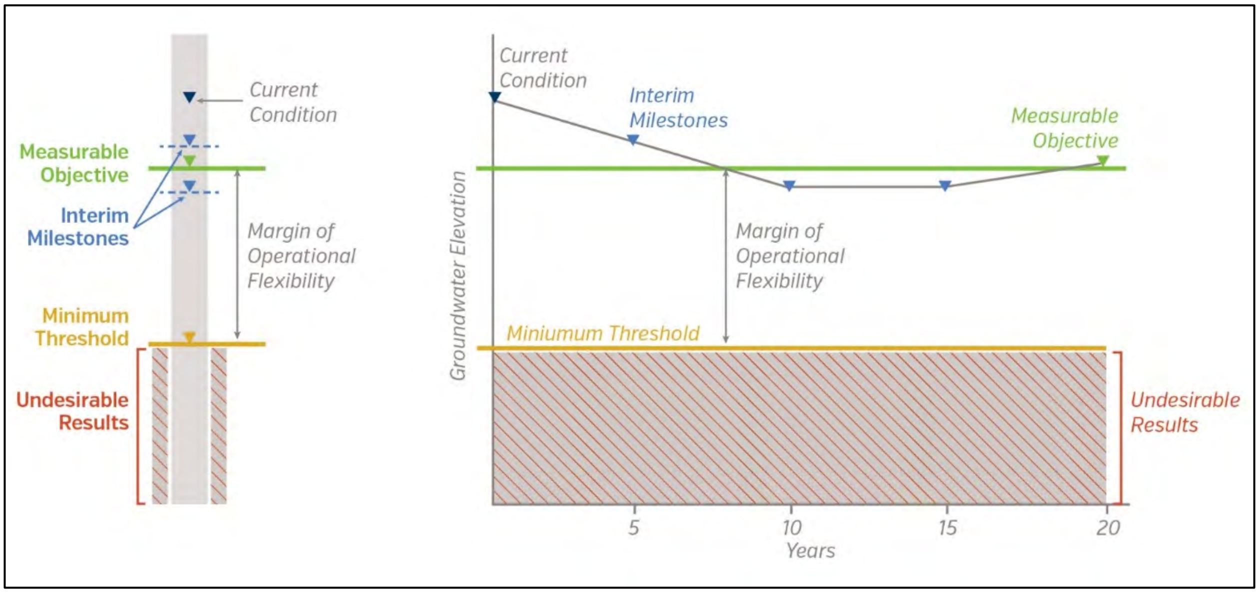

Figure 6-1. Sustainable Management Criteria Definitions Graphic (Groundwater Elevation Example)

6.2 SUSTAINABILITY GOAL

The sustainability goal for the Delta-Mendota Subbasin was established to succinctly state the objectives and desired conditions of the Subbasin that culminates in the absence of undesirable results by 2040. The sustainability goal for the Delta-Mendota Subbasin is as follows and was approved by the Delta-Mendota Coordination Committee:

> The Delta-Mendota Subbasin will manage groundwater resources for the benefit of all users of groundwater in a manner that allows for operational flexibility, ensures resource availability under drought conditions, and does not negatively impact surface water diversion and conveyance and delivery capabilities. This goal will be achieved through the implementation of the proposed projects and management actions to reach identified measurable objectives and milestones through the implementation of the GSP(s), and through continued coordination with neighboring subbasins to ensure the absence of undesirable results by 2040.

Additionally, the following sustainability goals for each applicable sustainability indicator have been approved by the Delta-Mendota Coordination Committee:

- Chronic Lowering of Groundwater Levels

  Maintain groundwater levels that are comparable to existing conditions (historic low conditions as of Water Year [WY] 2016) in order to continue meeting the demand of beneficial uses and users of groundwater and prevent a trend of decreasing groundwater levels. The Delta-Mendota Subbasin will continue successful and ongoing coordination with neighboring subbasins to address chronic lowering of groundwater levels caused by pumping outside the Subbasin.

- Reduction in Groundwater Storage

  Maintain historic groundwater storage volumes in order to continue meeting the demand of beneficial uses and users of groundwater and to provide a 3-year drought buffer. Minimize reductions in groundwater storage during extended dry periods. Work with neighboring subbasins to address reduction in groundwater storage caused by pumping outside of the Subbasin.

- Degraded Water Quality

  Minimize further impairment of water supplies resulting from groundwater management activities that cause the migration or concentration of contaminant plumes or the increased rate of movement or concentrations of constituents of concern. Coordinate with and support compliance with existing regulatory groundwater quality orders and objectives for drinking water, agricultural irrigation, and managed wetlands, which are described in the *Common Chapter* (**Appendix B**). Work with neighboring subbasins to address existing or potential impairments of groundwater quality in the Subbasin caused by groundwater management activities outside the Subbasin.

- Land Subsidence

  Minimize inelastic land subsidence by ramping down allowable subsidence caused by groundwater extraction in the Subbasin, with no additional subsidence after 2040. Work with neighboring subbasins to address inelastic land subsidence caused by groundwater extraction outside of the Subbasin.

- Depletions of Interconnected Surface Water

  Maintain interconnected surface waters comparable to existing conditions (historic low conditions as of WY2016) in order to prevent a trend of increased interconnected surface water loses for the San Joaquin River. Work with neighboring subbasins to address increased interconnected surface water losses caused by pumping outside of the Subbasin.

The sustainability goal described above was developed based on information presented in **Chapter 5** *Basin Setting*. Conjunctive use of groundwater and surface water is prevalent throughout the Delta-Mendota Subbasin, where many water purveyors and private landowners pump groundwater and receive surface water deliveries from the San Joaquin River, the Kings River, the Central Valley Project (CVP) via the Delta-Mendota Canal, and the State Water Project (SWP) via the California Aqueduct. Operational flexibility is critical for many agencies within the Delta-Mendota Subbasin to allow for increased use of groundwater when surface water supplies are reduced or unavailable during prolonged dry periods. Additionally, operational flexibility allows for the storage of surface water supplies or groundwater recharge during wet periods for recovery and use during dry periods, as well as to manage other undesirable results such as inelastic land subsidence as a result of Lower Aquifer pumping.

In order to make progress in meeting the sustainability goal, minimum thresholds and measurable objectives have been established for the Northern & Central Delta-Mendota Region GSP Group to define the ‘operating range’ of the groundwater subbasin. These criteria were developed in a coordinated fashion with the other GSP Groups in the Subbasin, where definitions of undesirable results and methods for establishing numeric minimum thresholds and measurable objectives were developed and approved by all GSP Groups within the Subbasin for each sustainability indicator.

Each GSP Group is responsible for managing to applicable sustainability indicators so conditions are improved as a whole and the Subbasin is sustainably managed by 2040. Projects and management actions, as detailed in **Section 7.1** *Projects & Management Actions*, were selected to address adverse conditions and mitigate undesirable results within the Plan area. For more information about sustainable yield and the projects and management actions to be implemented during the 20-year implementation period, refer to **Section 5.4.11** *Sustainable Yield* of the *Basin Setting* and **Section 7.1**.

Over the GSP planning and implementation horizon, Subbasin conditions are expected to fluctuate relative to minimum thresholds, measurable objectives, and interim milestones as projects and management actions are implemented and basin operations are modified to make progress toward sustainability. It is anticipated that, despite seasonal and short-term fluctuations, the Plan area and Subbasin will be managed to prevent undesirable results. Demonstration of the absence of undesirable results will support a determination that the Subbasin is operating within its sustainable yield and result in the conclusion that the sustainability goal has been achieved by 2040 and sustainability will be maintained beyond 2040.

6.3 SUSTAINABILITY THRESHOLDS

The following subsections present undesirable results, minimum thresholds, measurable objectives, and interim milestones for the following sustainability indicators:

- Chronic lowering of groundwater levels
- Reduction of groundwater storage
- Degraded water quality
- Seawater intrusion (not applicable to the Delta-Mendota Subbasin)
- Land subsidence
- Depletions of interconnected surface water

Sustainable Management Criteria were developed at the Subbasin-level for all application sustainability indicators. Please see the Common Chapter in **Appendix B** for tabular summaries of the SMC and for additional information on their development.

6.3.1 Chronic Lowering of Groundwater Levels

Undesirable results, minimum thresholds, measurable objectives, and interim milestones for the chronic lowering of groundwater levels sustainability indicator are described in the subsequent subsections.

6.3.1.1 Undesirable Results

A description of undesirable results as defined under SGMA and by the Delta-Mendota Subbasin GSAs, identification of undesirable results, potential causes of undesirable results, and potential effects of undesirable results relative to the chronic lowering of groundwater levels sustainability indicator are detailed below.

6.3.1.1.1 Description of Undesirable Results

The undesirable result related to groundwater levels is defined under SGMA as:

> *Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. 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* (California Water Code [CWC] Section 10721(x)(1)).

An undesirable result for chronic lowering of groundwater levels in the Delta-Mendota Subbasin is experienced through *significant and unreasonable chronic changes in groundwater levels that diminish access to groundwater, causing significant and unreasonable impacts to beneficial uses and users of groundwater*. This Subbasin-wide definition of an undesirable result was agreed upon by all GSP Groups through the Delta-Mendota Subbasin Coordination Committee.

6.3.1.1.2 Identification of Undesirable Results

A significant and unreasonable undesirable result for chronic lowering of groundwater levels is defined as:

Significant and unreasonable impacts to beneficial uses and users of groundwater are substantially increased costs associated with higher total pumping lift, lowering pumps, drilling deeper wells or otherwise modifying wells to access groundwater, securing alternative water sources, or required mitigation of groundwater dependent ecosystems. Significant and unreasonable is quantitatively defined as exceeding the minimum threshold at more than 50 percent of representative monitoring sites by principal aquifer in a GSP area.

For more information about the representative monitoring network for chronic lowering of groundwater levels, refer to **Section 7.2** *Monitoring* of the *Sustainability Implementation* chapter.

6.3.1.1.3 Potential Causes of Undesirable Results

The Delta-Mendota Subbasin is currently designated as a critically overdrafted basin by the California Department of Water Resources (DWR). Potential causes of undesirable results resulting from the chronic lowering of groundwater levels could include insufficient pumping offsets or reductions that result in localized or Plan area-wide lowering of groundwater elevations. Delays in implementation of projects or management actions due to increased demands or regulatory, permitting or funding obstacles may also cause undesirable results. Additionally, regulatory requirements placed on CVP and SWP operations, as well as instream flow requirements on the San Joaquin River and its tributaries, have and will continue to have negative impacts on surface water supplies available to the Subbasin, resulting in increased reliance on groundwater resources within the Delta-Mendota Subbasin and potentially resulting in the chronic lowering of groundwater levels.

6.3.1.1.4 Potential Effects of Undesirable Results

If groundwater levels in either of the two principal aquifers (Upper Aquifer and Lower Aquifer) were to reach levels causing undesirable results, dewatering of wells could occur, beginning with shallow domestic wells where many residents and communities rely on groundwater as their sole potable water supply. Groundwater levels (piezometric head) in the Lower Aquifer could be reduced to the point where significant and unreasonable inelastic land subsidence is observed, thus impacting land use and water conveyance capacity. There are also parts of the Plan area where no groundwater pumping occurs, and thus GSAs have no control over groundwater levels. As such, there is the potential for undesirable results to occur in these areas of no groundwater pumping.

Reduced groundwater levels could result in surface water depletions that may impact beneficial uses of interconnected surface water within the Plan area. Similarly, significantly declining groundwater elevations could also impact productive agriculture. Municipal users of groundwater may be impacted where groundwater is the primary or sole supply source, such as for the City of Patterson and the communities of Grayson and Westley. Potable water supply costs for municipalities are likely to increase in the event of undesirable results due to a need to deepen wells, increased power-related costs to lift the water, a need for new wells, and/or if municipalities are forced to seek supplemental or alternative potable water supplies, such as surface water.

6.3.1.2 Minimum Thresholds

The groundwater elevation that may lead to undesirable results is an elevation that is lower than the historical seasonal low. The historical seasonal low is a fixed elevation at each site, based on available groundwater level data prior to the end of WY2016. To account for future year-to-year variations in hydrology, compliance with the fixed historic seasonal low threshold will be compared with a 4-year rolling average of annual groundwater level measurements.

Figure 6-2 and **Figure 6-3** show the locations of groundwater level representative monitoring wells in the Upper Aquifer and Lower Aquifer, respectively, for the Delta-Mendota Subbasin, where the Northern & Central Delta-Mendota Region GSAs are responsible for monitoring the representative monitoring sites in their Plan area. **Table 6-1** shows the minimum thresholds at each representative monitoring site in the Upper Aquifer and Lower Aquifer for the chronic lowering of groundwater levels sustainability indicator in feet above mean sea level (msl) relative to the North American Vertical Datum of 1988 (NAVD88) within the Northern & Central Delta-Mendota Region. Hydrographs for all representative wells demonstrating the minimum threshold can be found in **Appendix E**.

Shorter-term ("acute") groundwater elevation thresholds will also be established at each representative monitoring site by 2025 using a coordinated methodology with the other Subbasin GSP Groups. Acute thresholds will be established at levels that are intended to avoid short-term undesirable results, particularly for domestic water wells, groundwater dependent ecosystems, and interconnected surface waters where present in the Upper Aquifer, and for subsidence in the Lower Aquifer. Each year, both the historic seasonal low and the acute groundwater elevation threshold will apply, whichever is more protective.

The subbasins adjacent to the Northern & Central Delta-Mendota Region GSP Group include the Tracy, Modesto, Turlock, Merced, Westside, and Kings Subbasins. The GSPs for the Tracy, Modesto, and Turlock Subbasins are not due to DWR until January 2022, therefore evaluation of how minimum thresholds for chronic lowering of groundwater levels in the Northern and Central Delta-Mendota Regions affect the ability of these adjacent basins to achieve their sustainability goals will be evaluated in subsequent annual reports, during the GSP updates, and through on-going coordination efforts with these adjoining subbasins. Interbasin coordination has occurred to some extent with the Merced, Westside and Kings Subbasins; however, time limitations have resulted in limited detailed discussions. As with the other three adjoining subbasins, ongoing coordination will occur during GSP implementation and will be reflected in the GSP updates.

Beneficial uses and users of groundwater, including domestic, municipal, agricultural and environmental use and their associated land uses and property interests, were considered in establishing minimum thresholds for the chronic lowering of groundwater levels sustainability indicator. Stakeholders, including the public, were invited to provide feedback on minimum thresholds during Working Group meetings and during public workshops centered around SMC held throughout the Delta-Mendota Subbasin in May 2019, as well as Delta-Mendota Coordination Committee meetings held between February and June 2022. Northern and Central Delta-Mendota regional representatives from the municipal and agricultural sectors are Working Group members and provided input in setting the minimum thresholds for the chronic lowering of groundwater levels sustainability indicator throughout the development process. Domestic wells are generally shallower than agricultural and municipal wells and thus more sensitive to undesirable results. Additionally, the loss of a domestic well usually results in a loss of water for consumption, cooking, and sanitary purposes, which can often have substantial impacts on the users of the water and can be financially difficult for the well owner to replace. Based on local knowledge and experience during the last drought, setting the minimum threshold as the hydrologic low prior to the end of WY2016 is protective of an undesirable result for chronic lowering of groundwater levels.

Currently, there are no other State, federal, or local standards within the Plan area that relate to the chronic lowering of groundwater levels sustainability indicator in the Northern and Central Delta-Mendota Regions. SGMA is the prevailing legislation dictating requirements and standards for the chronic lowering of groundwater levels sustainability indicator. Any future State, federal, or local standards that relate to the chronic lowering of groundwater levels sustainability indicator will be evaluated and considered in potential modifications to minimum thresholds during subsequent updates to this GSP.

For information regarding how minimum thresholds for the chronic lowering of groundwater levels will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2.5.1** *Groundwater Level Monitoring Network* of the *Sustainability Implementation* chapter.

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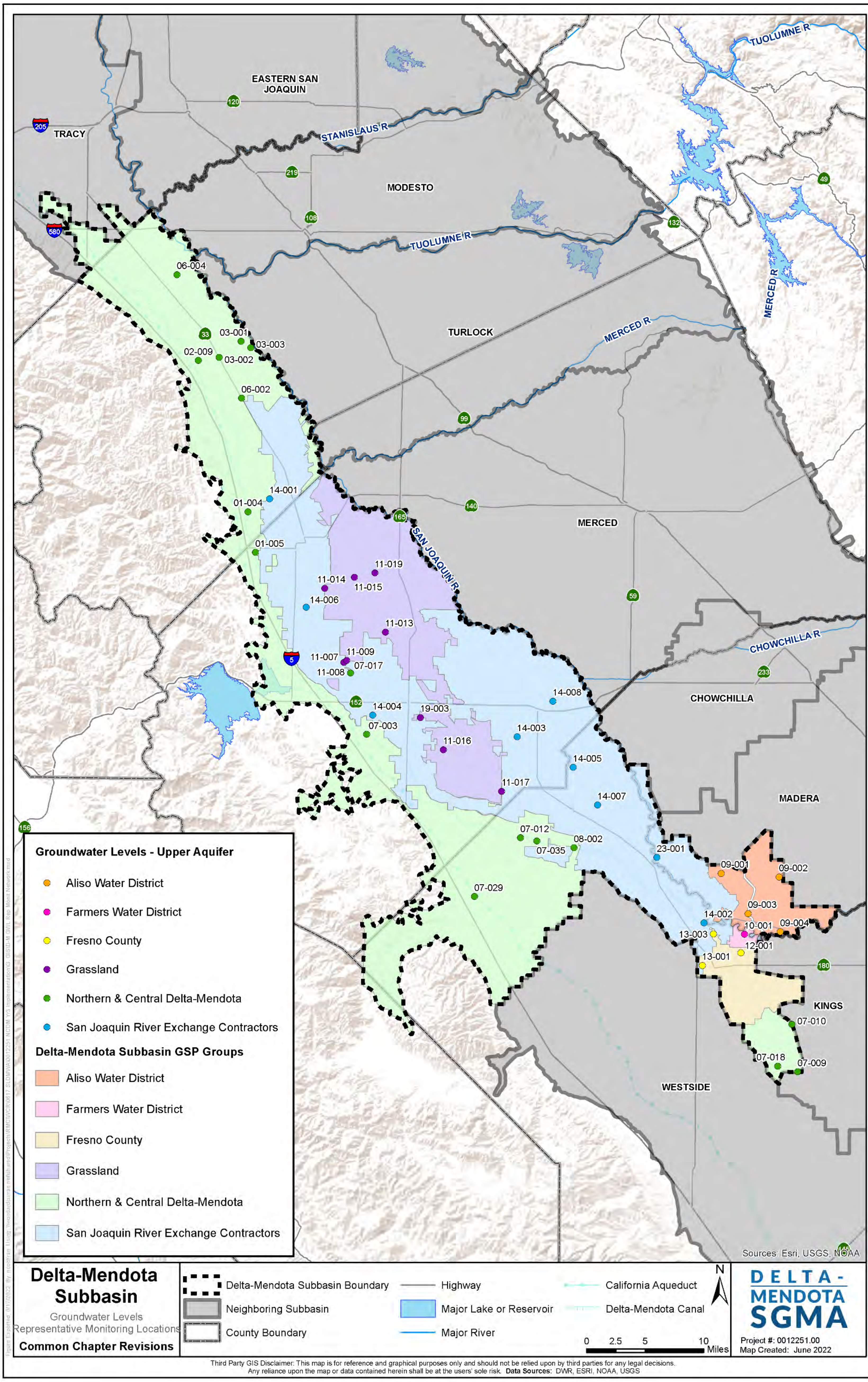

Figure 6-2. Location of Representative Monitoring Wells for Groundwater Levels, Upper Aquifer

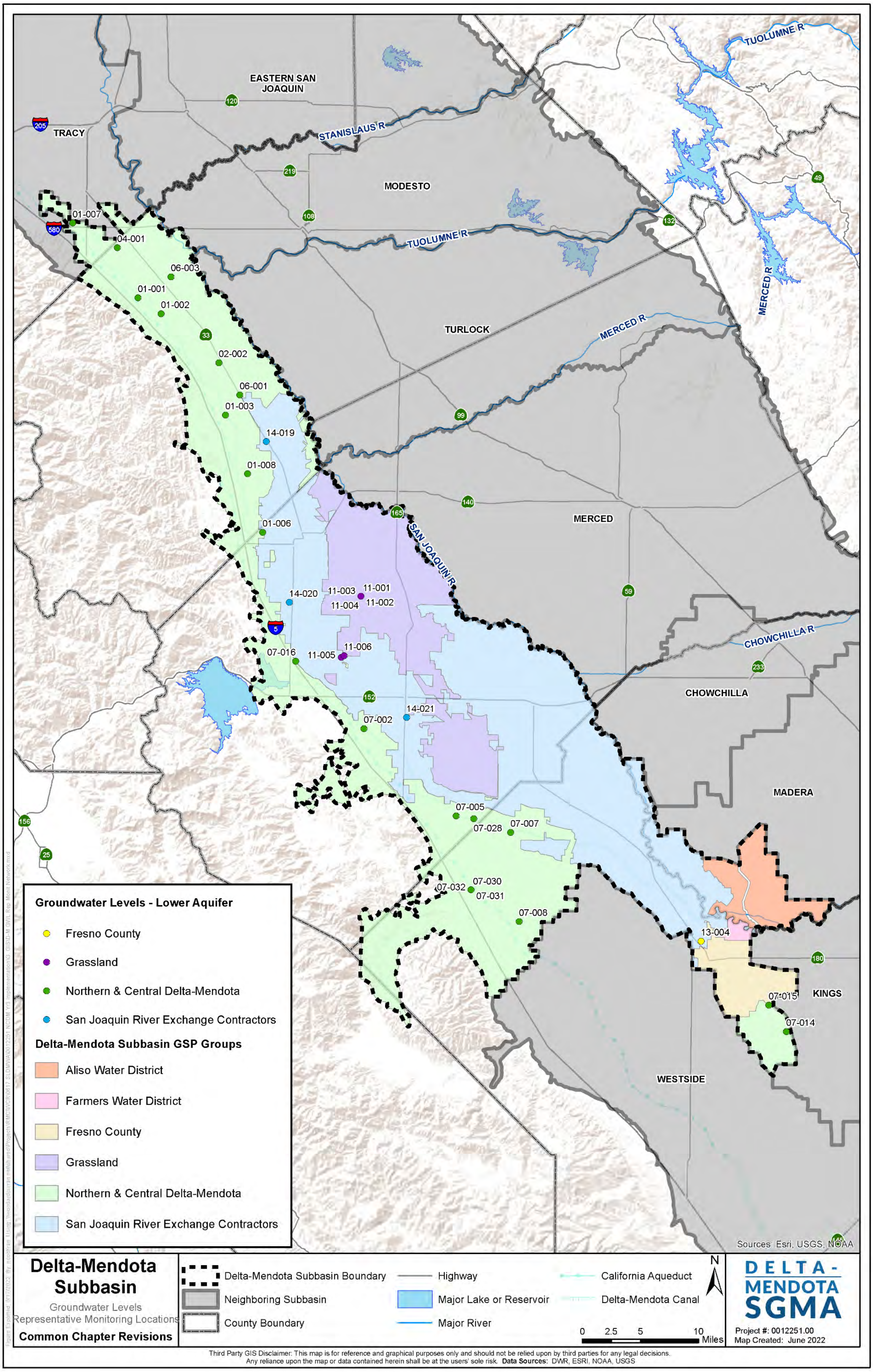

Figure 6-3. Location of Representative Monitoring Wells for Groundwater Levels, Lower Aquifer

Table 6-1. Minimum Thresholds for Chronic Lowering of Groundwater Levels

Data Management System (DMS) ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Minimum Threshold (feet above msl NAVD88)
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Lower	-44.9
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Lower	-36.1
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Lower	-21.79
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Upper	158.9
01-005	08S08E15G001M	372424N1210754W001	MP058.28L	Upper	110.6
01-006		372604N1210611W001	91	Lower	77.1
01-007			MP021.12L	Lower	12.3
01-008			MP051.66L	Lower	-44.9
02-002			WELL 02 - NORTH 5TH STREET	Lower	-18.3
02-009			Keystone well	Upper	-6.2
03-001		375015N1211011W001	MW-2	Upper	30.7
03-002			MW-3	Upper	7.7
03-003	05S/08E-16R		WSJ003	Upper	TBD
04-001		376129N1212942W001	121	Lower	-17.6
06-001	06S08E09E001M	374316N1210994W001	P259-1	Lower	-52.3
06-002	06S08E09E003M	374316N1210994W003	P259-3	Upper	31.5
06-003		375774N1212096W001	WSID 3	Lower	-9.1
06-004			MP031.31L1-L2Well1	Upper	14.8
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Lower	1.6
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Upper	62.5
07-005	12S11E03Q001M	369097N1207554W001	MP091.68R	Lower	-84.7
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Lower	-53.4

Data Management System (DMS) ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Minimum Threshold (feet above msl NAVD88)
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Lower	-63.0
07-009		366000N1202300W001	KRCDTID03	Upper	49.3
07-010		366500N1202500W001	KRCDTID02	Upper	64.0
07-012	12S/12E-16B		GDA003	Upper	TBD
07-014			TW-4	Lower	-133.5
07-015			TW-5	Lower	-147.0
07-016			Well 01	Lower	-2.4
07-017			Well 1	Upper	TBD
07-018	15S/16E-20		WSJ001	Upper	TBD
07-028		369064N1207276W001	MP093.27L / Well 500	Lower	-88.2
07-029			CDMGSA-01A	Upper	TBD
07-030			CDMGSA-01B	Lower	TBD
07-031			CDMGSA-01C	Lower	TBD
07-032			CDMGSA-01D	Lower	TBD
07-035		368871N1206355W001	MP098.74L	Upper	-99.8
08-002			MP102.04L / Well M-1	Upper	50.7

TBD – Numeric SMC to be determined after five years of data have been collected for this representative monitoring site.

6.3.1.3 Measurable Objectives and Interim Milestones

Measurable objectives are quantitative goals that reflect the desired Plan area conditions and allow the Subbasin to achieve the sustainability goal. The measurable objective is set to allow a reasonable margin of operational flexibility (Margin) between the measurable objective and minimum threshold for the active management of the groundwater basin. The Margin is intended to accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. The purpose of establishing measurable objectives is to define specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions, thereby defining the range of operational flexibility for basin management.

For the chronic lowering of groundwater levels sustainability indicator, the measurable objective is to maintain seasonal high groundwater levels at an elevation that is at or above the WY2015 seasonal high at more than 50 percent of representative monitoring sites in the GSP area. The WY2015 seasonal high is a fixed elevation at each site, based on available groundwater elevation data. If data are unavailable for WY2015 at a representative monitoring site, either a WY2014 or WY2016 seasonal high is used. To account for future year-to-year variations in hydrology, compliance with the fixed seasonal high threshold will be compared with a 4-year rolling average of annual groundwater level measurements. **Table 6-2** lists the measurable objectives for each representative monitoring well in the Upper Aquifer and Lower Aquifer in feet above msl NAVD88 in the Plan area. Hydrographs for each representative monitoring site, when available, that show the minimum threshold and measurable objective for that location are located in **Appendix E**.

To assist the Plan area in reaching the measurable objectives for groundwater levels by 2040, interim milestones are established for 2025, 2030, and 2035 as a means of assessing progress towards the Subasin's sustainability goal. The interim milestones for chronic lowering of groundwater levels are therefore set as follows:

- **Year 5 (2025):** Gather data and complete the establishment of seasonal low and seasonal high elevations at representative monitoring sites where currently to be determined. Develop a coordinated methodology and complete the establishment of acute groundwater elevation thresholds. Identify chronic lowering of groundwater levels caused by pumping outside the Subbasin.
- **Year 10 (2030):** Maintain groundwater levels at measurable objectives. Where chronic lowering of groundwater levels is caused by pumping outside of the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.
- **Year 15 (2035):** Maintain groundwater levels at measurable objectives. Where chronic lowering of groundwater levels is caused by pumping outside of the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.

The established measurable objectives and interim milestones will aid in achieving the sustainability goal within 20 years of Plan implementation.

Table 6-2. Measurable Objective for Chronic Lowering of Groundwater Levels

Data Management System (DMS) ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Measurable Objective (feet above msl NAVD88)
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Lower	-13.4
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Lower	-18.9
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Lower	62.3
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Upper	161.8
01-005	08S08E15G001M	372424N1210754W001	MP058.28L	Upper	179.6
01-006		372604N1210611W001	91	Lower	94.0
01-007			MP021.12L	Lower	56.7
01-008			MP051.66L	Lower	2.4
02-002			WELL 02 - NORTH 5TH STREET	Lower	33.7

Data Management System (DMS) ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Measurable Objective (feet above msl NAVD88)
02-009			Keystone well	Upper	29.8
03-001		375015N1211011W001	MW-2	Upper	46.7
03-002			MW-3	Upper	67.2
03-003	05S/08E-16R		WSJ003	Upper	TBD
04-001		376129N1212942W001	121	Lower	-3.6
06-001	06S08E09E001M	374316N1210994W001	P259-1	Lower	16.1
06-002	06S08E09E003M	374316N1210994W003	P259-3	Upper	44.6
06-003		375774N1212096W001	WSID 3	Lower	18.5
06-004			MP031.31L1-L2Well1	Upper	30.5
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Lower	10.8
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Upper	89.9
07-005	12S11E03Q001M	369097N1207554W001	MP091.68R	Lower	-41.8
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Lower	-26.6
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Lower	-47.0
07-009		366000N1202300W001	KRCDTID03	Upper	73.9
07-010		366500N1202500W001	KRCDTID02	Upper	96.2
07-012	12S/12E-16B		GDA003	Upper	TBD
07-014			TW-4	Lower	-47.2
07-015			TW-5	Lower	-65.0
07-016			Well 01	Lower	74.6
07-017			Well 1	Upper	TBD
07-018	15S/16E-20		WSJ001	Upper	TBD
07-028		369064N1207276W001	MP093.27L / Well 500	Lower	-64.8
07-029			CDMGSA-01A	Upper	TBD

Data Management System (DMS) ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Measurable Objective (feet above msl NAVD88)
07-030			CDMGSA-01B	Lower	TBD
07-031			CDMGSA-01C	Lower	TBD
07-032			CDMGSA-01D	Lower	TBD
07-035		368871N1206355W001	MP098.74L	Upper	95.2
08-002			MP102.04L / Well M-1	Upper	83.7

TBD – Numeric SMC to be determined after five years of data have been collected for this representative monitoring site.

6.3.2 Reduction of Groundwater Storage

Undesirable results, minimum thresholds, measurable objectives, and interim milestones for the reduction in groundwater storage sustainability indicator are described in the subsequent subsections.

6.3.2.1 Undesirable Results

A description of undesirable results as defined under SGMA and by the Delta-Mendota Subbasin GSAs, identification of undesirable results, potential causes of undesirable results, and potential effects of undesirable results relative to the reduction in groundwater storage sustainability indicator are detailed below.

6.3.2.1.1 Description of Undesirable Results

The undesirable result related to groundwater storage is defined under SGMA as:

> *Significant and unreasonable reduction of groundwater storage* (CWC Section 10721(x)(2)).

A significant and unreasonable undesirable result for reduction of groundwater storage in the Delta-Mendota Subbasin is defined as a *chronic decrease in groundwater storage that causes a significant and unreasonable impact to the beneficial uses and users of groundwater*. A significant and unreasonable impact to beneficial uses and users of groundwater is *insufficient water storage to maintain beneficial uses and natural resource areas in the Subbasin, including the conjunctive use of groundwater*. This definition of an undesirable result was agreed upon by all GSP Groups through the Delta-Mendota Subbasin Coordination Committee.

Depletion of groundwater storage appears to have occurred over the historic and current period established in the water budgets for the Northern and Central Delta-Mendota Regions; however, based on existing data, this trend appears to have been reversed as a result of recent wet years, and are not anticipated to occur in the future with the implementation of projects and management actions to promote long-term subbasin sustainability. Groundwater pumping from the Upper Aquifer is largely limited by poorer quality water compared to the Lower Aquifer, particularly in the Stanislaus County portion of the Plan area, and areas with shallow groundwater within the southwestern portion of the Subbasin indicate that Upper Aquifer water supplies are abundant, where shallow groundwater is drained from the root zone to allow for agricultural production. The Lower Aquifer extends from the bottom of the Corcoran Clay layer to the top of the base of freshwater, which is located around -2,000 feet above mean sea level, as defined by Page (1973) (see **Section 5.2** *Hydrogeologic Conceptual Model* of the *Basin Setting* chapter for more information about the base of freshwater). Based on the definition of the base of freshwater for the Delta-Mendota Subbasin, a large volume of groundwater is available in storage within the Lower Aquifer. Extractions from the Lower Aquifer are dictated by other sustainability indicators, such as inelastic land subsidence, rather than by available storage.

6.3.2.1.2 Identification of Undesirable Results

The same trigger for an undesirable result for the chronic lowering of groundwater levels is applicable to the long-term reduction of groundwater storage in the Upper Aquifer and for inelastic land subsidence in the Lower Aquifer. Long-term reductions in storage are not anticipated for either principal aquifer so long as groundwater levels in the Upper Aquifer and land subsidence in the Lower Aquifer are managed above the respective proxy minimum thresholds. Through coordination with the other GSP Groups in the Delta-Mendota Subbasin, additional projects and/or management actions will be implemented to prevent long-term decline in groundwater storage.

6.3.2.1.3 Potential Causes of Undesirable Results

Although the Subbasin has enough fresh groundwater in both principal aquifers to sustain groundwater pumping with the addition of projects and management actions, dramatic increases in reliance on groundwater, severe drought, or other major changes in groundwater management over time would cause the volume of fresh groundwater in storage to decline to a significant and unreasonable level. Additionally, regulatory requirements placed on CVP and SWP operations, as well as instream flow requirements on the San Joaquin River and its tributaries, have and will continue to have negative impacts on surface water supplies available to the Subbasin, resulting in increased reliance on groundwater resources within the Delta-Mendota Subbasin and potentially resulting in the long-term reduction in groundwater storage.

6.3.2.1.4 Potential Effects of Undesirable Results

If groundwater levels were to reach the point where undesirable results are observed, undesirable effects could include encroachment on the groundwater reserved as a drought buffer, increased cost of pumping as deeper wells are required to access groundwater, and reduction in beneficial uses. Groundwater pumping from the Lower Aquifer is known to cause inelastic land subsidence. Therefore, increased pumping from the Lower Aquifer could result in undesirable results for the land subsidence sustainability indicator.

6.3.2.2 Minimum Thresholds

This GSP uses the minimum thresholds for the chronic lowering of groundwater levels as a proxy for the reduction of groundwater storage sustainability indicator for the Upper Aquifer, and correlates minimum thresholds for inelastic land subsidence with the reduction in groundwater storage that would case un undesirable result for the Lower Aquifer. For the Upper Aquifer, as a responsible proxy for an individual groundwater storage threshold, groundwater levels will be maintained in accordance with the minimum threshold set for the chronic lowering of groundwater levels. For the Lower Aquifer, the sustainable management criteria correlated with inelastic land subsidence SMC results in a minimum threshold for the reduction of groundwater storage as estimated to be 1.1 million acre-feet of storage loss by 2040 attributable to groundwater extraction in the Subbasin.

GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. In order to rely on groundwater levels as a proxy, one approach suggested by DWR is to:

> *Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the*

minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site (DWR, 2017).

Minimum thresholds for groundwater levels will effectively avoid undesirable results for reduction of groundwater storage in the Upper Aquifer by ensuring that groundwater elevations (and therefore the volume of groundwater in storage) does not chronically decline in the future and has a demonstrated ability to rebound in subsequent normal and wet years following a drought. Minimum thresholds and measurable objectives for groundwater levels can therefore be used as a proxy for reduction in groundwater storage in the Upper Aquifer because groundwater levels are sufficiently protective against occurrences of significant and unreasonable reductions in groundwater storage.

Minimum thresholds for inelastic land subsidence will effectively avoid undesirable results for the reduction of groundwater storage from the Lower Aquifer by ensuring that the permanent loss of Lower Aquifer resulting from the collapse of compressible formations as a result of Lower Aquifer pumping does not chronically increase in the future.

6.3.2.3 Measurable Objectives and Interim Milestones

Since the SMC for the chronic lowering of groundwater levels are used as a proxy for reduction in groundwater storage in the Upper Aquifer, the measurable objectives and interim milestones for the reduction in groundwater storage sustainability indicator are consistent with the measurable objectives and interim milestones for the chronic lowering of groundwater levels sustainability indicator as set forth in **Section 6.3.1.3** and will utilize the same monitoring networks and data sets for the evaluating performance and sustainability metrics for the Upper Aquifer. The measurable objective for reduction of groundwater storage in the Lower Aquifer is to minimize loss of groundwater storage caused by inelastic land subsidence; therefore using the measurable objectives for the land subsidence sustainability indicator as a proxy (as detailed in **Section 6.3.5.3**).

To assist the Plan area in reaching the measurable objectives for groundwater storage by 2040, interim milestones are established for 2025, 2030, and 2035 as a means of assessing progress toward the Subbasin's sustainability goal. The interim milestones for chronic lowering of groundwater levels are therefore set as follows:

- **Year 5 (2025):** Maintain groundwater levels in accordance with the measurable objectives. Identify reduction of groundwater storage caused by pumping outside the Subbasin.
- **Year 10 (2023):** Maintain groundwater levels in accordance with the measurable objectives. Where reduction in groundwater storage is caused by pumping outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.
- **Year 15 (2035):** Maintain groundwater levels in accordance with the measurable objectives. Where reduction in groundwater storage is caused by pumping outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.

6.3.3 Degraded Water Quality

Undesirable results, minimum thresholds, measurable objectives, and interim milestones for the degraded water quality sustainability indicator are described in the subsequent subsections.

6.3.3.1 Undesirable Results

A description of undesirable results as defined under SGMA and by the Delta-Mendota Subbasin GSAs, identification of undesirable results, potential causes of undesirable results, and potential effects of undesirable results relative to the degraded water quality sustainability indicator are detailed below.

6.3.3.1.1 Description of Undesirable Results

The undesirable result related to degraded water quality is defined under SGMA as:

> *Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies* (CWC Section 10721(x)(4).

Undesirable results for the degradation of groundwater quality in the Delta-Mendota Subbasin is defined as the degradation of groundwater quality as a result of groundwater management activities that causes *significant and unreasonable impacts to beneficial uses and users of groundwater.* Significant and unreasonable impacts to beneficial uses and users of groundwater as a result of groundwater management activities are the migration of contaminant plumes or elevated concentrations of constituents of concern that reduce groundwater availability, and the degradation of surface water quality as a result of groundwater migration that substantially impair an existing beneficial use. This definition of an undesirable result was agreed upon by all GSP Groups through the Delta-Mendota Subbasin Coordination Committee.

As described in **Section 5.3** *Groundwater Conditions* of the *Basin Setting* chapter, groundwater quality concerns within the Plan area are largely related to non-point sources and/or naturally-occurring constituents. Total dissolved solids (TDS) has been identified as a Subbasin-wide constituent of concern related to groundwater levels or other SGMA-related groundwater quality management activities and was selected based on available data, the potential to impact existing or future groundwater use, the ability to address groundwater quality impacts through projects and/or management actions, and the source of the constituent. Based on publicly available datasets, there are no known groundwater contamination sites or plumes within the Northern and Central Delta-Mendota Regions. While other constituents of concern are known to exist in the Delta-Mendota Subbasin (such as arsenic, selenium, and hexavalent chromium), concentrations of these constituents do not appear to be linked to groundwater elevations or other groundwater-related management activities. The groundwater quality monitoring network developed for this GSP will continue to collect data relative to ongoing groundwater concentrations for these constituents for future assessment in coordination with other existing and anticipated future regulatory programs.

6.3.3.1.2 Identification of Undesirable Results

An undesirable result for degraded water quality is triggered, or considered “significant and unreasonable,” when the minimum threshold at more than 50 percent of representative monitoring sites by principal aquifer in the GSP area is exceeded where current groundwater quality does not exceed 1,000 milligrams per liter (mg/L) of TDS.

6.3.3.1.3 Potential Causes of Undesirable Results

As previously stated, TDS has been identified as a Subbasin-wide constituent of concern and is largely the result of non-point sources. Elevated TDS concentrations are primarily a result of a combination of land use practices, the geochemistry of the Coast Range rocks, recharge derived from the Coast Range streams, dissolvable materials within the alluvial fan complexes, and the naturally poor-draining conditions which tends to result in accumulation of these constituents. For more information about groundwater water quality in the Plan area, refer to **Section 5.2.8** *Water Quality* and **Section 5.3.5** *Groundwater Quality* of the *Basin Setting* chapter.

6.3.3.1.4 Potential Effects of Undesirable Results

If an undesirable result for the degraded water quality sustainability indicator were to occur, the overarching impact would be a reduction in usable groundwater supply for all beneficial users of groundwater within the Plan area and/or an increased need for groundwater treatment prior to use. Wellhead or distribution system treatment would be necessary before domestic, municipal, or agricultural use or alternative supplies might be sought out, with small domestic users most impacted financially by these potential imposed costs. For agricultural groundwater users, degraded water quality may cause potential changes in irrigation practices, crops grown, agricultural efficiencies, adverse effects on property values, and other economic impacts, with the potential to adversely impact the larger economy throughout the Subbasin.

6.3.3.2 Minimum Thresholds

The minimum threshold for TDS is established at 1,000 mg/L, the upper Secondary MCL for TDS (State of California, 2006), for all representative monitoring sites where current groundwater quality (groundwater quality prior to the end of WY2016) does not exceed 1,000 mg/L. For representative monitoring sites that currently exceed the minimum threshold, existing regulatory water compliance and remediation programs will apply, including but not limited to, the CV-SALTS Salt Control Program, the Irrigated Lands Regulatory Program, the County Drought Plan requirements for State Small Water Systems and Domestic Wells (SB 552), and the Safe and Affordable Funding for Equity and Resilience (SAFER) program.

For any representative monitoring site without data prior to the end of WY2016, current (ambient) groundwater quality will be established using data collected during the first five years of monitoring following WY2016 or following construction of the well. For representative monitoring sites that do not currently exceed the minimum threshold, but are found to exceed minimum thresholds in the future, the applicable GSP group will conduct and publish an assessment of the effect of groundwater management activities on the documented exceedance, and propose timely actions to manage groundwater differently, if needed, to avoid exacerbating the exceedance. The applicable GSP group will also coordinate with the appropriate regulatory program to address the impact.

Figure 6-4 and **Figure 6-5** show the locations of groundwater quality representative monitoring wells in the Upper Aquifer and Lower Aquifer, respectively, for the Delta-Mendota Subbasin, where the Northern & Central Delta-Mendota Region GSAs are responsible for monitoring the representative monitoring sites in their Plan area. **Table 6-3** shows the minimum thresholds at each representative monitoring site in the Upper Aquifer and Lower Aquifer for the degradation of groundwater quality sustainability indicator.

In developing the minimum thresholds for groundwater quality, State, federal, and local standards were evaluated to ensure consistency with existing water quality standards within the Plan area. Under the Central Valley Regional Water Quality Control Board's (CV-RWQCB) *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (or Basin Plan) (SWRCB, May 2018), the Delta-Mendota Subbasin is given a municipal (MUN) beneficial use designation, which dictates the WQOs for ambient water quality consistent with drinking water standards. The Statewide Recycled Water Policy regulations were also incorporated into the minimum thresholds for degraded water quality as recycled water-related projects are currently planned to aid in GSP implementation (see **Section 7.1** *Projects & Management Actions* for more information about recycled water projects in the Plan area). Resolution 68-16 (SWRCB, 1968), also known as the California Anti-Degradation Policy, was also used to inform the minimum thresholds for the degraded water quality sustainability indicator where existing groundwater will be maintained to ensure the highest water quality to the maximum benefit to the people of the State. The Basin Plan, Statewide Recycled Water Policy, and Resolution 68-18, combined with the requirement to establish existing baseline conditions under SGMA, were relied upon to establish and justify the minimum thresholds for the degraded water quality sustainability indicator.

Water quality in the Delta-Mendota Subbasin varies both by principal aquifer and by location within the Subbasin. The Upper Aquifer is considered a semi-confined aquifer and elevated concentrations detected in groundwater are mostly associated with anthropogenic activities, such as through irrigation water and fertilizer application. The Lower Aquifer, as a confined aquifer, generally has good water quality (as the Corcoran Clay acts as a barrier to the downward migration of constituents), but is impacted to some extent along the western margin of the Subbasin (where the Corcoran Clay does not exist) or where composite wells are screened across the Corcoran Clay and have the potential to act as a conduit for constituent migration within and between primary aquifers.

TDS is also naturally-occurring in both the Upper Aquifer and Lower Aquifer. Water quality conditions were evaluated based on aquifer designation and the range of conditions present. Across sustainability indicators, the constituents of concern that will be monitored under this GSP in coordination with groundwater levels to support groundwater management operations, providing future insight into potential links between groundwater levels and water quality. Management of the chronic lowering of groundwater levels relative to minimum thresholds for groundwater levels is anticipated to avoid an undesirable result for degraded water quality based on professional judgement and local knowledge of concentrations of constituents of concern observed at hydrologic low conditions (as supported by historical changes in groundwater quality during periods of low groundwater elevations). It should be noted that minimum thresholds for the degraded water quality sustainability indicator are established for ambient groundwater quality, where treatment may be required prior to the intended beneficial use of groundwater.

Similar to the establishment of sustainability indicators for groundwater elevations, limited inter-basin coordination has been conducted relative to establishing the minimum thresholds and measurable objectives for groundwater quality. As previously noted, three of the adjoining subbasins (Tracy, Modesto, and Turlock Subbasins) are not required to submit their GSPs to DWR until January 2022, and due to time constraints in preparing the GSPs, limited coordination was conducted with the Merced, Westside, and Kings Subbasins. As such, ongoing inter-basin coordination between the subbasins will be conducted during GSP implementation, and the annual reports and GSP updates will contain evaluations of how minimum thresholds for degraded water quality in the Northern and Central Delta-Mendota Regions may affect the ability of these adjacent basins to meet achieve their sustainability goals.

The beneficial uses and users of groundwater, as well as land uses and property interests, were considered when establishing minimum thresholds for the degraded water quality sustainability indicator. Stakeholders, including the public, were invited to provide feedback on minimum thresholds during Working Group meetings (publicly noticed per Brown Act requirements) and during public workshops centered around SMC held throughout the Delta-Mendota Subbasin in May 2019, as well as during Delta-Mendota Coordination Committee meetings held between February and June 2022. Representatives from the municipal sector (primarily the City of Patterson and Santa Nella County Water District) and agricultural sector are Working Group members and provided input in setting the minimum thresholds for the degraded water quality sustainability indicator throughout the development process. Agricultural sector representatives indicated that ambient groundwater quality consistent with the Secondary MCL for TDS is sufficiently protective of the agricultural beneficial use of groundwater as they are consistent with State regulations and the agricultural WQOs described in the *Delta-Mendota Canal Non-Project Water Pump-in Program Monitoring Plan* (USBR, 2018) and given that waters containing higher concentrations of TDS may be blended with other waters for use within the Subbasin.

For information regarding how minimum thresholds for the degraded water quality sustainability indicator will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2.5.4** *Degraded Water Quality Monitoring Network* of the *Sustainability Implementation* chapter.

Table 6-3. Minimum Thresholds for Degraded Water Quality

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Minimum Threshold (TDS in mg/L)
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Lower	1,000
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Lower	1,000
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Lower	N/A
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Upper	1,000
01-006		372604N1210611W001	91	Lower	1,000
01-007			MP021.12L	Lower	1,000
01-008			MP051.66L	Lower	1,000
01-018			Gemperle well	Upper	1,000
02-002			WELL 02 - NORTH 5TH STREET	Lower	1,000
02-009			Keystone well	Upper	1,000
03-001		375015N1211011W001	MW-2	Upper	N/A
03-003	05S/08E-16R		WSJ003	Upper	N/A
03-007		374410N1210638W001	MW-1	Upper	1,000
04-001		376129N1212942W001	121	Lower	1,000
06-001	06S08E09E001M	374316N1210994W001	P259-1	Lower	1,000
06-002	06S08E09E003M	374316N1210994W003	P259-3	Upper	1,000
06-003		375774N1212096W001	WSID 3	Lower	1,000
06-004			MP031.31L1-L2Well1	Upper	N/A
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Lower	1,000
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Upper	1,000
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Lower	1,000
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Lower	N/A
07-012	12S/12E-16B		GDA003	Upper	N/A
07-014			TW-4	Lower	1,000

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Minimum Threshold (TDS in mg/L)
07-015			TW-5	Lower	1,000
07-016			Well 01	Lower	1,000
07-017			Well 1	Upper	1,000
07-018	15S/16E-20		WSJ001	Upper	N/A
07-028		369064N1207276W001	MP093.27L / Well 500	Lower	N/A
07-029			CDMGSA-01A	Upper	N/A
07-030			CDMGSA-01B	Lower	N/A
07-031			CDMGSA-01C	Lower	N/A
07-032			CDMGSA-01D	Lower	N/A
07-033			TW-4 Upper	Upper	1,000
07-034		369057N1207470W001	MP092.20R	Lower	N/A
07-035		368871N1206355W001	MP098.74L	Upper	N/A
08-002			MP102.04L	Upper	N/A

N/A – Current groundwater quality exceeds 1,000 mg/L

6.3.3.3 Measurable Objectives and Interim Milestones

The measurable objective for degraded water quality is set as less than 1,000 mg/L TDS. Each GSP Group will participate in, provide data for, and track and report on compliance with orders and objectives adopted by the State and Central Valley Regional Water Quality Control Boards and similar regulatory agencies, in coordination with the Central Valley Groundwater Monitoring Collaborative.

Table 6-4 reflects the measurable objectives for degraded water quality for the Upper Aquifer and Lower Aquifer in the Plan area. The selected measurable objectives reflect input from local drinking water purveyors, as well as the local agricultural community, and is expected to maintain beneficial uses of groundwater for both drinking water and agricultural users. It should be noted that concentrations presented for measurable objectives reflect ambient groundwater quality, where additional treatment and/or blending may be necessary to meet State and federal MCLs for drinking water.

To assist the Plan area in reaching the measurable objective for degraded water quality, interim milestones are established for 2025, 2030, and 2035 as a means of assessing progress towards the Subbasin's sustainability goal:

- **Year 5 (2025):** Maintain TDS consistent with measurable objectives. Participate in, provide data for, and track and report on compliance with orders and objectives adopted by the State Water Resources and Central Valley Regional Water Quality Control Boards and similar regulatory agencies, in coordination with the Central Valley Groundwater Monitoring Collaborative. Develop correlation between groundwater quality and groundwater levels in order to establish methodology for the use of groundwater levels as a proxy for groundwater quality.
- **Year 10 (2030):** Maintain water quality consistent with measurable objectives. Continue monitoring and publishing groundwater quality data, and tracking and reporting on compliance with regulatory orders and objectives. Where water quality impairments are caused by activities outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs. Utilizing the methodology developed by the Year 5 interim milestone, develop minimum thresholds and measurable objectives for groundwater quality that utilize groundwater elevations as a proxy for monitoring.
- **Year 15 (2035):** Maintain water quality consistent with measurable objectives. Continue monitoring and publishing groundwater quality data, and tracking and reporting on compliance with regulatory orders and objectives. Where water quality impairments are caused by activities outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.

Table 6-4. Measurable Objective for Degraded Water Quality

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Measurable Objective (TDS in mg/L)
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Lower	< 1,000
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Lower	< 1,000
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Lower	N/A
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Upper	< 1,000
01-006		372604N1210611W001	91	Lower	< 1,000
01-007			MP021.12L	Lower	< 1,000
01-008			MP051.66L	Lower	< 1,000

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Measurable Objective (TDS in mg/L)
01-018			Gemperle well	Upper	< 1,000
02-002			WELL 02 - NORTH 5TH STREET	Lower	< 1,000
02-009			Keystone well	Upper	< 1,000
03-001		375015N1211011W001	MW-2	Upper	N/A
03-003	05S/08E-16R		WSJ003	Upper	N/A
03-007		374410N1210638W001	MW-1	Upper	< 1,000
04-001		376129N1212942W001	121	Lower	< 1,000
06-001	06S08E09E001M	374316N1210994W001	P259-1	Lower	< 1,000
06-002	06S08E09E003M	374316N1210994W003	P259-3	Upper	< 1,000
06-003		375774N1212096W001	WSID 3	Lower	< 1,000
06-004			MP031.31L1-L2Well1	Upper	N/A
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Lower	< 1,000
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Upper	< 1,000
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Lower	< 1,000
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Lower	N/A
07-012	12S/12E-16B		GDA003	Upper	N/A
07-014			TW-4	Lower	< 1,000
07-015			TW-5	Lower	< 1,000
07-016			Well 01	Lower	< 1,000
07-017			Well 1	Upper	< 1,000
07-018	15S/16E-20		WSJ001	Upper	N/A
07-028		369064N1207276W001	MP093.27L / Well 500	Lower	N/A
07-029			CDMGSA-01A	Upper	N/A
07-030			CDMGSA-01B	Lower	N/A

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Principal Aquifer	Measurable Objective (TDS in mg/L)
07-031			CDMGSA-01C	Lower	N/A
07-032			CDMGSA-01D	Lower	N/A
07-033			TW-4 Upper	Upper	< 1,000
07-034		369057N1207470W001	MP092.20R	Lower	N/A
07-035		368871N1206355W001	MP098.74L	Upper	N/A
08-002			MP102.04L	Upper	N/A

N/A – Current groundwater quality exceeds 1,000 mg/L

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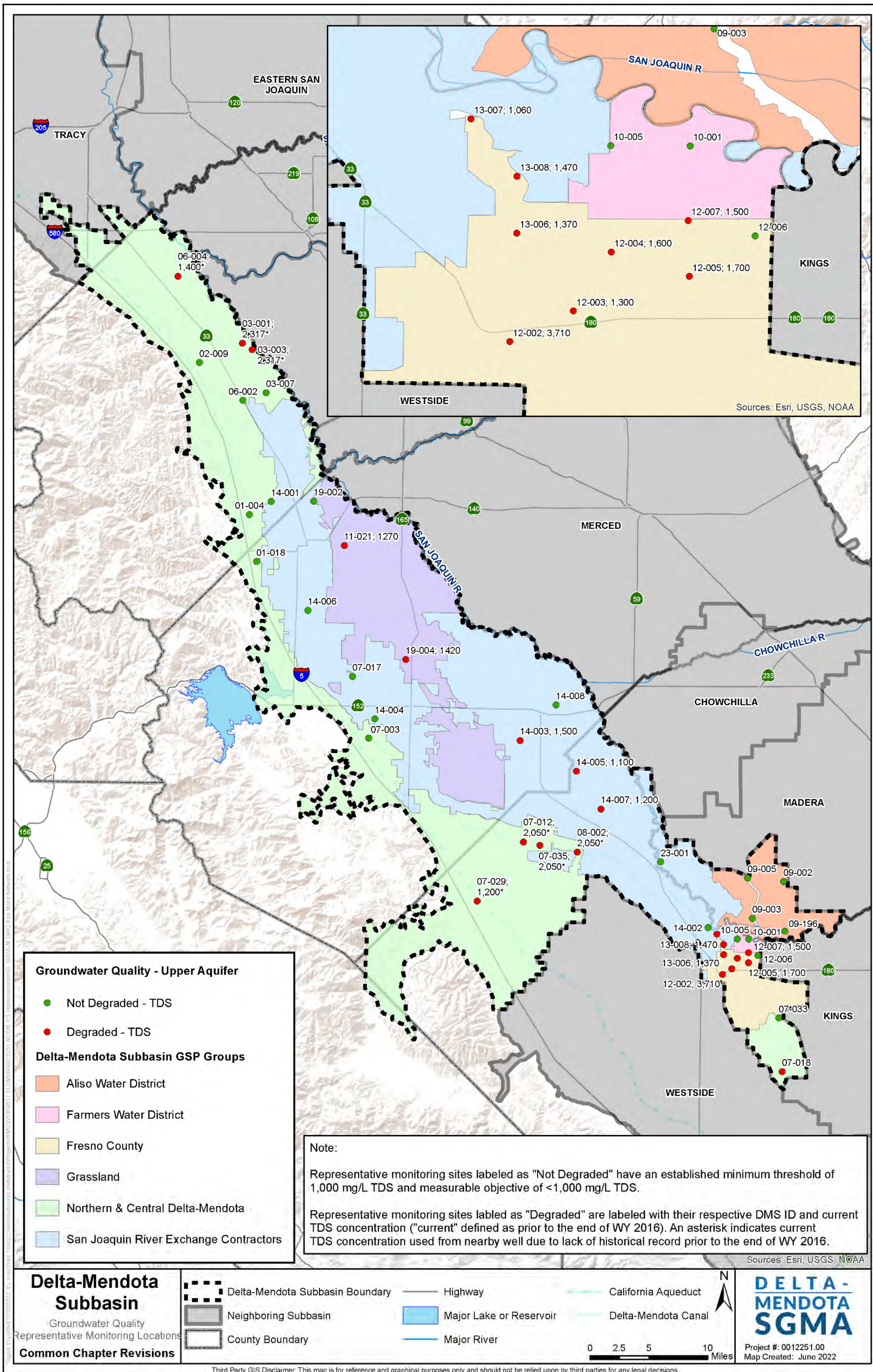

Figure 6-4. Locations of Representative Monitoring Wells for Degraded Water Quality, Upper Aquifer

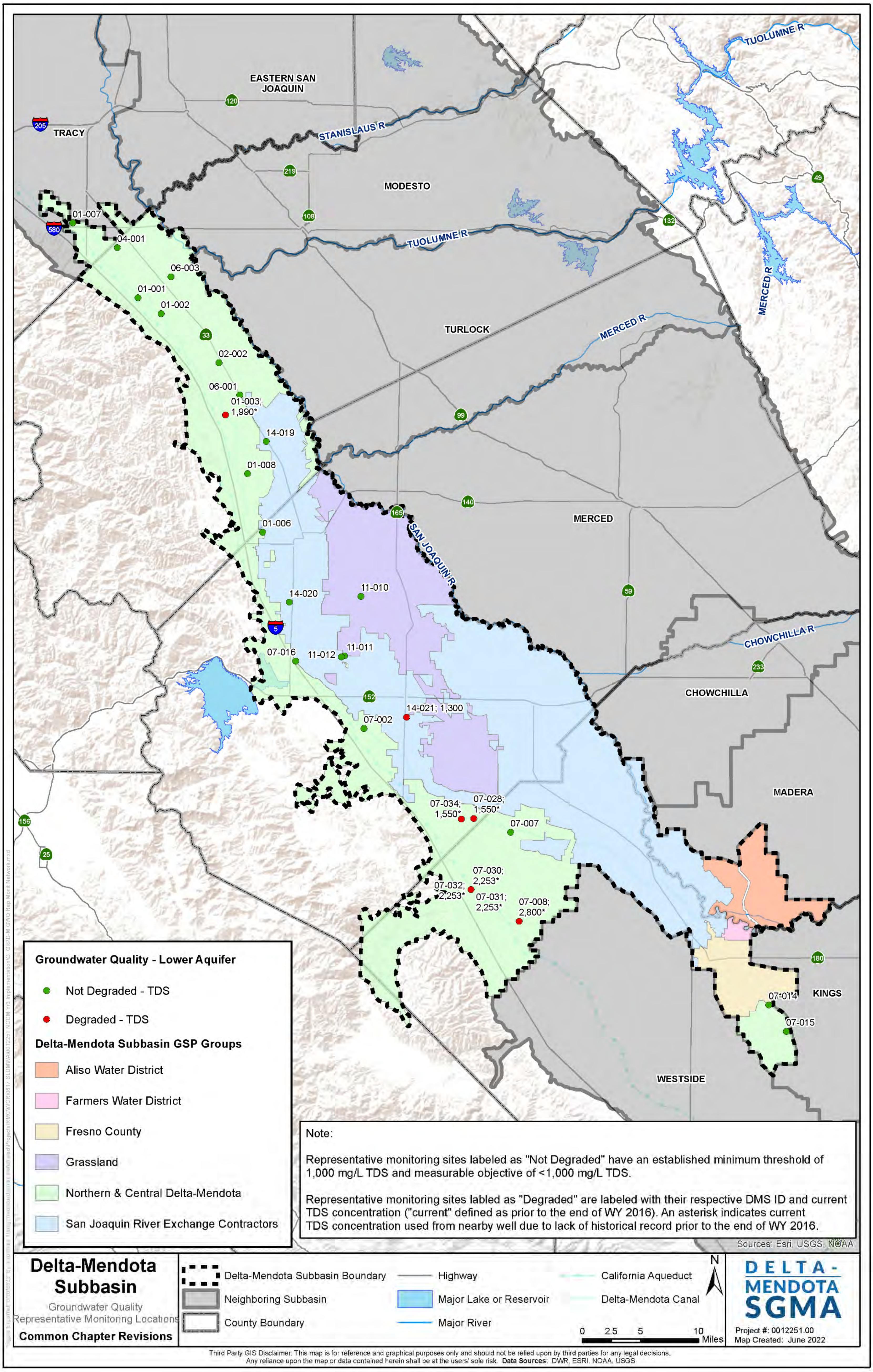

Figure 6-5. Locations of Representative Monitoring Wells for Degraded Water Quality, Lower Aquifer

6.3.4 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator for the Delta-Mendota Subbasin as the Subbasin is located inland from the Pacific Ocean. Therefore, sustainable management criteria for seawater intrusion will not be set for the Plan area.

6.3.5 Land Subsidence

Undesirable results, minimum thresholds, measurable objectives, and interim milestones for the land subsidence sustainability indicator are described in the subsequent subsections.

6.3.5.1 Undesirable Results

A description of undesirable results as defined under SGMA and by the Delta-Mendota Subbasin, identification of undesirable results, potential causes of undesirable results, and potential effects of undesirable results relative to the land subsidence sustainability indicator are detailed below.

6.3.5.1.1 Description of Undesirable Results

The undesirable result related to land subsidence is defined under SGMA as:

> *Significant and unreasonable land subsidence that substantially interferes with surface land uses* (CWC Section 10721(x)(5).

An undesirable result for land subsidence in the Delta-Mendota Subbasin is experienced through *changes in ground surface elevation that cause damage to critical infrastructure that would cause significant and unreasonable reductions of conveyance capacity, impacts to natural resources, or conditions that threaten public health and safety*. This definition of an undesirable result was agreed upon by all GSP Groups through the Delta-Mendota Subbasin Coordination Committee.

6.3.5.1.2 Identification of Undesirable Results

An undesirable result for land subsidence is triggered, or considered "significant and unreasonable," when:

- Significant and unreasonable damage to conveyance capacity from inelastic land subsidence is structural damage that decreases an unmitigated and unmanageable reduction of design capacity or freeboard.
- Significant and unreasonable impacts to natural resource areas from inelastic land subsidence are unmitigated decreases in the ability to flood or drain such areas by gravity.
- Significant and unreasonable threats to public health and safety from inelastic land subsidence are those that cause an unmitigated reduction of freeboard that allows for flooding, or unmitigated damage to roads and bridges.

6.3.5.1.3 Potential Causes of Undesirable Results

Land subsidence in the Delta-Mendota Subbasin typically is the result of over-extraction of groundwater. Inelastic land subsidence throughout the Subbasin largely occurs from Lower Aquifer groundwater pumping resulting in the compaction of clays below the Corcoran Clay layer as a result of the loss of piezometric head. Generally poor water quality within the Upper Aquifer and transitions from pasture or fallowed land to irrigated land uses has resulted in increased groundwater demand from the Lower Aquifer. Conjunctive use of surface water and groundwater is prevalent throughout the Plan area as supplies from the San Joaquin River, Kings River, CVP, and SWP are utilized and supplemented with groundwater when surface water deliveries are reduced or non-existent. As a result, groundwater extractions increase during periods of drought or as the result of regulatory constraints, when surface water supplies are inadequate to meet agricultural demand, resulting in higher rates of inelastic land subsidence.

6.3.5.1.4 Potential Effects of Undesirable Results

Undesirable results related to land subsidence could potentially cause unrecoverable loss of groundwater storage and differential changes in land surface elevation, resulting in damage to water conveyance infrastructure, flood control facilities and other infrastructure, and causing decreased capacity to convey water or control flood waters. This could impact the ability to deliver surface water within the Subbasin, as well as throughout California as the DMC and California Aqueduct run nearly the entire length of the Northern and Central Delta-Mendota Regions. The cost to convey surface water or control flood waters would likely increase as gradients of gravity-driven conveyance structures would require repair and modification or increased energy to pump and move surface or flood water. These potential effects could result in significant economic costs and adversely impact property value as well as public safety.

6.3.5.2 Minimum Thresholds

The minimum thresholds for the land subsidence sustainability indicator are set to 2 feet of additional inelastic land subsidence attributable to groundwater extractions in the Subbasin. Subsidence caused by groundwater extractions in the Delta-Mendota Subbasin that exceeds corrective design standards or established triggers for critical infrastructure including the Delta-Mendota Canal, California Aqueduct, and roads and bridges will also be avoided. **Figure 6-6** shows the locations of land subsidence representative monitoring sites for the Delta-Mendota Subbasin, where the Northern & Central Delta-Mendota Region GSAs are responsible for monitoring the representative monitoring sites in their Plan area. **Table 6-5** includes the minimum thresholds at each representative monitoring site for the land subsidence sustainability indicator within the Northern & Central Delta-Mendota Region.

The minimum thresholds for land subsidence do not directly impact any of the other applicable sustainability indicators. As previously stated, the land subsidence, chronic lowering of groundwater levels and reductio in groundwater storage sustainability indicators are linked as groundwater pumping from the Lower Aquifer results in declines in deeper groundwater levels and compaction of compressible soils as a result of dewatering, resulting in inelastic subsidence.

Similar to the establishment of sustainability indicators for groundwater elevations, limited inter-basin coordination has been conducted relative to establishing the minimum thresholds and measurable objectives for inelastic land subsidence. As previously noted, three of the adjoining subbasins (Tracy, Modesto, and Turlock Subbasins) are not required to submit their GSPs to DWR until January 2022, and due to time constraints in preparing the GSPs, limited coordination was conducted with the Merced, Westside, and Kings Subbasins. As such, ongoing inter-basin coordination between the subbasins will be conducted during GSP implementation, and the annual reports and GSP updates will contain evaluations of how minimum thresholds for land subsidence in the Northern and Central Delta-Mendota Regions may affect the ability of these adjacent basins to meet and achieve their sustainability goals.

The beneficial uses and users of groundwater, as well as land uses and property interests, were considered when establishing minimum thresholds for the land subsidence sustainability indicator. Stakeholders, including the public, were invited to provide feedback on minimum thresholds during Working Group meetings (publicly noticed per Brown Act requirements) and during public workshops centered around SMC held throughout the Delta-Mendota Subbasin in May 2019, as well as during Delta-Mendota Coordination Committee meetings held between February and June 2022. Representatives from the municipal sector (primarily the City of Patterson and Santa Nella County Water District) and agricultural sector are Working Group members and provided input in setting the minimum thresholds for the land subsidence sustainability indicator throughout the development process. Many agricultural water users within the Plan area conjunctively use groundwater and surface water and therefore provided feedback in setting minimum thresholds for the land subsidence sustainability indicator related to both surface water and groundwater. An undesirable result for land subsidence throughout the Plan area relates to damage of critical infrastructure for conveying surface water through reductions in conveyance capacity, impacts to natural resources, or conditions that threaten public health and safety as a result of Lower Aquifer groundwater pumping and associated inelastic land subsidence. Based on the above described communication with beneficial users of groundwater, it was deemed that the minimum thresholds set for the land subsidence and chronic lowering of groundwater levels sustainability indicators would avoid undesirable results for both sustainability indicators.

Currently, there are no other State, federal, or local standards within the Plan area that relate to the land subsidence sustainability indicator. SGMA is the prevailing legislation dictating requirements and standards for the land subsidence sustainability indicator. Since the California Aqueduct runs nearly the entire length of the Plan area and is managed by DWR, the Northern and Central Delta-Mendota Regions met with representatives from DWR and coordinated with DWR in regards to land subsidence throughout the development of this GSP. As this GSP was being developed, DWR was conducting an on-going evaluation of land subsidence relative to the California Aqueduct, which is expected to be complete and released in late 2019. Discussions and coordination with DWR involved DWR's tolerance for additional land subsidence along the California Aqueduct within the Delta-Mendota Subbasin to ensure minimum thresholds set in this GSP are compatible with DWR's projected operations of the California Aqueduct. DWR did not, however, opt to participate in GSP development prior to the release of the Public Draft GSP.

For information regarding how minimum thresholds for the land subsidence sustainability indicator will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2.5.5** *Land Subsidence Monitoring Network* of the *Sustainability Implementation* chapter.

6.3.5.3 Measurable Objectives and Interim Milestones

The measurable objectives for land subsidence are to minimize inelastic land subsidence attributable to groundwater extraction within the Subbasin, with no additional subsidence after 2040.

Table 6-5 reflects the measurable objectives for land subsidence at each representative monitoring site in the Plan area. As previously noted, undesirable results for land subsidence relate to conveyance capacity of water conveyance or flood control infrastructure as significant and unreasonable rates of land subsidence occur. By managing the Lower Aquifer according to the chronic lowering of groundwater levels measurable objectives, as well as the measurable objectives set forth for the land subsidence sustainability indicator, it is anticipated that an undesirable result for land subsidence will be avoided and therefore the sustainability goal will be met by 2040.

To assist the Plan area in reaching the measurable objective for land subsidence, interim milestones are established for 2025, 2030, and 2035 as a means of assessing progress towards the Subbasin's sustainability goal:

- **Year 5 (2025):** Interim goal of no more than 1 foot of additional inelastic land subsidence attributable to groundwater extraction in the Subbasin during the first 5-year period of SGMA implementation. Review and revise Hydrogeologic Conceptual Model (HCM) to incorporate new data. Re-evaluate inelastic land subsidence SMC to consider new data and studies and to assess allowable land subsidence on a Subbasin and localized (subbasin subarea) basis. Gather data and complete the selection of establishment of representative monitoring sites for land subsidence, with particular attention to the locations of critical infrastructure in the Subbasin, and in coordination with the Bureau of Reclamation and Department of Water Resources. Determine the relative portion of subsidence caused by groundwater extraction within and outside the Subbasin at each representative monitoring site. Where subsidence is caused by pumping outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.

- **Year 10 (2030):** Interim goal of no more than 0.5 feet of additional inelastic land subsidence attributable to groundwater extraction in the Subbasin during the second 5-year period of SGMA implementation, for a cumulative total of 1.5 feet in the first 10 years. Where subsidence is caused by groundwater extraction outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs. Continue work to improve understanding of interconnection between groundwater extractions and land subsidence, utilizing model simulations and/or data collection and analysis.
- **Year 15 (2035):** Interim goal of no more than 0.25 feet of additional inelastic land subsidence attributable to groundwater extraction in the Subbasin during the third 5-year period of SGMA implementation, for a cumulative total of 1.75 feet in the first 15 years. Where subsidence is caused by groundwater extraction outside the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs. Continue work to improve understanding of interconnection between groundwater extractions and land subsidence, utilizing model simulations and/or data collection and analysis.

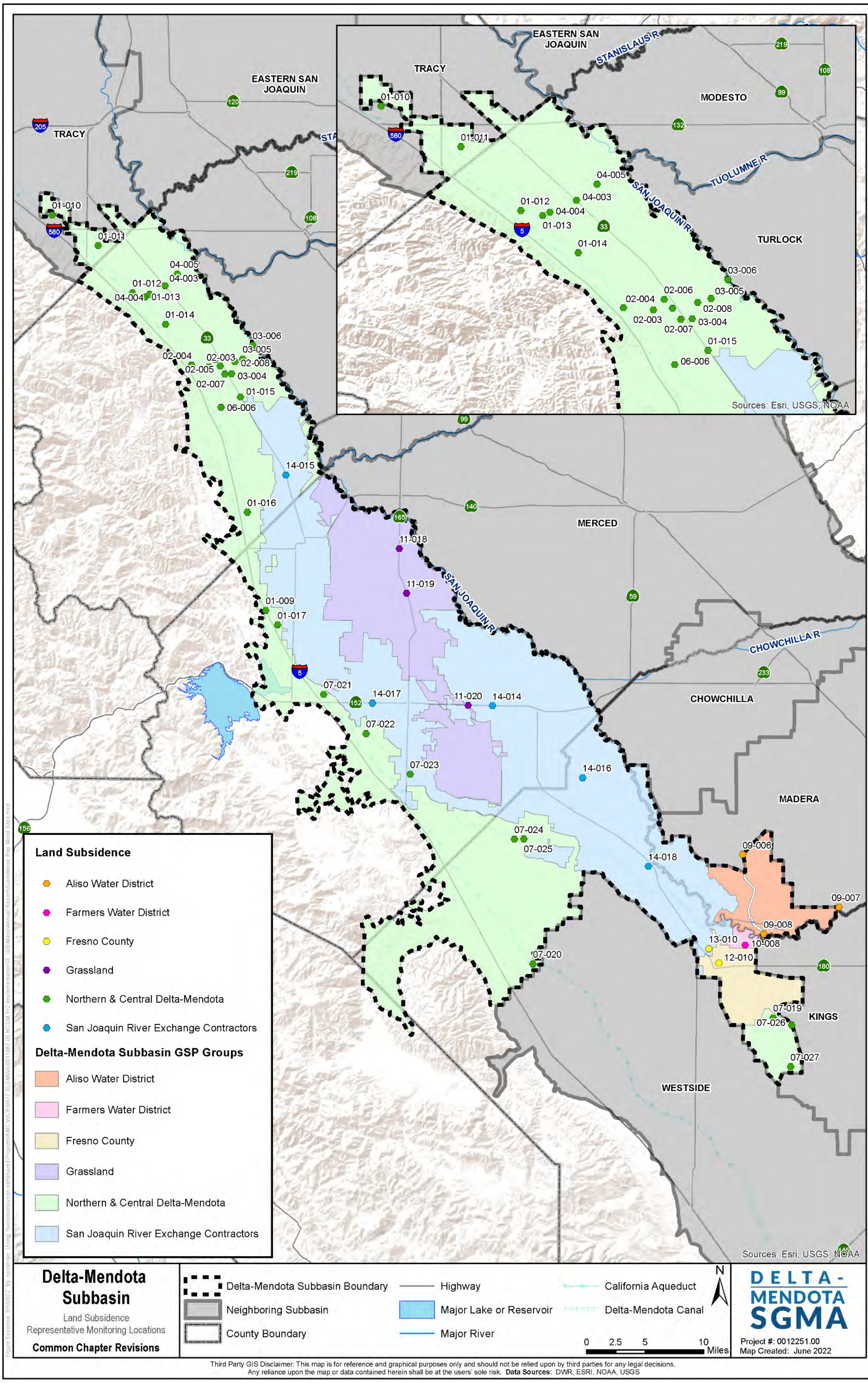

Figure 6-6. Location of Representative Monitoring Sites for Land Subsidence

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Table 6-5. Minimum Thresholds and Measurable Objectives for Land Subsidence

DMS ID	Local ID	Minimum Threshold (feet of inelastic land subsidence)	Measurable Objective (feet of inelastic land subsidence)
02-003	Floragold Well	2	0
02-008	Well 11	2	0
02-005	Well 2	2	0
02-006	Well 4	2	0
02-007	Well 6	2	0
03-004	Locust Avenue Well	2	0
03-005	Pumping Plant No. 2	2	0
03-006	River Station	2	0
01-010	Subsidence Monitoring Point #1	2	0
01-011	Subsidence Monitoring Point #2	2	0
01-012	Subsidence Monitoring Point #3	2	0
01-013	Subsidence Monitoring Point #4	2	0
01-014	Subsidence Monitoring Point #5	2	0
02-004	Subsidence Monitoring Point #6	2	0
04-003	WSID 11	2	0
04-004	WSID 21	2	0
04-005	WSID 2	2	0
01-015	Subsidence Monitoring Point #7	2	0
06-006	Subsidence Monitoring Point #8	2	0
01-016	Subsidence Monitoring Point #9	2	0
01-017	Subsidence Monitoring Point #10	2	0
07-021	Subsidence Monitoring Point #11	2	0
01-009	P252	2	0
07-022	Subsidence Monitoring Point #12	2	0
07-023	Subsidence Monitoring Point #13	2	0
07-020	104.20-R	2	0
07-024	Subsidence Monitoring Point #14	2	0
07-025	Subsidence Monitoring Point #15	2	0
07-019	AG-24	2	0
07-026	TID A	2	0
07-027	TID B	2	0

6.3.6 Depletions of Interconnected Surface Water

Undesirable results, minimum thresholds, measurable objectives, and interim milestones for the depletions of interconnected surface water sustainability indicator are described in the subsequent subsections.

6.3.6.1 Undesirable Results

A description of undesirable results as defined under SGMA and by the Delta-Mendota Subbasin, identification of undesirable results, potential causes of undesirable results, and potential effects of undesirable results relative to the depletions of interconnected surface water sustainability indicator are detailed below.

6.3.6.1.1 Description of Undesirable Results

The undesirable result related to depletions of interconnected surface water is defined under SGMA as:

> *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water* (CWC Section 10721(x)(6)).

Undesirable results for depletions of interconnected surface water in the Delta-Mendota Subbasin is experienced through *depletions of interconnected surface water as a direct result of groundwater pumping that causes significant and unreasonable impacts on natural resources or downstream beneficial uses and users*. This definition of an undesirable result was agreed upon by all GSP Groups through the Delta-Mendota Subbasin Coordination Committee.

6.3.6.1.2 Identification of Undesirable Results

An undesirable result for depletions of interconnected surface water is triggered, or considered “significant and unreasonable,” when impacts on natural resources or downstream beneficial uses and users of groundwater are a reduction in available surface water supplies for natural resource areas, and reductions in downstream water availability as a result of increased streamflow depletions along the San Joaquin River when compared to similar historic water year types.

6.3.6.1.3 Potential Causes of Undesirable Results

The potential causes of undesirable results for the depletions of interconnected surface water includes increased groundwater demand along interconnected corridors. The portion of the San Joaquin River bordering the Northern Delta-Mendota Region has been identified as the only interconnected surface water body in the Plan area, based on information available during development of this GSP as described in **Section 5.3.7** *Interconnected Surface Water Systems* of the *Basin Setting* chapter.

6.3.6.1.4 Potential Effects of Undesirable Results

If depletions of interconnected surface water were to reach levels causing undesirable results, adverse effects could include reduced flow and stage within the San Joaquin River to the extent that insufficient surface water flows would be available to support diversions for agricultural uses or to support regulatory environmental requirements. This could result in increased groundwater production, changes in irrigation practices and crops grown, and could cause adverse effects to property values and the subbasin-wide economy. Such impacts could also be tied to the inability to meet minimum flow requirements, which are defined for the San Joaquin River and are managed by upstream dams and reservoir releases.

6.3.6.2 Minimum Thresholds

At the time of GSP development, there are insufficient data and monitoring locations available to set numeric values for minimum thresholds for the depletions of interconnected surface water sustainability indicator in a manner that is not subjective. Interconnected surface water is an identified data gap in the Delta-Mendota Subbasin. Therefore, as an interim minimum threshold, the chronic lowering of groundwater levels minimum thresholds will be used as proxy for impacts to interconnected surface waters. Minimum thresholds for the chronic lowering of groundwater as a proxy is groundwater elevations that are lower than the historical seasonal low. The historic seasonal low is a fixed elevation at each site, based on available groundwater level data prior to the end of WY2016. As with the chronic lowering of groundwater levels SMC, to account for future year-to-year variation in hydrology, compliance with the fixed historic seasonal low threshold will be compared with a 4-year rolling average of annual groundwater level measurements, with groundwater levels are measured as water surface elevation.

For any representative monitoring site without data prior to WY2016, minimum thresholds will be established using the aforementioned methodologies and the data resulting from the first five years of monitoring following WY2016 or following construction of the well.

Figure 6-7 shows the proposed representative monitoring locations for the depletions of interconnected surface water sustainability indicator for the Delta-Mendota Subbasin once data gaps have been filled and minimum thresholds specific to interconnected surface water are established.

6.3.6.3 Measurable Objectives and Interim Milestones

At the time of GSP development, there are insufficient data and monitoring locations available to set numeric values for measurable objectives and interim milestones for the depletions of interconnected surface water sustainability indicator. Interconnected surface water is an identified data gap in the Delta-Mendota Subbasin. As an interim measurable objective, the chronic lowering of groundwater levels measurable objective will be used as proxy for interconnected surface water; this measurable objective is to maintain seasonal high groundwater levels at an elevation that is at or above the WY2015 seasonal high in the GSP area. The WY2015 seasonal high is a fixed elevation at each site, based on available groundwater level data. If data are unavailable for WY2015 at a representative monitoring site, either a WY2014 or WY2016 seasonal high will be used. As with the minimum thresholds, to account for future year-to-year variations in hydrology, compliance with the fixed seasonal high threshold will be compared with a 4-year rolling average of annual groundwater level measurements. Groundwater levels are measured as water surface elevation. For any representative monitoring site without data prior to WY2016, measurable objectives will be established using the aforementioned methodology and the data resulting from the first five years of monitoring following WY2016 or following the construction of the well.

To assist the Plan Area in reaching the measurable objective for interconnected surface water, interim milestones are established for 2025, 2030, and 2035 as a means of assessing progress toward the Subbasin's sustainability goal:

- **Year 5 (2025):** Fill data gaps, establish, and manage groundwater use to avoid the rate or volume of surface water depletions that have adverse impacts on beneficial uses and users and may lead to undesirable results. Additionally, the Subbasin will complete a monitoring network of interconnected surface water sites that will include existing sites and datasets. The GSP groups will complete the monitoring network with additional sites installed with SGMA Implementation Grant funding awarded to the Subbasin. Nine existing monitoring sites that are part of the San Joaquin River Restoration Program and are located along the San Joaquin River at the southern end of the Subbasin will also be used. These sites, and the associated datasets, will continue to be utilized in the Subbasin as part of its monitoring network. Additional representative monitoring network sites for interconnected surface water will focus on the Northern & Central Delta-Mendota Region and Grassland GSP areas along the San Joaquin River.

- **Year 10 (2030):** Gather and analyze data from Subbasin's established representative monitoring sites. Also gather and analyze available data in cooperation with neighboring subbasins, the U.S. Bureau of Reclamation's San Joaquin River Restoration Program, the U.S. Geological Survey, and DWR's California Data Exchange Center (CDEC), to estimate the influence of groundwater on gains and losses in the San Joaquin River. Establish minimum thresholds and measurable objectives as a rate or volume of surface water depletions that have adverse impacts on beneficial uses and users and may lead to undesirable results.

- **Year 15 (2035):** Monitor and maintain interconnected surface waters in accordance with revised minimum thresholds and measurable objectives. Where increased interconnected surface water losses are caused by pumping outside of the Subbasin, seek remedies in coordination with the Department of Water Resources and neighboring GSAs.

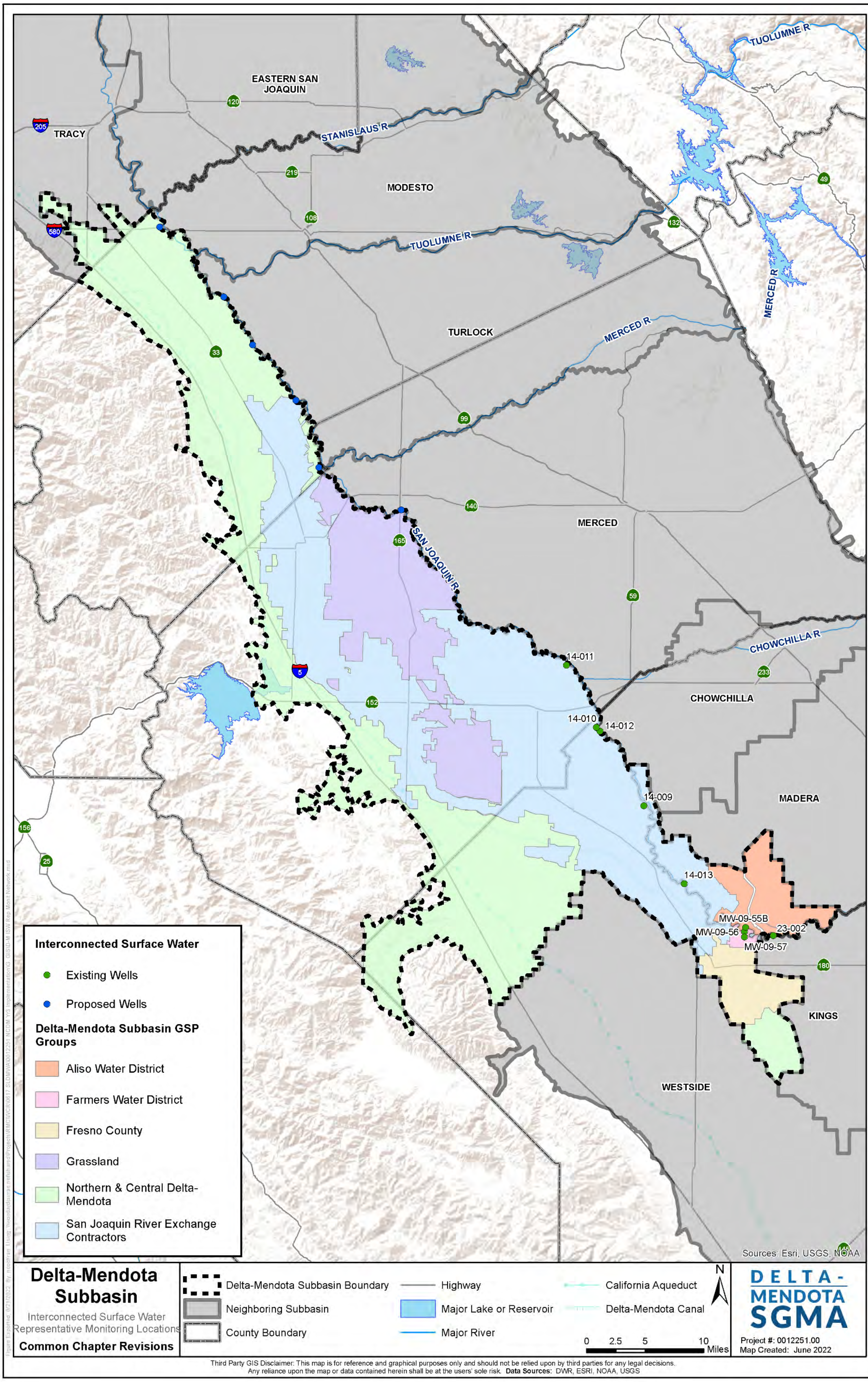

Figure 6-7. Proposed Locations of Representative Monitoring Wells for Depletions of Interconnected Surface Water

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Section 7

Sustainability Implementation

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7. SUSTAINABILITY IMPLEMENTATION

7.1 PROJECTS AND MANAGEMENT ACTIONS

The projects and management actions detailed in this section have been identified for implementation to support groundwater sustainability in the Northern and Central Regions of the Delta-Mendota Subbasin and to respond to projected changing conditions in the Subbasin over the planning and implementation horizon, as required by the Groundwater Sustainability Plan (GSP) Emergency Regulations Article 5 Plan Contents, Subarticle 5 Projects and Management Actions (§354.42 - §354.44). Pursuant to Section 354.44, each project and management action description included herein contains the following information:

- A description of the measurable objective that is expected to benefit from the project or management action;
- Criteria for implementation;
- Quantification of demand reduction for overdraft mitigation;
- A summary of permitting and regulatory processes required for each project and management action;
- The status of each project and management action;
- An explanation of benefits expected to be realized and how benefits will be evaluated;
- An explanation of how the project or management action will be accomplished;
- The legal authority required for each project and management action;
- Estimated cost and how costs will be met; and
- A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

Projects selected for inclusion in the projected water budget for the Northern and Central Delta-Mendota Regions were based on several criteria including:

- The status of project development;
- The feasibility of quantifying anticipated benefits at the time of GSP development; and
- The ability of projects and management actions to help meet the Subbasin sustainability goal.

It is anticipated that projects and management actions identified herein will change during the implementation process as more information is learned about the Delta-Mendota Subbasin and how the Subbasin reacts to implemented projects and management actions. Implementation of projects identified herein is contingent upon the availability of funding for construction, operation and maintenance. Projects and management actions not implemented during the first five years of the GSP implementation period will be re-evaluated based on data collection efforts through 2025. Additional projects and management actions will also be evaluated for inclusion in subsequent 5-Year Plan updates to ensure Subbasin sustainability is achieved by 2040.

The projects and management actions contained herein were divided into three tiers based on design and funding status and anticipated timeframe of implementation:

- **Tier 1 –** Near-term projects and management actions that the Groundwater Sustainability Agencies (GSAs) are committed to implementing at this time. These projects and management actions are either currently in the process of being implemented or could be implemented in the near future (constructed and operational) within the next five years (by 2025).

- **Tier 2 –** Projects and management actions that have been identified and require further development before implementation can occur. It is anticipated that these projects and management actions could be developed over the next five years and implemented beginning in 2026 or later, pending re-evaluation prior to the 5-Year GSP Update in 2025.
- **Tier 3 –** Longer-term projects and management actions that may be implemented in the future as needed. Many of these projects are outside of the GSAs' control but could have implications on surface water availability and/or are additional projects/management actions that could be implemented under an adaptive management approach.

The projects and management actions selected for implementation are summarized in **Table 7-1** and described in more detail in the following subsections. The project proponents (or implementing agencies) are also shown in **Table 7-1**. Generally, management actions do not have a specific project proponent, but rather would be implemented by a single GSA, all of the GSAs in the Plan area or Subbasin, and/or a proponent/manager for the management action would be identified prior to implementation. **Table 7-2** includes a summary of how projects and management actions described herein address each sustainability indicator applicable to the Plan Area. It should be noted that projects related to the use of surplus surface water, stormwater or flood flow for groundwater recharge will be required to obtain proper water rights prior to project construction.

The projected water budget, with applied climate change factors and anticipated projects and management actions, contained in **Section 5.4** *Water Budget* of the *Basin Setting* chapter was completed assuming implementation of Tier 1 projects, Tier 2 projects, and Tier 2 management actions. Because Tier 3 projects are longer term and/or are outside the direct control of the Northern and Central Delta-Mendota Regions GSAs and project details have not yet been determined, these projects were not included in the projected water budget. For details regarding how each of the Tier 1 and Tier 2 projects and Tier 2 management actions were incorporated into the projected water budget, refer to **Appendix D** *Water Budgets Model Development Technical Memorandum*.

Table 7-1. Northern & Central Delta-Mendota Region GSP Projects and Management Actions

Tier	Category	Project / Management Action	Project Proponent
Tier 1	Projects	Los Banos Creek Recharge and Recovery Project	San Luis Water District
		Orestimba Creek Recharge and Recovery Project	Del Puerto Water District
		North Valley Regional Recycled Water Program (NVRRWP) – Modesto and Early Turlock Years	Del Puerto Water District
		City of Patterson Percolation Ponds for Stormwater Capture and Recharge	City of Patterson
		Kaljian Drainwater Reuse Project	San Luis Water District
		West Stanislaus Irrigation District Lateral 4-North Recapture and Recirculation Reservoir	West Stanislaus Irrigation District
		Revision to Tranquillity Irrigation District Lower Aquifer Pumping	Tranquillity Irrigation District
	Management Actions	Lower Aquifer Pumping Rules for Minimizing Subsidence	N/A
		Maximize Use of Other Water Supplies	N/A
		Increasing GSA Access to and Input on Well Permits	N/A
		Drought Contingency Planning in Urban Areas	N/A
		Fill Data Gaps	N/A
Tier 2	Projects	Del Puerto Canyon Reservoir Project	Del Puerto Water District
		Little Salado Creek Groundwater Recharge and Flood Control Basin	Stanislaus County
		Patterson Irrigation District Groundwater Bank and/or Flood-Managed Aquifer Recharge (MAR)-type Project	Patterson Irrigation District
		West Stanislaus Irrigation District Lateral 4-South Recapture and Recirculation Reservoir	West Stanislaus Irrigation District
		Ortigalita Creek Groundwater Recharge and Recovery Project	San Luis Water District
	Management Action	Develop Program to Incentivize Use of Surface Water and Reduce Groundwater Demand	N/A
Tier 3	Projects	Pacheco Reservoir Expansion	Santa Clara Valley Water District
		Raising San Luis Reservoir	U.S. Bureau of Reclamation (USBR)
		Sites Reservoir	Sites Project Authority
		Los Vaqueros Expansion Phase 2	Contra Costa Water District
	Management Actions	Groundwater Extraction Fee with Land Use Modifications	N/A
		City of Patterson Reduced Groundwater Use Portfolio	City of Patterson
		Rotational Fallowing of Crop Lands	N/A

N/A – Not applicable; no specific project proponent identified. In most cases, management action will be implemented by a single GSA, all of the GSAs, and/or a proponent/manager for the management action will be identified prior to implementation.

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Table 7-2. Summary of How Northern & Central Delta-Mendota Region GSP Projects and Management Actions Address Sustainability Indicators

Activity	Sustainability Indicator				
	Chronic Lowering of Groundwater Levels	Reduction of Groundwater Storage	Degraded Water Quality	Land Subsidence	Depletions of Interconnected Surface Water
Tier 1 Projects					
Los Banos Creek Recharge and Recovery Project	Increased groundwater recharge; directly contributing to increased groundwater levels in the Upper Aquifer.	Increased groundwater recharge; directly contributing to increased storage in the Upper Aquifer.	Contributes to increased groundwater levels through increased recharge, reducing groundwater quality degradation associated with declining groundwater levels.	This project does not address this sustainability indicator.	Increased groundwater recharge reduces the potential for groundwater levels to decline and negatively impact interconnected surface water flows.
Orestimba Creek Recharge and Recovery Project	Increased groundwater recharge during wet periods; directly contributing to increased groundwater levels in the Upper Aquifer. Provides an alternative source of water during dry/critically dry periods for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations.	Increased groundwater recharge; directly contributing to increased storage in the Upper Aquifer.	Contributes to increased groundwater levels through increased recharge during wet periods, reducing groundwater quality degradation associated with declining groundwater levels. Provides an alternative source of water during dry periods for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations that potentially lead to reduced groundwater quality degradation.	As water demand is met by water in the Upper Aquifer, reliance on Lower Aquifer pumping decreases, which results in a reduced risk of inelastic land subsidence.	Increased groundwater recharge reduces the potential for groundwater levels to decline and negatively impact interconnected surface water flows.
North Valley Regional Recycled Water Program (NVRRWP) – Modesto and Early Turlock Years	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater storage.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations potentially leading to reduced groundwater quality degradation associated with declining groundwater levels.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in Lower Aquifer piezometric head, resulting in a reduced risk of inelastic land subsidence.	Provide an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations and associated potential impacts to interconnected surface water.
City of Patterson Percolation Ponds for Stormwater Capture and Recharge	Increased groundwater recharge; directly contributing to increased groundwater levels in the Upper Aquifer.	Increased groundwater recharge; directly contributing to increased storage in the Upper Aquifer.	Contributes to increased groundwater levels through increased recharge, reducing groundwater quality degradation associated with declining groundwater levels.	Increased recharge in the Upper Aquifer will allow the City to utilize this aquifer in lieu of pumping the Lower Aquifer, which will result in reduced risk of inelastic land subsidence.	Increased groundwater recharge reduces the potential for groundwater levels to decline and negatively impact interconnected surface water flows.
Kaljian Drainwater Reuse Project	Provides a new source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations.	Provides new source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater storage.	Provides a new source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations potentially leading to reduced groundwater quality degradation associated with declining groundwater levels.	Provides a new source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in Lower Aquifer piezometric head, resulting in a reduced risk of inelastic land subsidence.	Provides a new source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations and associated potential impacts to interconnected surface water.
West Stanislaus Irrigation District Lateral 4-North Recapture and Recirculation Reservoir	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater storage.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations potentially leading to reduced groundwater quality degradation associated with declining groundwater levels.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in Lower Aquifer piezometric head, resulting in a reduced risk of inelastic land subsidence.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations and associated potential impacts to interconnected surface water.
Revision to Tranquillity Irrigation District Lower Aquifer Pumping	Modifies the way in which Lower Aquifer groundwater is extracted, reducing declines in Lower Aquifer piezometric head.	Modifies the way in which Lower Aquifer groundwater is extracted, reducing declines in Lower Aquifer piezometric head and overall groundwater extractions from the Lower Aquifer.	This project does not address this sustainability indicator.	Modifies the way in which Lower Aquifer groundwater is extracted, reducing declines in Lower Aquifer piezometric head resulting in a reduced risk of inelastic land subsidence.	This project does not address this sustainability indicator.
Tier 1 Management Actions					

Activity	Sustainability Indicator				
	Chronic Lowering of Groundwater Levels	Reduction of Groundwater Storage	Degraded Water Quality	Land Subsidence	Depletions of Interconnected Surface Water
Lower Aquifer Pumping Rules for Minimizing Subsidence	Provides an additional buffer to keep groundwater levels above minimum thresholds at representative monitoring locations in the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and avoiding undesirable results for this sustainability indicator.	Reduced declines in Lower Aquifer piezometric head as a result reduces overall groundwater extractions from the Lower Aquifer.	This management action does not address this sustainability indicator.	Providing an additional buffer to keep groundwater levels above the minimum thresholds at representative monitoring locations for Chronic Lowering of Groundwater Levels reduces declines in Lower Aquifer piezometric head, resulting in reduced risk of inelastic land subsidence.	This management action does not address this sustainability indicator.
Maximize Use of Other Water Supplies	Increased use of water supplies other than groundwater offsets groundwater pumping from each principal aquifer, thus reducing declines in groundwater elevations in each principal aquifer.	Increased use of water supplies other than groundwater offsets groundwater pumping and reduces declines in groundwater storage.	Groundwater quality could improve with the increased use of other water supplies to offset groundwater pumping, particularly for constituents of concern that are correlated with groundwater levels (where increased groundwater levels may demonstrate decreased concentrations of certain constituents of concern).	Increased use of other water supplies can offset groundwater pumped from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	Increased use of other water supplies can offset groundwater pumped from areas where surface water-groundwater interaction is known or suspected to occur, thus reducing the risk of depletions of interconnected surface waters.
Increasing GSA Access to and Input on Well Permits	Input from GSAs regarding new well locations may avoid undesirable results related to this sustainability indicator within the GSA's jurisdictional area, where groundwater extractions can also be metered or measured.	Input from GSAs regarding new well locations may avoid undesirable results related to this sustainability indicator within the GSA's jurisdictional area, where groundwater extractions can also be metered or measured.	Input from GSAs regarding new well locations may aid in avoiding areas where groundwater pumping is expected to cause increased concentrations of constituents of concern.	Input from GSAs regarding new well locations may also include proposed depth and screened intervals for a new well, where such input may reduce the number of new wells pumping from the Lower Aquifer resulting in reduced risk of inelastic land subsidence.	Input from GSAs regarding new well locations may aid in avoiding installation of wells located where pumping has the potential to cause depletions of interconnected surface water.
Drought Contingency Planning in Urban Areas	Drought contingency planning may result in the ability to prepare for and respond to water shortage during times of drought by increasing efficiency of use of available groundwater resources or seeking alternative or supplemental water supply sources, thus reducing declines in groundwater elevations in each principal aquifer.	Drought contingency planning may result in the ability to prepare for and respond to water shortage during times of drought by increasing efficiency of use of available groundwater resources or seeking alternative or supplemental water supply sources, thus reducing declines in groundwater storage.	This management action does not address this sustainability indicator.	Drought contingency planning may result in the ability to prepare for and respond to water shortages during times of drought by utilizing other water supplies as opposed to continued pumping from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	This management action does not address this sustainability indicator.
Fill Data Gaps	Filling in data gaps related to this sustainability indicator will aid in refining water budgets, improve the representative monitoring network, and provide additional data for setting/refining numeric minimum thresholds and measurable objectives.	Filling in data gaps related to this sustainability indicator will aid in refining water budgets, improve the representative monitoring network, and provide additional data for setting/refining numeric minimum thresholds and measurable objectives.	Filling in data gaps related to this sustainability indicator will aid in refining water budgets, improve the representative monitoring network, and provide additional data for setting/refining numeric minimum thresholds and measurable objectives.	Filling in data gaps related to this sustainability indicator will aid in refining water budgets, improve the representative monitoring network, and provide additional data for setting/refining numeric minimum thresholds and measurable objectives.	Filling in data gaps related to this sustainability indicator will aid in refining water budgets, improve the representative monitoring network, and provide additional data for setting/refining numeric minimum thresholds and measurable objectives.
Tier 2 Projects					
Del Puerto Canyon Reservoir Project	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater storage.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations potentially leading to	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in Lower Aquifer	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations and associated potential impacts to interconnected surface water.

Activity	Sustainability Indicator				
	Chronic Lowering of Groundwater Levels	**Reduction of Groundwater Storage**	**Degraded Water Quality**	**Land Subsidence**	**Depletions of Interconnected Surface Water**
			reduced groundwater quality degradation associated with declining groundwater levels.	piezometric head, resulting in a reduced risk of inelastic land subsidence.	
Little Salado Creek Groundwater Recharge and Flood Control Basin	Increased groundwater recharge, directly contributing to increased groundwater levels in the Upper Aquifer.	Increased groundwater recharge, directly contributing to increased storage in the Upper Aquifer.	Contributes to increased groundwater levels through increased recharge, reducing groundwater quality degradation associated with declining groundwater levels.	This project does not address this sustainability indicator.	Increased groundwater recharge reduces the potential for groundwater levels to decline and negatively impact interconnected surface water flows.
Patterson Irrigation District Groundwater Bank and/or Flood-MAR-type Project	Increased groundwater recharge, directly contributing to increased groundwater levels in the Upper Aquifer.	Increased groundwater recharge, directly contributing to increased storage in the Upper Aquifer.	Contributes to increased groundwater levels through increased recharge, reducing groundwater quality degradation associated with declining groundwater levels.	This project does not address this sustainability indicator.	Increased groundwater recharge reduces the potential for groundwater levels to decline and negatively impact interconnected surface water flows.
West Stanislaus Irrigation District Lateral 4-South Recapture and Recirculation Reservoir	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater storage.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations potentially leading to reduced groundwater quality degradation associated with declining groundwater levels.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in Lower Aquifer piezometric head, resulting in a reduced risk of inelastic land subsidence.	Provides an alternative source of water for irrigation, thereby offsetting groundwater pumping and reducing declines in groundwater elevations and associated potential impacts to interconnected surface water.
Ortigalita Creek Groundwater Recharge and Recovery Project	Increased groundwater recharge, directly contributing to increased groundwater levels in the Upper Aquifer.	Increased groundwater, directly contributing to increased storage in the Upper Aquifer.	Contributes to increased groundwater levels through increased recharge, reducing groundwater quality degradation associated with declining groundwater levels.	This project does not address this sustainability indicator.	Increased groundwater recharge reduces the potential for groundwater levels to decline and negatively impact interconnected surface water flows.
Tier 2 Management Actions					
Develop Program to Incentivize Use of Surface Water and Reduce Groundwater Demand	Incentivizing the use of surface water supplies offsets groundwater pumping from each principal aquifer, thus reducing declines in groundwater elevations in each principal aquifer.	Incentivizing the use of surface water supplies offsets groundwater pumping and reduces declines in groundwater storage.	Groundwater quality could improve by incentivizing the use of surface water supplies to offset groundwater pumping, particularly for constituents of concern that are correlated with groundwater levels (where increased groundwater levels may demonstrate decreased concentrations of certain constituents of concern).	Incentivizing the use of surface water supplies can offset groundwater pumped from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	Incentivizing the use of surface water can offset groundwater pumped from areas where surface water-groundwater interaction is known or suspected to occur, thus reducing the risk of depletions of interconnected surface waters.
Tier 3 Projects					
Pacheco Reservoir Expansion	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, thereby reducing declines in groundwater elevations in each principal aquifer.	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing declines in groundwater storage.	Increased reliability of surface water supplies (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing degradation of groundwater quality particularly for constituents of concern that are correlated with groundwater levels (where increased groundwater levels may demonstrate decreased concentrations of certain constituents of concern).	Increased water supply reliability (directly and indirectly) and operational flexibility can offset groundwater pumping from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	This project does not address this sustainability indicator.
Raising San Luis Reservoir	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, thereby reducing declines in	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing declines in groundwater storage.	Increased reliability of surface water supplies and operational flexibility offsets groundwater pumping, reducing degradation of groundwater quality particularly for constituents of concern that are correlated with groundwater levels (where increased groundwater levels	Increased water supply reliability (directly and indirectly) and operational flexibility can offset groundwater pumping from the Lower Aquifer, thus reducing declines in Lower Aquifer	This project does not address this sustainability indicator.

Activity	Sustainability Indicator				
	Chronic Lowering of Groundwater Levels	Reduction of Groundwater Storage	Degraded Water Quality	Land Subsidence	Depletions of Interconnected Surface Water
	groundwater elevations in each principal aquifer.		may demonstrate decreased concentrations of certain constituents of concern).	piezometric head and resulting in reduced risk of inelastic land subsidence.	
Sites Reservoir	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, thereby reducing declines in groundwater elevations in each principal aquifer.	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing declines in groundwater storage.	Increased reliability of surface water supplies (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing degradation of groundwater quality particularly for constituents of concern that are correlated with groundwater levels (where increased groundwater levels may demonstrate decreased concentrations of certain constituents of concern).	Increased water supply reliability (directly and indirectly) and operational flexibility can offset groundwater pumping from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	This project does not address this sustainability indicator.
Los Vaqueros Expansion Phase 2	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, thereby reducing declines in groundwater elevations in each principal aquifer.	Increased water supply reliability (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing declines in groundwater storage.	Increased reliability of surface water supplies (directly and indirectly) and operational flexibility offsets groundwater pumping, reducing degradation of groundwater quality particularly for constituents of concern that are correlated with groundwater levels (where increased groundwater levels may demonstrate decreased concentrations of certain constituents of concern).	Increased water supply reliability (directly and indirectly) and operational flexibility can offset groundwater pumping from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	This project does not address this sustainability indicator.
Tier 3 Management Actions					
Groundwater Extraction Fee with Land Use Modifications	Collection of groundwater extraction fees incentivizes the use of supplemental or alternative water supplies where fees can also fund activities/projects that increase groundwater supplies, such as groundwater recharge, thus reducing declines in groundwater elevations.	Collection of groundwater extraction fees incentivizes the use of supplemental or alternative water supplies where fees can also fund activities/projects that increase groundwater supplies, such as groundwater recharge, thereby offsetting groundwater pumping and reducing declines in groundwater storage.	Collection of groundwater extraction fees incentivizes the use of supplemental or alternative water supplies where fees can also fund activities/projects that reduce degradation of groundwater quality, such as the proper construction and destruction of wells to prevent groundwater contamination.	Collection of groundwater extraction fees incentivizes the use of supplemental or alternative water supplies that offset Lower Aquifer pumping, reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	Collection of groundwater extraction fees can incentivize the use of supplemental or alternative water supplies over groundwater pumping from areas where surface water-groundwater interaction is known or suspected to occur, thus reducing the risk of depletions of interconnected surface water.
City of Patterson Reduced Groundwater Use Portfolio	Increased use of water supplies other than groundwater and easier implementation of water supply projects offsets groundwater pumping, thus reducing declines in groundwater elevations.	Increased use of water supplies other than groundwater and easier implementation of water supply projects offsets groundwater pumping and reduces declines in groundwater storage.	This management action does not address this sustainability indicator.	Increased use of other water supplies and easier implementation of water supply projects can offset groundwater pumped from the Lower Aquifer, thus reducing declines in Lower Aquifer piezometric head and resulting in reduced risk of inelastic land subsidence.	This management action does not address this sustainability indicator.
Rotational Fallowing of Crop Lands	Rotational fallowing of crop lands can temporarily reduce agricultural water use, thereby increasing groundwater levels.	Rotational fallowing of crop lands can temporarily reduce agricultural water uses, thereby reducing declines in groundwater storage.	Rotational fallowing of crop lands can temporarily reduce agricultural water use, thereby improving groundwater quality.	Rotational fallowing of crop lands can temporarily reduce agricultural water use, thereby reducing the risk of inelastic land subsidence.	This management action does not address this sustainability indicator.

7.1.1 Description of Projects and Management Actions

The following subsections describe the projects and management actions associated with each tier as summarized above. A full vetting of projects described herein, including required permitting, environmental review (as required for compliance with California Environmental Quality Act [CEQA] and/or National Environmental Policy Act [NEPA]) and funding, is not within the scope of this GSP and may lead to identified projects being rendered infeasible. Further assessments of feasibility will be conducted by the individual project proponents. Subsequent 5-Year GSP Updates will include revisions to or removal of projects described in this GSP and the addition of other projects as necessary in order to achieve Subbasin sustainability by 2040.

7.1.1.1 Tier 1 Projects

Tier 1 projects are anticipated to be implemented, or begin to be implemented, in the first five years of GSP implementation (between 2020 and 2025). These projects are at various points in development and operation but are anticipated to begin to provide benefits to the Plan area prior to the first 5-Year GSP Update in 2025.

7.1.1.1.1 Los Banos Creek Recharge and Recovery Project

The Los Banos Creek Recharge and Recovery Project is located in and adjacent to Los Banos Creek, which is south of the City of Los Banos between the San Luis Canal and Central California Irrigation District's (CCID) Outside Canal. The project will develop a recharge basin, convert three rock quarry pits to temporary storage/recharge basins, construct three storage recovery sump pumps, six shallow groundwater recovery wells, a bridge crossing of Los Banos Creek, and a weir located just downstream of the Outside Canal. Project flood waters and surplus irrigation supply will be temporarily stored in the pits/basin for beneficial use and flood mitigation purposes with surplus waters percolated into the Upper Aquifer. Project beneficiaries include San Luis Water District (SLWD), CCID, Grassland Water District, and regional groundwater users (including the City of Los Banos). A hydrogeologic study conducted by Kenneth D. Schmidt and Associates in 2017 concluded that the local geology and aquifer are likely suitable for groundwater recharge and recovery operations.

The recharge portion of the project will increase groundwater elevations in the Upper Aquifer, along with the volume of water stored above the Corcoran Clay. Utilization of water stored in the local aquifer in surplus years for irrigation supply in drought years offsets deficit groundwater pumping and/or a portion of the need to acquire open market water, much of which is acquired through the Sacramento-San Joaquin Delta (Delta) or from sources which would otherwise contribute to Delta flows. It is estimated 200 acre-feet per year (AFY) of groundwater recharge will be achieved within the first year of operation.

The project is currently at 30% design. It is anticipated that Final Design and permitting can be completed within two years with recharge beginning in 2020. It is anticipated this project will require an Environmental Impact Report (EIR) with a Mitigated Negative Declaration to comply with the CEQA and NEPA along with Waste Discharge Requirement permits for the recharge portion of the project and well permits for the recovery portion of the project. Environmental documentation has not yet begun. It is anticipated that all required environmental documentation work can be completed within two years of start. Construction and project completion would be achieved within three years. Project advancement is ready to proceed as soon as funding becomes available.

7.1.1.1.2 Orestimba Creek Recharge and Recovery Project

The Orestimba Creek Recharge and Recovery Project (OCRRP), led by Del Puerto Water District (DPWD) and CCID, is designed to capture flood flows, excess winter flows, and Section 215 contract water (non-storable flows authorized by the United States Bureau of Reclamation [USBR]) from Orestimba Creek and the Delta-Mendota Canal (DMC) for groundwater recharge and later use during dry periods. Phase 1 of the project includes the construction of two 10-acre recharge ponds, enlargement of the existing canal to convey 10 cubic feet per second (cfs) of flows, construction of five monitoring wells (two 250-feet deep wells and three 150-feet deep wells), and construction of one production well. Phase 2 of the project includes the construction of 60 acres of additional recharge ponds, a diversion point out of Orestimba Creek, pipelines from Orestimba Creek and the DMC to the recharge facilities, five recovery wells, and associated appurtenances and pipelines along the project site between the DMC and the Eastin Water District boundary and along the CCID Main Canal. The project will receive flood flows from both the San Joaquin and Kings Rivers together with surface water from Orestimba Creek, CCID and/or DPWD. The DMC, as well as a proposed pipeline from Orestimba Creek, will be used to convey water to the project site. It is anticipated that 7,500 AFY of benefits will be actualized from this project within the Northern Delta-Mendota Region.

The initial 20 acres of recharge ponds and the monitoring wells under Phase 1 have been constructed. The production well will be constructed based on the results of the initial monitoring. Depending on the results of Phase 1, Phase 2 of the project will be designed and constructed. A Mitigated Negative Declaration to comply with CEQA and NEPA was prepared for Phase 1, and it is assumed that the same would be completed for the potential expansion of the ponds. Design and environmental documentation will not be completed until a determination that an expansion would be pursued by the project proponents, likely in 2019.

The proposed project will help support elevated groundwater levels and increased storage in the Upper Aquifer by banking excess water, thus accelerating the rate of groundwater recharge for the underlying aquifer. Monitoring or observation wells will be installed at key locations to monitor the rate of groundwater recharge. Data collected from these wells will also be used to determine the volume of water allowed to be extracted so that the rate of recharge will always exceed extraction. It was anticipated that DPWD (and their project partners) will store up to 7,500 AFY of water as a result of the OCRRP beginning in 2020. During Below Normal Water Years (WYs) [San Joaquin River WY Index], DPWD could withdraw 3,750 acre-feet (AF), less a 10% leave behind. In Dry and Critical WYs, DPWD could withdraw 7,500 AF, less a 10% leave behind. Both DPWD and CCID rely on the Delta for their water supply. The OCRRP provides a means to capture flood flows and excess surface water flows for later use during dry periods, thereby reducing demands on the Delta and improving the sustainability of the Upper Aquifer during these critical dry periods.

7.1.1.1.3 North Valley Regional Recycled Water Program (NVRRWP) – Modesto and Early Turlock Years

The North Valley Regional Recycled Water Program (NVRRWP) conveys tertiary-treated recycled water from the cities of Modesto and Turlock to the DMC for conveyance to growers in the DPWD service area, as well as south-of-the-Delta wildlife refuges. With the development of conveyance capability, at buildout, up to 59,000 AFY of tertiary-treated recycled water produced from municipal wastewater and stormwater collected from the cities of Ceres, Turlock, and Modesto will be delivered DPWD growers and wildlife refuges. Recycled water is conveyed to DPWD lands to supplement Central Valley Project (CVP) supplies and offset groundwater pumping that has been occurring to make up for delivery shortages. Recycled water delivered by this project is also conveyed by USBR to supplement water supplies to wildlife refuges.

DPWD provides water to approximately 45,000 acres of productive farmland in western San Joaquin, Stanislaus, and Merced Counties. DPWD's current sole source of water is via a contract with USBR that provides up to 140,210 AFY of CVP water. However, DPWD's annual CVP water allocation has been significantly reduced since the 1990s, sometimes receiving 0% allocation in recent years. During periods of surface water delivery shortages, groundwater extraction from private wells is used to meet crop demands. Utilizing this new water supply provided by the NVRRWP, DPWD's dependence on highly unreliable CVP supplies is reduced, its surface water supply resiliency improved, and a resultant reduction in groundwater pumping realized.

An Environmental Impact Report / Environmental Impact Statement (EIR/EIS) was prepared for the NVRRWP in 2015 to comply with CEQA and NEPA. Modesto has completed its portion of the NVRRWP (consisting of a pipeline from Modesto's wastewater treatment plant to the DMC) and recycled water deliveries to DPWD customers began in

December 2017. Turlock completed design of its components in 2018 and began construction in August 2018. Turlock's recycled water will be delivered to the DMC, and ultimately the growers in DPWD's service area, in 2020. Additional recycled water supplies are expected to increase from 10,000 AFY in 2020 to 30,000 AFY in 2040 and onward as the cities grow.

7.1.1.1.4 City of Patterson Percolation Ponds for Stormwater Capture and Recharge

The City of Patterson Percolation Ponds for Stormwater Capture and Recharge project consists of constructing percolation ponds to capture and infiltrate stormwater from Del Puerto Creek. The ponds will cover roughly 14 acres. Sizing of the percolation ponds is based on existing infiltration rate data and will be updated when field investigations are completed. Implementation of this project may be phased such that the ponds are constructed over a number of years. The project is anticipated to result in 1,700 AFY of direct groundwater recharge using stormwater runoff captured within the City and conveyed to recharge locations beginning in 2020. At present, the project is in the conceptual stage and environmental (CEQA) documentation has not yet started; however, project design and associated environmental documentation can be completed within a two-year period pending available funding.

7.1.1.1.5 Kaljian Drainwater Reuse Project

The Kaljian Drainwater Reuse Project is located within SLWD's service area, approximately nine miles from the City of Los Banos. Project improvements include re-grading and/or installing lift pumps within the drainage ditches; construction of a turnout pipeline; modification of the Kaljian pump structure; and restoration of the Fitji and Kaljian pump stations, Kaljian pipeline, and 1st Lift Canal. The project will reclaim tile drain water from Charleston Drainage District for blending and permit conveyance of other supplies for beneficial use. The project will augment SLWD's supply and increase reliability, enable the conveyance of flood water for beneficial use, reduce poor quality drain water discharges to the San Joaquin River, and free up capacity in the San Joaquin River Water Quality Improvement Project.

The project will allow SLWD to wheel San Joaquin and Kings River flood waters and utilize that water for recharge. Of the 2,700 AFY average yield, it is estimated that up to 500 AFY can be available for recharge, where a portion of this water may be directly recharged in the Los Banos Creek Recharge Project. This project will reduce dependence on imported water coming from the Delta by increasing local supply in utilizing the local tile drain water to augment irrigation supplies (including offset groundwater pumping to meet crop demand not met by surface water supplies).

The project has completed a feasibility study report and 30% design plans. Further progress can be made on design, permitting, and environmental documentation when funding becomes available. It is anticipated that these items could be completed within one to 1½ years and that construction could begin within six months of completing design and permitting, with construction is anticipated to be complete in 2020. A Mitigated Negative Declaration will be prepared to comply with CEQA and NEPA. Environmental documentation is not yet started.

7.1.1.1.6 West Stanislaus Irrigation District Lateral 4-North Recapture and Recirculation Reservoir

The West Stanislaus Irrigation District (WSID) Lateral 4-North Recapture and Recirculation Reservoir project will be implemented by WSID. This project consists of a reservoir on a 7-acre parcel currently not in production. The reservoir, once complete, will collect operational spill from two distribution laterals and irrigation tailwater on the north side of WSID's service area and store those waters for reliable use downstream. This project will also provide two additional benefits: First, the project will allow flexible water delivery service to users during times of drought or capture constraints; and second, the project will improve water quality to downstream users by mixing water from the DMC with surface water of lesser quality from the San Joaquin River. This project is estimated to result in roughly 1,800 AFY of recapture, of which approximately 270 AFY will percolate through the reservoir bottom and recharge the underlying Upper Aquifer helping to offset groundwater extractions in other locations of the Subbasin.

The project is currently in the conceptual stage. Design is expected to take eight months. A Mitigated Negative Declaration is expected to be required to comply with CEQA, which would be completed in parallel with design. The anticipated date of full buildout is 2020.

7.1.1.1.7 Revision to Tranquillity Irrigation District Lower Aquifer Pumping

Tranquillity Irrigation District (TRID) maintains and operates 28 wells that extract water from the Lower Aquifer and two wells from the Upper Aquifer. At times, depending on the water year, the 30 wells have pumped from the two aquifers continuously. Based on historic records, the most groundwater pumped in a single year was 24,000 AF. Beginning in 2017, TRID revised the pumping regime from the Lower Aquifer within district boundaries, allowing roughly only 10 wells to be operational at a time and shutting the wells off at night to allow for drawdown to recover. In addition, under this revised pumping regime, the most water to be pumped within a year will be 8,000 AF. During Average and Wet WYs, an estimated 1,000 AF could be pumped from the Lower Aquifer (see **Section 5.4** *Water Budget* for more information about Delta-Mendota Subbasin WY designations). During Dry WYs, up to 8,000 AF could be pumped from the Lower Aquifer (see **Section 5.4** *Water Budget* for more information about Delta-Mendota Subbasin WY designations). TRID began implementing this revised pumping regime in 2017, with actual Lower Aquifer groundwater extractions totaling 200 AFY each in 2017 and 2018.

7.1.1.2 Tier 1 Management Actions

It is assumed that all of the Tier 1 management actions may be implemented beginning in February 2020. What is described below are not projects that would be constructed, but rather strategies that will be developed and applied to benefit the Plan area. GSAs may implement all, some, or none of the Tier 1 management actions under their individual discretion and authority as necessary to meet the objectives of this GSP within their individual areas. Coordination among the GSAs and agencies throughout the Northern and Central Delta-Mendota Regions will be required prior to implementing the following management actions.

7.1.1.2.1 Lower Aquifer Pumping Rules for Minimizing Subsidence

In **Chapter 6** *Sustainable Management Criteria*, minimum thresholds and measurable objectives associated with each representative monitoring location in the Lower Aquifer have been developed. Entities extracting groundwater from the Lower Aquifer in the Northern and Central Delta-Mendota Regions will be required to comply with these sustainable management criteria. Specifically, during groundwater extraction, if groundwater elevations approach or reach the minimum threshold of the nearest representative monitoring well(s), actions must be implemented in order to avoid undesirable results.

7.1.1.2.2 Maximizing Use of Other Water Supplies

Maximizing the use of water supplies other than groundwater can improve the quality and volume of groundwater in storage in each principal aquifer. Where possible, surface water, recycled water, stormwater, and tile drain water will be used to offset groundwater deficits. In order to implement this management action, the GSAs will develop a program to incentivize the use of alternative supplies over groundwater when possible. This program may also include, but is not limited to, taking advantage of available surplus surface water for groundwater recharge in order to increase groundwater levels in the Upper Aquifer. Surplus surface water is typically available during Wet and Above Normal WYs (San Joaquin River WY Index) when surface water supplies exceed demand. If a GSA or GSA member agency has rights to surface water and all demands have been met, the surplus water can be used for recharge through an existing groundwater recharge project or fallowed lands and/or sold to entities without surface water rights to offset groundwater pumping. As less groundwater is pumped, groundwater levels and storage could remain the same or increase, overall groundwater quality could improve, and subsidence could be reduced or eliminated in certain areas.

7.1.1.2.3 Increasing GSA Access to and Input on Well Permits

Counties in the Delta-Mendota Subbasin with well construction permit authority include Stanislaus, Merced, and Fresno Counties. Under this management action, the Counties would develop and/or change internal policies associated with well permitting to include consultation with and consideration of input from GSAs relative to if and where a proposed well would be located. This will be done to determine if the pumping associated with a new well will cause undesirable results in the GSA's jurisdictional area and to ensure that groundwater extractions are metered or measured in some fashion. These policies will also make GSAs aware of new wells such that they can be incorporated into any management programs that may be implemented as a result of Sustainable Groundwater Management Act (SGMA) compliance. Additionally, GSAs are able to develop policies regarding groundwater use, which may impact future well permitting by the Counties.

7.1.1.2.4 Drought Contingency Planning in Urban Areas

Under this management action, GSAs or GSA member agencies responsible for municipal supplies dependent on groundwater for some or all of their supplies will develop and implement drought contingency planning in urban areas in order to prepare for and respond to water shortages during times of drought. Urban water suppliers are already required to address water shortage contingency planning in their Urban Water Management Plans prepared every five years. These planning strategies can be expanded upon, if necessary, and applied in order to minimize impacts to groundwater storage and water levels when supplies become limited.

7.1.1.2.5 Fill Data Gaps

SGMA-related data gaps are identified and summarized in **Section 5.3** *Groundwater Conditions* of this GSP. In order to refine water budgets, improve the monitoring network, and provide additional data necessary for setting/refining numeric values associated with minimum thresholds and/or measurable objectives, efforts will be made to fill the identified data gaps as funding permits.

7.1.1.3 Tier 2 Projects

Tier 2 projects are projects currently in preliminary or conceptual design that will require additional time for development and implementation. For the most part, it is anticipated that Tier 2 projects will be developed over the next five years with the intent of bringing them online by 2026 or later.

7.1.1.3.1 Del Puerto Canyon Reservoir Project

The Del Puerto Canyon Reservoir Project will construct a 270-foot tall earthen dam at the mouth of Del Puerto Canyon providing 85,000 AF of storage for DPWD and the member agencies of the San Joaquin River Exchange Contractors Water Authority (SJRECWA). Water would be pumped into the reservoir from the DMC when excess water is available and discharged back to the DMC when necessary. Minimal seasonal storm flows through Del Puerto Canyon would be captured by the reservoir and discharged perennially to Del Puerto Creek for downstream use.

The districts would be storing CVP supplies from their annual entitlements when excess to their immediate needs. Thus, this project would benefit the Region allowing the districts to store water south of the Delta when excess water is available to them and utilize that water during dry periods when supplies may be limited.

An initial feasibility study and preliminary economic feasibility assessment were prepared for the Del Puerto Canyon Reservoir. Design and environmental documentation began in February 2019. It is anticipated that an EIR/EIS will be prepared over the next two years to comply with CEQA and NEPA with completion scheduled in August 2020. It is assumed water would be available for storage in the reservoir every year beginning in 2030. On average, 2,756 AFY from Del Puerto Creek would be captured and stored in the reservoir. During Wet WYs (San Joaquin River WY Index), up to 35,570 AFY of creek flows could be stored for later use in the reservoir.

The Del Puerto Canyon Reservoir project will assist the Northern and Central Delta-Mendota Regions with water supply reliability, both allowing for better management of supplies and providing for storage of additional CVP surface water supplies that can be used to offset groundwater pumping in drier years. This will help the Regions maintain sustainable groundwater elevations and storage in both principal aquifers.

7.1.1.3.2 Little Salado Creek Groundwater Recharge and Flood Control Basin

The Little Salado Creek Groundwater Recharge and Flood Control Basin project, proposed by Stanislaus County, consists of constructing a stormwater detention basin to partially divert, retain, and percolate up to 270 cfs of flow from Little Salado Creek. Little Salado Creek has a drainage of 874 AFY. It was assumed the detention basin would recharge 489 AFY in Wet WYs (San Joaquin River WY Index). The basin would be located in the future Crows Landing Industrial Business Park and would have a capacity of 380 AF. The project will provide flood relief to the downstream City of Patterson and the Upper Aquifer recharge will offset groundwater pumping required to supply the new development, thereby limiting impacts on Upper Aquifer groundwater elevations and storage due to this project's development.

A drainage study was completed in November 2016 to define preliminary storm drain system infrastructure improvements necessary to accommodate the development of the Crows Landing Industrial Business Park. A Draft EIR was completed in January 2018 and was released for public review from January 22, 2018 to March 12, 2018. Stanislaus County is ready to proceed with design once funding is secured, with 2032 as the estimated date of full buildout.

7.1.1.3.3 Patterson Irrigation District Groundwater Bank and/or Flood-Managed Aquifer Recharge (MAR)-type Project

Within Patterson Irrigation District's (PID) service area, there are currently approximately 800 to 900 acres fallow each year. The University of California at Davis' Soil Agricultural Groundwater Banking (SAGBI) index was used to assess the range of potential groundwater recharge volumes that could be achieved given those fallow acres. The SAGBI index is a suitability index for groundwater recharge on agricultural land based on five major factors that are critical to successful agricultural groundwater banking: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

Based on the analysis conducted, the PID service area has the potential to recharge between 3,000 AFY and 9,700 AFY on the fallowed land. As a pre-1914 water rights holder, PID has access to surplus surface water from the San Joaquin River that can be used for Upper Aquifer recharge. It is assumed 3,000 AFY could be percolated in Average WYs with a larger volume during Wet WYs (see **Section 5.4** *Water Budget* for more information about Delta-Mendota Subbasin WY designations). Recharge would occur over a 120-day period from January through March. The project is currently in the conceptual phase and additional feasibility studies, pilot studies, and project design are required with an anticipated buildout date of 2032.

7.1.1.3.4 West Stanislaus Irrigation District Lateral 4-South Recapture and Recirculation Reservoir

WSID is implementing the WSID Lateral 4-North Recapture and Recirculation Reservoir project in the north side of the District's service area as described in **Section 7.1.1.1** *Tier 1 Project*. The WSID Lateral 4-South Recapture and Recirculation Reservoir project would be a similar project, but on the south side of the District's service area. WSID would identify a parcel to construct a new reservoir to collect operational spill from distribution laterals and irrigation tailwater on the south side of the District and store those waters for reliable use downstream. For planning purposes, it is assumed 1,800 AFY could be recaptured and reused. Like the recapture and recirculation reservoir project on the northern end of the District, this project would also improve water supply reliability during droughts or in times of capture constraints. It is assumed 270 AFY of water would percolate through the reservoir bottom and recharge the underlying Upper Aquifer, helping to offset groundwater extractions in other locations of the Subbasin.

The project is currently in the conceptual stage. Design is expected to take eight months. A Mitigated Negative Declaration is expected to be required to comply with CEQA and would be completed in parallel with design. The anticipated date of full buildout is 2026.

7.1.1.3.5 Ortigalita Creek Groundwater Recharge and Recovery Project

The Ortigalita Creek Groundwater Recharge and Recover Project is a conceptual project that will be implemented by SLWD. Similar to other storm water capture recharge and recovery projects in the Tier 1 project list, this project would capture storm water runoff and/or use surplus surface water available to SLWD to recharge the Upper Aquifer. Based on local experience and knowledge, during wet years, an estimated 3,000 AFY of water could be recharged into the Upper Aquifer near Ortigalita Creek. During dry years when water is needed, a portion of this (volume yet to be determined) would be recovered from the Upper Aquifer for use by SLWD to offset surface water supply shortages.

As previously noted, this project is currently in the conceptual stage. It is anticipated that, over the next five years, project feasibility studies will be conducted and a preliminary design of the project developed. CEQA compliance documentation would then be prepared in coordination with further project design. It is assumed that this project would recharge water during Wet WYs (San Joaquin River WY Index) beginning in 2026. As with similar Tier 1 projects, this project will help support elevated groundwater levels and increased storage in the Upper Aquifer by banking excess water, thus accelerating the rate of groundwater recharge for the underlying aquifer.

7.1.1.4 Tier 2 Management Actions

The following Tier 2 management actions have been identified and require further development before implementation can occur. It is anticipated that these management actions could be developed over the next five years and implemented beginning in 2026 or later, pending re-evaluation prior to the 5-Year GSP Update in 2025.

7.1.1.4.1 Develop Program to Incentivize Use of Surface Water and Reduce Groundwater Demand

When groundwater extraction is less expensive than other water supplies, economics dictate that customers may sometimes choose to pump groundwater rather than purchase the more-costly surface water supply. To reduce groundwater demand to allow and encourage the recovery of the groundwater aquifers, especially when other supplies such as surface water are available, the use of surface water will be incentivized. Programs that could incentivize the use of surface water over groundwater could include, but are not limited to, groundwater extraction fees, a groundwater accounting framework, and rules that allow growers to sell ‘groundwater credits.’ It is assumed that this management action will be developed over the next five years with input from the GSAs and participating growers and would be implemented beginning in January 2026.

7.1.1.5 Tier 3 Projects

Tier 3 projects are those that have the potential to substantially affect the conjunctive use of surface water and groundwater supplies in the Northern and Central Delta-Mendota Regions by increasing water supply reliability south of the Delta, in turn impacting CVP and State Water Project (SWP) operations. As the Delta-Mendota Subbasin is dependent upon water from the CVP and SWP, Tier 3 projects have the potential to impact overall basin management. However, GSAs have little to no control over the implementation of these projects, which may be required to help achieve sustainability in the Subbasin by 2040. As such, these projects do not have specific deadlines identified herein by which it is anticipated that these projects will (if ever) be implemented.

Listed below are several projects of this nature that have the ability to directly and/or indirectly affect the availability of surface water in the Delta-Mendota Subbasin. This is not intended to be an exhaustive list; other projects are currently being considered on a regional and statewide basis that also fall into this Tier 3 category.

7.1.1.5.1 Pacheco Reservoir Expansion

The Pacheco Reservoir Expansion Project, proposed by Santa Clara Valley Water District (SCVWD) in partnership with San Benito County Water District (SBCWD) and Pacheco Pass Water District (PPWD), would raise the existing dam on Pacheco Creek to increase reservoir capacity from 5,500 AF to 140,000 AF. Pacheco Reservoir is located 60 miles southeast of San Jose on the north fork of Pacheco Creek. The project would construct a new earthen dam made of rock and other soil materials within the footprint of the existing reservoir. The project would improve water supply reliability, increase flood protection, and enhance fish habitat (SCVWD, n.d.). In July 2018, the California Water Commission (CWC) announced that the project would receive a $484.55 million grant through the Prop 1 Water Storage Investment Program (WSIP), contributing to half of the funds needed for the $969 million project. SBCWD and PPWD also plan to pursue federal funds. Remaining project costs would be paid through local water rates over multiple decades (Santa Clara Valley Water News, July 2018).

7.1.1.5.2 Raising San Luis Reservoir

The existing San Luis Reservoir has a capacity of 2 million (MAF). San Luis Reservoir was created on San Luis Creek by USBR's B.F. Sisk Dam (Sisk Dam), approximately 12 miles west of Los Banos. Water is lifted from the O'Neill Forebay into the reservoir by the Gianelli Pumping-Generating Plant, where water is stored and then released for future use. Since 2001, USBR has studied alternatives for improving delivery reliability issues that result when the reservoir storage drops to a "low point" below 300,000 AF as part of its San Luis Low Point Improvement Project (SLLPIP). In 2008, the SLLPIP identified raising the Sisk Dam as one alternative. It was later eliminated from the study after a subsequent report identified more cost-effective solutions that seemed viable at the time. In 2006, it was determined that Sisk Dam is at risk for seismic failure. Alternatives were evaluated to reduce the seismic risk of the dam, one of which included raising the dam. In December 2013, USBR prepared the *San Luis Reservoir Expansion – Appraisal Report* (USBR, December 2013) to further evaluate raising the dam to address the "low point" issue and seismic risk. Modifications to the dam were found to be technically feasible. The alternative evaluated in the report consists of raising the reservoir water surface by 10 feet, raising the dam crest by 20 feet, and increasing reservoir capacity by approximately 130,000 AF. Based on the conceptual design, construction was estimated to cost $360 million. Additional studies and project development would be needed to further refine project details, costs, and schedule.

7.1.1.5.3 Sites Reservoir

Sites Reservoir would be a new 1.8 MAF offstream reservoir located in a valley west of the City of Williams along the Glenn-Colusa County line. The reservoir would store water conveyed via 14 miles of pipeline from the Sacramento River. The reservoir would be operated to allow other reservoirs in California to hold more water into summer months and increase operational flexibility. Sites Reservoir will increase Sacramento Valley water storage by 15% and add up to 500,000 AFY to California's water system (Sites Water Authority, August 2018). The project is estimated to cost $4.4 billion (in 2015 dollars).

In 2018, CWC awarded the project $816 million of grant funding from WSIP. The remainder of the project costs would come from participating water agencies. Project implementation is led by the Sites Project Authority with a board currently comprised of representatives from Reclamation District 108, Placer County Water Agency, City of Roseville, Colusa County, Glenn County, Glenn-Colusa Irrigation District, City of Sacramento, Sacramento County Water Agency, Tehama-Colusa Canal Authority, Westside Water District, USBR, and the California Department of Water Resources (DWR). Many other participants have been identified. Design and environmental documentation are currently underway. It is anticipated that project construction could begin in 2022 with full operations beginning in 2029.

7.1.1.5.4 Los Vaqueros Expansion Phase 2

Los Vaqueros Reservoir, located 17 miles south of the City of Antioch, was completed in 1998 and expanded from 100,000 AF to 160,000 AF in 2012 (Phase 1 Expansion). The EIS/EIR for the expansion also evaluated further expansion up to 275,000 AF (Phase 2). In July 2018, CWC announced that the Phase 2 Expansion would receive a $459 million WSIP grant. There are 15 agencies interested in partnering on the project and contributing to the local cost share. Some of these include Contra Costa Water District (CCWD), Alameda County Water District, Byron-Bethany Irrigation District, Bay Area Water Supply and Conservation Agency, City of Brentwood, DPWD, East Bay Municipal Utility District, Grassland Water District, San Luis & Delta-Mendota Water Authority, SCVWD, and Westlands Water District. Design, permitting, and environmental documentation are underway with expected completion in 2021 (CCWD, n.d.).

7.1.1.6 Tier 3 Management Actions

After implementation of the Tier 1 and Tier 2 projects and management actions, Tier 3 management actions would be implemented if additional measures are required to reduce undesirable results in the Plan area. These are long-term actions and do not have an assumed start date, but rather would be implemented as needed sometime after 2026 following reevaluation during the 5-Year GSP Update in 2025.

7.1.1.6.1 Groundwater Extraction Fee with Land Use Modifications

A groundwater extraction fee or groundwater production charge could be collected from entities that own or operate a water-producing well. Revenue from these fees could then be used to pay for a variety of activities such as the construction of water infrastructure, protection of groundwater, proper construction and destruction of wells to prevent contamination, groundwater recharge and recovery projects, purchase of imported water or other supplies to replenish the groundwater basin, and/or purchasing and permanent fallowing of marginally-productive agricultural lands dependent on groundwater. Several agencies in California have already implemented such a program and have seen success in utilizing revenue to benefit the local groundwater basin. A similar methodology could be applied by various agencies within the Northern and Central Delta-Mendota Regions.

7.1.1.6.2 City of Patterson Reduced Groundwater Use Portfolio

The City of Patterson's 2018 *Water Master Plan* evaluated various water supply portfolios to meet anticipated future supply gaps (i.e., the City's existing supply subtracted from future demands). The two most relevant portfolios include the Patterson Control Portfolio and Low Reliance on Groundwater (2) Portfolio. The preferred portfolio, Patterson Control Portfolio, provides the City independent control of its water supply and easier implementation of water supply projects. The Low Reliance on Groundwater (2) Portfolio would diversify the City's water supply portfolio to reduce the City's groundwater use with the addition of a long-term surface water transfer in which the City negotiates a long-term contract to purchase water from another entity. As a Tier 3 management action, the City could explore a long-term water transfer and move forward towards the Low Reliance on Groundwater (2) Portfolio to further reduce groundwater extractions from the Lower Aquifer, if needed.

7.1.1.6.3 Rotational Fallowing of Crop Lands

Agricultural water use can be temporarily reduced by fallowing crop lands. While this can have economic impacts to a region, the benefits can include improved water supply reliability, improved groundwater quality, increased groundwater levels, reduced subsidence, and operational flexibility. Rotational fallowing of crop lands reduces the economic impacts to any one area by rotating the areas of fallowing. This management action could be combined with a recharge project through the application of surplus water supplies to the fallowed lands resulting in in-lieu groundwater recharge.

This management action could be implemented, if needed, after 2026 to help the Northern and Central Delta-Mendota Regions work towards interim sustainability goals. However, the rules by which this management action would be implemented will have to be developed by the GSAs within the Plan area.

7.1.2 Legal Authority

All of the project proponents for the Tier 1 and 2 projects and management actions are water districts, irrigation districts, counties, cities, GSAs with specific authorities granted under SGMA or part of the agency-enabling act. As such, all have legal authority over water management decisions within their boundaries. In addition, the cities and counties in the Delta-Mendota Subbasin have legal authority in the form of land use planning and decision making.

7.1.3 Costs

Costs that have been estimated for the Tier 1 and Tier 2 projects are summarized in **Table 7-3**. Some costs have yet to be determined due to unknown or uncertain project status as indicated by "TBD" (To Be Determined). Costs for management actions were not developed since they are more strategies to be applied rather than construction of facilities and will vary based on GSA-specific implementation. Similarly, Tier 3 projects and management actions are too conceptual or long-term to estimate costs at this time; therefore, such costs are not included in the table. Also summarized are the potential funding sources for financing project implementation. Financing for project and Plan implementation is also described in more detail in **Section 8.2** *Implementation Costs and Funding Sources*.

Table 7-3. Project Costs

Tier	Project	Project Proponent	Estimated Capital Cost [1]	Potential Funding Source(s) [2]
Tier 1	Los Banos Creek Recharge and Recovery Project	San Luis Water District	$9,116,374	Office of Emergency Services (FEMA); Local funds
	Orestimba Creek Recharge and Recovery Project	Del Puerto Water District	$7,923,450	Hazard Mitigation Grant Program (HMGP); Local funds
	North Valley Regional Recycled Water Program (NVRRWP) – Modesto and Early Turlock Years	Del Puerto Water District	$96,000,000	Clean Water State Revolving Fund; Water Recycling Funding Program; Title XVI Water Infrastructure Improvements for the Nation (WIIN) Grant Program; Integrated Regional Water Management (IRWM) Grant Program
	City of Patterson Percolation Ponds for Stormwater Capture and Recharge	City of Patterson	$7,800,000	State grant funds (TBD); Local funds
	Kaljian Drainwater Reuse Project	San Luis Water District	$16,500,000	USBR grant funds; Local funds
	West Stanislaus Irrigation District Lateral 4-North Recapture and Recirculation Reservoir	West Stanislaus Irrigation District	$1,120,000	IRWM Grant Program
	Revision to Tranquillity Irrigation District Lower Aquifer Pumping	Tranquillity Irrigation District	$0 [3]	Not Applicable
Tier 2	Del Puerto Canyon Reservoir Project	Del Puerto Water District	$491,300,000	WIIN; Local funds
	Little Salado Creek Groundwater Recharge and Flood Control Basin	Stanislaus County	$7,710,000	State grant funds (TBD); Local funds
	Patterson Irrigation District Groundwater Bank and/or Flood-MAR-type Project	Patterson Irrigation District	TBD	TBD
	West Stanislaus Irrigation District Lateral 4-South Recapture and Recirculation Reservoir	West Stanislaus Irrigation District	$1,500,000	State grant funds (TBD)
	Ortigalita Creek Groundwater Recharge and Recovery Project	San Luis Water District	TBD	State grant funds (TBD); Local funds

TBD – To be determined

Notes:

1. Tier 2 costs are estimated or yet to be determined based on project design.
2. State grant and low-interest loan projects, such as the Integrated Regional Water Management (IRWM) grant program, Storm Water Resources Program (SWRP) grant program, and State Revolving Fund (SRF) programs may be utilized to provide funding for any of the afore-mentioned projects or management actions, as available.
3. No direct cost as this is a revision to pumping operations within the District.

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7.1.4 Public Noticing

The Northern and Central Delta-Mendota Regions GSAs understand the benefits of an open and transparent GSP development, project planning and implementation process. While there is no formal requirement for public noticing of a project by the project proponent as part of the Northern & Central Delta-Mendota Region GSP prior to or during implementation, project proponents are encouraged to keep the public informed about project development, status, and implementation. Public noticing is often required as part of the funding, environmental, and/or permitting processes. Each project and project proponent will comply with public noticing requirements as applicable. For example, if a project proponent is preparing an EIR for a project to comply with CEQA, the project proponent would publish a Notice of Preparation, Notice of Availability, Notice of Completion, and/or Notice of Adoption. In addition, public noticing prior to public meetings, such as a scoping meeting or the meeting conducted by the governing body to adopt the EIR, would be required.

Program details for management actions implemented as part of this GSP will be developed by individual GSAs or jointly by the GSAs comprising the Northern and Central Delta-Mendota Regions. As part of management action implementation, public noticing and outreach will be conducted to provide the goals and details for each management action and to provide stakeholders with information regarding implementation and potential outcomes or impacts.

7.1.5 Permitting

Every project identified in this GSP will acquire project-specific permits prior to and during construction and/or operation. It will be the responsibility of the project proponent to ensure that these permits are secured. The permitting and regulatory approval process will be coordinated by and be the responsibility of the project proponent. This may not apply to management actions as these typically are not projects that would involve construction and thus, permits would not be needed.

Permits needed for a project are usually identified during the design and environmental review phases and are dependent upon, among other things, site characteristics, construction methods, and timelines. The types of permits that may generally be needed for the projects summarized below:

- California State Water Resources Control Board (SWRCB) Water Rights Permitting and Licensing – required to establish a riparian, overlying and/or appropriative water right. An appropriative water right license may be necessary for recharge and recovery projects as well as stormwater capture projects.
- Encroachment permits - required when a facility or construction will take place within the jurisdiction of another entity (e.g., an encroachment permit from the California Department of Transportation is required when construction will be within any portion of the State highway right-of-way). Encroachment permits may be needed for county, irrigation district, or other jurisdictional entities.
- U.S. Army Corps of Engineers 401 Permit and 404 Permit – required when construction will take place within or the project will result in the fill of any wetland or water of the United States.
- California Department of Fish and Wildlife (CDFW) Streambed Alteration Agreement – required if a pipeline or project facility will cross a stream.
- California Waste Discharge Requirement or National Pollutant Discharge Elimination System (NPDES) Permit – required when a project will discharge wastewaters (including recycled water) to land or surface waters.
- Grading permits – usually acquired at the county level and required when excavation or fill volumes meet certain parameters.

- Authority to Construct / Permit to Operate – required from certain entities (e.g., air pollution control boards) prior to construction and/or operation to manage air emissions associated with project construction and/or operation.
- Well permits – permits acquired from the county prior to the construction or destruction of a well.
- Building permits – an approval from a local governmental agency allowing the contractor to proceed with construction.

7.1.6 Benefits and Evaluation of Benefits

Projects of the same type tend to have similar benefits, which can generally be evaluated in the same way. **Table 7-4** summarizes the benefits that are anticipated to be realized by project type. **Table 7-5** is a crosswalk table that identifies the project type for the projects included in this GSP.

Table 7-4. Project Type and Benefits

Project Type	Benefits	Evaluation of Benefits
Recharge and Recovery	Increased groundwater storage / recharge Improved water supply reliability Improved groundwater quality Reduced land subsidence and/or fissuring	Acre-feet of water stored (directly or in-lieu) Groundwater elevations Water quality monitoring data Estimates of water in storage
Recycled Water	Improved water supply reliability Increased groundwater levels through in-lieu recharge and decreased groundwater pumping	Acre-feet of recycled water delivered Acre-feet of groundwater offset
Reservoir Creation / Expansion	Improved water supply reliability Improved groundwater quality (through reduced pumping) In-lieu groundwater recharge through seepage Increased groundwater storage / recharge (through reduced pumping)	Acre-feet of water stored Acre-feet of surface water delivered in-lieu of groundwater pumped
Pumping Changes	Reduced groundwater pumping	Acre-feet of groundwater pumped

Table 7-5. Project Types

Tier	Project	Project Type
Tier 1	Los Banos Creek Recharge and Recovery Project	Recharge and Recovery
	Orestimba Creek Recharge and Recovery Project	Recharge and Recovery
	North Valley Regional Recycled Water Program (NVRRWP) – Modesto and Early Turlock Years	Recycled Water
	City of Patterson Percolation Ponds for Stormwater Capture and Recharge	Recharge and Recovery
	Kaljian Drainwater Reuse Project	Recycled Water
	West Stanislaus Irrigation District Lateral 4-North Recapture and Recirculation Reservoir	Reservoir Creation / Expansion
	Revision to Tranquillity Irrigation District Lower Aquifer Pumping	Pumping Changes
Tier 2	Del Puerto Canyon Reservoir Project	Reservoir Creation / Expansion
	Little Salado Creek Groundwater Recharge and Flood Control Basin	Recharge and Recovery
	Patterson Irrigation District Groundwater Bank and/or Flood-MAR-type Project	Recharge and Recovery
	West Stanislaus Irrigation District Lateral 4-South Recapture and Recirculation Reservoir	Reservoir Creation / Expansion
	Ortigalita Creek Groundwater Recharge and Recovery Project	Recharge and Recovery
Tier 3	Pacheco Reservoir Expansion	Reservoir Creation / Expansion
	Raising San Luis Reservoir	Reservoir Creation / Expansion
	Sites Reservoir	Reservoir Creation / Expansion
	Los Vaqueros Expansion Phase 2	Reservoir Creation / Expansion

7.2 MONITORING

This section documents the monitoring networks and protocols developed to assess progress toward sustainability within the Northern & Central Delta-Mendota Region Groundwater Sustainability Plan (GSP) Plan area. Comprehensive monitoring networks have been established for each applicable sustainability indicator within the Plan area: chronic lowering of groundwater levels, reduction of groundwater storage, degraded water quality, land subsidence, and depletions of interconnected surface water. (Note, seawater intrusion is not applicable to the Delta-Mendota Subbasin.) Sustainable management criteria, including minimum thresholds, measurable objectives, and interim milestones, have been set for each applicable sustainability indicator at each individual monitoring location and are discussed in further detail in **Chapter 6** *Sustainable Management Criteria*.

The monitoring networks described herein were developed to coordinate with existing monitoring programs to the extent possible while providing the coverage necessary for assessing groundwater sustainability within the Delta-Mendota Subbasin. This section includes a description of the monitoring objectives, monitoring protocols, and data reporting requirements.

The monitoring networks shown herein promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related interconnected surface water conditions in the Plan Area and to evaluate changing conditions that occur through implementation of the Plan (GSP Emergency Regulations § 352.2 and § 354.32 through § 354.38). Data gaps, and a plan to fill data gaps, are also identified for each monitoring network (GSP Emergency Regulations § 354.38). For more information on existing water resources monitoring and management programs within the Delta-Mendota Subbasin, refer to **Chapter 2** *Plan Area*.

7.2.1 Useful Terms

A list and description of technical terms used throughout this section to discuss groundwater wells, water quality indicators, subsidence measurements, and other monitoring characteristics are listed below. **Figure 7-1** shows a schematic of a standard monitoring well with key measurements and terms identified. The terms and their descriptions are identified here to guide readers through this section and are not a definitive definition of each term.

- **Best Available Science** – Refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice (California [CA] Code of Regulations 351).
- **Best Management Practice** – Refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science (CA Code of Regulations, Title 23, Article 2).
- **Constituent** – Refers to a water quality parameter measured to assess groundwater quality.
- **Data Gap** – Refers to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of [GSP] implementation and could limit the ability to assess whether a basin is being sustainably managed (CA Code of Regulations, Title 23, Article 2).
- **Depth to Bottom Perforation** – The distance to the bottom of the perforated (or screen) interval of a well from the ground surface.
- **Depth to Top Perforation** – The distance to the top of the perforated (or screen) interval in a well from the ground surface.
- **Depth to Water** – The distance from the ground surface elevation (or reference point) to water surface elevation.

- **Ground Surface Elevation –** The elevation of the land surface in feet at the monitoring site location. Elevation is commonly expressed as feet above mean sea level (msl) and is reported relative to the North American Vertical Datum of 1988 (NAVD88) in this document per Sustainable Groundwater Act (SGMA) regulations.
- **Inelastic Subsidence** – Refers to the permanent sinking or downward settling of the Earth's surface. In the context of this GSP, it is primarily due to the unsustainable extraction of groundwater.
- **Interconnected Surface Water** – Refers to surface water that is hydraulically connected at any point in time or space by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.
- **Lower Aquifer –** The alluvial aquifer below the Corcoran Clay (or E-clay) layer.
- **Measurable Objectives** – Refers to 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.
- **Minimum Threshold** – Refers to a numeric value for each sustainability indicator used to define significant and unreasonable undesirable results.
- **NAVD88** – Refers to the North American Vertical Datum of 1988 computed by the National Geodetic Survey, or as modified.
- **Plan Implementation** – Refers to an Agency's exercise of the powers and authorities described in the Sustainable Groundwater Management Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.
- **Principal Aquifers** – Refers to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. For the purpose of this GSP, the two principal aquifers discussed and referenced are the Upper Aquifer and Lower Aquifer.
- **Representative Monitoring** - Refers to a monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin (CA Code of Regulations, Title 23, Article 2).
- **Reference Point** – Refers to a permanent, stationary, and readily identifiable mark or point on a well, such as the top of casing, from which groundwater level measurements are taken, or other monitoring site (CA Code of Regulations, Title 23, Article 2). Reference point elevation is reported relative to NAVD88 and is used to convert depth to water measurements into water surface elevation values.
- **Screen Interval –** The portion(s) of a well casing that is screened to allow water from the surrounding aquifer into the well pipe. Screen interval is usually reported in feet below ground surface for both the upper-most limit and lower-most limit of the screen.
- **Seasonal High –** Refers to the highest annual static groundwater elevation that is typically measured in the Spring and associated with stable aquifer conditions following a period of lowest annual groundwater demand.
- **Seasonal Low** – Refers to the lowest annual static groundwater elevation that is typically measured in the Summer or Fall and associated with a period of stable aquifer conditions following a period of highest annual groundwater demand.
- **Sustainability Goal –** The existence and implementation of one or more Groundwater Sustainability Plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.

- **Sustainability Indicator –** Refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).
- **Sustainable Groundwater Management –** The management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.
- **Total Well Depth –** The depth that a well is installed to, measured from the ground surface. This depth is often deeper than the bottom of the deepest screen interval.
- **Undesirable Result –** One or more of the following effects caused by groundwater conditions occurring throughout the basin:
    1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon.
    2) Significant and unreasonable reduction of groundwater storage.
    3) Significant and unreasonable seawater intrusion.
    4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
    5) Significant and unreasonable inelastic land subsidence that substantially interferes with surface land uses.
    6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.
- **Upper Aquifer –** The alluvial aquifer above the Corcoran Clay (or E-clay) layer.
- **Water Surface Elevation –** The elevation in feet relative to NAVD88 that groundwater is encountered inside the well. Elevation is commonly expressed as feet above mean sea level (msl) and is reported relative to the North American Vertical Datum of 1988 (NAVD88) in this document per SGMA regulations.

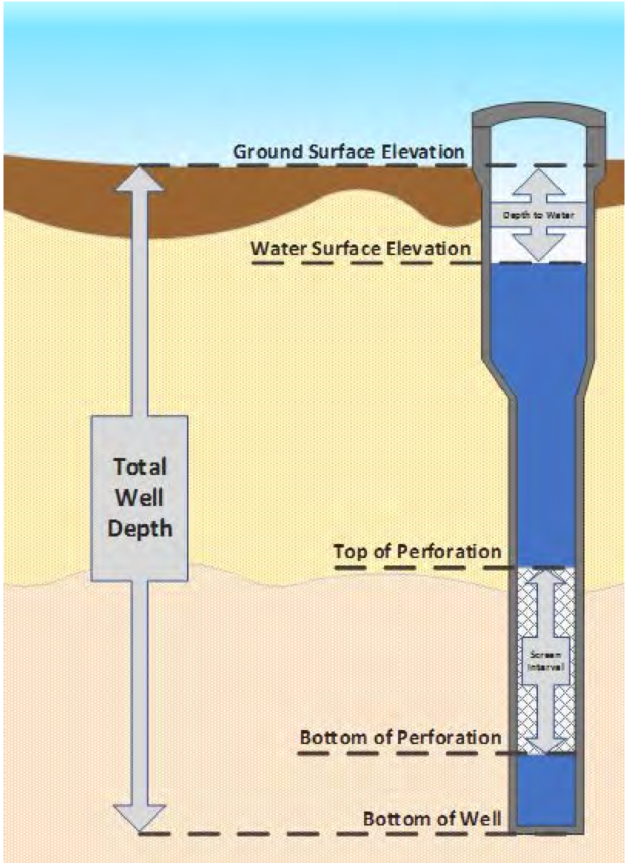

Figure 7-1. Diagram of Key Groundwater Monitoring Well Measurements

7.2.2 Monitoring Network Objectives

This section describes the Northern & Central Delta-Mendota Region GSP representative monitoring networks for the five sustainability indicators applicable to the Delta-Mendota Subbasin. The objective of these monitoring networks is to detect undesirable results in the Plan Area using the sustainability management criteria described in **Chapter 6** *Sustainable Management Criteria*. Other related objectives of the monitoring networks, as defined by the GSP Emergency Regulations, are as follows:

- Demonstrate progress toward achieving measurable objectives described in the GSP;
- Monitor impacts to the beneficial uses or users of groundwater;
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds; and
- Quantify annual changes in water budget components.

The monitoring network plan for the Northern & Central Delta-Mendota Region GSP is intended to monitor for the:

- Chronic lowering of groundwater levels
- Long-term reduction in groundwater storage
- Degradation of water quality
- Inelastic land subsidence
- Depletions of interconnected surface water

The monitoring networks described herein were developed by evaluating monitoring locations and data available through existing monitoring programs within the Northern and Central Delta-Mendota Regions along with information available for accessible monitoring sites. Sites selected for inclusion in the monitoring networks for this GSP were considered based on criteria described herein.

7.2.2.1 Conditions Relevant to Monitoring Network Development

This section summarizes key conditions that influence the development of monitoring networks in the Northern and Central Delta-Mendota Regions. These key conditions include hydrogeology, land use, and water conveyance infrastructure.

The Delta-Mendota Subbasin, as described in **Section 5.2** *Hydrogeologic Conceptual Model*, is generally composed of two principal aquifers divided by a regional aquitard referred to as the Corcoran Clay or E-clay layer. The semi-confined Upper Aquifer overlies the Corcoran Clay, while the confined Lower Aquifer is below the Corcoran Clay. Local variation in hydrogeology does exist throughout the Delta-Mendota Subbasin; for example, shallow clay layers known as the A- and C-clay layers exist in the southern portion of the Subbasin. The monitoring networks described herein account for these local variations as appropriate while considering the general formations comprising the Delta-Mendota Subbasin.

The largest land use by volume of groundwater within the Northern and Central Delta-Mendota Regions is irrigated agriculture. Cities and communities reliant on groundwater, in whole or in part, for their water supply include the City of Patterson and the communities of Grayson, Westley, Crows Landing, Santa Nella, and Tranquillity as well as unincorporated communities within Oro Loma Water District's service area. Groundwater use is described in greater detail in **Chapter 2** *Plan Area* of this GSP.

Water conveyance infrastructure of statewide importance, including the Delta-Mendota Canal (DMC) and California Aqueduct, runs the length of the Delta-Mendota Subbasin, mostly through the Northern and Central Delta-Mendota Regions. Historic inelastic land subsidence has resulted in reduced capacity of the DMC and California Aqueduct by uneven decline in ground surface elevations along the canals, decreasing flow velocity and reducing freeboard resulting in erosion along the canal walls. Further detail on major water-related infrastructure within the Northern and Central Delta-Mendota Regions is contained in **Chapter 2** *Plan Area*.

7.2.3 Representative Monitoring

The monitoring networks contained herein are the representative monitoring networks for the Northern and Central Delta-Mendota Regions, as defined in GSP Emergency Regulations § 354.36. Groundwater levels are being used to monitor the chronic lowering of groundwater levels sustainability indicator, as well as a proxy for data collection and analyses relative to the reduction of groundwater storage (Upper Aquifer only) and depletions of interconnected surface water sustainability indicators. Land surface elevation is used for assessing sustainability relative to the land subsidence sustainability indicator and as a proxy for Lower Aquifer reduction of groundwater storage sustainability indicator, while groundwater quality data are used for assessing sustainability relative to the degraded water quality sustainability indicator.

7.2.4 Scientific Rationale for Monitoring Site Selection

The monitoring networks described herein were developed to ensure they can provide the data necessary to detect changes in conditions within the Plan area such that the Northern and Central Delta-Mendota Regions can manage the Plan area and ensure sustainability criteria are met. It is anticipated that these monitoring networks will be refined in future updates to this GSP, with the intent of ensuring that no undesirable results are present after 20 years of Subbasin sustainable management (e.g. post-2040) and, if undesirable results do occur, ensure that conditions will improve and begin trending toward the established measurable objective.

The monitoring networks herein were developed to detect short-term, seasonal, and long-term trends for all sustainability indicators applicable to the Northern and Central Delta-Mendota Regions. The monitoring networks were also developed to include information about temporal frequency and spatial density so the Northern and Central Delta-Mendota Regions can evaluate information, both independently and in cooperation with the other five Subbasin GSPs, regarding how groundwater conditions change spatially and temporally as projects and management actions are implemented to aid in reaching subbasin-wide sustainability by 2040.

7.2.4.1 Monitoring Site Selection Criteria

Monitoring site selection criteria specific to the monitoring networks for each applicable sustainability indicator is described in detail in **Section 7.2.5** *Monitoring Networks*.

7.2.4.2 Existing Monitoring Programs

Existing monitoring programs were evaluated and utilized to develop the Northern & Central Delta-Mendota Region GSP monitoring networks with the ultimate goal of coordinating required monitoring efforts in the Subbasin for all relative programs. Further detail regarding existing monitoring programs can be found in **Section 2.3.3** (*Plan Area* chapter).

7.2.4.3 Data and Reporting Standards

The following data and reporting standards apply to all categories of information required of a GSP, unless otherwise indicated (DWR, 2016c):

1. Water volumes shall be reported in acre-feet.

2. Surface water flow shall be reported in cubic feet per second.

3. Groundwater flow shall be reported in acre-feet per year.

4. Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to the North American Vertical Datum of 1988 (NAVD88), or another national standard that is convertible to NAVD88, and the method of measurement described.

5. Reference point (RP) elevations shall be measured and reported in feet to an accuracy of 0.1 feet, or the best available information, relative to NAVD88 or another national standard that is convertible to NAVD88, and the method of measurement described.

6. Geographic locations shall be reported in Global Positioning System (GPS) coordinates by latitude and longitude in decimal degree to a minimum accuracy of 30 feet relative to NAD83 or another national standard that is convertible to NAD83.

<u>Monitoring Sites</u>

The following protocols will be applied to all monitoring sites included in the Northern & Central Delta-Mendota Region GSP monitoring networks for all sustainability indicators (DWR, 2016c):

1. Long-term access agreements that include year-round site access to allow for increased monitoring frequency.

2. A unique site identification number and narrative description of the site location.

3. A description of the type of monitoring, type of measurement taken, and monitoring frequency shall be documented.
4. Location, elevation of the ground surface, and identification and description of the reference point shall be documented.
5. A description of the standards used to install the monitoring site. Sites that do not conform to Best Management Practices (BMPs) shall be identified and the nature of the divergence from BMPs described in the monitoring site file.
6. A modification log is to be kept in order to track all modifications to the monitoring site.

Wells

The following standards apply to wells (DWR, 2016c):

1. Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and the following information shall be provided in both tabular and geodatabase-compatible shapefile form:
    a. California Statewide Groundwater Elevation Monitoring (CASGEM) well identification number, if available. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by the California Department of Water Resources (DWR).
    b. Well location, elevation of the ground surface and reference point, including a description of the reference point.
    c. A description of the well use (such as public supply, irrigation, domestic, monitoring, or other type of well), whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.
    d. Casing perforations, borehole depth, and total well depth.
    e. Well completion reports, if available, from which the names of private owners have been redacted.
    f. Geophysical logs, well construction diagrams, or other relevant information, if available.
    g. Identification of principal aquifers monitored.
    h. Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.
2. If an agency relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a GSP, the agency shall describe a schedule for acquiring monitoring wells with the necessary information or demonstrate to the DWR that such information is not necessary to understand and manage groundwater in the basin.

Maps

Maps submitted by the Northern and Central Delta-Mendota Regions' Groundwater Sustainability Agencies (GSAs) will meet the following requirements (DWR, 2016c):

1. Data layers, shapefiles, geodatabases, and other information provided with each map shall be submitted electronically to the DWR.

2. Maps shall be clearly labeled and contain a level of detail to ensure that the map is informative and useful.

3. The datum shall be clearly identified on the maps or in an associated legend.

Hydrographs

Hydrographs submitted by the Northern and Central Delta-Mendota Regions' GSAs shall meet the following requirements (DWR, 2016c):

1. Hydrographs shall be submitted electronically to the Department in accordance with the procedures described in Article 4, Procedures of the GSP Regulations.

2. Hydrographs shall include a unique site identification number and the ground surface elevation for each site.

3. Hydrographs shall use the same datum and scaling to the greatest extent practical.

Groundwater and Surface Water Models

Groundwater and surface water models used shall meet the following standards (DWR, 2016c):

1. The model shall include publicly available supporting documentation.

2. The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

3. Groundwater and surface water models developed in support of a GSP after the effective date of the GSP regulations shall consist of public domain open-source software.

Data Management System

The Northern and Central Delta-Mendota Regions' GSAs have developed and will maintain a data management system (DMS) that is capable of storing and reporting information relevant to the development or implementation of the coordinated GSP and monitoring of the Delta-Mendota Subbasin (DWR, 2016c). For more information about the Delta-Mendota Subbasin DMS, refer to **Section 8.3.4** of the *Plan Implementation* chapter.

7.2.5 Monitoring Networks

A description of each monitoring network within the Plan area is included herein. Each monitoring network was established for collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions as well as yield representative information about groundwater conditions as necessary to evaluate Plan implementation. Selected monitoring sites are presented on maps and in tabular form. Monitoring protocols and data reporting requirements, frequency and timing of monitoring events, and spatial density are briefly described in this section with more specific information on monitoring protocols found in **Appendix F** (*Quality Assurance Program Plan for Northern & Central Delta-Mendota Region GSP Monitoring Protocol*). Existing data gaps are identified and described, as well as plans to assess and improve the monitoring networks in future GSP updates. A more detailed plan for addressing identified data gaps will be developed by the Regions in 2020, detailing work efforts to be conducted and scheduling. This plan will be available upon request following completion.

Monitoring frequency and density of monitoring sites will be adjusted over time through periodic assessment and refinements to ensure an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under the following circumstances:

1. Minimum threshold exceedances;
2. Highly variable spatial or temporal conditions;
3. Adverse impacts to beneficial uses and users of groundwater; and
4. The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

7.2.5.1 Groundwater Level Monitoring Network

Groundwater level monitoring networks for each principal aquifer are established to demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and interconnected surface water features by the following methods:

1. A sufficient density of monitoring wells to collect representative groundwater elevation measurements through depth-discrete perforated (or screened) intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
2. Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

Groundwater level monitoring is conducted through a groundwater well monitoring network. The following subsections provide information about how the groundwater level monitoring network for each principal aquifer was developed, criteria for selecting monitoring wells, summary of protocols, monitoring frequency and timing, spatial density, and identification and strategies to fill data gaps.

7.2.5.1.1 Selected Monitoring Sites

Wells identified and summarized in **Table 7-6** and **Table 7-7** were selected to evaluate short-term, seasonal, and long-term trends in groundwater levels in the Upper Aquifer and Lower Aquifer, respectively. The overall groundwater level monitoring network is comprised of 17 wells perforated in the Upper Aquifer (**Figure 7-2**) and 21 wells in the Lower Aquifer (**Figure 7-3**), where these maps show the representative monitoring network for the entire Delta-Mendota Subbasin.

Table 7-6. Groundwater Level Monitoring Network, Upper Aquifer

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Status	Well Use	Monitoring Agency	Monitoring Program	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	135	115 - 135	2012	2019	81
01-005	08S08E15G001M	372424N1210754W001	MP058.28L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	170	120 - 150	1995	2019	54
02-009		374772N1211672W001	Keystone well	Active	Irrigation	City of Patterson	Local agency	286	176 - 200	2014	2021	53
03-001		375015N1211011W001	MW-2	Active	Monitoring	Patterson Irrigation District	CASGEM (Mandatory)	250	220 - 250	2010	2018	21
03-002			MW-3	Unknown	Monitoring	Patterson Irrigation District	Local agency	260	220 - 250	2010	2018	16
03-003	05S/08E-16R		WSJ003	Unknown	Irrigation	Westside San Joaquin River Watershed Coalition	Groundwater Quality Trend Monitoring Program (Irrigated Lands Regulatory Program [ILRP])	255	130 - 250	Not available	Not available	Not available
06-002	06S08E09E003M	374316N1210994W003	P259-3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	115	95 - 115	2012	2019	81
06-004			MP031.31L1-L2Well1	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	140-160; 200-240	2009	2019	27
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	160	150 - 160	2012	2019	81
07-009		366000N1202300W001	KRCDTID03	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	543	434-510	2014	2018	9
07-010		366500N1202500W001	KRCDTID02	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	540	295-535	2014	2018	9
07-012	12S/12E-16B		GDA003	Unknown	Irrigation	Grassland Drainage Area Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	410	270 - 390	1995	2019	84
07-017			Well 1	Unknown	Public Supply	Volta Community Services District	Local agency	Unknown	170-253	Not available	Not available	Not available
07-018	15S/16E-20		WSJ001	Unknown	Domestic	Westside San Joaquin River Watershed Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	205	165 - 205	Not available	Not available	Not available
07-029		368176N1207307W001	CDMGSA-01A	Active	Monitoring	DWR	Technical Support Services	608	100 - 120	2021	2021	1
07-035		368871N1206355W001	MP098.74L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	400	300 - 390	1995	2021	90
08-002		368790N1205784W001	MP102.04L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	420	183 - 223; 233 - 393	2012	2021	23

Table 7-7. Groundwater Level Monitoring Network, Lower Aquifer

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Status	Well Use	Monitoring Agency	Monitoring Program	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	475	230 - 475	1995	2019	83
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	510	235 - 475	1995	2019	72
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	721	218 - 242; 290 - 346; 353 - 358; 418 - 480; 490 - 538; 562 - 550; 600 - 595; 658 - 610	1995	2019	83
01-006		372604N1210611W001	91	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	260	120 - 210	2016	2019	5
01-007			MP021.12L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	400-570 (assumed)	1995	2019	63
01-008			MP051.66L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	290-470 (assumed)	1995	2019	62
02-002			WELL 02 - NORTH 5TH STREET	Unknown	Public Supply	City of Patterson	Local agency	360	170-356	2003	2019	55
04-001		376129N1212942W001	121	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	600	400 - 570	2016	2018	5
06-001	06S08E09E001M	374316N1210994W001	P259-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	430	390 - 410	2012	2019	81
06-003		375774N1212096W001	WSID 3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	400	280 - 380	2009	2018	19
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	355	335 - 355	2012	2019	81
07-005	12S11E03Q001M	369097N1207554W001	MP091.68R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	615	425 - 455; 495 - 615	1995	2019	94
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	550	530 - 550	2011	2019	78
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	1,002	542 - 982	2009	2019	10
07-014			TW-4	Unknown	Monitoring	Tranquillity Irrigation District	Local agency	690	650-690	2015	2019	38
07-015			TW-5	Unknown	Nested Monitoring	Tranquillity Irrigation District	Local agency	630	630-670	2015	2019	38
07-016			Well 01	Unknown	Public Supply	Santa Nella County Water District	Local agency	Unknown	185-225	Not available	Not available	Not available

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Status	Well Use	Monitoring Agency	Monitoring Program	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
07-028		369064N1207276W001	MP093.27L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	647.5	438.9 - 462.2; 508.9 - 600.4	1995	2001	106
07-030		368176N1207307W002	CDMGSA-01B	Active	Monitoring	DWR	Technical Support Services	608	190 - 210	2021	2021	1
07-031		368176N1207307W003	CDMGSA-01C	Active	Monitoring	DWR	Technical Support Services	608	320 - 340	2021	2021	2
07-032		368176N1207307W004	CDMGSA-01D	Active	Monitoring	DWR	Technical Support Services	608	505 - 525	2021	2021	2

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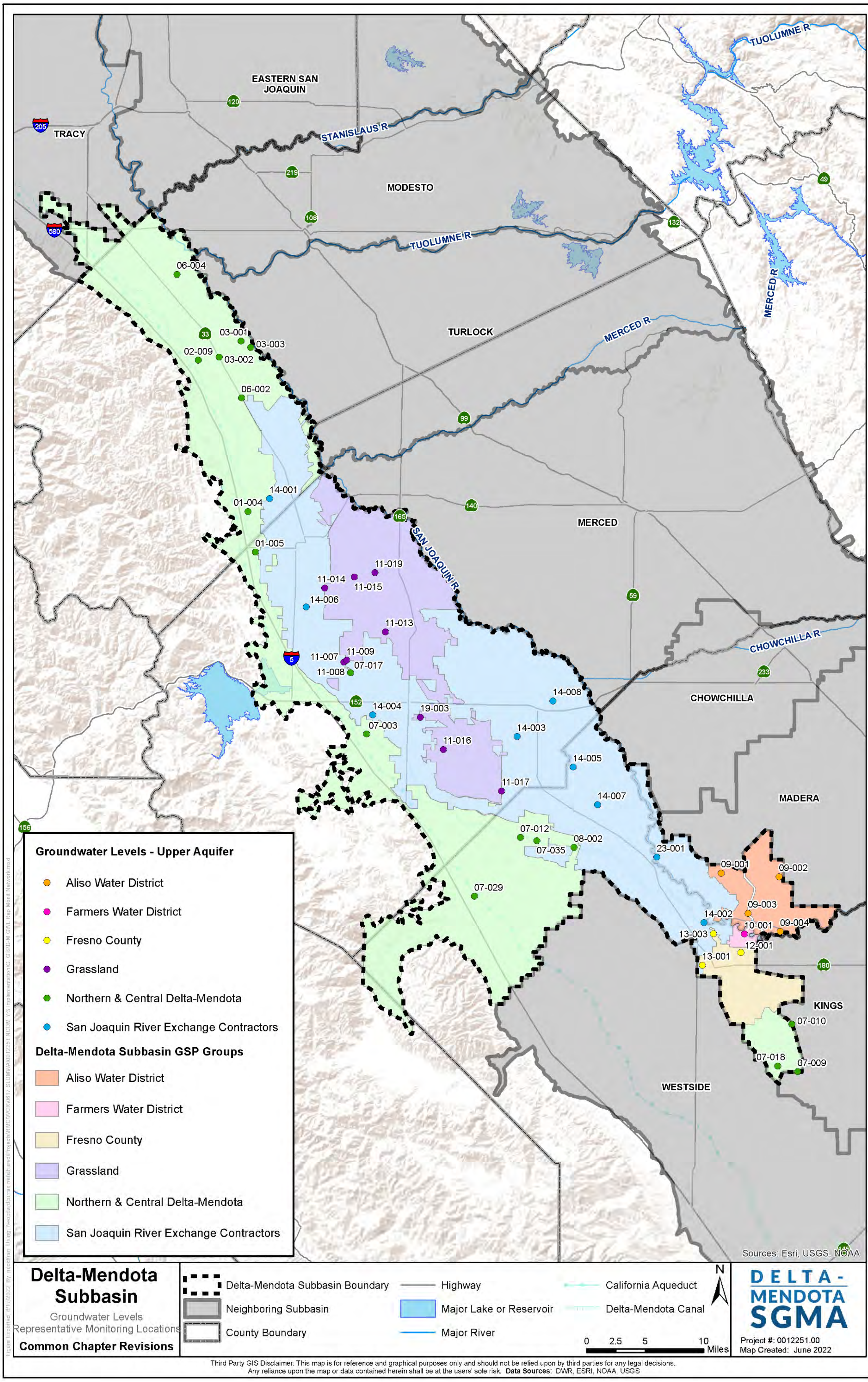

Figure 7-2. Groundwater Level Monitoring Network, Upper Aquifer

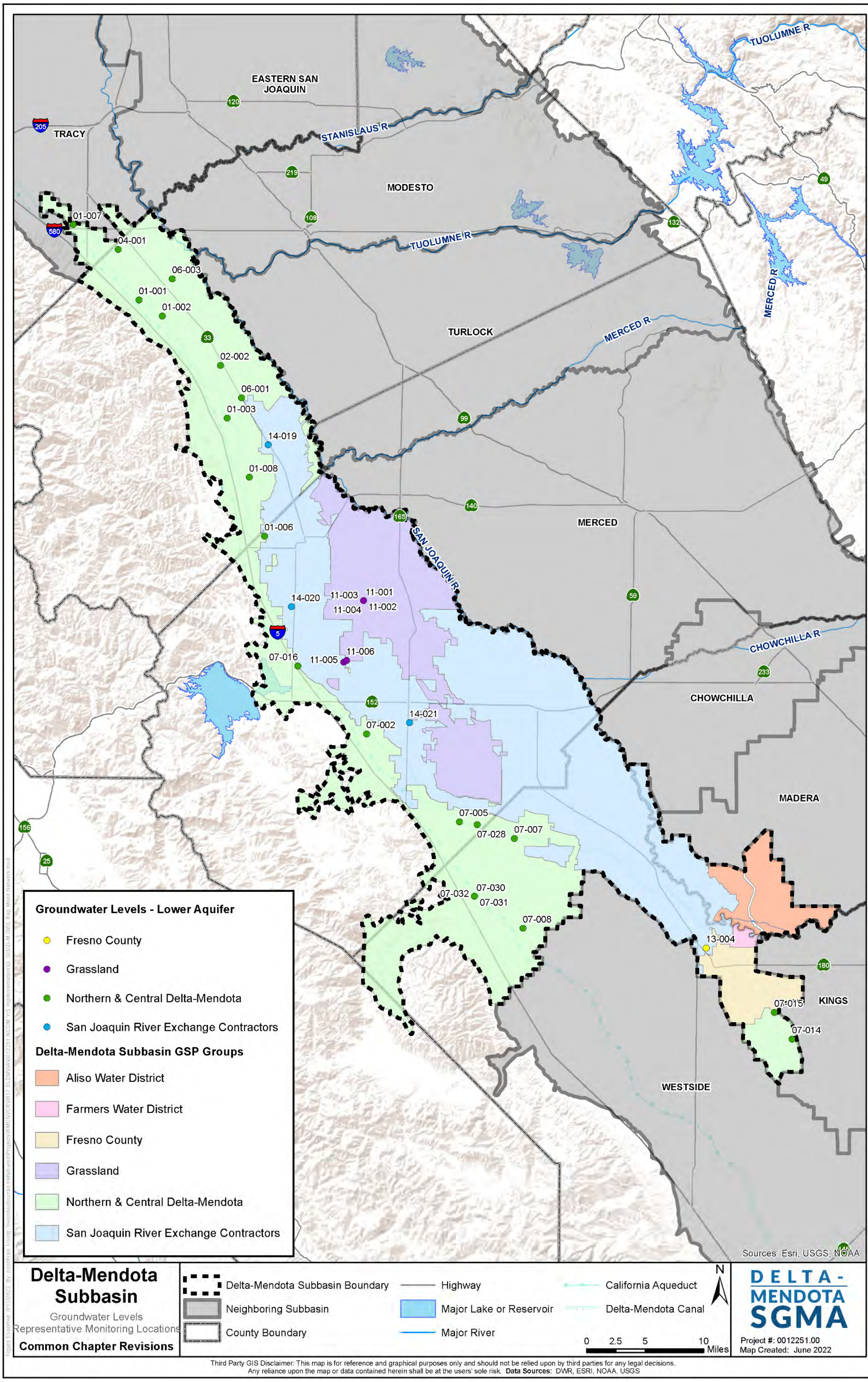

Figure 7-3. Groundwater Level Monitoring Network, Lower Aquifer

Wells were selected for the groundwater level monitoring networks for the Upper Aquifer and Lower Aquifer based on the following criteria:

1. **Existing Monitoring Program –** Wells within existing, on-going monitoring program networks were preferred since access to wells for monitoring purposes have previously been granted, construction information is available, and a historical record of groundwater levels exists.

2. **Adequate Construction Information –** Well information such as screen intervals, construction date, and well depth was considered when evaluating existing well sites.

3. **Confirmed Well Access –** Access to all wells included in the monitoring networks have been confirmed along with the ability to temporary shut down pumping from wells currently being used prior to data collection (per BMPs for data collection).

4. **Screened Exclusively within a Single Principal Aquifer –** Only wells screened exclusively within either the Upper Aquifer or Lower Aquifer (i.e. not across the Corcoran Clay layer) were considered for inclusion in the groundwater level monitoring network. This is consistent with the BMPs published by DWR for establishing monitoring networks (DWR, 2016a).

5. **Robust and Extensive Historical Data –** Existing monitoring sites with longer, more robust historical datasets provide insight into long-term trends and indicate aquifer response under various climate conditions as well as anthropogenic effects regarding groundwater use patterns and were preferred over those without historic records.

6. **Consistency with Best Management Practices –** Using published BMPs provided by DWR ensures consistency across all basins and compliance with established regulations.

7. **Local Knowledge –** Representatives from local agencies and the public were invited to provide any information and insight related to well location, construction, or historical record through each iteration of the groundwater level monitoring network.

8. **Professional Judgment and Best Available Science –** Professional judgement and best available science were used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

The criteria detailed herein used to develop the groundwater level monitoring network does not indicate any particular ranking or order of importance of each criterion. Rather, all criteria were considered collectively to create the groundwater level monitoring networks for the Upper Aquifer and Lower Aquifer.

7.2.5.1.2 Monitoring Protocols and Data Reporting Requirements

Monitoring protocols and data reporting requirements for the groundwater level monitoring networks have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Northern & Central Delta-Mendota Region GSP monitoring networks are detailed in **Section 7.2.4.3**. Additional details regarding monitoring protocols and data reporting requirements can be found in **Appendix F** (*Quality Assurance Program Plan [QAPP] for Northern & Central Delta-Mendota GSP Monitoring Protocol*). Monitoring networks, protocols, and data reporting requirements established for the groundwater level monitoring networks will be reviewed every five years and refined as necessary, where any modifications to the monitoring protocols will be documents in detail within future GSP updates.

<u>Measuring Groundwater Elevation</u>

The following guidelines were adopted from DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b):

- Well construction, anticipated groundwater level measuring equipment, field conditions, and well operations will be considered prior to collection of the groundwater level measurement. Depth to water measurements will use procedures appropriate for the measuring device and equipment must be operated and maintained in accordance with manufacturer instructions.
- Depth to groundwater must be measured relevant to an established RP on the well casing, usually identified with a permanent market, paint spot, or notch in the lip of the well casing. Depth to groundwater must be measured to an accuracy of 0.1 foot and should be measured to NAVD88. An accuracy of 0.01 foot below the RP is preferable, if possible.
- For measuring wells that are under pressure, a period of time after uncapping will occur during which groundwater levels in the well will equilibrate and stabilize. In these cases, multiple measurements will be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value will be appropriately qualified as a questionable measurement. Record the dimension of the extension and document measurements and configuration.
- The sampler will calculate the groundwater elevation as:

$$GWE = RPE - DTW$$

Where:

GWE = Groundwater Elevation
RPE = Reference Point Elevation
DTW = Depth to Water

The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.

- The sampler will replace any well caps or plugs and lock any well buildings or covers prior to departing the monitoring location.

Recording Groundwater Levels

Prior to collecting semiannual field measurements and before going to the field, the sampling personnel will assemble the following equipment and supplies (SLDMWA, 2015):

- Semiannual Groundwater Level form
- Well sounding location details
- Steel measuring tape and chalk or electric water level sounder
- Clean rags and gloves
- Cell phone
- First aid kit
- Watch or stopwatch
- Ballpoint pen and clipboard

In general, the sampler will record the following for each well in a field notebook:

- Well identifier
- Date and time of measurements (24-hour format)
- RP elevation

- Height of RP above or below ground surface
- Depth to water
- Groundwater elevation (as calculated from RP and depth to water)
- Comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, or well condition.

If there is a questionable measurement or the measurement cannot be obtained, it will be noted. Standardized field forms will be used for all data collection.

Data Reduction, Validation, and Reporting

After field personnel have completed their work, data should be cross-checked and submitted to the GSP Lead for compilation with other Regional data collection efforts. All monitoring locations in the Northern & Central Delta-Mendota Region GSP monitoring networks have been assigned a unique well identification (ID), and information associated with wells, such as well characteristics and historical hydrologic observations, will be compiled and maintained within the DMS.

Agencies will collect groundwater level measurements during the designated seasonal high and seasonal low time periods (as identified in **Section 7.2.5.1.3**). Each GSA member agency is responsible for collecting groundwater level measurements and supplying those data to the GSA Lead for compilation and a quality assurance/quality control (QA/QC) review to avoid data entry mistakes. The GSA Lead then submits the compiled data to the GSP Representative for compilation at the GSP level. The GSP Representative will compile the GSA-level data into standard forms for uploading to the Subbasin DMS using import wizards and checks that data has been uploaded correctly. All data is to be updated by October 31 each year for inclusion in the annual report. San Luis & Delta-Mendota Water Authority (SLDMWA), as Plan Administrator, then reviews data uploaded by all six Delta-Mendota GSP Groups prior to compilation at the Subbasin level for annual reporting. Should a measurement appear suspicious, a confirmation reading shall be obtained.

7.2.5.1.3 Frequency and Timing of Monitoring

GSP Emergency Regulations § 354.34(c)(1)(b) indicate that static groundwater elevation measurements shall be collected at least two times per year to represent seasonal low and seasonal high groundwater conditions. Seasonal high groundwater level measurements occur between February and April (classified as “Spring”) and seasonal low groundwater level measurements occur between September and October (classified as “Fall”) within the Delta-Mendota Subbasin. All GSP Groups within the Delta-Mendota Subbasin are responsible for collecting and reporting seasonal high and seasonal low measurements for compilation and reporting to the State.

Coordination with existing monitoring entities will take place regarding the frequency and timing of monitoring events to ensure access to the well site and ensure proper protocols are followed to ensure static groundwater level readings.

7.2.5.1.4 Spatial Density

The goal of the groundwater level monitoring network is to provide adequate spatial coverage of the Plan area for each principal aquifer. This includes the ability to monitor and identify changes in groundwater conditions across the Plan area over time to assess progress toward the sustainability goal by 2040 and beyond. Consideration of the spatial location of monitoring wells included well accessibility, availability of well construction information, proximity to other monitoring wells, and ensuring adequate coverage where undesirable results are occurring or are likely to occur.

The well density of the current monitoring network for the Northern and Central Delta-Mendota Regions is within the range recommended by DWR's *Monitoring Networks and Identifications of Data Gaps BMP* (2016a), where spatial density may be higher in areas where local agencies deem necessary. Spatial density of the groundwater level monitoring networks for both the Upper Aquifer and Lower Aquifer will be reevaluated during future GSP updates and revised as deemed necessary.

7.2.5.1.5 Data Gaps

Groundwater level monitoring data gaps exist in areas where data are limited both spatially and temporally. The lack of available well construction information to determine principal aquifer designation is also a data gap within the Northern and Central Delta-Mendota Regions and throughout the Delta-Mendota Subbasin. Unavailable or inaccurate construction information eliminated the majority of wells with known coordinates from inclusion within the groundwater level monitoring network. Temporal data gaps exist at individual well sites and across wells throughout the Delta-Mendota Subbasin. This is due to a multitude of reasons, including historical differences in the timing of collected measurement, well construction date, and ability to access the well site. The Northern and Central Delta-Mendota Regions and the Delta-Mendota Subbasin GSAs will continue to evaluate the spatial density of the monitoring network throughout the GSP implementation period and determine the need for additional monitoring locations to better understand subbasin characteristics.

7.2.5.1.6 Plan to Fill Data Gaps

Data gaps for the groundwater level monitoring networks for each principal aquifer will be filled through a combination of video surveying well boreholes to identify screen intervals and constructing new dedicated monitoring wells as funding allows (including through Technical Support Services [TSS] funding provided by DWR, future grant funding, and GSA funding). Within the Northern and Central Delta-Mendota Regions, a total of 14 wells will be video logged to identify screen intervals and determine aquifer designation, and one multi-completion well will be installed near Panoche Creek within the Central Delta-Mendota Subbasin GSA through DWR's TSS program (installed in July 2020). For the purpose of monitoring depletions of interconnected surface water, where groundwater levels are used as a proxy, five additional wells with tentative locations (**Figure 7-7**) have been identified that will be installed using SGMA Implementation Grant funding awarded in 2022 and which will, along with nine existing wells, form the monitoring network for interconnected surface water. As wells with unknown construction are video surveyed and new wells are installed, professional judgement will be used to determine if each well meets the criteria for inclusion in the groundwater level monitoring network for each principal aquifer. Any new monitoring wells will be installed in accordance with guidance provided in DWR's *Monitoring Networks and Identifications of Data Gaps BMP* (2016a) and with the State's well standards.

While past temporal data gaps cannot be rectified, future temporal data gaps can be prevented or reduced by ensuring proper sampling and data management protocols are followed, as detailed in **Sections 7.2.5.1.2** and **7.2.5.1.3**.

Current uses for each well within the groundwater level monitoring networks for the Upper Aquifer and Lower Aquifer are identified in **Table 7-6** and **Table 7-7**. Not all wells included in these networks are dedicated monitoring wells, as recommended by DWR's *Monitoring Networks and Identifications of Data Gaps BMP* (2016a). A concerted effort will be made to convert or replace production wells with dedicated monitoring wells over time as funding allows. The use of dedicated monitoring wells is important because such wells have known construction, where screened intervals can be restricted to a single aquifer, do not require the cessation of pumping before measurement, and allow for static measurements that more accurately reflect conditions of single aquifers. As production wells are replaced by dedicated monitoring wells, GSA member agencies will provide input regarding converting existing monitoring wells to dedicated monitoring wells, selecting an alternative well to convert to a dedicated monitoring well, or selecting the location to install a new dedicated monitoring well.

7.2.5.2 Groundwater Storage Monitoring Network

Groundwater levels for the Upper Aquifer and land subsidence for the Lower Aquifer will be used as proxies for the reduction of groundwater storage sustainability indicator. Refer to **Section 7.2.5.1** (*Groundwater Level Monitoring Network*) for more detail on the groundwater level monitoring network, **Section 7.2.5.5** (*Land Subsidence Monitoring Network*) for more detail on the land subsidence monitoring network, and **Chapter 6** *Sustainable Management Criteria* for more detail regarding minimum thresholds, measurable objectives, and interim milestones related to groundwater storage.

7.2.5.3 Seawater Intrusion Monitoring Network

Seawater intrusion is not an applicable sustainability indicator for the Delta-Mendota Subbasin as a whole, as the Subbasin is located inland from the Pacific Ocean and any other large source of seawater. As a result, the Plan Area is not at risk of seawater intrusion and a monitoring network will not be established for this sustainability indicator (GSP Emergency Regulations § 354.34(j)). Total Dissolved Solids (TDS), which is a water quality constituent commonly associated with salinity, will be monitored as part of the groundwater quality network but the primary naturally occurring TDS in the Delta-Mendota Subbasin is due to the geochemistry of the Coast Range rocks, rather than seawater intrusion.

7.2.5.4 Degraded Water Quality Monitoring Network

Groundwater quality monitoring networks for each principal aquifer are designed to collect sufficient spatial and temporal data to determine groundwater quality trends to address known water quality issues. TDS has been identified by the Northern and Central Delta-Mendota Regions and the Delta-Mendota Subbasin as a water quality constituent of concern within the Plan Area associated with groundwater management.

This section provides information about how the groundwater quality monitoring network for each principal aquifer was developed, criteria for selecting monitoring wells, summary of protocols, monitoring frequency and timing, spatial density, and identification and strategies to fill data gaps.

7.2.5.4.1 Selected Monitoring Sites

Wells identified and summarized in **Table 7-8** and **Table 7-9** were selected to evaluate short-term, seasonal, and long-term trends in groundwater quality in the Upper Aquifer and Lower Aquifer, respectively, as well as for trends in groundwater elevations. The overall groundwater quality monitoring network is comprised of 16 wells perforated in the Upper Aquifer (**Figure 7-4**) and 21 wells in the Lower Aquifer (**Figure 7-5**), where these maps show the representative monitoring network for the entire Delta-Mendota Subbasin.

The well selection criteria described in **Section 7.2.5.1.1** for the groundwater levels monitoring network were also used to establish the groundwater quality monitoring network.

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Table 7-8. Groundwater Quality Monitoring Network, Upper Aquifer

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Status	Well Use	Monitoring Agency	Monitoring Program	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	135	115 - 135	2011	2012	8
01-018			Gemperle well	Active	Unknown	Del Puerto Water District	Local agency	Unknown	Unknown	2021	2021	1
02-009		374772N1211672W001	Keystone well	Active	Irrigation	City of Patterson	Local agency	286	176 - 200	2021	2021	1
03-001		375015N1211011W001	MW-2	Active	Monitoring	Patterson Irrigation District	CASGEM (Mandatory)	250	220 - 250	Not available	Not available	Not available
03-003	05S/08E-16R		WSJ003	Unknown	Irrigation	Westside San Joaquin River Watershed Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	255	130 - 250	Not available	Not available	Not available
03-007		374410N1210638W001	MW-1	Active	Monitoring	Patterson Irrigation District	Local agency	250	220 - 250	2021	2021	1
06-002	06S08E09E003M	374316N1210994W003	P259-3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	115	95 - 115	2010	2012	8
06-004			MP031.31L1-L2Well1	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	140-160; 200-240	Not available	Not available	Not available
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	160	150 - 160	Not available	Not available	Not available
07-012	12S/12E-16B		GDA003	Unknown	Irrigation	Grassland Drainage Area Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	410	270 - 390	Not available	Not available	Not available
07-017			Well 1	Unknown	Public Supply	Volta Community Services District	Local agency	Unknown	170-253	2002	2017	8
07-018	15S/16E-20		WSJ001	Unknown	Domestic	Westside San Joaquin River Watershed Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	205	165 - 205	Not available	Not available	Not available
07-029		368176N1207307W001	CDMGSA-01A	Active	Monitoring	DWR	Technical Support Services	608	100 - 120	Not available	Not available	Not available
07-033		366758N1202678W002	TW-4 Upper	Active	Monitoring	Tranquillity Irrigation District	Local agency	700	405 - 445	2021	2021	1
07-035		368871N1206355W001	MP098.74L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	400	300 - 390	Not available	Not available	Not available
08-002		368790N1205784W001	MP102.04L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	420	183 - 223; 233 - 393	2021	2021	1

Table 7-9. Groundwater Quality Monitoring Network, Lower Aquifer

DMS ID	Primary Well ID	CASGEM ID (if applicable)	Local ID	Status	Well Use	Agency	Program	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	475	230 - 475	2013	2016	5
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	510	235 - 475	2001	2013	5
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	721	218 - 242; 290 - 346; 353 - 358; 418 - 480; 490 - 538; 562 - 550; 600 - 595; 658 - 610	Not available	Not available	Not available
01-006		372604N1210611W001	91	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	260	120 - 210	Not available	Not available	Not available
01-007			MP021.12L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	400-570 (assumed)	2008	2016	7
01-008			MP051.66L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	290-470 (assumed)	2007	2016	7
02-002			WELL 02 - NORTH 5TH STREET	Unknown	Public Supply	City of Patterson	Local agency	360	170-356	2000	2016	12
04-001		376129N1212942W001	121	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	600	400 - 570	Not available	Not available	Not available
06-001	06S08E09E001M	374316N1210994W001	P259-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	430	390 - 410	2010	2010	8
06-003		375774N1212096W001	WSID 3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	400	280 - 380	Not available	Not available	Not available
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	355	335 - 355	Not available	Not available	Not available
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	550	530 - 550	2010	2010	1

DMS ID	Primary Well ID	CASGEM ID (if applicable)	Local ID	Status	Well Use	Agency	Program	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	1,002	542 - 982	Not available	Not available	Not available
07-014			TW-4	Unknown	Monitoring	Tranquillity Irrigation District	Local agency	690	650-690	Not available	Not available	Not available
07-015			TW-5	Unknown	Nested Monitoring	Tranquillity Irrigation District	Local agency	630	630-670	Not available	Not available	Not available
07-016			Well 01	Unknown	Public Supply	Santa Nella County Water District	Local agency	Unknown	185-225	2000	2017	10
07-028		369064N1207276W001	MP093.27L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	647.5	438.9 - 462.2; 508.9 - 600.4	2021	2021	1
07-030		368176N1207307W002	CDMGSA-01B	Active	Monitoring	DWR	Technical Support Services	608	190 - 210	Not available	Not available	Not available
07-031		368176N1207307W003	CDMGSA-01C	Active	Monitoring	DWR	Technical Support Services	608	320 - 340	2021	2021	1
07-032		368176N1207307W004	CDMGSA-01D	Active	Monitoring	DWR	Technical Support Services	608	505 - 525	2021	2021	1
07-034		369057N1207470W001	MP092.20R	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Unknown	Unknown	2021	2021	1

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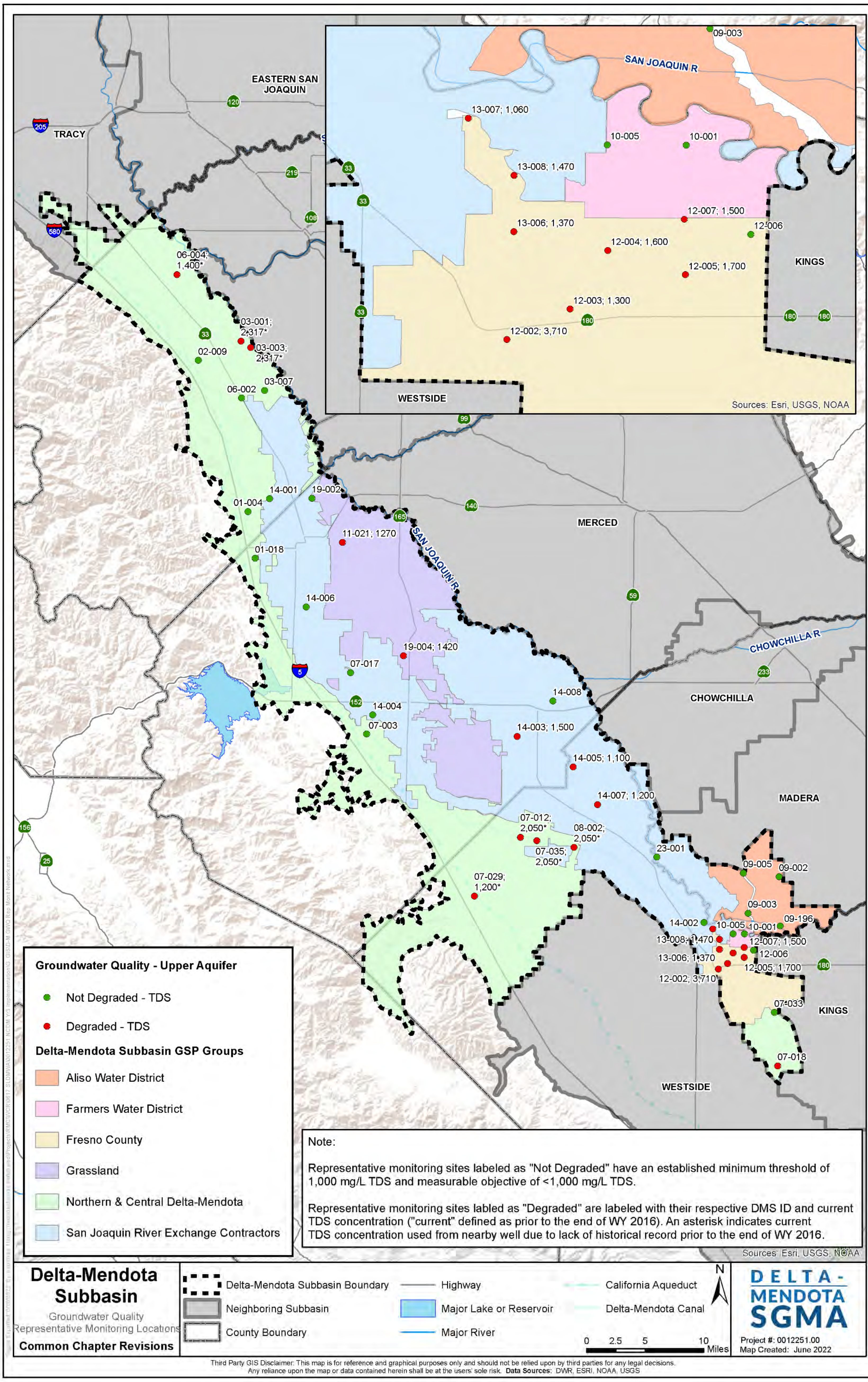

Figure 7-4. Groundwater Quality Monitoring Network, Upper Aquifer

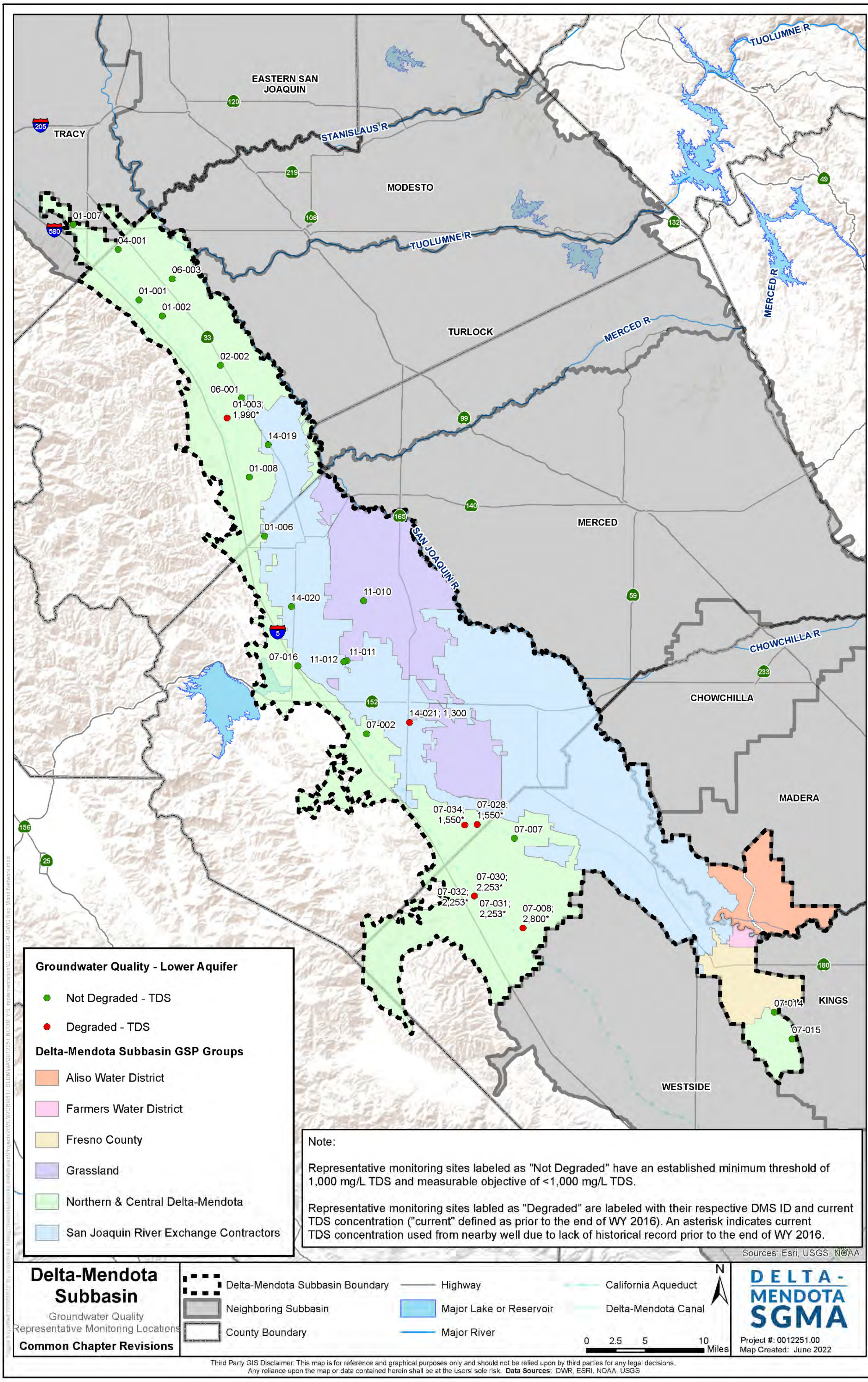

Figure 7-5. Groundwater Quality Monitoring Network, Lower Aquifer

7.2.5.4.2 Monitoring Protocols and Data Reporting Requirements

Monitoring protocols and data reporting requirements for the groundwater quality monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Northern & Central Delta-Mendota Region GSP monitoring networks are detailed in **Section 7.2.4.3**. Additional details for the monitoring protocols and data reporting requirements can be found in **Appendix F** (*QAPP for Northern & Central Delta-Mendota Region GSP Monitoring Protocol*). Monitoring protocols established for the groundwater quality monitoring network will be reviewed every five years and modified as necessary, particularly as new methods or technology are developed, where any modifications to the monitoring protocols will be documents in detail within future GSP updates.

Sampling Water Quality Data

The following guidelines were adopted from DWR's *Standardized [Groundwater Quality Sampling] Protocols* (DWR, 2016b):

- Prior to sampling, the sampler must contact the State-certified analytical laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- The sampler will clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well will be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water will be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment will be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), the condition will be documented and the well allowed to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the data quality objective (DQOs) and adjusted as necessary.
- Field parameters of pH, electrical conductivity (EC), and temperature will be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH will only be measured in the field; lab pH analysis are typically unachievable due to short hold times. All field instruments will be calibrated daily and evaluated for drift throughout the day.
- Sample containers will be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples will be collected under laminar flow conditions when possible with the goal of reducing turbulence. This may require reducing pumping rates prior to sample collection.

- Samples should be collected according to appropriate standards such as those listed in the *Standard Methods for the Examination of Water and Wastewater*, United States Geological Survey (USGS) *National Field Manual for the Collection of Water Quality Data,* or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. The sampler will ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals will be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples will be maintained at a temperature in accordance with the laboratory's Quality Assurance Management Plan's chilling and shipping requirements.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- The laboratory will be instructed to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels.

Analytical Methods

Wells in the groundwater quality monitoring network will be sampled in coordination with other ongoing water quality sampling programs and the Quality Assurance Program Plan (QAPP) included in **Appendix F** of this GSP. Wells will be appropriately purged in accordance with their type and operational history to ensure that a representative groundwater sample is collected from the well. Wells will be purged for a sufficient time (see basic purging below) to evacuate water held in casing storage before collecting the water sample. This is important to ensure that water collected from a well is representative of groundwater in the aquifer formation outside the well bore.

Prior to sampling of a well, the depth to the water in the well will be measured, if possible, and recorded. It may not be possible to measure the water level due to wellhead accessibility or because the well is actively pumping. The well operational status prior to and at the time of sampling will be noted and any other observations at a well site that may potentially relate to the well or groundwater sampling will be described. Field water quality parameters, including EC, pH, and temperature, will be tested and recorded during sampling. Observed characteristics of the water during sampling, such as color, smell, or other visual observations, will be documented in a field notebook. All instruments used to measure field conditions during sampling will be calibrated on a regular basis in accordance with manufacturer guidelines and recommendations.

Water samples collected for laboratory analytical testing will be collected in appropriate laboratory-approved sample containers and stored in accordance with recommended sample handling procedures indicated by the laboratory and established in the QAPP (**Appendix F**). The sample identification, time, date, and any other informational fields indicated on the sample container label will be clearly provided. The associated laboratory chain of custody (COC) for samples will be completed and signed and provided with the samples at the time of delivery of samples to the laboratory for analysis.

Basic Purging. If possible, three casing volumes will be purged from the well prior to sample collection. Larger-capacity wells may not need purging (or may need more pumping) depending on their operational history. For smaller-capacity wells, such as domestic wells, achieving a three-casing volume purge may not be practical because of operational constraints relating to the well and water distribution system. In cases where a three-casing volume purge is not achievable, field parameters (EC, pH, temperature, etc.) of the water will be monitored during pumping/purging and a sample will not be collected until the field parameters have sufficiently stabilized. Field parameters will be monitored and recorded at least three times during well pumping/purging.

Low Flow. In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the protocols set forth in the USEPA's *Low-flow (minimal drawdown) ground-water sampling procedures* (Puls and Barcelona, 1996). These protocols are not intended for bailers and apply to low-flow sampling equipment that generally pumps between 0.026 and 0.13 gallons per minute [0.1 and 0.5 liters per minute] (DWR, 2016b).

No Flow. For wells lacking pumping equipment and with casing volumes that make well purging difficult or impractical, a no-purge sampling device, such as a HydraSleeve, may be utilized to collect the sample. No-purge sampling methods should be conducted in accordance with recommended guidelines for the sample collection specific to the sampling device. When using a no-purge sampling method, a sufficient water sample should be collected for measuring field parameters and filling all necessary laboratory sample bottles.

For monitoring wells with installed pumping systems, groundwater samples will be collected from a point in the distribution system as near to the wellhead as possible and prior to any filtration or pressure tank, if possible.

Data Reduction, Validation, and Reporting

Chain of custody documentation will be used to document sample collection, shipping, storage, preservation, and analysis. All individuals transferring and receiving samples will sign, date, and record the time on the COC that the samples are transferred. Laboratory COC procedures are described in each laboratory's Quality Assurance Program Manual. Laboratories must receive the COC documentation submitted with each batch of samples and sign, date, and record the time the samples are transferred. Laboratories will also note any sample discrepancies (e.g., labeling, breakage). After generating the laboratory data report for the client, samples will be stored for a minimum of 30 days in a secured area prior to disposal.

Water quality samples should be delivered and tested at a state accredited analytical laboratory. A list of approved laboratories is provided in the USBR's *2013 Delta-Mendota Canal Groundwater Pump-in Program Water Quality Monitoring Plan* (USBR, 2013) or on the SWRCB Environmental Laboratory Accreditation Program (ELAP) website at https://www.waterboards.ca.gov/drinking_water/certlic/labs/.

Data generated or acquired as part of the Northern & Central Delta-Mendota Region GSP monitoring networks will be uploaded to the coordinated DMS as soon as possible. All monitoring locations in the GSP monitoring networks of the Delta-Mendota Subbasin will be assigned a unique ID and information associated with each monitoring location, such as well characteristics and historical hydrologic observations, will be compiled and maintained within the DMS. The structure of the DMS will be compatible with Geographic Information System (GIS) and other data formats and to facilitate future uploading of data to a state GSP database. Care should be taken to avoid data entry mistakes and electronic data transfers from the analytical laboratory should be used whenever possible.

Each GSA member agency is responsible for collecting groundwater quality samples and supplying the resultant data to the GSA Lead for compilation and a QA/QC review to avoid data entry mistakes. The GSA Lead then submits the compiled data to the GSP Representative for compilation at the GSP level. The GSP Representative will compile the GSA-level data into standard forms for uploading to the Subbasin DMS using import wizards and checks that data has been uploaded correctly. All data is to be updated by October 31 each year for inclusion in the annual report. SLDMWA, as Plan Administrator, then reviews data uploaded by all six Delta-Mendota GSP Groups prior to compilation at the Subbasin level for annual reporting. Should a result appear suspicious, a second sample shall be obtained as soon as possible for confirmation of the analytical result.

7.2.5.4.3 Frequency and Timing of Monitoring

Groundwater quality sampling will occur once per year during irrigation season, typically between May and August. The frequency and timing for groundwater quality monitoring were agreed upon by the Northern and Central Delta-Mendota Management Committee as well as the Delta-Mendota Subbasin Coordination Committee and deemed sufficient for evaluating the long-term trends in water quality. The frequency and timing of water quality monitoring will be continuously evaluated and modified as necessary prior to the 5-Year GSP Update.

7.2.5.4.4 Spatial Density

According to DWR's *Monitoring Networks and Identification of Data Gaps BMP* (2016a), "the spatial distribution [of wells] should be adequate to map or supplement mapping of known contaminants." The goal of the groundwater quality monitoring network is to adequately cover the Plan area to accurately characterize concentrations and trends of constituents of concern. This includes both spatial and temporal coverage in order to identify changes in ambient groundwater quality over time. As such, professional judgement was used along with available well construction and groundwater quality data to identify the appropriate spatial density for the groundwater quality monitoring network for each principal aquifer.

7.2.5.4.5 Data Gaps

Groundwater quality monitoring data gaps include both temporal and spatial gaps. Data gaps for the groundwater quality monitoring network are similar in nature to the groundwater levels monitoring network, which are detailed in **Section 7.2.5.1.5**.

7.2.5.4.6 Plan to Fill Data Gaps

Refer to **Section 7.2.5.1.6** for the plan to fill data gaps in the groundwater levels monitoring network, which will be similarly applied to the groundwater quality monitoring network. As more data are collected regarding ambient groundwater quality in the Northern and Central Delta-Mendota Regions, the groundwater quality monitoring networks for the Upper Aquifer and Lower Aquifer will be evaluated and refined, and data gaps reexamined to determine if this monitoring network continues to provide adequate spatial coverage to monitor and manage groundwater quality according to the established sustainable management criteria.

While past temporal data gaps cannot be rectified, future temporal data gaps can be prevented or reduced by ensuring proper sampling and data management protocols are followed, as detailed in **Sections 7.2.5.4.2** and **7.2.5.4.3**.

Well use for each monitoring well within the groundwater quality monitoring networks for the Upper Aquifer and Lower Aquifer is identified in **Table 7-8** and **Table 7-9**. Not all wells included in these networks are dedicated monitoring wells, as recommended by DWR's *Monitoring Networks and Identifications of Data Gaps BMP* (2016a). A concerted effort will be made to convert or replace production wells with dedicated monitoring wells over time as funding allows. As production wells are replaced by dedicated monitoring wells, GSA member agencies will provide input regarding converting existing monitoring wells to dedicated monitoring wells, selecting an alternative well to convert to a dedicated monitoring well, or selecting the location to install a new dedicated monitoring well.

7.2.5.5 Land Subsidence Monitoring Network

A land subsidence monitoring network for the Northern and Central Delta-Mendota Regions has been established to identify the rate and extent of inelastic land subsidence, which may be measured by extensometers, land surveying, remote sensing technology, or other appropriate method. Selection of land surface elevation monitoring sites were considered in relation to major water conveyance infrastructure, geographically separated areas, and areas with adequate surface water supplies available to develop a network for managing conditions in relation to each sustainability goal set for land subsidence.

This section provides information about how the land subsidence monitoring network was developed, criteria for selecting monitoring locations, summary of protocols, monitoring frequency and timing, spatial density, and identification and strategies to fill data gaps.

7.2.5.5.1 Selected Monitoring Sites

Land subsidence monitoring sites are identified and summarized in **Table 7-10**. A total of 30 benchmarks and one (1) continuous Global Positioning System (CGPS) station comprise the land subsidence monitoring network. **Figure 7-6** shows the locations of each land subsidence monitoring location within the Plan area, as well as the Delta-Mendota Subbasin.

Land subsidence monitoring locations were selected based on the following criteria:

1. **Existing Monitoring Program** – Monitoring sites within existing, on-going monitoring program networks were preferred since access to land subsidence monitoring sites have previously been granted and a historical record of subsidence measurements likely exists.
2. **Historical Data Available –** Existing monitoring sites with longer, more robust historical datasets provide insight into long-term trends regarding subsidence rates and extents related to groundwater pumping patterns.
3. **Coverage –**A sufficient quantity and density of monitoring sites were selected to evaluate conditions and manage land subsidence relative to the sustainable management criteria.
4. **Adequate Spatial Distribution –** Land subsidence monitoring sites were selected to provide adequate spatial distribution to evaluate conditions relative to sustainable management criteria throughout the Plan Area and established MAs.
5. **Local Knowledge –** Representatives from local agencies as well as the public were invited to provide any information and insight related to subsidence and historical record through each iteration of the land subsidence monitoring network.
6. **Professional Judgement and Best Available Science –** Professional judgement and best available science were used to make the final decision about each land subsidence monitoring location, particularly when more than one suitable site exists in an area of interest.

The criteria detailed herein used to develop the land subsidence monitoring network does not indicate any particular ranking or order of importance of each criterion. Rather, all criteria were considered collectively to create the land subsidence monitoring network for the Northern & Central Delta-Mendota Region GSP.

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Table 7-10. Land Subsidence Monitoring Network

DMS ID	Local ID	Monitoring Agency	Site Type	First Measurement Year	Last Measurement Year	Measurement Frequency
01-009	P252	University NAVSTAR Consortium (UNAVCO)	CGPS	2005	2019	Daily
01-010	Subsidence Monitoring Point #1	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-011	Subsidence Monitoring Point #2	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-012	Subsidence Monitoring Point #3	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-013	Subsidence Monitoring Point #4	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-014	Subsidence Monitoring Point #5	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-015	Subsidence Monitoring Point #7	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-016	Subsidence Monitoring Point #9	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
01-017	Subsidence Monitoring Point #10	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
02-003	Floragold Well	City of Patterson	Benchmark	2006	2019	Periodic
02-004	Subsidence Monitoring Point #6	San Luis & Delta-Mendota Water Authority, City of Patterson	Benchmark	1984	2018	Periodic
02-005	Well 2	City of Patterson	Benchmark	2006	2019	Periodic
02-006	Well 4	City of Patterson	Benchmark	2006	2019	Periodic
02-007	Well 6	City of Patterson	Benchmark	2006	2019	Periodic
02-008	Well 11	City of Patterson	Benchmark	2006	2019	Periodic
03-004	Locust Avenue Well	Patterson Irrigation District	Benchmark	Unknown	2019	Periodic
03-005	Pumping Plant No. 2	Patterson Irrigation District	Benchmark	Unknown	2019	Periodic
03-006	River Station	Patterson Irrigation District	Benchmark	Unknown	2019	Periodic
04-003	WSID 11	West Stanislaus Irrigation District	Benchmark	Unknown	Unknown	Periodic
04-004	WSID 21	West Stanislaus Irrigation District	Benchmark	Unknown	Unknown	Periodic
04-005	WSID 2	West Stanislaus Irrigation District	Benchmark	2019	2021	periodic
06-006	Subsidence Monitoring Point #8	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
07-019	AG-24	Tranquillity Irrigation District	Benchmark	2013	2019	Annual
07-020	104.20-R	San Luis Water District	Benchmark	1967	2019	Periodic
07-021	Subsidence Monitoring Point #11	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
07-022	Subsidence Monitoring Point #12	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
07-023	Subsidence Monitoring Point #13	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
07-024	Subsidence Monitoring Point #14	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
07-025	Subsidence Monitoring Point #15	San Luis & Delta-Mendota Water Authority	Benchmark	1984	2018	Periodic
07-026	TID A	Tranquillity Irrigation District	Benchmark	2013	2019	Annual
07-027	TID B	Tranquillity Irrigation District	Benchmark	2013	2019	Annual

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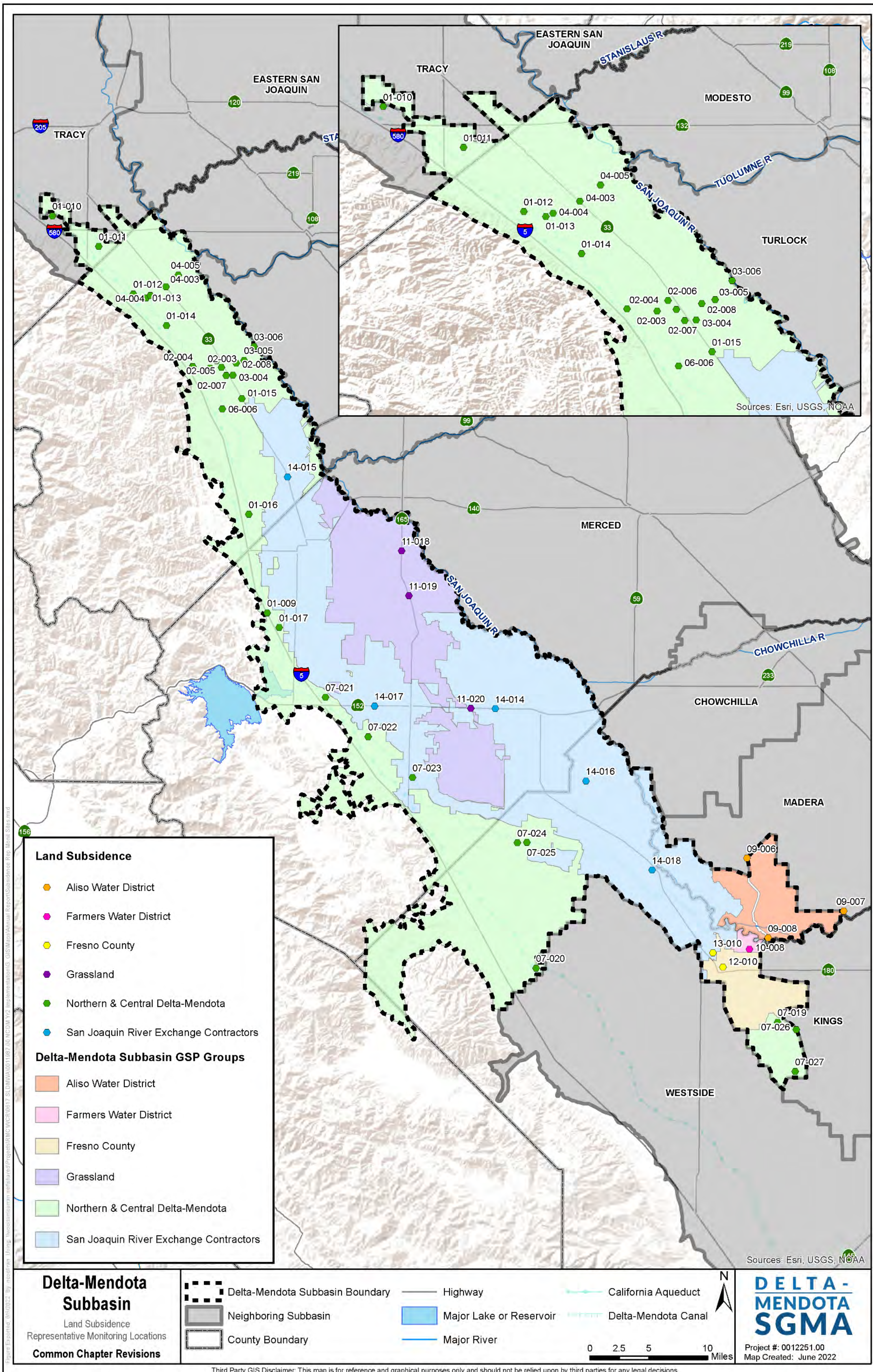

Figure 7-6. Land Subsidence Monitoring Network

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7.2.5.5.2 Monitoring Protocols and Data Reporting Requirements

Monitoring protocols and data reporting requirements for the land subsidence monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Northern & Central Delta-Mendota Region GSP monitoring networks are detailed in **Section 7.2.4.3**. Additional details regarding monitoring protocols and data reporting requirements can be found in **Appendix F** (*QAPP for Northern & Central Delta-Mendota Region GSP Monitoring Protocol*). Monitoring protocols established for the land subsidence monitoring network will be reviewed every five years and modified as necessary, where any modifications to the monitoring protocols will be documented in detail in future GSP updates.

Land Surveying Procedures

The following guidelines for conducting ground surface elevations measurements via land surveying were adopted from the United States Department of Agriculture, Natural Resources Conservation Service *Engineering Field Handbook* (2008):

- All surveys will be conducted by a California licensed land surveyor and will tie into established benchmarks.
- Prior to taking the first measurement at a given representative monitoring location, the established benchmark for the monitoring site will be identified and information will be obtained from the appropriate entity prior to field work.
- Maps and photographs of the monitoring site will be made available to the surveyor.
- Proper protocols and procedures will be followed to set up and level the surveying equipment.
- Before taking a reading, ensure the measurement rod is in the vertical position and no foreign material prevents clear contact between the rod and the point to be read.
- The leveling bubble on the surveying equipment will be checked regularly during use by the surveyor to make sure no inadvertent movement has occurred. If necessary, proper protocols and procedures to re-level the surveying equipment will be followed to begin measuring again. Adjustments to the level should never be made part way through a circuit.
- All vertical elevation measurements will be collected relative to NAVD88.
- Field notes will, at a minimum, contain the following information:
    - Location of survey (including coordinates and written description)
    - Date and time of survey
    - Instruments and technique used
    - Established benchmark tied to the monitoring site
    - Monitoring site ID
    - Measured benchmark elevation (to 0.1-foot accuracy)
    - Measured elevation at monitoring site relative to the established benchmark (to 0.1-foot accuracy)
    - Description of any modifications to the monitoring site

Data Reduction, Validation, and Reporting

Data generated or acquired as part of the Northern & Central Delta-Mendota Region GSP monitoring networks will be uploaded to the Subbasin coordinated DMS as soon as possible following validation. All representative monitoring sites will be assigned a unique ID number and information associated with monitoring site, such as such as location descriptions and associated photographs, will be compiled and maintained within the DMS. The structure of the DMS will be compatible with GIS and other data formats to facilitate future uploading of data to external databases.

Each GSA member agency is responsible for collecting land survey measurements and supplying the resultant data to the GSA Lead for compilation and a QA/QC review to avoid data entry mistakes. The GSA Lead then submits the compiled data to the GSP Representative for compilation at the GSP level. The GSP Representative will compile the GSA-level data into standard forms for uploading to the Subbasin DMS using import wizards and checks that data has been uploaded correctly. All data is to be updated by October 31 each year for inclusion in the annual report. SLDMWA, as Plan Administrator, then reviews data uploaded by all six Delta-Mendota GSP Groups prior to compilation at the Subbasin level for annual reporting. Should a measurement appear suspicious, a second confirmation reading shall be obtained as soon as possible.

In addition to data collected directly by the Northern and Central Delta-Mendota Regions' GSAs, subsidence data will be downloaded from publicly available sources such as UNAVCO and DWR's SGMA Data Viewer for assessment with local data. All data will be maintained in the Subbasin coordinated DMS.

7.2.5.5.3 Frequency and Timing of Monitoring

Elevation surveys will be performed every other year with surveys taking place during even years. Elevation surveys performed by either by the United States Bureau of Reclamation or the San Luis & Delta-Mendota Water Authority during the month of July.

Benchmark monitoring sites will be surveyed during the same period (e.g. Spring or Fall) to ensure measurements represent the same condition related to subsidence. Data collected from publicly available sources (such as UNAVCO and DWR's SGMA Data Viewer) will also be downloaded and used to supplement survey data. Coordination with existing monitoring entities will take place regarding the frequency and timing of monitoring events to ensure access to the monitoring site and ensure proper protocols are followed.

7.2.5.5.4 Spatial Density

Guidance related to the spatial density of land subsidence monitoring sites is not provided in DWR's *Monitoring Networks and Identification of Data Gaps BMP* (2016a). It is noted that the land subsidence monitoring network "should be established to observe the sustainability indicator such that the sustainability goal can be met" (DWR, 2016a). Professional judgement, along with historical survey data, existing survey benchmarks and local experience, to establish the appropriate spatial density of land subsidence monitoring networks within the Plan area.

7.2.5.5.5 Data Gaps

There are no known spatial data gaps identified for the land subsidence monitoring network within the Northern and Central Delta-Mendota Regions. Professional judgement and local knowledge were used in the development of the land subsidence monitoring network determined that there is adequate spatial distribution of benchmark sites to collect subsidence data relative to sustainable management criteria going forward.

Temporal data gaps exist at individual monitoring sites and across monitoring sites throughout the Delta-Mendota Subbasin. This is due to a multitude of reasons including historical differences in the timing of collected measurement, monitoring site construction date, and ability to access the monitoring site. Future land surveys, coordinated amongst the GSAs and combined with publicly available land survey datasets, will eliminate these temporal data gaps in the future.

7.2.5.5.6 Plan to Fill Data Gaps

While there are currently no known spatial data gaps within the land subsidence monitoring network, a concerted effort will be made to continually assess the land subsidence monitoring network for data gaps and to refine the network through the process outlined in DWR's *Monitoring Networks and Identification of Data Gaps BMP* (2016a). Such efforts will take place prior to updates to this GSP.

While past temporal data gaps cannot be rectified, future temporal data gaps can be prevented or reduced by ensuring proper sampling and data management protocols are followed, as detailed in **Sections 7.2.5.5.2** and **7.2.5.5.3**.

7.2.5.6 Depletions of Interconnected Surface Water Monitoring Network

A monitoring network for the depletions of interconnected surface water sustainability indicator is designed to monitor surface water and groundwater conditions at locations where interconnected surface water conditions exist to characterize the spatial and temporal relationship between surface water stage and Upper Aquifer groundwater elevations. This monitoring network is also designed to provide the necessary data for calculating depletions of surface water caused by groundwater extractions. The monitoring network is intended to characterize the following:

1. Flow conditions in interconnected surface water bodies, including surface water discharge, surface water stage, and baseflow contribution.
2. The approximate data and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
3. Temporal change in conditions due to variations in stream discharge and regional groundwater extractions.
4. Other factors that may be necessary to identify adverse impacts on beneficial uses of surface water.

This section provides information about how the depletions of interconnected surface water monitoring network was developed, criteria for selecting monitoring wells, summary of protocols, monitoring frequency and timing, spatial density, and identification and strategies to fill data gaps.

7.2.5.6.1 Selected Monitoring Sites

The monitoring network for the depletions of interconnected surface water sustainability indicator uses the groundwater level monitoring network as an interim proxy, as interconnected surface water is an identified data gap. Therefore, the criteria for selecting wells for the depletions of interconnected surface water monitoring network is the same as the criteria applied in developing the groundwater level monitoring network (detailed in **Section 7.2.5.1.1**). New monitoring wells will be constructed for this sustainability indicator over the next five years, for use along with nine existing monitoring wells currently being used as part of the San Joaquin River Restoration Project, to develop a Subbasin-wide monitoring network for interconnected surface waters.

7.2.5.6.2 Monitoring Protocols and Data Reporting Requirements

Depletions of interconnected surface water will be assessed using groundwater levels as a proxy. As such, the monitoring protocols for the groundwater level monitoring network are also applicable for collecting information relevant to the monitoring network for the depletions of interconnected surface water sustainability indicator.

Monitoring protocols for the groundwater level monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Northern & Central Delta-Mendota Region GSP monitoring networks are detailed in **Section 7.2.4.3**. Greater detail regarding monitoring protocols and data reporting requirements can be found in **Appendix F** (*QAPP for Northern & Central*

Delta-Mendota Region GSP Monitoring Protocol). Monitoring protocols established for the groundwater level monitoring network will be reviewed every five years and modified as necessary, where any modifications to the monitoring protocols will be documents in detail in each future GSP update.

For the analysis of future management of interconnected surface waters, streamflow and/or surface water stage data will be downloaded from publicly available databases and/or obtained from local sources and combined with groundwater elevation data for assessing the status of this sustainability criterion. Specifically, future data collection efforts will attempt to link groundwater elevations and gradients with river stage, groundwater pumping data and hydrologic conditions to establish a relationship between groundwater use and interconnected surface water. All data collected and utilized will be uploaded to the Subbasin coordinated DMS.

Protocols for Measuring Streamflow

The following guidelines were adopted from DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b):

- The use of existing streamflow monitoring locations will be incorporated to the greatest extent possible.
- Establishment of new streamflow monitoring sites should consider existing representative monitoring networks and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any surface water monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.
- To establish a new streamflow monitoring station, special consideration must be made in the field to select an appropriate location for measuring flows and/or stage. Once a site is selected, development of a relationship between stream stage and discharges will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages may be necessary to develop the ratings curve correlating stage to discharge. Following development of the ratings curve, a simple stilling well and pressure transducer with data logger can be used to evaluate state on a frequent basis.
- Streamflow measurements will be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. – Measurement of Stage Discharge* (Rantz et al., 1982a) and *Volume 2. – Computation of Discharge* (Rantz et al., 1982b). This methodology is currently being used by both USGS and DWR for existing streamflow monitoring throughout the State.

Data Reduction, Validation, and Reporting

After field personnel have completed collection of groundwater level measurements and river stage (if appropriate), data should be entered into the Delta-Mendota Subbasin coordinated DMS as soon as possible. Each GSA member agency is responsible for collecting the appropriate groundwater and surface water level data during the designated seasonal high and seasonal low time periods (as designated in **Section 7.2.5.1.3**) and supplying the resultant data to the GSA Lead for compilation and a QA/QC review to avoid data entry mistakes. The GSA Lead then submits the compiled data to the GSP Representative for compilation at the GSP level. The GSP Representative will compile the GSA-level data into standard forms for uploading to the Subbasin DMS using import wizards and checks that data has been uploaded correctly. All data is to be updated by October 31 each year for inclusion in the annual report. SLDMWA, as Plan Administrator, then reviews data uploaded by all six Delta-Mendota GSP Groups prior to compilation at the Subbasin level for annual reporting. Should a measurement appear suspicious, a second confirmation reading shall be obtained as soon as possible.

For river discharge and stage data collected from publicly available sources as well as local gauges, a visual check of the data will be performed to ensure that the reported value matches stream conditions. The same protocol will be taken to enter stream-related data into the Subbasin coordinated DMS as for groundwater level data.

7.2.5.6.3 Frequency and Timing of Monitoring

Since groundwater levels are being used as a proxy for monitoring depletions of interconnected surface water, the frequency and timing of monitoring events can be found in **Section 7.2.5.1.3**. Publicly available stream gauge data, such as from the USGS's National Water Information System (NWIS) and DWR's California Data Exchange Center (CDEC), will be paired with groundwater level and extraction data to evaluate for any significant and sustained change in gradient between monitoring wells and the San Joaquin River, potentially indicating a significant and unreasonable loss of interconnected surface water as a result of groundwater extractions.

As described in **Chapter 6** *Sustainable Management Criteria*, the first 5-year interim goal is to establish numeric minimum thresholds, measurable objectives, and subsequent interim milestones for the depletion of interconnected surface water sustainability indicator. Prior to the 5-Year GSP Update, the frequency and timing of depletion of interconnected surface water monitoring will be evaluated and refined to better understand the timing and quantity of depletions (if any) from the San Joaquin River.

7.2.5.6.4 Spatial Density

In the absence of spatial density guidelines or recommendations contained within DWR's *Monitoring Networks and Identification of Data Gaps BMP* (2016a) for the depletions of interconnected surface water monitoring network, professional judgement was used along with available data and monitoring locations to determine the appropriate density of monitoring sites. Only two well sites were available for inclusion in the monitoring network based on the groundwater level well criteria described in **Section 7.2.5.1.1** and located within approximately three miles of the river or as appropriate for the flow regime. DWR's *Monitoring Networks and Identification of Data Gaps BMP* (2016a) recommends GSPs identify and quantify both timing and volume of groundwater pumping within approximately three miles of the stream or as appropriate for the flow regime.

Stream gauge data to be paired with groundwater elevation data will be collected from publicly available data sources, such as USGS's NWIS and DWR's CDEC, and local data as available. Future efforts will be made to evaluate the spatial density and location of stream gauges for assessing the depletions of interconnected surface water sustainability indicator, and a plan to fill this data gap will be evaluated during the five-year GSP updates.

7.2.5.6.5 Data Gaps

Depletions of interconnected surface water data gaps exist in areas where data are limited both spatially and temporally. The entire area along the San Joaquin River within the Northern Delta-Mendota Region is considered to be a data gap for the depletions of interconnected surface water monitoring network. The absence of known well locations within approximately three miles of the San Joaquin River is the primary driver currently limiting monitoring of the depletions of interconnected surface water sustainability indicator, as groundwater levels and potential changes in gradient between wells and the stream stage are used as proxy for monitoring this sustainability indicator.

Temporal data gaps exist at individual and across well sites throughout the Northern Delta-Mendota Region. This is due to a multitude of reasons including limited monitoring locations, historical differences in the timing of collected measurements, well or stream gauge construction date, and ability to access the well site or stream gauge.

7.2.5.6.6 Plan to Fill Data Gaps

For the purpose of monitoring for depletions of interconnected surface water where groundwater levels are used as an interim proxy, the locations of five (5) clustered or nested wells with proposed locations in the Plan area have been identified for new construction with funding provided through DWR's SGMA Implementation Grant awarded in 2022 (**Figure 7-7**). Any new monitoring wells will be installed in accordance with guidance provided in DWR's *Monitoring Networks and Identifications of Data Gaps BMP* (2016a) and will be paired with a nearby stream gauge where possible. While there are no current plans to include supplemental stream gauges beyond those available through publicly available data sets or local gauges, an assessment will be made prior to the 5-Year Update to this GSP to determine if data gaps exist within existing stream gauge networks and guidance provided in DWR's *Monitoring Networks and Identification of Data Gaps BMP* (2016a) will be used to install additional gauges, if required.

While past temporal data gaps cannot be rectified, future temporal data gaps can be prevented or reduced by ensuring proper sampling and data management protocols are followed, as detailed in **Sections 7.2.5.6.2** and **7.2.5.6.3** and in DWR's *Monitoring Protocols, Standards, and Sites* BMP (2016b) for streamflow measuring protocols.

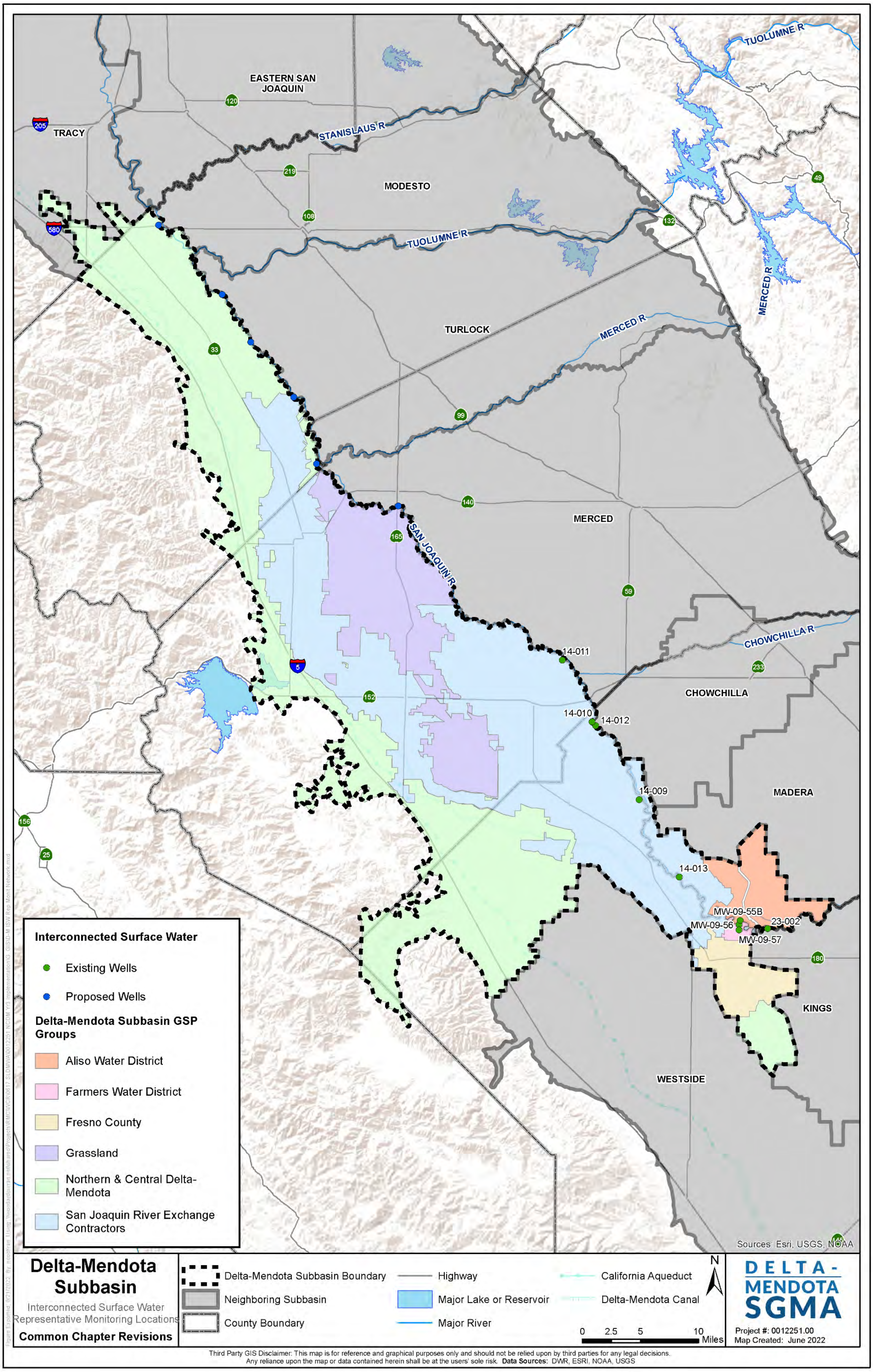

Figure 7-7. Proposed Depletions of Interconnected Surface Water Monitoring Sites

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7.3 REFERENCES

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Section 8

Plan Implementation

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8. PLAN IMPLEMENTATION

8.1 PLAN IMPLEMENTATION

Implementation of this Groundwater Sustainability Plan (GSP) includes implementation of the projects and management actions included in **Chapter 7**, as well as the following:

- Groundwater Sustainability Plan implementation, administration, and management
- Implementation of the monitoring program described in **Chapter 7** of this GSP
- Annual Reporting
- Five-year assessment reports, also referred to as 5-Year Updates to this GSP

This chapter also describes the contents of both the annual reports and five-year assessment reports that must be provided to the California Department of Water Resources (DWR) as required by Sustainable Groundwater Management Act (SGMA) regulations.

8.1.1 Implementation Schedule

Figure 8-1 illustrates the implementation schedule for this GSP through 2025. Included in the chart are activities necessary for ongoing GSP monitoring and updates, as well as tentative schedules for the anticipated projects and management actions, to the first interim goal. Additional details about the activities included in the schedule are provided in the respective sections of this GSP. Adaptive management actions will only be implemented if the GSP interim goals, as described in **Chapter 6** *Sustainable Management Criteria*, are not being met.

8.2 IMPLEMENTATION COSTS AND FUNDING SOURCES

Northern and Central Delta-Mendota Regions Groundwater Sustainability Agencies (GSAs) operations and GSP implementation will incur costs which will require funding by the individual entities comprising the GSAs. The five primary activities that will incur costs include:

- Implementing the GSP
- Implementing GSP-related projects and management actions
- GSA and Plan Administrator operations
- Annual data collection, analysis, and reporting
- Developing five-year assessment reports

Table 8-1 summarizes these activities and their estimated costs, where some costs and associated activities will be undertaken by each Northern and Central Delta-Mendota Regions GSAs as well as San Luis & Delta-Mendota Water Authority (SLDMWA). Costs are subject to change based on whether GSAs, SLDMWA, or consulting staff conduct each activity. Costs associated with implementing GSP-related projects and management actions are included in **Section 7.1** *Projects and Management Actions* of the *Sustainability Implementation* chapter.

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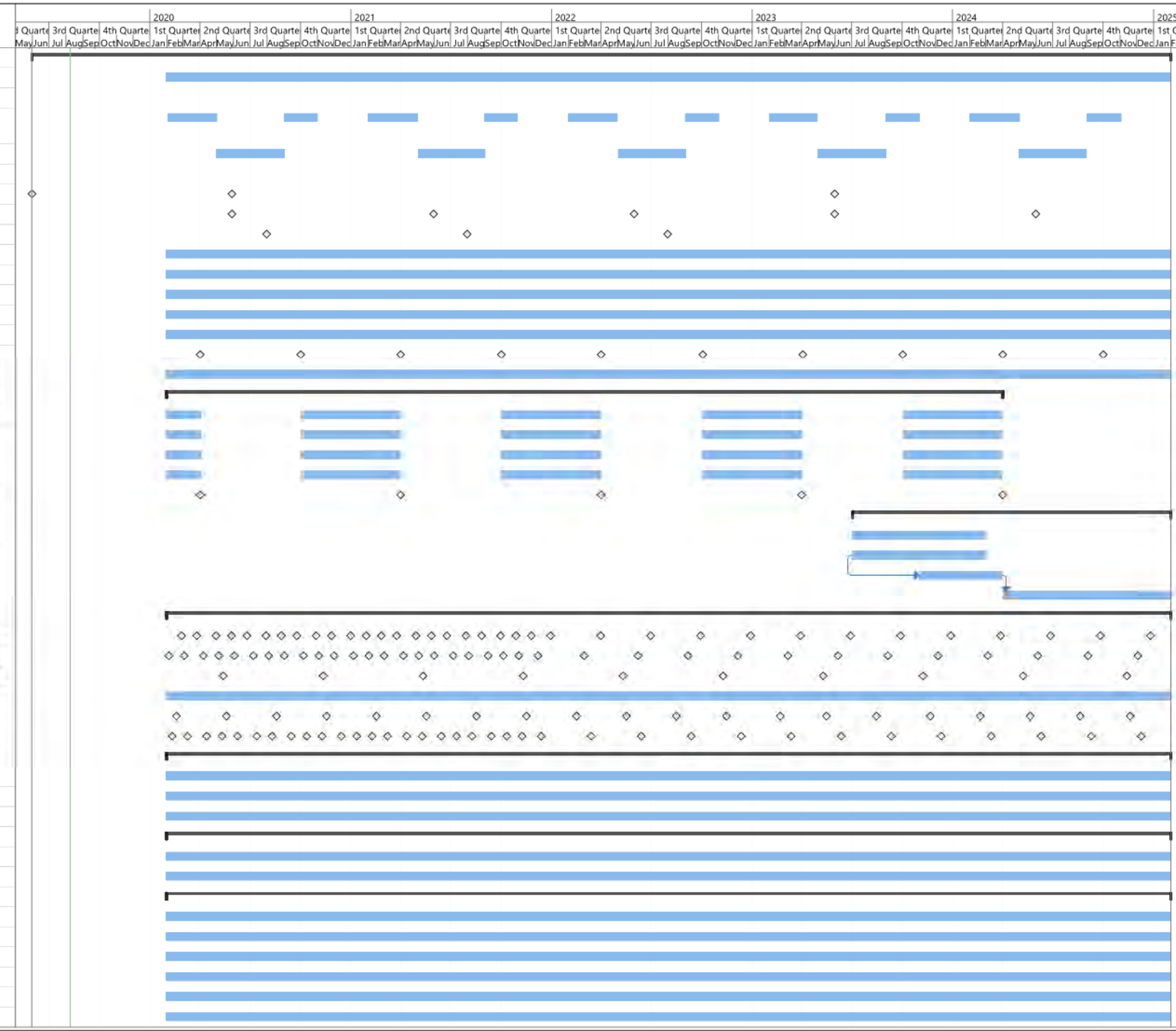
Task Name	Duration	Start	Finish
Task 1: Monitoring Program	**1481 days**	**Fri 5/31/19**	**Fri 1/31/25**
Coordination with Monitoring Entities	1306 days	Fri 1/31/20	Fri 1/31/25
Data Field Collection	1416 days	Fri 5/31/19	Fri 11/1/24
Groundwater Levels and Interconnected Surface Water	1240 days	Mon 2/3/20	Fri 11/1/24
Groundwater Quality	1131 days	Fri 5/1/20	Fri 8/30/24
Subsidence	1305 days	Fri 5/31/19	Fri 5/31/24
WSID-PID Management Area	1043 days	Fri 5/31/19	Wed 5/31/23
TRID Management Area	1045 days	Fri 5/29/20	Fri 5/31/24
Remaining GSP Area	521 days	Fri 7/31/20	Sun 7/31/22
Monitoring Data Quality Control and Analysis	1306 days	Fri 1/31/20	Fri 1/31/25
Oversight and Coordination of Monitoring	1306 days	Fri 1/31/20	Fri 1/31/25
Monitoring Network Maintenance	1306 days	Fri 1/31/20	Fri 1/31/25
Data Gap Tracking	1306 days	Fri 1/31/20	Fri 1/31/25
Local Monitoring	1306 days	Fri 1/31/20	Fri 1/31/25
Lab Testing	1174 days	Wed 4/1/20	Tue 10/1/24
Training	1306 days	Fri 1/31/20	Fri 1/31/25
Task 2: Annual Reporting and Analysis	**1086 days**	**Fri 1/31/20**	**Mon 4/1/24**
Water Levels	1086 days	Fri 1/31/20	Fri 3/29/24
Change in Storage	1086 days	Fri 1/31/20	Fri 3/29/24
Water Quality	1086 days	Fri 1/31/20	Fri 3/29/24
Subsidence	1086 days	Fri 1/31/20	Fri 3/29/24
Annual Report Documentation	1043 days	Wed 4/1/20	Mon 4/1/24
Task 3: 5-Year Update	**415 days**	**Mon 7/3/23**	**Fri 1/31/25**
Threshold Evaluation and Updating	174 days	Mon 7/3/23	Thu 2/29/24
Numerical Model Updates and Coordination	174 days	Mon 7/3/23	Thu 2/29/24
Evaluation of intial GSP Effectiveness	108 days	Wed 11/1/23	Fri 3/29/24
Plan to Improve GSP	219 days	Tue 4/2/24	Fri 1/31/25
Task 4: Coordination	**1306 days**	**Fri 1/31/20**	**Fri 1/31/25**
Advisory Committee Meeting Support	1260 days	Thu 2/27/20	Thu 12/26/24
GSA Board Meeting Support	1260 days	Tue 2/4/20	Tue 12/3/24
Public Outreach	1175 days	Wed 5/13/20	Wed 11/13/24
Website Maintenance	1306 days	Fri 1/31/20	Fri 1/31/25
Interbasin Coordination	1240 days	Tue 2/18/20	Tue 11/19/24
Intrabasin Coordination	1260 days	Mon 2/10/20	Mon 12/9/24
Task 5: Data Management System Maintenance	**1306 days**	**Fri 1/31/20**	**Fri 1/31/25**
Data Quality Control	1306 days	Fri 1/31/20	Fri 1/31/25
Data Management System Cleanup/Maintenance	1306 days	Fri 1/31/20	Fri 1/31/25
Task 6: Budget Schedule and Monitoring	**1306 days**	**Fri 1/31/20**	**Fri 1/31/25**
Task 7: Grant Tracking and Administration	**1306 days**	**Fri 1/31/20**	**Fri 1/31/25**
Grant Tracking and Pursuit	1306 days	Fri 1/31/20	Fri 1/31/25
Grant Administration	1306 days	Fri 1/31/20	Fri 1/31/25
Task 8: General Administration	**1306 days**	**Fri 1/31/20**	**Fri 1/31/25**
Accounting	1306 days	Fri 1/31/20	Fri 1/31/25
Auditing	1306 days	Fri 1/31/20	Fri 1/31/25
Document Management	1306 days	Fri 1/31/20	Fri 1/31/25
General Staff Oversight	1306 days	Fri 1/31/20	Fri 1/31/25
Contract Management	1306 days	Fri 1/31/20	Fri 1/31/25
Task 9: Legal Support	**1306 days**	**Fri 1/31/20**	**Fri 1/31/25**



Project: Implementation Schedule, Northern & Central Delta-Mendota GSP
Date: 2020-2025

Task | Summary | Milestone

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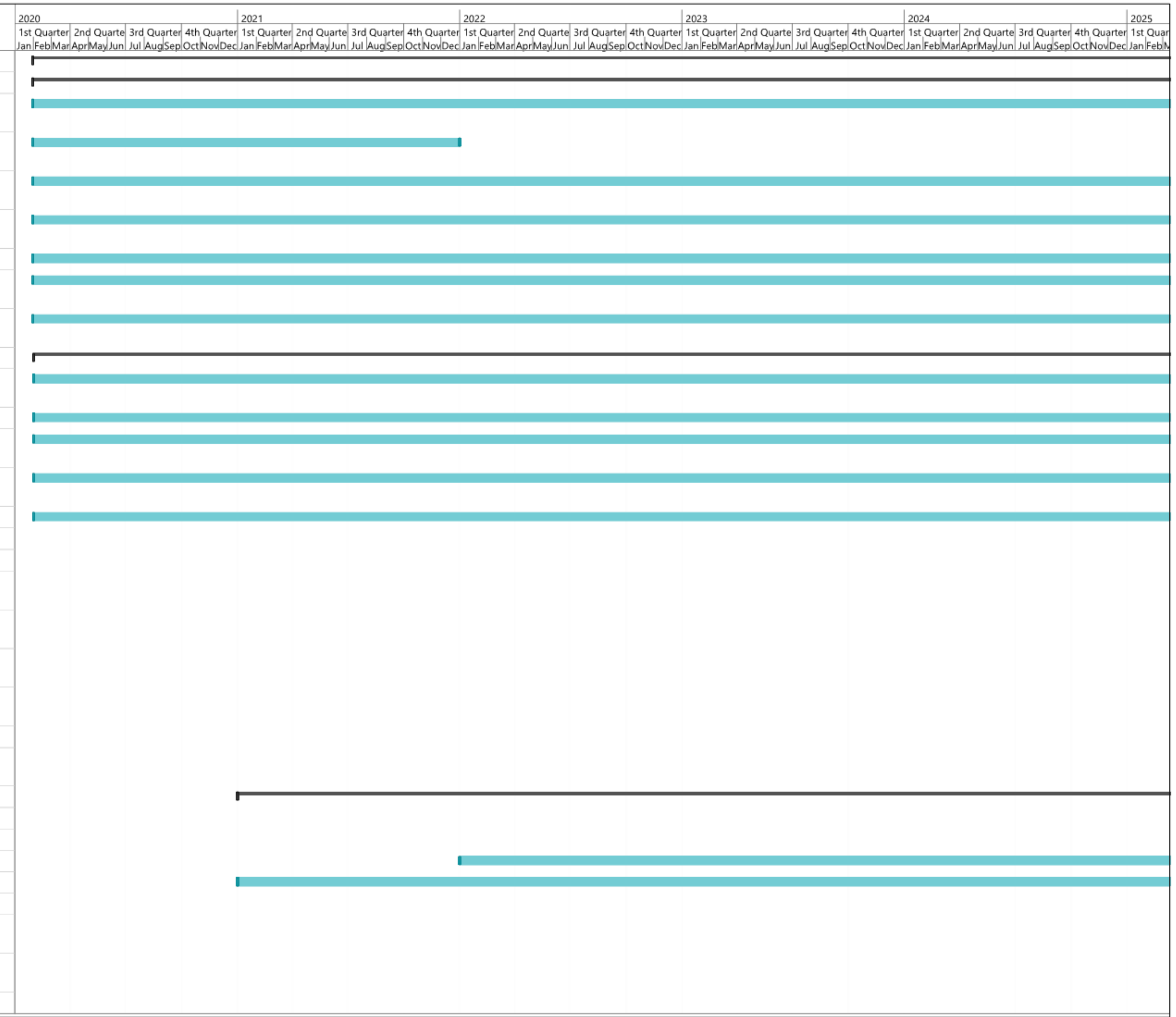
Figure 8-1. Implementation Schedule

Task Name	Duration	Start	Finish
Projects and Management Actions	**5457 days**	**Fri 1/31/20**	**Mon 12/31/40**
Tier 1 Projects	**1544 days**	**Fri 1/31/20**	**Wed 12/31/25**
Los Banos Creek Recharge and Recovery Project	1544 days	Fri 1/31/20	Wed 12/31/25
Orestimba Creek Recharge and Recovery Project	501 days	Fri 1/31/20	Fri 12/31/21
North Valley Regional Recycled Water Program (NVRRWP)	1544 days	Fri 1/31/20	Wed 12/31/25
City of Patterson Percolation Ponds for Stormwater Capture and Recharge	1544 days	Fri 1/31/20	Wed 12/31/25
Kaljian Drainwater Reuse Project	1544 days	Fri 1/31/20	Wed 12/31/25
West Stanislaus Irrigation District Lateral 4-North Recapture and Recirculation Reservoir	1544 days	Fri 1/31/20	Wed 12/31/25
Revision to Tranquillity Irrigation District Lower Aquifer Pumping	1544 days	Fri 1/31/20	Wed 12/31/25
Tier 1 Management Actions	**1543 days**	**Sat 2/1/20**	**Wed 12/31/25**
Lower Aquifer Pumping Rules for Minimizing Subsidence	1544 days	Sat 2/1/20	Wed 12/31/25
Maximize Use of Other Water Supplies	1544 days	Sat 2/1/20	Wed 12/31/25
Increasing GSA Access to and Input on Well Permits	1544 days	Sat 2/1/20	Wed 12/31/25
Drought Contingency Planning in Urban Areas	1544 days	Sat 2/1/20	Wed 12/31/25
Fill Data Gaps	1544 days	Sat 2/1/20	Wed 12/31/25
Tier 2 Projects	**1827 days**	**Thu 1/1/26**	**Fri 12/31/32**
Del Puerto Canyon Reservoir Project	261 days	Tue 1/1/30	Tue 12/31/30
Little Salado Creek Groundwater Recharge and Flood Control Basin	261 days	Thu 1/1/26	Thu 12/31/26
Patterson Irrigation District Groundwater Bank and/or Flood-MAR-type Project	262 days	Thu 1/1/32	Fri 12/31/32
West Stanislaus Irrigation District Lateral 4-South Recapture and Recirculation Reservoir	1304 days	Thu 1/1/26	Tue 12/31/30
Ortigalita Creek Groundwater Recharge and Recovery Project	1304 days	Thu 1/1/26	Tue 12/31/30
Tier 2 Management Actions	**22 days**	**Thu 1/1/26**	**Sat 1/31/26**
Develop Program to Incentivize Use of Surface Water and Reduce Groundwater Demand	23 days	Thu 1/1/26	Sat 1/31/26
Tier 3 Projects	**5217 days**	**Fri 1/1/21**	**Mon 12/31/40**
Pacheco Reservoir Expansion	2870 days	Tue 1/1/30	Mon 12/31/40
Raising San Luis Reservoir	2870 days	Tue 1/1/30	Mon 12/31/40
Sites Reservoir	2087 days	Sat 1/1/22	Mon 12/31/29
Los Vaqueros Expansion Phase 2	5217 days	Fri 1/1/21	Mon 12/31/40
Tier 3 Management Actions	**3652 days**	**Fri 1/1/27**	**Mon 12/31/40**
Groundwater Extraction Fee with Land Use Modifications	3652 days	Fri 1/1/27	Mon 12/31/40
City of Patterson Reduced Groundwater Use Portfolio	3652 days	Fri 1/1/27	Mon 12/31/40
Rotational Fallowing of Crop Lands	3652 days	Fri 1/1/27	Mon 12/31/40



Project: Implementation Schedule, Northern & Central Delta-Mendota GSP
Date: 2020-2025

Summary — Manual Task

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Figure 8-1. Implementation Schedule (continued)

Table 8-1. Northern & Central Delta-Mendota Region GSP Estimated Implementation Costs

Activity	Estimated Cost	Assumptions
Monitoring Program		
Coordination with Monitoring Entities	$74,000 annually	Coordination with GSAs or member agencies at the GSP-level
Data Field Collection	$136,000 annually	Completed by SLDMWA with consultant support as requested to perform their monitoring activities; Includes two (2) days of field work for water levels per year, one (1) day of field work for water quality per year, and one (1) day of field work for subsidence per year
Monitoring Data Quality Control and Analysis	$53,000 annually	Data collection and entry from local entities and performing quality control on collected data
Oversight and Coordination of Monitoring	$44,000 annually	Staff oversight and scheduling with local and contract labor
Monitoring Network Maintenance	$22,000 annually	As needed
Data Gap Tracking	$51,000 annually	Tracking of ongoing studies and data collection by other entities and programs
Local Monitoring	$52,000 annually	Data collection and reporting to the GSP-level
Lab Testing	$31,000 annually	Sending water quality samples to the lab and associated chain of custody; Includes annual water quality sampling.
Training	$38,000 annually	Training for new employees or skills
Annual Reporting and Analysis		
Water Levels	$27,000 annually during years with no 5-Year Update	Tracking relative to sustainability indicators and associated thresholds, which include data analysis, tracking trends, and reporting to SLDMWA (Plan Manager)
Change in Storage	$27,000 annually during years with no 5-Year Update	
Water Quality	$27,000 annually during years with no 5-Year Update	
Subsidence	$27,000 annually during years with no 5-Year Update	
Annual Report Documentation	$67,000 annually during years with no 5-Year Update	
5-Year Update		
Threshold Evaluation and Updating	$238,000 every five years (across two years to develop)	
Numerical Model Updates and Coordination	$390,000 every five years (across two years to develop)	Includes model runs and refinement
Evaluation of Initial GSP Effectiveness	$284,000 every five years (across two years to develop)	
Plan to Improve GSP	$284,000 every five years (across two years to develop)	

Activity	Estimated Cost	Assumptions
Coordination		
Advisory Committee Meeting Support	$49,000 annually	Monthly meetings for first two (2) years (2020 and 2021) then, then quarterly thereafter and associated preparation by SLDMWA staff or consultant
GSA Board Meeting Support	$18,000 annually	Monthly meetings for first two (2) years (2020 and 2021) then, then quarterly thereafter and associated preparation by SLDMWA staff or consultant
Public Outreach	$46,000 annually	For modifications and re-adoption of the GSP; Supporting fee development, promote compliance with program, etc.; Includes two (2) public meetings per year
Website Maintenance	$9,000 annually	
Interbasin Coordination	$85,000 annually	Quarterly meetings; Includes consultation with legal support
Intrabasin Coordination	$73,000 annually	Monthly meetings for first two years (2020 and 2021), then quarterly thereafter; Includes consultation with legal support
Regulatory Tracking and Enforcement	$76,000 annually	Oversight by Plan Manager to ensure efforts are staying on Plan
Data Management System (DMS) Maintenance		
Data Quality Control	$45,000 annually	
DMS Cleanup/Maintenance	$24,000 annually	
Budget and Schedule Monitoring	$53,000 annually	
Grant Tracking and Administration		
Grant Tracking and Pursuit	$9,000 annually	Includes tracking grant programs and writing two (2) Requests for Proposals per year; Does not include grant application writing
Grant Administration	$129,000 annually	
General Administration		
Accounting	$15,000 annually	SLDMWA expenses related to GSP implementation, annual reporting, and 5-Year Update
Auditing	$6,000 annually	
Document Management	$7,000 annually	
General Staff Oversight	$47,000 annually	
Contract Management	$3,000 annually	
Legal Support	$88,000 annually	For litigation, Joint Powers Authority (JPA) formation, and coordination with outside counsel
Total - during Annual Report years (2020-2024)	**$1,458,000 annually**	
Total - during 5-Year Update years (2024-2025)	**$2,479,000 annually**	

8.2.1 GSP Implementation and Funding

Costs associated with GSP implementation and Northern and Central Delta-Mendota Regions GSAs and Plan Administrator operations include the following:

- **GSP-associated administration:** Overall program management and coordination activities
- **Stakeholder/Board engagement:** Monthly Northern and Central Delta-Mendota Activity Agreement Management Committee meetings for first two (2) years, then quarterly thereafter; monthly Delta-Mendota Subbasin Coordination Committee meetings for first two (2) years, then quarterly thereafter; and semi-annual public workshops
- **Outreach:** Email communications, newsletters, and website management
- **GSP implementation program management:** Program management and oversight of project and management action implementation, including coordination among GSAs, Plan Administrator staff and stakeholders, coordination of GSA implementation technical activities, oversight and management of consultants, budget tracking, schedule management, and quality assurance/quality control of project implementation activities
- **Monitoring:** Groundwater level monitoring, groundwater quality monitoring, and land surveying at subsidence benchmarks; collect publicly available subsidence monitoring data and stream gauge data; conduct quality control checks on and manage data; summarize and/or estimate other data sets required for annual reporting
- **Data Management:** Ongoing management of Data Management System (DMS), including data uploads and system improvements

Implementation of this GSP is projected to run between approximately $1.5 million and $2.5 million per year, with projects and management actions adding an additional $6.6 million to $40 million per year over the 20-year planning horizon. Development of this GSP (and the other five Delta-Mendota Subbasin GSPs) was funded through a Proposition 1 Sustainable Groundwater Planning Grant along with contributions from Subbasin GSA member agencies. Although implementation of this GSP is anticipated to require contributions from the GSAs it represents (and whom are funded through water rates, property taxes, or other public funds), additional funding may be required to implement the GSP. Funding through grants or loans have varying levels of certainty and may be available for some GSP implementation activities (including project implementation). As such, the Northern and Central Delta-Mendota Regions GSAs may choose one or more of the following financing approaches to supplement anticipated GSP implementation costs:

- **Assessments:** Assessments could be levied using a fee-based assessment on land area or irrigated acreage. Two possible methods for implementing an assessment based on acreage include assessing a fee for all acres in the Plan area (approximately 316,000 acres). Under this scenario, to fund the GSP implementation, assessments would range between approximately $5 and $8 per acre per year and this assessment would not distinguish between land use types. A second option would be to assess a fee only on irrigated acres (approximately 197,000 acres during the current conditions water year [2013]). This type of assessment (based on irrigated acreage) would range between $8 and $13 per acre per year. An assessment solely on irrigated acreage could affect agricultural operations and contribute to land use conversions, which could, in turn, affect the overall assessment amount.
- **Pumping Fees:** Pumping fees are typically a charge for pumping that would be used to fund GSP implementation activities. In the absence of other sources of funding (i.e., grants, loans, or combined with assessments), fees would range between $11 and $25 per acre-foot (AF) of water pumped per year (based on projected baseline pumping on an average annual basis from 2020 to 2025 and 2020 to 2070, respectively). To meet the funding needs of the GSP, a tiered approach may be used where fees would be lower when groundwater elevations are higher, and be more when groundwater elevations are lower to encourage conservation or a modified fee structure implemented based on the type of pumping (domestic vs agricultural vs municipal).

- **Combination of fees and assessments:** This approach would combine pumping fees and assessments to moderate the effects of either approach on the economy in the Northern & Central Delta-Mendota Region GSP. This approach would likely include an assessment that would apply to all acres within the Plan area, rather than just to irrigated acreage (thereby accounting for a shared regulatory compliance cost), coupled with a pumping fee to account for those properties that extract more groundwater than others.

Ultimately, it will be up to the individual GSAs to determine the means by which they achieve both the Delta-Mendota Subbasin sustainability goal and financial goals for GSP implementation. However, prior to implementing any fee or assessment program, the Northern & Central Delta-Mendota Region GSP Group should agree on the approach, which may include completion of a rate assessment study and other analyses consistent with the requirements of Proposition (Prop) 218, Prop 26, and/or other California regulations, in order to facilitate the public review process across the GSP Plan area.

If grants or loans are secured for project implementation, potential pumping fees and assessments may be adjusted to align with operating costs of ongoing GSP implementation activities. Potential grant or low-interest loan programs that may be used for GSP implementation are summarized in **Table 8-2** along with an assessment of their respective certainty that the funding source could be obtained to help finance GSP implementation.

Table 8-2. Potential Funding Sources for GSP Implementation

Funding Source	Certainty
Ratepayers (within Project Proponent service area or area of project benefit)	**High** – User rates pay for operation and maintenance (O&M) of a utility's system. Depends upon rate structure adopted by the project proponent and the Prop 218 rate approval process, which is dependent upon the structure of the GSA and its authority to collect rates from users. Can be used for project implementation as well as project O&M.
General Funds or Capital Improvement Funds (of Project Proponents)	**High** – General or capital improvement funds are set aside by agencies to fund general operations and construction of facility improvements. Depends upon agency approval.
Special taxes, assessments, and user fees (within Project Proponent service area or area of project benefit)	**High** - Monthly user fees, special taxes, and assessments can be assessed by some agencies should new facilities directly benefit existing customers. Depends upon the rate structure adopted by the project proponent and the Prop 218 rate approval process, which is dependent upon the structure of the GSA and its authority to collect taxes/assessments/fees from users.
Clean Water State Revolving Fund (CWSRF) Loan Program administered by the California State Water Resources Control Board (SWRCB)	**Medium** – Historically, the SWRCB has had $200 to $300 million available annually for low-interest loans (typically ½ of the General Obligation Bond Rate) for water recycling, wastewater treatment, and sewer collection projects. During recent years, available funding has become limited due to high demand. Success in securing a low-interest loan depends on demand of the CWSRF Program and available funding. Applications are accepted on a continuous basis. SWRCB prepares a fundable list for each fiscal year. In order to receive funding, a project must be on the fundable list. Full applications must be submitted by the end of the calendar year to be considered for inclusion on the following year's fundable list.

Funding Source	Certainty
Water Recycling Funding Program (WRFP) – Planning and Construction Grants from SWRCB	**High** (planning) / **Low** (construction) – WRFP grants are funded by Prop 1, as well as the general CWSRF Program. Planning grants (for facilities planning) are available and can fund 50% of eligible costs, up to $75,000. Construction grants have been exhausted. Low-interest loans through the CWSRF program are available and while limited, recycled water projects receive priority over wastewater projects (which are also eligible under CWSRF, the umbrella program for the WRFP).
Drinking Water State Revolving Fund Loan Program administered by the SWRCB Division of Drinking Water	**High** – Approximately $100 to $200 million is available on an annual basis for drinking water projects. Low-interest loans are available for project proponents should they decide to seek financing. Funding has become more limited; however, applicants are encouraged to apply.
Water & Waste Disposal Loan & Grant Program in California administered by the United States Department of Agriculture (USDA), Rural Development	**High** – Long-term, low-interest loans and grants available to fund clean and reliable drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage to household and businesses in eligible rural areas (areas or towns with populations of 10,000 or less). Funds may be used to finance the acquisition, construction, or improvement of drinking water sourcing, treatment, storage, and distribution as well as storm water collection, transmission, and disposal, for example Eligible applicants include most state and local governmental entities, private nonprofits, and federally-recognized tribes. Applications are accepted year-round.
Community Facilities Direct Loan & Grant Program in California administered by USDA, Rural Development	**High** – Low interest direct loans and grants available to provide affordable funding to develop essential community facilities in rural areas. An essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area and does not include private, commercial, or business undertakings. Funding priorities include small communities with a population of 5,500 or less and low-income communities having a median household income below 80% of the state nonmetropolitan median household income.
Infrastructure State Revolving Fund Loan Program administered by the California Infrastructure and Economic Development Bank (I-Bank)	**High** – Low-interest loans are available from I-Bank for infrastructure projects (such as water distribution). Maximum loan amount is $25 million per applicant. Applications are accepted on a continuous basis.
Title XVI Water Recycling and Reclamation / Water Infrastructure Improvements for the Nation (WIIN) Program – Construction Grants administered by the United States Bureau of Reclamation (USBR)	**Medium** – Grants up to 25% of project costs or $20 million, whichever is less, are available from USBR for water recycling projects. A Title XVI Feasibility Study must be submitted to and approved by USBR to be eligible. USBR solicits grants annually.
WaterSMART Grant Programs administered by USBR	**Medium** – During Fiscal Year 2019, $34 million was appropriated to WaterSMART grant programs. Examples of WaterSMART grant programs include Water and Energy Efficient Grants and Small-Scale

Funding Source	Certainty
	Water Efficiency Projects. Both grant programs can help fund projects such as canal lining/piping, municipal metering, and supervisory control and data acquisition (SCADA) systems.
WaterSMART Title XVI Water Recycling and Reclamation Program – Feasibility Study Grants administered by USBR	**Low –** Grants up to $150,000 have been available in the past for preparation of Title XVI Feasibility Studies. It is possible future rounds may be administered.
Bonds	**Medium –** Revenue bonds can be issued to pay for capital costs of projects allowing for repayment of debt service over 20- to 30- year timeframe. Depends on the bond market and the existing debt of project proponents.
Integrated Regional Water Management (IRWM) implementation grants administered by DWR	**High** (San Joaquin River Funding Area) **/ Medium** (Tulare-Kern Funding Area) – The Westside-San Joaquin IRWM Region, the primary IRWM region overlapping the Delta-Mendota Subbasin, will pursue grant funding through the Prop 1, Round 1 IRWM Implementation Grants. Applications are expected to be due in Fall 2019 through late 2019, depending on the Funding Area. Approximately $28 million will be available in the San Joaquin River Funding Area and approximately $30 million will be available in the Tulare-Kern Funding Area over two rounds of grant awards.
Proposition 68 grant programs administered by various state agencies	**Medium** – Grant programs funded through Proposition 68, which was passed by California voters in June 2018, administered by various state agencies are expected to be applicable to fund GSP implementation activities. These grant programs are expected to be competitive, where $74 million has been set aside for Groundwater Sustainability statewide.
Disadvantaged Community (DAC) Involvement Program	**Medium** – The Westside-San Joaquin IRWM Region will receive funding through DWR's DAC Involvement Program for the San Joaquin River Funding Area (which was awarded a total of $3.1 million for the Funding Area as a whole) and the Tulare/Kern Funding Area (which was awarded a total of $3.4 million for the Funding Area). This funding has been secured by the respective Funding Areas. Funding may be used to help develop a project within the Westside-San Joaquin IRWM Region in order to advance it toward implementation. This program is not guaranteed to be funded in the future.

8.2.2 Projects and Management Actions

Costs for projects and management actions are described in **Chapter 7** of this GSP. Financing of the projects and management actions vary depending on the activity and timing. Potential financing for projects and management actions are provided in **Table 7-3** in **Section 7.1** *Projects and Management Actions*, though other financing may be pursued as opportunities arise or as appropriate.

8.3 ANNUAL REPORTS

Annual reports must be submitted by April 1st of each year following GSP adoption, per the GSP Emergency Regulations § 356.2 Annual Reports. Each of the six Delta-Mendota Subbasin GSP Groups will be responsible for compiling information relevant to annual reports for their respective GSP Group consistent with the GSP Emergency Regulations. San Luis & Delta-Mendota Water Authority, as Plan Administrator, will compile the annual report information received from each GSP Group for the submission of a single annual report for the Delta-Mendota Subbasin to DWR. Annual reports must include three key sections as follows:

- General Information
- Basin Conditions
- Plan Implementation Progress

A general outline of what information will be provided in each of these sections of the annual report is included below. Annual reporting would be completed in a manner and format consistent with § 356.2 of the GSP Emergency Regulations, including that the annual report covers the prior water year (October 1 to September 30).

At present, there is no specific format for annual reports as required by DWR. As annual reporting continues, it is anticipated that this outline will change to reflect State requirements, Subbasin conditions, and GSA priorities.

8.3.1 General Information

General information will include an executive summary that highlights the key content of the annual report. As part of the executive summary, this section will include a map of the Subbasin, description of the sustainability goal, and provide a description of GSP projects and their progress, as well as an annual update to the GSP implementation schedule. Key components as required by the GSP Emergency Regulations include:

- Executive Summary
- Map of the Basin

8.3.2 Subbasin Conditions

Subbasin conditions will describe the current groundwater conditions and monitoring results. This section will include an evaluation of how conditions have changed in the Subbasin over the previous year and compare groundwater data for the water year to historical groundwater data. Pumping data, effects of project implementation (e.g., recharge data, conservation, etc., if applicable), surface water flows, total water use, and groundwater storage will be included. Key components as required by the GSP Emergency Regulations include:

- Groundwater elevation data from the monitoring network, including seasonal high and seasonal low contour maps for each principal aquifer
- Hydrographs of elevation data at representative monitoring locations
- Groundwater extraction data
- Surface water supply data by sector and source
- Total water use data
- Change in groundwater storage, including maps for each principal aquifer
- Subsidence rates and survey data

8.3.3 Plan Implementation Progress

Progress toward successful Plan implementation will be included in the annual report. This section of the annual report will describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key components as required by GSP Emergency Regulations include:

- Plan implementation progress, including any proposed changes to the Plan
- Progress toward the Subbasin sustainability goal

8.3.4 Data Handling and Coordinated Data Management System

As required in §352.6 Data Management System of the GSP Emergency Regulations, each GSA is required to develop and maintain a DMS that is capable of storing and reporting information relevant to the development or implementation of the GSP(s). Additionally, per §354.4 Reporting Monitoring Data to the Department, all monitoring data is to be stored in a DMS with copies of the monitoring data included in the annual report and submitted electronically on forms provided by DWR. Recognizing that GSP implementation, including annual reporting, will require some efforts at the subbasin level, the 23 GSAs overlying the Delta-Mendota Subbasin have chosen to develop a coordinated DMS that can be utilized by each GSP Group for management of their data, which will allow for the required compendium of data sets for preparation of Subbasin annual reports.

It will be the responsibility of each GSP Group and their respective GSA member agencies to conduct their monitoring programs and associated data collection, including data quality assurance and control, for ensuring that these data are available at the Subbasin-level for analysis in annual reports. **Figure 8-2** shows the general flow of data collected from the Delta-Mendota Monitoring programs. **Figure 8-3** shows the roles and responsibilities of each GSA and GSP Group in the collecting, processing, and reporting of data for the GSP monitoring networks. Additionally, it is the responsibility of each GSP Group, including their respective GSAs, to maintain the monitoring network and, as appropriate, revise and/or expand the monitoring networks to fill identified data gaps. For more information about monitoring networks in the Northern & Central Delta-Mendota Region GSP, refer to **Section 7.2** *Monitoring* of the *Sustainability Implementation* chapter.

8.3.4.1 DMS Development and Functionality

Leading up to the development of the Subbasin-wide DMS, the Delta-Mendota Subbasin GSP Groups used an ad hoc working group of the Delta-Mendota Subbasin Coordination Committee to develop a conceptual design for the DMS software requirements. Following the development of a conceptual design, the software vendor (Houston Engineering, Inc.) created wireframes to communicate the functionality of the DMS.

During the process of DMS development, the ad hoc working group developed data standards for each data type to make data aggregation at the Subbasin-level feasible. The DMS includes permissions and business rules so each Delta-Mendota GSP Group can upload data for only their GSP based upon usernames and roles. The GSP Groups are also not allowed to see data uploaded by other GSP Groups until all annual reporting has been completed, reviewed, and accepted by the Plan Manager.

The DMS developed for the Delta-Mendota Subbasin is a secured web-based application hosted on Amazon Web Services (AWS). The DMS focuses on five (5) core business requirements, which include: centralized data warehouse, security of data, permissioned-based access, data visualization, and reporting. Other goals of the DMS focus on improving data collection/aggregation processes, creating data standards, gaining efficiencies in reporting, and improving data sharing.

The coordinated Subbasin DMS is designed to aggregate data through import processes by GSP Groups to support data visualization and annual report generation. Underlying the web application is a relationship database used to store the information aggregated from GSP Groups across primary data types. These data types include groundwater extractions, surface water deliveries, groundwater storage, groundwater elevations, groundwater quality, interconnected surface water, and land subsidence. The web application functionality includes an embedded Geographic Information System (GIS) viewer, screens to view tables of time series data, and charting capabilities for hydrographs. The embedded GIS viewer contains functionality to store map layers such as reference data, GSA and GSP boundaries, and derived information such as groundwater elevation contours.

In order to facilitate data synthesis, the GSP Groups agreed on the following frequencies for monitoring data collection to be uploaded to the Subbasin-wide DMS:

- **For groundwater elevations –** Twice per year, with seasonal high groundwater elevation data collected between February and April, and seasonal low groundwater elevation data collected between September and October
- **For interconnected surface water –** Twice per year in conjunction with groundwater level monitoring
- **For groundwater quality –** Once per year during irrigation season, typically between May and August
- **For land subsidence/elevations –** Publicly available subsidence data will be used along with locally-collected data. At a minimum, three data points will be collected within the first five years of GSP implementation, with a baseline value from 2019 or a date prior to that.

Additionally, the GSP Groups will utilize agreed-upon monitoring protocols, which may be the same as, or equal to, data collection protocols (i.e. industry standards and best management practices) to ensure the collection of comparable data using comparable methods. The Northern and Central Delta-Mendota Regions have additionally agreed to use a more detailed monitoring protocol described in the Quality Assurance Program Plan (QAPP) included in **Appendix F** to ensure that the data were collected in a consistent and coordinated fashion.

In order to be able to track data by location, each monitoring location is assigned a unique identifier in the DMS. The number system is in a format of ##-####, where the first two digits indicates which GSA the monitoring location is associated with and the subsequent four digits indicate which specific monitoring location in that GSA area. As shown in **Figure 8-3**, the general methodology agreed upon for data import and management is as follows:

- Each GSA collects their respective data per agreed-upon monitoring protocols and transmits it to the GSA Representative.
- Each GSA Representative then compiles the data and conducts a quality control check.
- The GSA Representative then transmits the compiled data set to the GSP Lead or Representative, who then aggregates the data from all GSAs and conducts a second quality control check.
- The GSP Lead or Representative then uploads the data set into the DMS using import wizards designed specifically for this process.
- The Subbasin Plan Manager then uses the data in the DMS to compile information as required for the annual report.

Compiled data sets from the DMS are then augmented with required maps generated externally to produce the required annual report. Mapping prepared outside the DMS are subsequently imported into the DMS as GIS files to ensure all data are kept in one place and to allow for access by GSAs and other Subbasin stakeholders.

The DMS will be maintained by the San Luis & Delta-Mendota Water Authority, while acting as the Plan Manager, with a contract with the software vendor for hosting, maintenance and future maintenance. Each GSP will pay a maintenance fee for the continued hosting and support of the Subbasin coordinated DMS.

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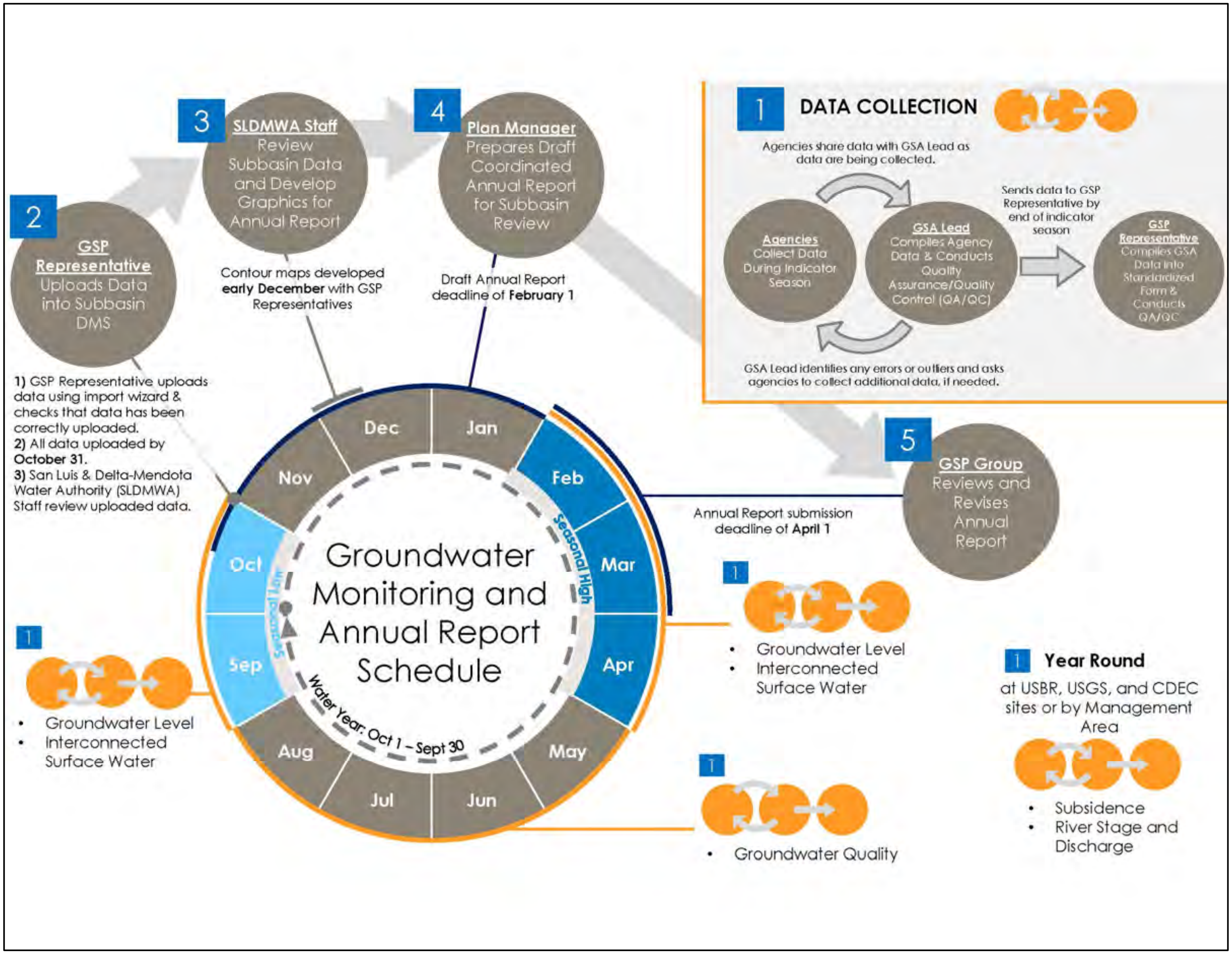

Figure 8-2. Data Flow in Delta-Mendota Subbasin

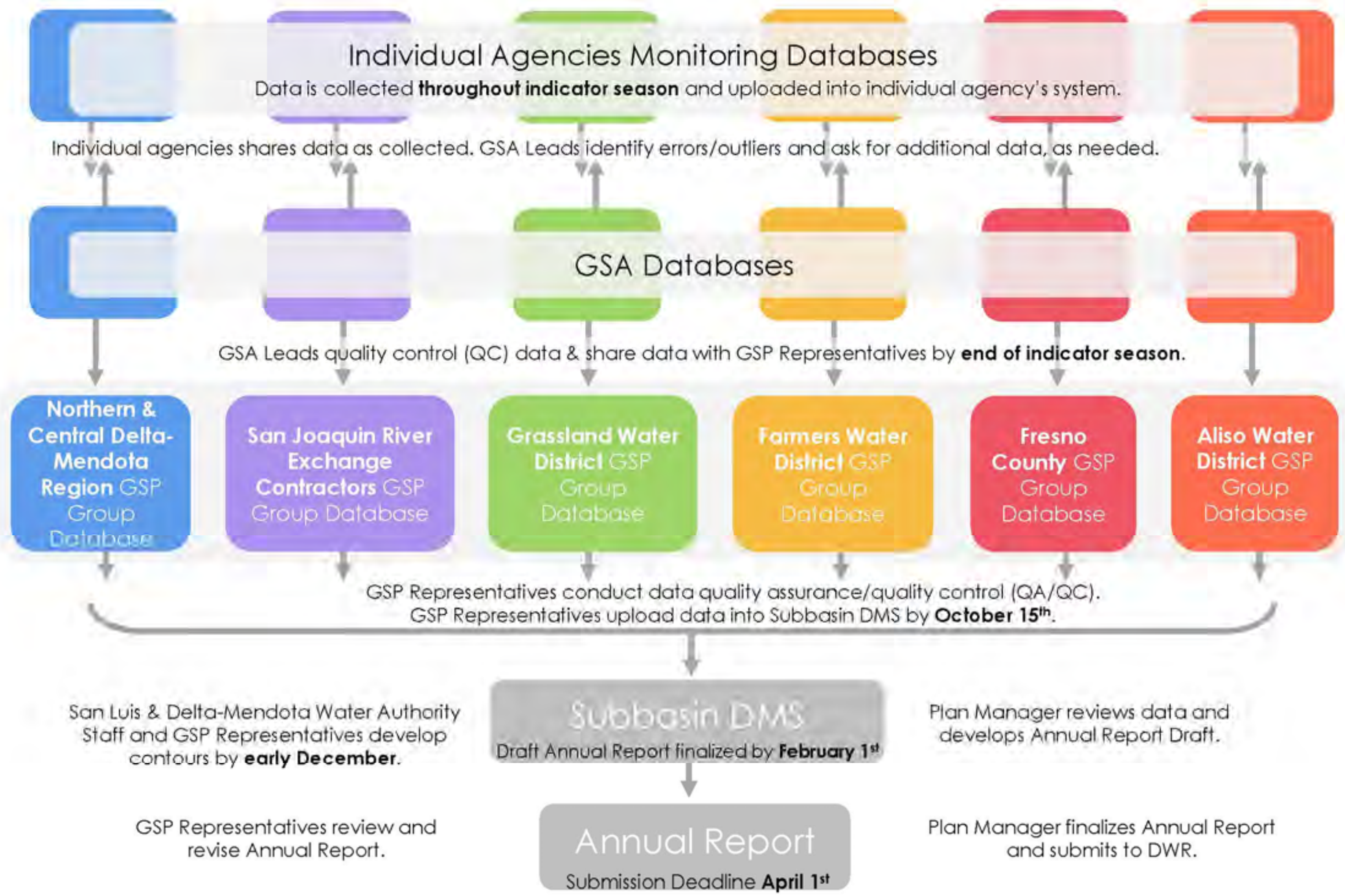

Figure 8-3. Delta-Mendota Subbasin Monitoring and Data Management Roles and Responsibilities

8.4 FIVE-YEAR ASSESSMENT REPORT

SGMA requires an evaluation of GSPs, assessing their progress toward meeting the approved Subbasin sustainability goal, at least every five years or sooner whenever the Plan is amended. SGMA also requires developing a written assessment and submittal of this assessment to DWR. A description of the information that will be included in the five-year assessment report (or periodic evaluation assessment report) and GSP update is provided in the subsequent subsections. All five-year assessment reports (5-Year updates) or periodic evaluation assessment reports will be prepared in a manner consistent with § 356.4 of the GSP Emergency Regulations.

8.4.1 Sustainability Evaluation

This section will contain a description of current groundwater conditions for each applicable sustainability indicator and will include a discussion of overall Subbasin sustainability. Progress toward achieving interim milestones and measurable objectives will be included, along with an evaluation of groundwater elevations (i.e., those being used as direct or proxy measures for the sustainability indicators) in relation to minimum thresholds. If any of the adaptative management triggers are found to be met during this evaluation, a plan for implementing adaptive management described in the GSP would be included.

8.4.2 Plan Implementation Progress

This section will describe the current status of project and management action implementation and report on whether any adaptive management action triggers had been activated since the previous 5-Year Plan update. An updated project implementation schedule will be included, along with any new projects developed to support the sustainability goal of the Subbasin and a description of any projects that are no longer included in the GSP. The effect on groundwater conditions resulting from projects or management actions that have been implemented will be included, and updates on projects and management actions that are underway at the time of the 5-Year Plan update will also be reported.

8.4.3 Reconsideration of GSP Elements

Part of the 5-Year GSP assessment will include a reconsideration of GSP elements. As additional monitoring data are collected during GSP implementation, land uses and community characteristics change over time, and GSP projects and management actions are implemented, it may become necessary to reconsider elements of this GSP and revise the Plan as appropriate. Plan elements to be reassessed may include Subbasin setting, management areas, undesirable results, minimum thresholds, and measurable objectives. If appropriate, the revised GSP completed at the end of the 5-year assessment period will include revisions informed by the outcomes of the monitoring network and changes in the Subbasin, including changes to groundwater uses or supplies and outcomes of project implementation. Additionally, if an evaluation of a GSP shows that the Subbasin is experiencing overdraft conditions or not on the path to achieving an interim goal, an assessment of measures to mitigate the condition will be included.

8.4.4 Monitoring Network Description

A description of the monitoring network will be provided in the 5-Year update to the GSP. Data gaps, or areas of the Subbasin that are not monitored in a manner commensurate with the requirements of Sections 352.4 and 354.34(c) of the GSP Emergency Regulations will be identified. An assessment of the monitoring network's function will also be provided, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a program for addressing these data gaps, along with an implementation schedule for addressing gaps and how the Delta-Mendota Subbasin GSP Groups will incorporate updated data into their respective GSPs. At this time, the Regions intend to develop a more detailed plan for addressing identified data gaps in 2020, including a scope of services and schedule for addressing those data gaps. This plan will be available upon request following completion.

8.4.5 New Information

New information that becomes available during the 5-year implementation period will be considered and incorporated into the 5-Year Plan assessment. If the new information should warrant a change to the GSP, this would also be included, as described in **Section 8.4.3**.

8.4.6 Regulations or Ordinances

The 5-Year assessment of GSP implementation will include a summary of the regulations or ordinances related to the GSP that have been implemented by DWR since the previous report and address how these may require updates to the GSP.

8.4.7 Legal or Enforcement Actions

Enforcement or legal actions taken by the Subbasin GSAs or their member agencies in relation to the GSP will be summarized in this section along with how such actions support sustainability in the Subbasin.

8.4.8 Plan Amendments

A description of amendments to the GSP will be provided in the 5-year Plan assessment, including adopted amendments, recommended amendments for future updates, and amendments that are underway during development of the 5-Year Update to the GSP.

8.4.9 Coordination

Ongoing coordination will be required by the GSAs comprising the Northern & Central Delta-Mendota Region GSP Group for plan implementation, in addition to coordination with other GSAs within the remaining five Delta-Mendota Subbasin GSP Groups, neighboring subbasins, and GSAs in neighboring subbasins. This section of the 5-year assessment report will describe coordination activities between these entities, such as meetings, joint projects, or data collection efforts. If additional neighboring GSAs have been formed, existing GSAs have been modified, or changes in neighboring basins have occurred since the previous report that result in a need for new or additional coordination within or outside the Subbasin, such coordination activities would also be included and discussed.

8.4.10 Reporting to Stakeholders and the Public

Any outreach activities associated with the GSP assessment and any resultant updates should be documented in this section of the 5-Year assessment report.

Section 9

References and Technical Studies

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9. TECHNICAL STUDIES

The following tables summarize the technical studies used in the development of the Northern & Central Delta-Mendota Region Groundwater Sustainability Plan (GSP). References used in developing the various sections of the GSP are summarized at the end of each GSP chapter.

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Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Groundwater Management Plan for the Northern Agencies in the Delta-Mendota Canal Service Area	AECOM	2011	https://water.ca.gov/LegacyFiles/lgagrant/docs/applications/City%20of%20Patterson%20(201209870076)/Att03_LGA12_CityofPatterson_GWMP_2of2.pdf		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Management Plan for the Southern Agencies in the Delta-Mendota Canal Service Area	AECOM	2011; rev 2014	https://water.ca.gov/LegacyFiles/groundwater/docs/GWMP/SJ-14_SanLuisDeltaMendotaWA-South_GWMP_2014.pdf		Chapter 2 - Plan Area
Delta-Mendota Subbasin Coordination Agreement	All Delta-Mendota Subbasin GSAs	2018			Chapter 3 - Governance & Administration
Water quality for agriculture	Ayers, R.S. and D.W. Westcot	1985	http://www.fao.org/docrep/003/T0234E/T0234E00.htm	Table 1 – Guidelines for Interpretations of Water Quality for Irrigation and Table 21 – Recommended Maximum Concentrations of Trace Elements in Irrigation Water. FAO Irrigation and Drainage Paper 29 Rev. 1	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions; Chapter 6 - Sustainable Management Criteria
Numeric simulation of ground-water flow in the central part of the Western San Joaquin Valley, California	Belitz, K, S.P. Phillips, and J.M. Gronberg	1993	https://doi.org/10.3133/wsp2396	U.S. Geological Survey Water-Supply Paper 2396, 69 p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Character and Evolution of Ground-Water flow System in the Central Part of the Western San Joaquin Valley, California	Belitz, K. and F.J. Heimes	1990	https://doi.org/10.3133/wsp2348	USGS WaterSupply Paper 2348	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Ground water in the Central Valley, California - A Summary Report	Bertoldi, G.L., R.H. Johnston, and K.D. Evenson	1991	https://doi.org/10.3133/pp1401A	U.S. Geological Survey Professional Paper 1401-A	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model and Section 5.3 Groundwater Conditions
Land Subsidence from Groundwater Use in California	Borchers, J.W. and M. Carpenter	2014	https://water.ca.gov/LegacyFiles/waterplan/docs/cwpu2013/Final/vol4/groundwater/13Land_Subsidence_Groundwater_Use.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Assembly Bill No. 1471 Water Quality, Supply, and Infrastructure Improvement Act of 2014	California Assembly	2014	https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1471	Approved by Governor, filed with Secretary of State in August 2014	Chapter 2 - Plan Area
Faults shapefiles	California Department of Conservation, California Geologic Survey	Various Dates	https://maps.conservation.ca.gov/cgs/#datalist		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
CDFW GIS Clearning House - California Lakes shapefile	California Department of Fish and Wildlife (CDFW)	2013	https://www.wildlife.ca.gov/Data/GIS/Clearinghouse		Maps in all GSP Chapters
CDFW GIS Clearning House - California Streams shapefile	California Department of Fish and Wildlife (CDFW)	2016	https://www.wildlife.ca.gov/Data/GIS/Clearinghouse		Maps in all GSP Chapters
Little Panoche Reservoir Wildlife Area: Description	California Department of Fish and Wildlife (CDFW)	2017	https://www.wildlife.ca.gov/Lands/Places-to-Visit/Little-Panoche-Reservoir-WA		Chapter 2 - Plan Area
Mendota Wildlife Area: Description	California Department of Fish and Wildlife (CDFW)	2017	https://www.wildlife.ca.gov/Lands/Places-to-Visit/Mendota-WA		Chapter 2 - Plan Area
North Grasslands Wildlife Area: Description	California Department of Fish and Wildlife (CDFW)	2017	https://www.wildlife.ca.gov/Lands/Places-to-Visit/North-Grasslands-WA		Chapter 2 - Plan Area
O'Neill Forebay Wildlife Area: Description	California Department of Fish and Wildlife (CDFW)	2017	https://www.wildlife.ca.gov/Lands/Places-to-Visit/ONeill-Forebay-WA		Chapter 2 - Plan Area
West Hilmar Wildlife Area: Description	California Department of Fish and Wildlife (CDFW)	2017	https://www.wildlife.ca.gov/Lands/Places-to-Visit/West-Hilmar-WA		Chapter 2 - Plan Area
CalWater 2.2.1 Watershed Boundaries shapefile	California Department of Forestry and Fire Protection	1999	http://frap.fire.ca.gov/data/frapgisdata-sw-calwater_download		Chapter 2 - Plan Area
The California Water Plan Update, Volumes 1 and 2	California Department of Water Resources	1998	https://water.ca.gov/LegacyFiles/pubs/planning/california_water_plan_1998_update__bulletin_160-98_/b16098_vol1.pdf and https://water.ca.gov/LegacyFiles/pubs/planning/california_water_plan_1998_update__bulletin_160-98_/b16098_vol2.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
San Joaquin Valley Drainage Investigation – San Joaquin Master Drain	California Department of Water Resources (DWR)	1965	http://wdl.water.ca.gov/waterdatalibrary/docs/historic/Bulletins/Bulletin_127/Bulletin_127-P__1965.pdf	Department of Water Resources Bulletin No.127	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Water Well Standards Fresno County, Bulletin No. 74-6	California Department of Water Resources (DWR)	1968	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Wells/Files/Bulletin-74-6-Water-Well-Standards-Fresno-County-1968.pdf?la=en&hash=575EDC3D630BF16689B426E078DC299FB5BC3934		Chapter 2 - Plan Area
Water Well Standards San Joaquin County, Bulletin No. 74-5	California Department of Water Resources (DWR)	1969	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Wells/Files/Bulletin-74-5-Water-Well-Standards.pdf?la=en&hash=0CA6F3E7D243A6DA22E8174C9D92CC465791C90B		Chapter 2 - Plan Area
Water Well Standards: State of California, Bulletin 74-81	California Department of Water Resources (DWR)	1981	https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Wells/Files/Bulletin-74-81-Water-Well-Standards-State-of-California-December-1981.pdf?la=en&hash=7B64FA212D189E07BE9B1FA909B5C8FECDA20D68		Chapter 2 - Plan Area
California Well Standards, Bulletin 74-90	California Department of Water Resources (DWR)	1991	https://www.water.ca.gov/LegacyFiles/pubs/groundwater/water_well_standards__bulletin_74-90_/ca_well_standards_bulletin74-90_1991.pdf		Chapter 2 - Plan Area
California's Groundwater Bulletin 118 - Update 2003	California Department of Water Resources (DWR)	2003	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Bulletin-118/Files/Statewide-Reports/Bulletin_118_Update_2003.pdf		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Contract between the State of California Department of Water Resources and Oak Flat Water District for a Water Supply	California Department of Water Resources (DWR)	2003	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/State-Water-Project/Management/SWP-Water-Contractors/Oak-Flat-Water-District/Files/Original-Contract-with-Amendments-through-No-21-52803.pdf?la=en&hash=8B94326D5750ADEEC0F2A4B7E084AABFF1E76AC1		Chapter 2 - Plan Area
San Joaquin Valley Groundwater Basin Delta-Mendota Subbasin, DWR Bulletin 118	California Department of Water Resources (DWR)	2006	http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/5-22.07.pdf		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
California Statewide Groundwater Elevation Monitoring (CASGEM) database	California Department of Water Resources (DWR)	2009	https://www.casgem.water.ca.gov	Accessed on various dates	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
California statewide groundwater elevation monitoring (CASGEM) groundwater elevation monitoring guidelines	California Department of Water Resources (DWR)	2010	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/CASGEM/Files/CASGEM-DWR-GW-Guidelines-Final-121510.pdf		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Lines of Equal Elevation of Water in Wells, Unconfined Aquifer, San Joaquin Valley, Spring 2010	California Department of Water Resources (DWR)	2010			Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
IRWM Regions shapefile	California Department of Water Resources (DWR)	2012	https://data.cnra.ca.gov/dataset/irwm-regions		Chapter 2 - Plan Area
2016 Bulletin 118 Basin Boundary Descriptions: 5-022.07 San Joaquin Valley – Delta-Mendota	California Department of Water Resources (DWR)	2016	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Bulletin-118/Files/B118-Basin-Boundary-Descriptions-2016/B118-Basin-Boundary-Description-2016---5_022_07.pdf		Chapter 1 - Introduction

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Best Management Practices: Monitoring Networks and Identification of Data Gaps	California Department of Water Resources (DWR)	2016	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-and-Identification-of-Data-Gaps.pdf		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Best Management Practices: Monitoring Protocols, Standards, and Sites	California Department of Water Resources (DWR)	2016	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-1-Monitoring-Protocols-Standards-and-Sites.pdf		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
California Code of Regulations, Title 23 Waters, Division 2 Department of Water Resources, Chapter 1.5 Groundwater Management, Subchapter 2 Groundwater Sustainability Plans, Article 3 Technical and Reporting Standards	California Department of Water Resources (DWR)	2016	https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GSP_Emergency_Regulations.pdf		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Water Districts shapefile	California Department of Water Resources (DWR)	2016	https://data.cnra.ca.gov/dataset/water-districts		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model; Chapter 5 - Basin Setting, Section 5.5 Management Areas
Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria BMP (DRAFT)	California Department of Water Resources (DWR)	2017	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-6-Sustainable-Management-Criteria-DRAFT.pdf		Chapter 6 - Sustainable Management Criteria

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
California Aqueduct Subsidence Study	California Department of Water Resources (DWR)	2017	https://water.ca.gov/LegacyFiles/groundwater/docs/Aqueduct_Subsidence_Study-FINAL-2017.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Land Subsidence Monitoring	California Department of Water Resources (DWR)	2017	http://wdl.water.ca.gov/groundwater/landsubsidence/LSmonitoring.cfm		Chapter 2 - Plan Area
What is IRWM?	California Department of Water Resources (DWR)	2017	http://wdl.water.ca.gov/irwm/index.cfm		Chapter 2 - Plan Area
Crop Mapping 2014 shapefile	California Department of Water Resources (DWR)	2018	https://data.cnra.ca.gov/dataset/crop-mapping-2014		Chapter 2 - Plan Area
Disadvantaged Communities Mapping Tool	California Department of Water Resources (DWR)	2018	https://gis.water.ca.gov/app/dacs/		Chapter 2 - Plan Area
Economically Distressed Areas Mapping Tool	California Department of Water Resources (DWR)	2018	https://gis.water.ca.gov/app/edas/		Chapter 2 - Plan Area
Evaluation of the Effect of Subsidence on Flow Capacity in the Chowchilla and Eastside Bypasses, and Reach 4A of the San Joaquin River	California Department of Water Resources (DWR)	2018		Received via personal communication Alexis R. Phillips-Dowell (DWR)	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Natural Communities Commonly Associate with Groundwater (NCCAG) dataset	California Department of Water Resources (DWR)	2018	https://gis.water.ca.gov/app/NCDatasetViewer/#		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Statewide Gridded Precipitation and ET (Variable Infiltration Capacity [VIC] model) geodatabase	California Department of Water Resources (DWR)	2018	https://data.cnra.ca.gov/dataset/sgma-climate-change-resources/resource/f86f75e8-0de6-4232-968d-83521116496e		Chapter 5 - Basin Setting, Section 5.4 Water Budget
Best Management Practices for the Sustainable Management of Groundwater – Water Budget	California Department of Water Resources (DWR)	December 2016	https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf		Chapter 5 - Basin Setting, Section 5.4 Water Budget
Guidance Document for the Sustainable Management of Groundwater: Groundwater Sustainability Plan (GSP) Annotated Outline	California Department of Water Resources (DWR)	December 2016	https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf		Chapter 1 - Introduction
Groundwater Glossary	California Department of Water Resources (DWR)	n.d.	http://wdl.water.ca.gov/groundwater/groundwater_basics/groundwater_glossary.cfm		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Information Center Interactive Map Application (GICIMA)	California Department of Water Resources (DWR)	n.d.	https://gis.water.ca.gov/app/gicima/		Chapter 2 - Plan Area

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Groundwater Monitoring (CASGEM)	California Department of Water Resources (DWR)	n.d.	https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM		Chapter 2 - Plan Area
Water Data Library	California Department of Water Resources (DWR)	n.d.	http://wdl.water.ca.gov/waterdatalibrary/		Chapter 2 - Plan Area
Well Completion Report Map Application	California Department of Water Resources (DWR)	n.d.	https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37		Chapter 2 - Plan Area
Wells	California Department of Water Resources (DWR)	n.d.	https://www.water.ca.gov/Programs/Groundwater-Management/Wells		Chapter 2 - Plan Area
Depth to the Top of Corcoran Clay. 1:253,440 scale map	California Department of Water Resources (DWR), San Joaquin District	1981	https://water.ca.gov/LegacyFiles/pubs/groundwater/depth_to_top_of_corcoran_clay__map__1981/depth_to_the_top_of_corcoran_clay-1981.pdf		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Central Delta-Mendota GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/206		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration
City of Dos Palos GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/360		Chapter 2 - Plan Area
City of Firebaugh GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/269		Chapter 2 - Plan Area
City of Gustine GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/271		Chapter 2 - Plan Area
City of Los Banos GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/71		Chapter 2 - Plan Area
City of Mendota GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/67		Chapter 2 - Plan Area
City of Newman GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/57		Chapter 2 - Plan Area
City of Patterson GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/66		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration
County of Madera - 3 GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/70		Chapter 2 - Plan Area
DM-II GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/301		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration
Farmers Water District GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/30		Chapter 2 - Plan Area
Fresno County Management Area A GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/298		Chapter 2 - Plan Area
Fresno County Management Area B GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/308		Chapter 2 - Plan Area

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Grasslands Groundwater Sustainability Agency GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/62		Chapter 2 - Plan Area
Merced County - Delta Mendota GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/231		Chapter 2 - Plan Area
Northwestern Delta-Mendota GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/214		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration
Oro Loma Water District GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/302		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration
Patterson Irrigation District GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/17		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration; Chapter 5 - Basin Setting, Section 5.5 Management Areas
San Joaquin River Exchage Contractors Water Authority GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/10		Chapter 2 - Plan Area
Turner Island Water District - 2 GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/220		Chapter 2 - Plan Area
West Stanislaus Irrigation District GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/13		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration; Chapter 5 - Basin Setting, Section 5.5 Management Areas
Widren Water District GSA shapefile	California Department of Water Resources, SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/237		Chapter 2 - Plan Area; Chapter 3 - Governance & Administration
CA Bulletin 118 Groundwater Basins shapefile	California Natural Resources Agency	March 12, 2019	https://data.cnra.ca.gov/dataset/ca-bulletin-118-groundwater-basins		Maps in all GSP Chapters
California Protected Areas Database	California Protected Areas	2017	https://data.cnra.ca.gov/dataset/california-protected-areas-database-2017a		Chapter 2 - Plan Area
Regulations Related to Recycled Water	California State Water Resources Control Board	October 2018	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/rwregulations.pdf		Chapter 6 - Sustainable Management Criteria
Resolution 68-16 Statement of Policy with Respect to Maintaining High Quality of Waters in California	California State Water Resources Control Board (SWRCB)	1968	https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/1968/rs68_016.pdf		Chapter 6 - Sustainable Management Criteria

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
San Joaquin Valley Interagency Drainage Program Environmental Assessment – Phase I	California State Water Resources Control Board (SWRCB)	1977		Prepared for the California State Water Resources Control Board by Environmental Impact Planning Corporation	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
CV-SALTS Lower San Joaquin River Committee, April 28, 2011 Meeting Materials, Agenda Item 4 – Problem Statement	California State Water Resources Control Board (SWRCB)	2011	https://www.waterboards.ca.gov/centralvalley/water_issues/salinity/lower_sanjoaquin_river_committee/administrative_materials/#contracts		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Water quality goals online database	California State Water Resources Control Board (SWRCB)	2013	http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Ambient Monitoring and Assessment Program (GAMA) – Priority Basin Project	California State Water Resources Control Board (SWRCB)	2018	https://www.waterboards.ca.gov/gama/priority_basin_projects.html		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Maximum Contaminant Levels and Regulatory Dates for Drinking Water – U.S. EPA vs California	California State Water Resources Control Board (SWRCB)	2018	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ccr/MCLsEPAvsDWP-2018-03-21.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions; Chapter 6 - Sustainable Management Criteria
Groundwater Ambient Monitoring and Assessment Program (GAMA) Groundwater Information System database	California State Water Resources Control Board (SWRCB)	2019	https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp	Accessed on various dates	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region, Fifth Edition, The Sacramento River Basin and The San Joaquin River Basin	California State Water Resources Control Board (SWRCB)	May 2018	https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr_201805.pdf		Chapter 6 - Sustainable Management Criteria
Electronic Data Transfer (EDT) Library	California State Water Resources Control Board (SWRCB)	n.d.	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDTlibrary.html		Chapter 2 - Plan Area
Electronic Water Rights Information Management System (eWRIMS) Public Summary Page: El Solyo Water District (A001476)	California State Water Resources Control Board (SWRCB)	n.d.	http://ciwqs.waterboards.ca.gov/ciwqs/ewrims/EWServlet?Page_From=EWWaterRightSearchResults.jsp&Redirect_Page=EWPublicAppSummary.jsp&Purpose=getEwrimsPublicSummary&wrWaterRightID=221&applicationID=30681		Chapter 2 - Plan Area

Title	Author	Publish Year	Reference URL	Additional Data	GSP Chapter/Section
Electronic Water Rights Information Management System (eWRIMS) Public Summary Page: Twin Oaks Irrigation Company (A004237)	California State Water Resources Control Board (SWRCB)	n.d.	http://ciwqs.waterboards.ca.gov/ciwqs/ewrims/EWServlet?Page_From=EWWaterRightSearchResults.jsp&Redirect_Page=EWPublicAppSummary.jsp&Purpose=getEwrimsPublicSummary&wrWaterRightID=736&applicationID=1321		Chapter 2 - Plan Area
Electronic Water Rights Information Management System (eWRIMS) Public Summary Page: West Stanislaus Irrigation District (A001987)	California State Water Resources Control Board (SWRCB)	n.d.	http://ciwqs.waterboards.ca.gov/ciwqs/ewrims/EWServlet?Redirect_Page=EWPublicAppSummary.jsp&Purpose=getEwrimsPublicSummary&wrWaterRightID=299		Chapter 2 - Plan Area
GeoTracker GAMA	California State Water Resources Control Board (SWRCB)	n.d.	http://geotracker.waterboards.ca.gov/gama/		Chapter 2 - Plan Area
State Intervention - The State Back Stop, Sustainable Groundwater Management Act (SGMA)	California State Water Resources Control Board (SWRCB)	n.d.	https://www.waterboards.ca.gov/water_issues/programs/gmp/docs/intervention/intervention_fs.pdf		Chapter 2 - Plan Area
What is a Public Water System?	California State Water Resources Control Board (SWRCB)	n.d.	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/waterpartnerships/what_is_a_public_water_sys.pdf		Chapter 2 - Plan Area
California Cities (2015) shapefile	Caltrans	2015	http://www.dot.ca.gov/hq/tsip/gis/datalibrary/Metadata/cities.html		Chapter 2 - Plan Area
Caltrans Adjusted County Boundaries shapefile	Caltrans	2017	http://www.dot.ca.gov/hq/tsip/gis/datalibrary/Metadata/Counties.html		Maps throughout the GSP Chapters
Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, Fourth Edition	Central Valley Regional Water Quality Control Board (CVRWQCB)	2009	https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Irrigated Lands Regulatory Program Frequently Asked Questions	Central Valley Regional Water Quality Control Board (RWQCB)	2016	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/ilrp_faq.pdf		Chapter 2 - Plan Area
Irrigated Lands Regulatory Program (ILRP): Overview	Central Valley Regional Water Quality Control Board (RWQCB)	2018	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/		Chapter 2 - Plan Area
CV-SALTS Salt and Nutrient Management Plan, Section 3: Salt & Nitrate in the Central Valley	Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS)	2016	https://www.cvsalinity.org/docs/committee-document/technical-advisory-docs/conceptual-model-development/3560-snmp-section-3-s-n-conditions-110316-clean/file.html		Chapter 2 - Plan Area

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CV-SALTS Salt and Nutrient Management Plan, Section 4: Central Valley Salt & Nitrate Management Strategy	Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS)	2016	https://www.cvsalinity.org/docs/committee-document/technical-advisory-docs/conceptual-model-development/3559-snmp-section-4-snmp-strategy-110316-clean/file.html		Chapter 2 - Plan Area
CV-SALTS Salt and Nutrient Management Plan	Central Valley Salinity Alternatives Long-term Sustainability (CV-SALTS)	2016	https://www.cvsalinity.org/docs/central-valley-snmp/final-snmp.html		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Ambient groundwater Nitrate as N and TDS concentrations clipped for the Delta-Mendota Subbasin	Central Valley Salinity Alternatives Long-term Sustainability (CV-SALTS)	2018		Received via personal communication with Vicki Kretsinger at Luhdorff & Scalmanini Consulting Engineers (LSCE) on November 29, 2018	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
General Plan	City of Modesto	2008	http://www.modestogov.com/2069/General-Plan		Chapter 2 - Plan Area
General Plan	City of Patterson	2010	http://www.ci.patterson.ca.us/145/General-PlanCity-Maps		Chapter 2 - Plan Area
Los Vaqueros Reservoir Expansion Project – Project Documents	Contra Costa Water District (CCWD)	n.d.	https://www.ccwater.com/993/Project-Documents		Chapter 7 - Sustainability Implementation, Section 7.1 Projects & Management Actions
Groundwater flow net analysis for lower San Joaquin River Basin	Cooley, W.	2001	http://www.sjrdotmdl.org/concept_model/phys-chem_model/documents/300001039.pdf	Draft memo to CRWQCB Aug 8, 2001	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Field-scale monitoring of the long-term impact and sustainability of drainage water reuse on the west side of California's San Joaquin Valley	Corwin, D.L.	2012	https://doi.org/10.1039/c2em10796a	Journal of Environmental Monitoring, Vol. 14, 1576.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Subsurface geology of the Late Tertiary and Quarternary water-bearing deposits of the southern part of the San Joaquin Valley, California	Croft, M.G.	1972	https://pubs.usgs.gov/wsp/1999h/report.pdf	U.S. Geological Survey Water-Supply Paper 1999-H	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Ground-water conditions in the Mendota-Huron Area Fresno and Kings Counties, California	Davis, G.H. and J.F. Poland	1957	https://doi.org/10.3133/wsp1360G	U.S. Geological Survey Water Supply Paper No. 1360-G	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Use of ground-water reservoirs for storage of surface water in the San Joaquin Valley California	Davis, G.H., B.E. Lofgren, and S. Mack	1964	https://doi.org/10.3133/wsp1618	U.S. Geological Survey Water-Supply Paper 1618	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Ground water conditions and storage capacity in the San Joaquin Valley, California	Davis, G.H., J.H. Green, S.H. Olmstead, and D.W. Brown	1959	https://doi.org/10.3133/wsp1469	U.S. Geological Survey Water Supply Paper No. 1469, 287 p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model

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Del Puerto Water District Water Management Plan 2014 Criteria	Del Puerto Water District	2017	Received via personal communication		Chapter 2 - Plan Area
Groundwater flow and solute movement to drain laterals, western San Joaquin Valley, California	Deverl S.J. and J.L. Fio	1991	https://doi.org/10.1029/91WR01368	1. Geochemical Assessment. Water Resources Research 27(9), 2233-2246, 2247-2257	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Flood Hazard Area shapefile	Earth Data Analysis Center, University of New Mexico	2014	https://catalog.data.gov/dataset/flood-hazard-area		Chapter 2 - Plan Area
East Stanislaus Region Integrated Regional Water Management Plan Update - Public Draft	East Stanislaus Regional Water Management Group	2017	http://www.eaststanirwm.org/documents/2017-esirwmp-publicdraft.pdf		Chapter 2 - Plan Area
ESRI World Imagery layer	ESRI	2017	https://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9	Accessed on various dates	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Progress Report: Subsidence in California, March 2015 – September 2016	Farr, Tom G., Cathleen E. Jones, and Zhen Lieu	2017	https://water.ca.gov/LegacyFiles/waterconditions/docs/2017/JPL%20subsidence%20report%20final%20for%20public%20dec%202016.pdf	Jet Propulsion Laboratory, California Institute of Technology	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Region 4, Central Valley and Pacific Coast Ranges	Farrar, C.D., and G.L. Bertoldi	1988	https://doi.org/10.1130/DNAG-GNA-O2.59	in Back, William, Rosenshein, J.S., and Seaber, P.R., eds., Hydrogeology: Boulder, Colorado, Geological Society of America, Geology of North America, v. O-2, p. 59–67	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Groundwater availability of the Central Valley Aquifer, California	Faunt, C., R.T. Hanson, K. Belitz, W. Schmid, S. Predmore, D. L. Rewis, and K. McPherson	2009	http://pubs.usgs.gov/pp/1766/	U.S. Geological Survey Professional Paper 1766	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Development of a three-dimensional model of sedimentary texture in valley-fill deposits of Central Valley, California, USA	Faunt, C.C., K. Belitz., and R.T. Hanson	2010	https://doi.org/10.1007/s10040-009-0539-7	U.S. Geological Survey, Hydrogeology Journal, Vol. 18, 625	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Water availability and land subsidence in the Central Valley, California, USA	Faunt, C.C., M. Sneed, J. Traum, and J.T. Brandt	2015	https://link.springer.com/content/pdf/10.1007%2Fs10040-015-1339-x.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Calculation of a water budget and delineation of contributing sources to drainflows in the Western San Joaquin Valley, California	Fio, J.L.	1994	https://doi.org/10.3133/ofr9445	U.S. Geological Survey, Open-File Report 94-45	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater flow and solute movement to drain laterals, western San Joaquin Valley, California: 2. Quantitative hydrologic assessment	Fio, J.L. and S.J. Deverel	1991	https://doi.org/10.1029/91WR01368	Water Resources Research, Vol. 27, No. 9, 2247.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model

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Stratigraphy of the West Side Southern San Joaquin Valley	Foss, F.D., and R. Blaisdell	1968	http://www.sanjoaquingeologicalsociety.org/wp-content/abstracts/1968_Foss_Blaisdell.pdf		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater quality in the Western San Joaquin Valley study unit, 2010: California GAMA Priority Basin Project	Fram, M.S.	2017	https://pubs.usgs.gov/sir/2017/5032/sir20175032.pdf	U.S. Geological Survey Scientific Investigations Report 2017-5032, 130 p.	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Groundwater	Freeze, R.A., and J.A. Cherry	1979		Englewood Cliffs, NJ, Prentice-Hall, p. 60.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
General Plan	Fresno County	2000	http://www.co.fresno.ca.us/departments/public-works-planning/divisions-of-public-works-and-planning/development-services-division/planning-and-land-use/general-plan-maps		Chapter 2 - Plan Area
Zoning Ordinance of the County of Fresno - Land Use and Planning	Fresno County	2011	http://www.co.fresno.ca.us/departments/public-works-planning/divisions-of-public-works-and-planning/development-services-division/zoning-ordinance		Chapter 2 - Plan Area
Abandoned Well Information	Fresno County	n.d.	http://www.co.fresno.ca.us/departments/public-health/environmental-health/water-surveillance-program/water-well-permitting-program#abandoned		Chapter 2 - Plan Area
Code of Ordinances, Title 14 - Water and Sewage, Chapter 14.08 - Well Construction, Pump Installation and Well Destruction Standards	Fresno County	n.d.	https://library.municode.com/ca/fresno_county/codes/code_of_ordinances?nodeId=TIT14WASE_CH14.08WECOPUINWEDEST		Chapter 2 - Plan Area
Water Well Permitting Program	Fresno County	n.d.	http://www.co.fresno.ca.us/departments/public-health/environmental-health/water-surveillance-program/water-well-permitting-program		Chapter 2 - Plan Area
Requirements for Maintaining an Inactive Water Well	Fresno County Department of Public Health, Environmental Health Division	n.d.	http://www.co.fresno.ca.us/home/showdocument?id=4753		Chapter 2 - Plan Area
Well Destruction Requirements	Fresno County Department of Public Health, Environmental Health Division	n.d.	http://www.co.fresno.ca.us/home/showdocument?id=4763		Chapter 2 - Plan Area
San Joaquin Valley, California—Largest human alteration of the Earth's surface	Galloway, D.L., and F.S. Riley.	1999	https://pubs.usgs.gov/circ/circ1182/pdf/06SanJoaquinValley.pdf	U.S. Geological Survey Circular 1182, p. 23–34	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions

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Land subsidence in the United States	Galloway, D.L., D.R. Jones, and S.E. Ingebritsen	1999	https://doi.org/10.3133/cir1182	U.S. Geological Survey Circular 1182, 175 p	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Generalized subsurface geology of water-bearing deposits, northern San Joaquin Valley, California	Hotchkiss, W.R.	1972	https://doi.org/10.3133/ofr73119		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Geology, hydrology, and water quality of the Tracy-Dos Palo area, San Joaquin Valley, California	Hotchkiss, W.R. and G.O. Balding.	1971	https://doi.org/10.3133/ofr72169	U.S. Geological Survey Open-File Report 72-169. 107 p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Land subsidence in the San Joaquin Valley, California, as of 1980	Ireland R.L., J.F. Poland, and F.S. Riley	1984	https://doi.org/10.3133/pp437I	U.S. Geological Survey Professional Paper 437-I, 93 p	Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Land subsidence in the San Joaquin Valley, California, as of 1983	Ireland, R.L.	1986	https://doi.org/10.3133/wri854196	U.S. Geological Survey WaterResources Investigations Report 85–4196, 50 p	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
On the flow of water in an elastic artesian aquifer	Jacob, C.E.	1940	https://doi.org/10.1029/TR021i002p00574	American Geophysical Union Trans., pt. 2, p. 574-586.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Initial Study - Discretionary Well-Permitting and Management Program, Stanislaus County, California	Jacobson James & Associates and Tetra Tech	2016	http://www.stancounty.com/er/pdf/groundwater/InitialStudy.pdf		Chapter 2 - Plan Area
Geological Atlas of California – Santa Cruz Quadrangle.	Jennings, C.W. and R.G. Strand	1958	https://www.conservation.ca.gov/cgs/maps-data/rgm	California Geological Survey, Geologic Atlas of California Map No. 020, 1:250,000 scale	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
State of California Well Completion Report, Well No. E0132267.	Luhdorff & Scalmanini Consulting Engineers (LSCE)	2011		Received via personal communication	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Grassland Drainage Area Groundwater Quality Assessment Report	Luhdorff & Scalmanini Consulting Engineers (LSCE)	2016	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/grassland/ground_water/2016_0728_gda_gar.pdf		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model and Section 5.3 Groundwater Conditions
Grassland Drainage Area Groundwater Quality Trend Monitoring Workplan	Luhdorff & Scalmanini Consulting Engineers (LSCE)	2016	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/grassland/ground_water/2018_0516_gda_gtmp_wp.pdf		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Western San Joaquin River Watershed Groundwater Quality Trend Monitoring Workplan, Phase 1 - Monitoring Design Approach	Luhdorff & Scalmanini Consulting Engineers (LSCE)	2016	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/westside_sjr/ground_water/2016_0916_wsjr_gtmp.pdf		Chapter 2 - Plan Area; Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring

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Grassland Drainage Area Groundwater Quality Management Plan	Luhdorff & Scalmanini Consulting Engineers (LSCE)	2017	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/grassland/ground_water/20170831_gda_gqmp_req.pdf		Chapter 2 - Plan Area
Western San Joaquin River Watershed Groundwater Quality Assessment Report	Luhdorff & Scalmanini Consulting Engineers (LSCE), Davids Engineering, and Larry Walker Associates	2015	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/westside_sjr/ground_water/2015_0316_westside_gar.pdf		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model; Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Madera Integrated Regional Water Management Plan - Final Draft	Madera Regional Water Management Group	2014	https://water.ca.gov/LegacyFiles/irwm/grants/docs/PlanReviewProcess/Madera_IRWMP/Madera%20IRWMP.pdf		Chapter 2 - Plan Area
San Joaquin River Restoration Study Background Report	McBain & Trush, Inc.	2002	https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/sjrf_spprtinfo/mcbainandtrush_2002.pdf	Prepared for Friant Water Users Authority, Lindsay, CA, and Natural Resources Defense Council	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Ground water in the San Joaquin Valley, California	Mendenhall, W.C., R.B. Dole, and H. Stabler.	1916	https://doi.org/10.3133/wsp398	U.S. Geological Survey Water-Supply Paper 398, 310 p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
General Plan	Merced County	2011	http://www.co.merced.ca.us/1791/2030-Merced-County-General-Plan-Sections		Chapter 2 - Plan Area
Letter of Intent - Existing or Out of Service Well	Merced County	2012	http://www.co.merced.ca.us/DocumentCenter/View/5107		Chapter 2 - Plan Area
Groundwater Mining and Export Ordinance #1930 - Frequently Asked Questions	Merced County	2015	http://www.co.merced.ca.us/DocumentCenter/View/10906		Chapter 2 - Plan Area
County Code, Title 9 General Health and Safety, Chapter 9.28 Wells	Merced County	n.d.	http://www.qcode.us/codes/mercedcounty/view.php?topic=9-9_28&frames=on		Chapter 2 - Plan Area
Well Construction, Destruction, Mining, and Export Application/Permit	Merced County	n.d.	http://www.co.merced.ca.us/DocumentCenter/View/10907		Chapter 2 - Plan Area
Well Systems - Documents & Resources	Merced County	n.d.	http://www.co.merced.ca.us/2247/Well-Systems		Chapter 2 - Plan Area
Completing the Well Construction, Destruction, Mining, and Export Permit Application	Merced County Department of Public Health, Division of Environmental Health	2015	https://www.co.merced.ca.us/DocumentCenter/View/10905		Chapter 2 - Plan Area

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Quality Assurance Program Plan for groundwater monitoring by the Central Valley Groundwater Monitoring Collaborative	Michael L. Johnson-LLC (MLJ), Luhdorff & Scalmanini, and Provost & Pritchard	2018			Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Personal Communication	Mosley, J. Natural Resources Specialist/GIS Coordinator, Bureau of Indian Affairs Pacific Region	2017			Chapter 2 - Plan Area
Gravity Recovery and Climate Experiment	National Aeronautics and Space Administration (NASA)	2014	https://www.nasa.gov/mission_pages/Grace/index.html		Chapter 2 - Plan Area
Uninhabited Aerial Vehicle Synthetic Aperture Radar	National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory	2018	https://uavsar.jpl.nasa.gov/		Chapter 2 - Plan Area
Part 630 Hydrology National Engineering Handbook, Chapter 7 Hydrologic Soil Groups.	National Resources Conservation Service (NRCS).	2009	http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/search.shtml		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Soil Survey Manual	Natural Resources Conservation Service (NRCS)	2015	http://www.nrcs.usda.gov/wps/portal/nrcs/detail//?cid=nrcs142p2_054253		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Agricultural Land Use and Wildlife in the San Joaquin Valley, 1769-1930: An Overview. SOLO Heritage Research	Ogden, G. R.	1988		San Joaquin Valley Drainage Program, U.S. Department of Interior. Sacramento, California	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Base of fresh groundwater (approximately 2,000 micromhos) in the San Joaquin Valley, California:	Page, R.W.	1973	https://pubs.usgs.gov/of/1971/0223/plate-1.pdf	U.S. Geological Survey Hydrologic Investigations Atlas HA-489, 1 sheet, scale 1:500,000	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Patterson Irrigation District Water Management Plan/Agricultural Water Management Plan, 2008 Criteria	Patterson Irrigation District	2016	https://www.water.ca.gov/LegacyFiles/wateruseefficiency/sb7/docs/2016/Patterson ID WMP 2016 Update.pdf		Chapter 2 - Plan Area
Land subsidence in the San Joaquin Valley, California, as of 1972	Poland, J.F., B.E Lofgren, R.L. Ireland, and A.G. Pugh	1975	https://doi.org/10.3133/pp437H	U.S. Geological Survey Professional Paper 437-H, 78 p.	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
SJR Diversion Demand	Provost & Pritchard	June 2014		Received via personal communication with Joe Hopkins on May 22, 2019	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
City of Los Banos Urban Water Management Plan 2015 Update	Provost & Pritchard Consulting Group	2016	https://wuedata.water.ca.gov/public/uwmp_attachments/9729664444/2018%200130%20REVISED%20FINAL%202015%20UWMP%20combined.pdf		Chapter 2 - Plan Area

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Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. US EPA, Ground Water Issue EPA/540/S-95/504	Puls, R.W. and M.J. Barcelona	1996	https://www.epa.gov/sites/production/files/2015-06/documents/lwflw2a.pdf		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge	Rantz, S.E. and others	1982	https://pubs.usgs.gov/wsp/wsp2175/pdf/WSP2175_vol1a.pdf	United States Geological Survey (USGS) Water Supply Paper 2175	Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Measurement and Computation of Streamflow: Volume 2. Computation of Discharge	Rantz, S.E. and others	1982	https://pubs.usgs.gov/wsp/wsp2175/pdf/WSP2175_vol2a.pdf	United States Geological Survey (USGS) Water Supply Paper 2175	Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
North Valley Regional Recycled Water Program Final Report	RMC Water & Environment (RMC)	2015	http://www.nvr-recycledwater.org/docs/final_nvrrwp_facilities plan_19may2015_full.pdf		Chapter 2 - Plan Area
City of Patterson 2015 Urban Water Management Plan	RMC Water & Environment (RMC)	2016	https://wuedata.water.ca.gov/public/uwmp_attachments/5439267814/2015 UWMP_Final_w-Appendices.pdf		Chapter 2 - Plan Area
City of Patterson Water Master Plan, Appendix C: Ken Schmidt and Associates Hydrogeological Analysis	RMC Water & Environment/Woodard & Curran (RMC/W&C and Schmidt)	2014	https://www.ci.patterson.ca.us/DocumentCenter/View/4174/Patterson-WMP-Final-12March18_with-Appendices?bidId=		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans	Rohde, M.M., S. Matsumoto, J. Howard, S. Liu, L. Riege, and E.J. Remson (The Nature Conservancy)	2018	https://www.scienceforconservation.org/assets/downloads/GDEsUnderSGMA.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
2035 General Plan	San Benito County	2015	http://cosb.us/wp-content/uploads/Adopted-2035-GPU.pdf		Chapter 2 - Plan Area
San Benito County Code of Ordinances - Title 15 Public Works, Chapter 15.05 Water	San Benito County	n.d.	http://library.amlegal.com/nxt/gateway.dll/California/sanbenitocounty_ca/sanbenitocountycaliforniacodeofordinance?f=templates$fn=default.htm$3.0$vid=amlegal:sanbenitocounty_ca		Chapter 2 - Plan Area
Well Standards (San Joaquin County Ordinance Code Section9-1115.6)	San Joaquin County	2005	https://www.sjgov.org/uploadedFiles/SJC/Departments/EHD/Forms/Well Standards.pdf		Chapter 2 - Plan Area
General Plan	San Joaquin County	2016	https://www.sjgov.org/commdev/cgi-bin/cdyn.exe?grp=planning&htm=gp2035		Chapter 2 - Plan Area

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Division 11: Infrastructure Standards and Requirements	San Joaquin County	n.d.	https://www.sjgov.org/commdev/cgi-bin/cdyn.exe/file/Planning/Title 9/SJC TITLE 9 - Division (11).pdf		Chapter 2 - Plan Area
San Joaquin County Code of Ordinances - Title 5 Health and Sanitation, Division 4 Wells and Well Drilling, Chapter 3 Well Drilling Requirements	San Joaquin County	n.d.	https://library.municode.com/ca/san_joaquin_county/codes/code_of_ordinances?nodeId=TIT5HESA_DIV4WEWEDR_CH3WEDRRE		Chapter 2 - Plan Area
New Well Information form	San Joaquin County, Environmental Health Department	2017	https://www.sjgov.org/uploadedFiles/SJC/Departments/EHD/Forms/New Well Information 1-8-2018.pdf		Chapter 2 - Plan Area
Well/Pump Permit	San Joaquin County, Environmental Health Department	2018	https://www.sjgov.org/uploadedfiles/sjc/departments/ehd/forms/well permit and declaration(1).pdf		Chapter 2 - Plan Area
Water Well Permits	San Joaquin County, Environmental Health Department	n.d.	https://www.sjgov.org/department/envhealth/programs/default?id=26249		Chapter 2 - Plan Area
Well Exemption Statement	San Joaquin County, Environmental Health Department	n.d.	https://www.sjgov.org/uploadedfiles/sjc/departments/ehd/forms/new well information exemption statement.pdf		Chapter 2 - Plan Area
Subsidence Monitoring	San Joaquin River Restoration Program	n.d.	http://www.restoresjr.net/science/subsidence-monitoring/		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Delta-Mendota Subbasin Groundwater Monitoring Program	San Luis & Delta-Mendota Water Authority	2015	https://www.casgem.water.ca.gov/OSS/(S(5jjakkvz0a2rmysuhkssesh2))/Reports/FileDownload.aspx?MNID=314&MEID=5131&File=SLDMWA_Groundwater_Monitoring_Plan_-_Delta_Mendota_Subbasin_08052015124458.pdf	Submitted to the California Department of Water Resources CASGEM Program	Chapter 2 - Plan Area; Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
2019 Westside San Joaquin Integrated Regional Water Management Plan	San Luis & Delta-Mendota Water Authority	January 2019	http://sldmwa.org/OHTDocs/pdf_documents/Groundwater/WSJ_IRWMP_2019_Final_w_appendices.pdf		Chapter 2 - Plan Area
Delta-Mendota Canal	San Luis & Delta-Mendota Water Authority	n.d.	http://www.sldmwa.org/about-sldmwa-facilities/about-the-delta-mendota-canal/		Chapter 2 - Plan Area
Tracy Fish Collection Facility	San Luis & Delta-Mendota Water Authority	n.d.	http://www.sldmwa.org/about-sldmwa-facilities/tracy-fish-collection-facility/		Chapter 2 - Plan Area

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Central Delta-Mendota Region Sustainable Groundwater Management Act Services Activity Agreement	San Luis & Delta-Mendota Water Authority (SLDMWA)	2017			Chapter 3 - Governance & Administration
First Amendment to Central Delta-Mendota Region Sustainable Groundwater Management Act Services Activity Agreement and Consent of SS-MOA Participants	San Luis & Delta-Mendota Water Authority (SLDMWA)	2017			Chapter 3 - Governance & Administration
Memorandum of Agreement for Central Delta-Mendota Region Sustainable Groundwater Management Act Services	San Luis & Delta-Mendota Water Authority (SLDMWA)	2017			Chapter 3 - Governance & Administration
Northern Delta-Mendota Region Sustainable Groundwater Management Act Services Activity Agreement	San Luis & Delta-Mendota Water Authority (SLDMWA)	2017			Chapter 3 - Governance & Administration
Delta-Mendota Canal Check Points coordinates	San Luis & Delta-Mendota Water Authority (SLDMWA)	n.d.		Personal communication	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model

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SLDMWA Member Agencies shapefile	San Luis & Delta-Mendota Water Authority (SLDMWA)	n.d.		Personal communication	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Data Sharing Agreement	San Luis & Delta-Mendota Water Authority (SLDMWA) on behalf of Northern & Central Delta-Mendota GSP Group; Westlands Water District	2018			Chapter 3 - Governance & Administration
San Luis Water District 2015 SBx7-7 Supplemental Report and Measurement Certification	San Luis Water District	2016	https://www.water.ca.gov/LegacyFiles/wateruseefficiency/sb7/docs/2017/San Luis WD 2015 Supplemental Report.pdf		Chapter 2 - Plan Area
Pacheco Reservoir Expansion Project: A 21st Century Solution Delivering Sustainability Benefits for All of Us	Santa Clara Valley Water District (SCVWD)	n.d.	https://www.valleywater.org/project-updates/dam-reservoir-projects/pacheco-reservoir-expansion-project-proposed		Chapter 7 - Sustainability Implementation, Section 7.1 Projects & Management Actions
Statement from Chair Richard P. Santos on $485 Million Funding Award for the Pacheco Reservoir Expansion Project	Santa Clara Valley Water News	July 2018	https://valleywaternews.org/2018/07/24/statement-from-chair-richard-p-santos-on-485-million-funding-award-for-the-pacheco-reservoir-expansion-project/		Chapter 7 - Sustainability Implementation, Section 7.1 Projects & Management Actions
Topographic map of GSA and Location of Subsurface Geologic Cross Sections, with accompanying cross-sections for the Los Banos Creek area	Schmidt, K.D.	n.d.	\\woodardcurran.net\shared\Projects\RMC\WCR\0617 SLDMWA\0011081 GSP Development\R. Reference Material\Geology-Hydrogeo\Geologic Cross Sections, SJREC.pdf	Received via personal communication	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Conditions in and near the Central California Irrigation District	Schmidt, K.D.	1997		Los Banos, California. 89 p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Flows in the San Joaquin River Exchange Contractors Service Area	Schmidt, K.D.	1997		Prepared for SJREC, Los Banos, California, 46p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Groundwater Overdraft in the Delta-Mendota Subbasin	Schmidt, K.D.	2015			Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model; Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions

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Aliso Water District GSA shapefile	SGMA Portal	2017	https://sgma.water.ca.gov/portal/gsa/print/23		Chapter 2 - Plan Area
Sites Reservoir Project: Offstream Water Storage North of the Sacramento-San Joaquin Delta (Delta)	Sites Reservoir Authority	August 2018	https://www.sitesproject.org/wp-content/uploads/2018/08/Sites_Overview_Brochure_August2018-1.pdf		Chapter 7 - Sustainability Implementation, Section 7.1 Projects & Management Actions
Land subsidence in the San Joaquin Valley, California, USA, 2007-2014	Sneed, M. and J.T. Brandt	2015	https://www.proc-iahs.net/372/23/2015/piahs-372-23-2015.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Land subsidence along the Delta-Mendota Canal in the northern part of the San Joaquin Valley, California, 2003-10	Sneed, M., J. Brandt, and M. Solt	2013	http://dx.doi.org/10.3133/sir20135142	U.S. Geological Survey Scientific Investigations Report 2013-5142, 87 p.	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Web Soil Survey	Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture.	n.d.	https://websoilsurvey.nrcs.usda.gov/		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Crows Landing Community Plan	Stanislaus County	1987	http://www.stancounty.com/planning/pl/documents/gp/i-a-1-crows-landing-cp.pdf		Chapter 2 - Plan Area
Westley Community Plan	Stanislaus County	1987	http://www.stancounty.com/planning/pl/documents/gp/i-a-9-westley-cp.pdf		Chapter 2 - Plan Area
An Ordinance Amending Chapter 9.37 Relating to Groundwater	Stanislaus County	2014	http://www.stancounty.com/er/pdf/groundwater/chapter-9-37.pdf		Chapter 2 - Plan Area
Discretionary Well Permitting and Management Program, Notice of Preparation Program Environmental Impact Report	Stanislaus County	2016	http://www.stancounty.com/er/pdf/groundwater/notice-of-preparation.pdf		Chapter 2 - Plan Area
Stanislaus County Code, Title 9 Health and Safety, Chapter 9.37 Groundwater, 9.37.060 Implementation	Stanislaus County	n.d.	http://qcode.us/codes/stanislauscounty/?view=desktop&topic=9-9_37-9_37_060		Chapter 2 - Plan Area
Zoning Ordinance	Stanislaus County	n.d.	http://www.stancounty.com/planning/forms/stanislaus-county-code-title-21-zoning-ordinance.pdf		Chapter 2 - Plan Area
Application for Well Construction or Destruction	Stanislaus County, Department of Environmental Resources	2014	http://www.stancounty.com/er/pdf/water-well-construction-and-destruction-application.pdf		Chapter 2 - Plan Area
Groundwater Resources	Stanislaus County, Department of Environmental Resources	2018	http://www.stancounty.com/er/groundwater/		Chapter 2 - Plan Area
County Groundwater Ordinance - Well Application Review Process	Stanislaus County, Department of Environmental Resources	n.d.	http://www.stancounty.com/er/pdf/application-packet.pdf		Chapter 2 - Plan Area

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General Plan	Stanislaus County, Planning Division	2015	http://www.stancounty.com/planning/pl/general-plan.shtm		Chapter 2 - Plan Area
California Code of Regulation Title 22. Division 4. Environmental Health Chapter. 15 Domestic Water Quality and Monitoring Regulations Article 16. Secondary Water Standards	State of California	2006	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/recentlyadoptedregulations/R-21-03-finalregtext.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions; Chapter 6 - Sustainable Management Criteria
Senior Water Rights Curtailed in Delta, San Joaquin & Sacramento Watersheds	State of California	2015	http://www.drought.ca.gov/topstory/top-story-37.html		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
California Regulations Related to Drinking Water	State of California	2017	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dwregulations-2017-12-29.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Geologic nitrogen may pose hazard	Strathouse, S. M. and G. Sposito	1980	http://calag.ucanr.edu/archive/?type=pdf&article=ca.v034n08p20	California Agriculture	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Geologic nitrogen and the occurrence of high nitrate soils in western San Joaquin Valley, California	Sullivan, P.J., G. Sposito, S.M. Strathouse, and C.L. Hansen	1979	http://hilgardia.ucanr.edu/fileaccess.cfm?article=152819&p=WXIALI	Hilgardia, Vol. 47, No. 2, 15-49 p.	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Land subsidence in the San Joaquin Valley, updated to 1995	Swanson, A.A.	1998		Borchers, J.W., ed., Land subsidence case studies and current research: Proceedings of the Dr. Joseph F. Poland Symposium on Land Subsidence, Sacramento, Calif., October 4–5, 1995, Association of Engineering Geologists, Special Publication no. 8, p. 75–79.	Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Groundwater and Stream Interaction in California's Central Valley: Insights for Sustainable Groundwater Management	The Nature Conservancy (TNC)	2014	https://www.scienceforconservation.org/assets/downloads/GroundwaterStreamInteraction_2016.pdf		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Identifying Environmental Surface Water Users - Freshwater Species List for Each Groundwater Basin dataset, by GSA	The Nature Conservancy (TNC)	n.d.	https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Santa Nella Community Specific Plan	The Planning Center, CCS Planning and Engineering, and Land Use Economics	2000	http://web2.co.merced.ca.us/pdfs/planning/cplan/completed/santanella/Santa%20Nella%20CSP%2005052000.pdf		Chapter 2 - Plan Area

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State of California Well Completion Report, Well No. 568692.	Tranquillity Irrigation District (Tranquillity ID)	1994		Received via personal communication	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
State of California Well Completion Report, Well No. 814966.	Tranquillity Irrigation District (Tranquillity ID)	2000		Received via personal communication	Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
P252 – Overview | PBO Station page	UNAVCO	2019	https://www.unavco.org/instrumentation/networks/status/pbo/overview/P252		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
UNAVCO's Monitoring Network Map database	UNAVCO	2019	https://www.unavco.org/instrumentation/networks/map/map.html#/		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
PBO GPS Stations Network Monitoring	UNAVCO	n.d.	http://www.unavco.org/instrumentation/networks/status/pbo/gps		Chapter 2 - Plan Area
USBR computed full natural flows from 1906-2002	United State Bureau of Reclamation (USBR)	2002			Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Delta-Mendota Canal Non-Project Water Pump-in Program Monitoring Plan	United States Bureau of Reclamation	2018	https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=32784		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions; Chapter 6 - Sustainable Management Criteria
Delta-Mendota Canal Groundwater Pump-in Program Water Quality Monitoring Plan	United States Bureau of Reclamation (USBR)	2013	https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=11952		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
Central Valley Project (CVP) Water Contractors	United States Bureau of Reclamation (USBR)	2016	https://www.usbr.gov/mp/cvp-water/docs/latest-water-contractors.pdf		Chapter 2 - Plan Area
California Irrigiation District and Del Puerto Water District Orestimba Creek Groundwater Recharge Project, Finding of No Significant Impact	United States Bureau of Reclamation (USBR)	2017	https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=29141		Chapter 2 - Plan Area
Central California Irrigation District and Del Puerto Water District Orestimba Creek Groundwater Recharge Project, Draft Environmental Assessment/Initial Study and Mitigated Negative Declaration	United States Bureau of Reclamation (USBR)	2017	https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=28394		Chapter 2 - Plan Area
Grassland Bypass Project	United States Bureau of Reclamation (USBR)	2017	https://www.usbr.gov/mp/grassland/		Chapter 2 - Plan Area
Delta-Mendota Canal Groundwater Pump-in Program Revised Design Constraints, Final Environmental Assessment	United States Bureau of Reclamation (USBR)	2018	https://www.usbr.gov/mp/nepa/includes/documentShow.php?Doc_ID=33261		Chapter 2 - Plan Area

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San Luis Reservoir Expansion Draft Appraisal Report	United States Bureau of Reclamation (USBR)	December 2013	https://www.usbr.gov/mp/sllpp/docs/2013-11-19-draft-san-luis-expansion-appraisal-report.pdf		Chapter 7 - Sustainability Implementation, Section 7.1 Projects & Management Actions
2014 TIGER/Line Shapefiles: Roads, Primary and Secondary Roads, California	United States Census Bureau	2014	https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2014&layergroup=Roads		Maps throughout the GSP Chapters
Population Estimates Program	United States Census Bureau	2015	www.census.gov/quickfacts		Chapter 2 - Plan Area
American FactFinder 2016 California Block Group population data	United States Census Bureau	2016	https://factfinder.census.gov/faces/nav/jsf/pages/download_center.xhtml		Chapter 2 - Plan Area
California Block Group shapefile	United States Census Bureau	2016	https://www.census.gov/cgi-bin/geo/shapefiles/index.php		Chapter 2 - Plan Area
Incorporated Places and Census Designated Places shapefile	United States Census Bureau	2017	https://www.census.gov/geo/maps-data/data/cbf/cbf_place.html		Chapter 2 - Plan Area
Part 650 Engineering Field Handbook, Chapter 1 Surveying	United States Department of Agriculture (USDA), National Resource Conservation Service (NRCS)	October 2009	https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=25276.wba		Chapter 7 - Sustainability Implementation, Section 7.2 Monitoring
BLM National Surface Management Agency Area Polygons shapefiles	United States Department of the Interior, Bureau of Land Management	2013	https://catalog.data.gov/dataset/blm-national-surface-management-agency-area-polygons		Chapter 2 - Plan Area
About the Refuge: San Joaquin River National Wildlife Refuge, California	United States Fish & Wildlife Service	2012	https://www.fws.gov/Refuge/San_Joaquin_River/about.html		Chapter 2 - Plan Area
San Luis National Wildlife Refuge, California	United States Fish & Wildlife Service	2012	https://www.fws.gov/Refuge/San_Luis/about.html		Chapter 2 - Plan Area
Water resources data for California, 1910-2000 for various gaging stations within the San Joaquin Valley	United States Geological Survey (USGS)	2000			Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
Central Valley Spatial Database, Corcoran Clay Depth, Extent, and Thickness shapefiles	United States Geological Survey (USGS)	2012	https://ca.water.usgs.gov/projects/central-valley/central-valley-spatial-database.html		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
California Water Science Center (CAWSC) – Groundwater Ambient Monitoring and Assessment (GAMA) Program, Western San Joaquin Valley Study Unit	United States Geological Survey (USGS)	2018	https://ca.water.usgs.gov/gama/SU/w_sjv.htm		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
National Elevation Dataset, Ground Surface Elevation shapefile	United States Geological Survey (USGS)	2018	https://viewer.nationalmap.gov/advanced-viewer/		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
National Hydrograph Dataset	United States Geological Survey (USGS)	n.d.	https://viewer.nationalmap.gov/basic/?basemap=b1&category=nhd&title=NHD%20View		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model

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National Water Information System: Mapper	United States Geological Survey (USGS)	n.d.	https://maps.waterdata.usgs.gov/mapper/index.html		Chapter 2 - Plan Area
Delta-Mendota Canal: Evaluation of Groundwater Conditions & Land Subsidence	United States Geological Survey (USGS), California Water Science Center (CWSC)	2017	https://ca.water.usgs.gov/projects/central-valley/delta-mendota-canal.html		Chapter 5 - Basin Setting, Section 5.3 Groundwater Conditions
USGS Land Subsidence Resources	United States Geological Survey, California Water Science Center	n.d.	https://ca.water.usgs.gov/land_subsidence/california-subsidence-resources.php		Chapter 2 - Plan Area
Soil Agricultural Groundwater Banking Index (SAGBI)	University of California, Davis (UCD) Department of Agriculture and Natural Resources. n.d. Soil Resource Lab	n.d.	https://casoilresource.lawr.ucdavis.edu/sagbi/		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
Geologic Map of the San Francisco – San Jose Quadrangle. California Geological Survey, Regional Geologic Map No. 5A, 1:250,000 scale.	Wagner, D.L., Bortugno, E.J., and Mc Junkin, R.D.	1991	https://www.conservation.ca.gov/cgs/maps-data/rgm		Chapter 5 - Basin Setting, Section 5.2 Hydrogeologic Conceptual Model
San Luis Reservoir	Water Education Foundation	n.d.	http://www.watereducation.org/aquapedia/san-luis-reservoir		Chapter 2 - Plan Area
West Stanislaus Irrigation District Water Management Plan, 2011 Criteria	West Stanislaus Irrigation District	2014	https://www.water.ca.gov/LegacyFiles/wateruseefficiency/sb7/docs/2016/West Stanislaus ID 2014 WMP.pdf		Chapter 2 - Plan Area
City of Modesto 2015 Urban Water Management Plan	West Yost Associates	2016	https://wuedata.water.ca.gov/public/uwmp_attachments/9017789542/City of Modesto Final 2015 UWMP - June 2016.pdf		Chapter 2 - Plan Area
About Us	Westside San Joaquin River Watershed Coalition	n.d.	http://www.westsidesjr.org/		Chapter 2 - Plan Area
California Canals shapefile	Woodard & Curran	2010			Maps throughout the GSP Chapters
Water in the Bank: One Solution For Drought-Stricken California	Yale School of Foresty & Environmental Studies (YaleEnvironment360)	2015	https://e360.yale.edu/features/water_in_the_bank_one_solution_for_drought-stricken_california		Chapter 2 - Plan Area

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Central Delta-Mendota Groundwater Sustainability Agency Joint Powers Agreement		2019			Chapter 3 - Governance & Administration

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