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.

DPWD is the lead participant for both this project and the NVRRWP. DPWD will be receiving water from the NVRRWP throughout the year where NVRRWP water can be stored in the reservoir. The Del Puerto Canyon Reservoir Project will provide a reliable place of storage for NVRRWP supplies and the NVRRWP would provide a consistent supply source for the reservoir. Additionally, other partnering districts hold senior surface water rights or similar CVP supplies, most of which comes through the Delta. Thus, this project would benefit the Delta by providing operational flexibility and 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 Delta 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 conjunctive management of supplies and providing for storage of additional 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.

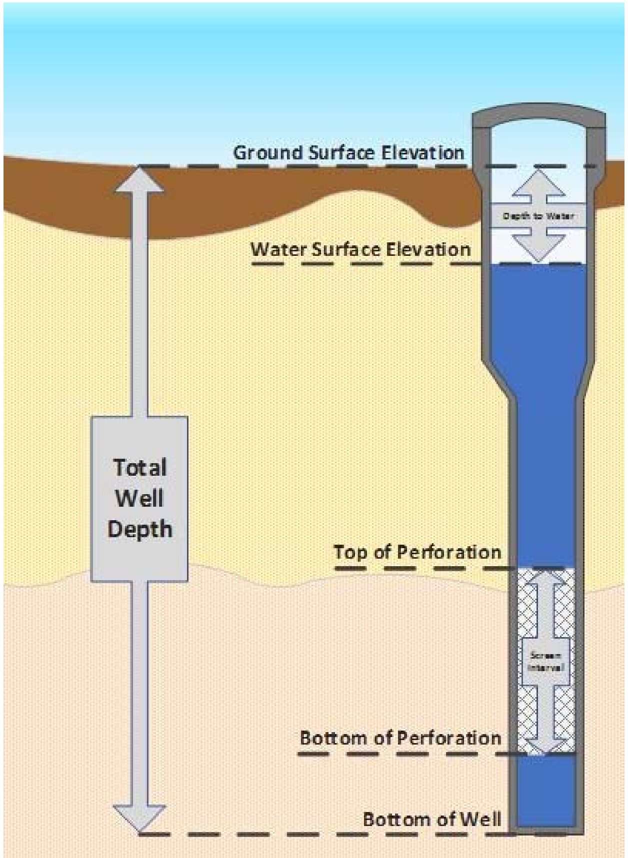

Figure 7-1. Diagram of Key Groundwater Monitoring Well Measurements

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 and depletions of interconnected surface water sustainability indicators. Land surface elevation is used for assessing sustainability relative to the land subsidence 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 Monitoring Network Subregions

The Northern & Central Delta-Mendota Region GSP Plan area was divided into six subregions, as depicted in Figure 7-2, for the purpose of assessing current conditions within the Plan area and for selecting monitoring sites for the groundwater level and groundwater water quality monitoring networks:

- North Subregion
- North-Central Subregion
- Central Subregion
- South-Central Subregion
- South Subregion
- Tranquillity Subregion

These subregions are not management areas. These subregions were established to qualifying spatial differences in groundwater levels and groundwater quality conditions throughout the Plan area and to aid in establishing minimum thresholds, measurable objectives, and interim milestones at each representative monitoring site (see Chapter 6 *Sustainable Management Criteria* for more detail). A minimum of two sites were selected per subregion for the groundwater level and groundwater quality monitoring networks for each principal aquifer to ensure adequate spatial coverage of monitoring sites throughout the Plan Area.

7.2.4.3 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).

7.2.4.4 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.

<u>Wells</u>

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.

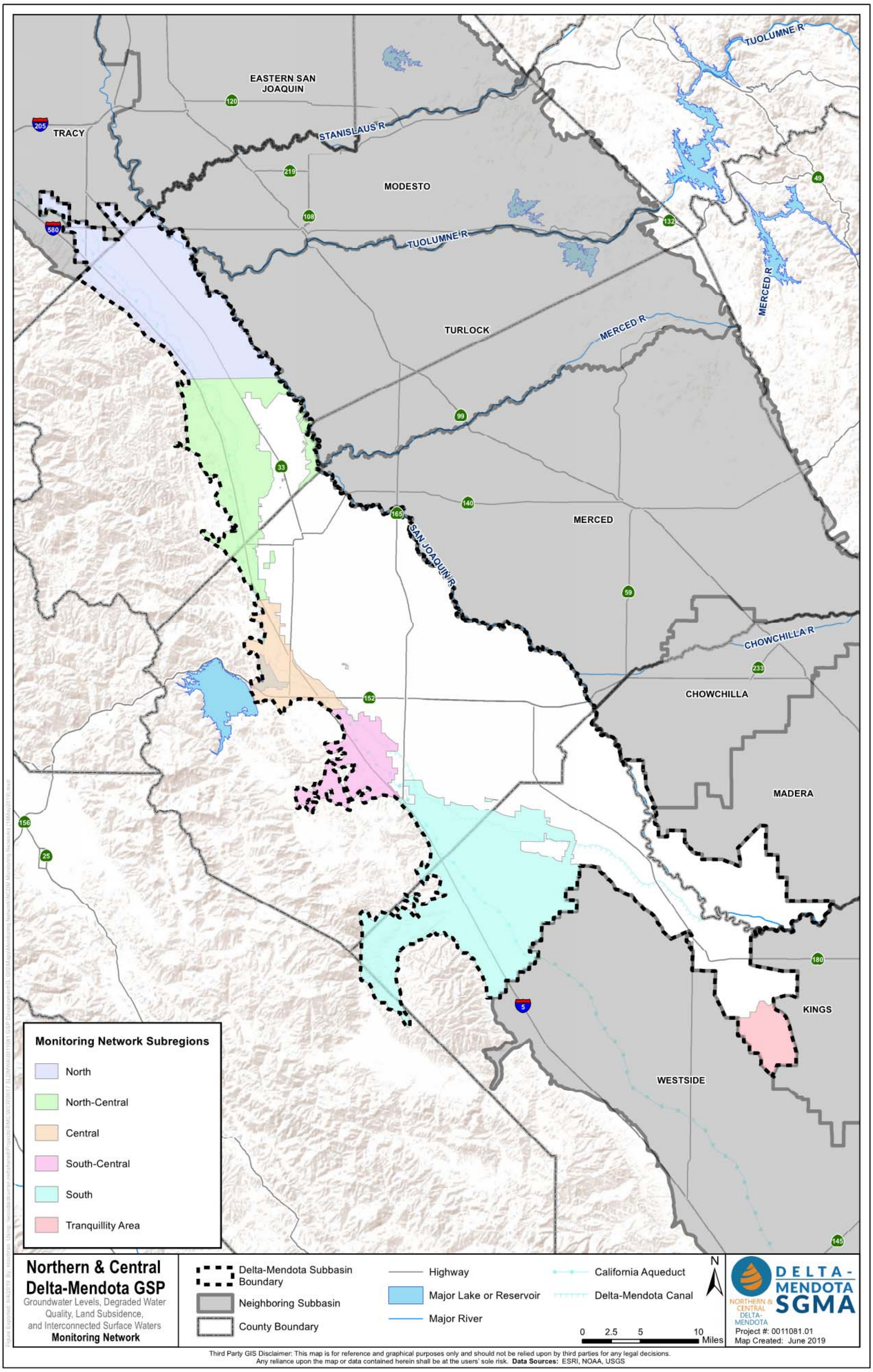

Figure 7-2. Monitoring Network Subregions

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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 7-3) and 18 wells in the Lower Aquifer (Figure 7-4).

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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	County	Subregion	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
02-001	05S07E15N002M	374934N1211934W001	MP037.32L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (United States Bureau of Reclamation [USBR]); CASGEM (Mandatory)	Stanislaus	North	360	150-360	1995	2019	51
06-004			MP031.31L1-L2Well1	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Stanislaus	North	Unknown	140-160; 200-240	2009	2019	27
03-001		375015N1211011W001	MW-2	Active	Monitoring	Patterson Irrigation District	CASGEM (Mandatory)	Stanislaus	North	250	220 - 250	2010	2018	21
03-002			MW-3	Unknown	Monitoring	Patterson Irrigation District	Local agency	Stanislaus	North	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])	Stanislaus	North	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)	Stanislaus	North-Central	115	95 - 115	2012	2019	81
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	North-Central	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)	Merced	North-Central	170	120 - 150	1995	2019	54
07-017			Well 1	Unknown	Public Supply	Volta Community Services District	Local agency	Merced	Central	Unknown	170-253	Not available	Not available	Not available
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Merced	South-Central	160	150 - 160	2012	2019	81
07-004	11S10E04L001M		MP081.08R	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Merced	South-Central	Unknown	140-200 (assumed)	2010	2019	29
07-011		368835N1206270W001	MP099.24L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Voluntary)	Fresno	South	405	300-390	1995	2019	69
07-012	12S/12E-16B		GDA003	Unknown	Irrigation	Grassland Drainage Area Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	Fresno	South	410	270 - 390	1995	2019	84
07-013			MP102.04R	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Fresno	South	600	220-240; 280-340	1995	2019	86
07-010		366500N1202500W001	KRCDTID02	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	Tranquillity	540	295-535	2014	2018	9
07-009		366000N1202300W001	KRCDTID03	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	Tranquillity	543	434-510	2014	2018	9
07-018	15S/16E-20		WSJ001	Unknown	Domestic	Westside San Joaquin River Watershed Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	Fresno	Tranquillity	205	165 - 205	Not available	Not available	Not available

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

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Status	Well Use	Agency	Program	County	Depth (ft)	Screen Intervals (ft)	Subregion	First Measurement Year	Last Measurement Year	Measurement Count
01-007			MP021.12L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	San Joaquin	Unknown	400-570 (assumed)	North	1995	2019	63
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Stanislaus	475	230 - 475	North	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)	Stanislaus	510	235 - 475	North	1995	2019	72
06-003		375774N1212096W001	WSID 3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	400	280 - 380	North	2009	2018	19
02-002			WELL 02 - NORTH 5TH STREET	Unknown	Public Supply	City of Patterson	Local agency	Stanislaus	360	170-356	North	2003	2019	55
06-001	06S08E09E001M	374316N1210994W001	P259-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	430	390 - 410	North-Central	2012	2019	81
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Stanislaus	721	218 - 242; 290 - 346; 353 - 358; 418 - 480; 490 - 538; 562 - 550; 600 - 595; 658 - 610	North-Central	1995	2019	83
04-001		376129N1212942W001	121	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	600	400 - 570	North-Central	2016	2018	5
01-008			MP051.66L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Stanislaus	Unknown	290-470 (assumed)	North-Central	1995	2019	62
01-006		372604N1210611W001	91	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Merced	260	120 - 210	North-Central	2016	2019	5
07-016			Well 01	Unknown	Public Supply	Santa Nella County Water District	Local agency	Merced	Unknown	185-225	Central	Not available	Not available	Not available
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Merced	355	335 - 355	South-Central	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)	Merced	615	425 - 455; 495 - 615	South	1995	2019	94
07-006	12S12E07E001M	369044N1207092W001	MP094.26L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Fresno	840	440 - 600; 640 - 720	South	1995	2019	84
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	550	530 - 550	South	2011	2019	78
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	1,002	542 - 982	South	2009	2019	10
07-014			TW-4	Unknown	Monitoring	Tranquillity Irrigation District	Local agency	Fresno	690	650-690	Tranquillity	2015	2019	38
07-015			TW-5	Unknown	Nested Monitoring	Tranquillity Irrigation District	Local agency	Fresno	630	630-670	Tranquillity	2015	2019	38

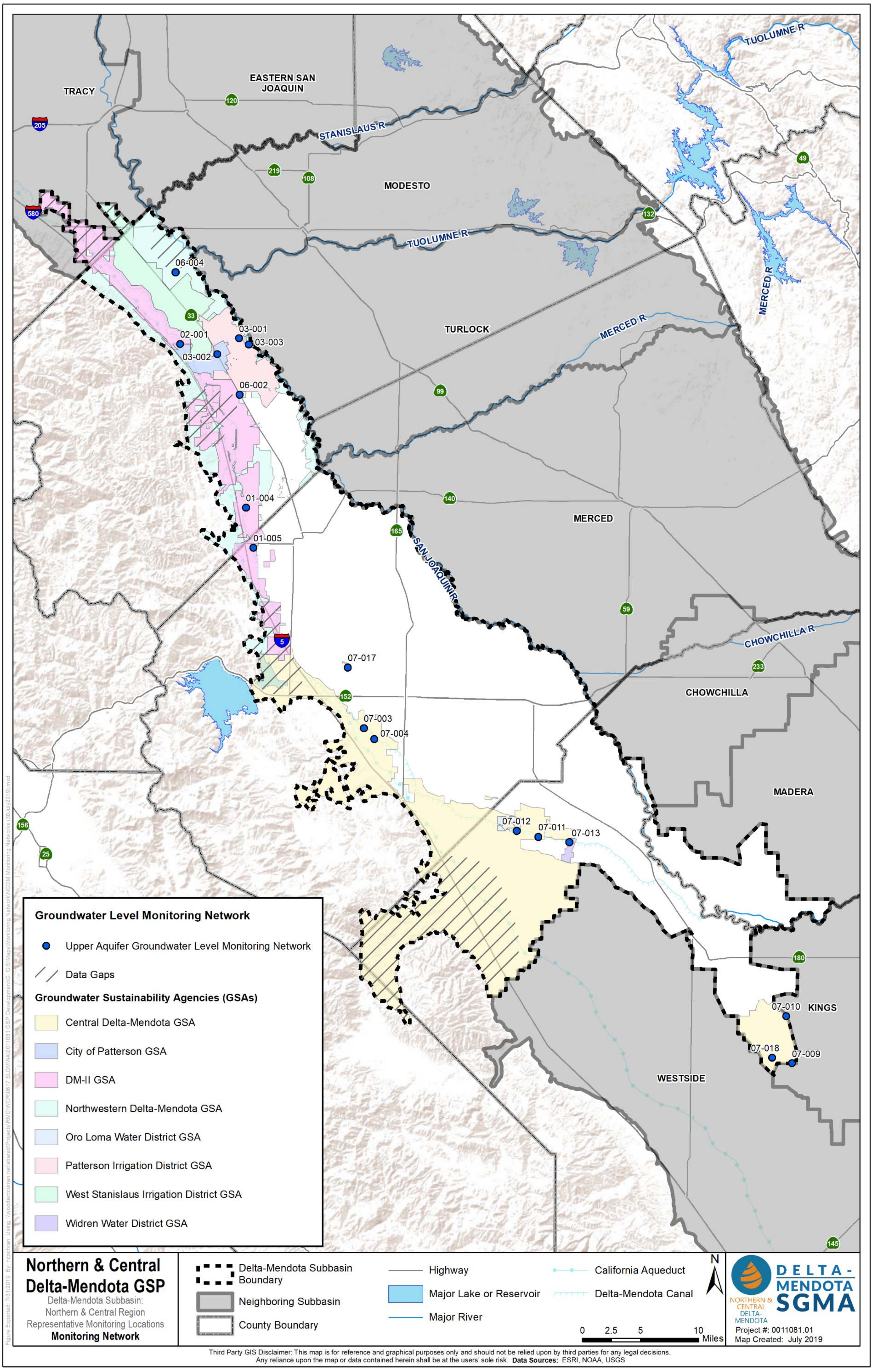

Figure 7-3. Groundwater Level Monitoring Network, Upper Aquifer

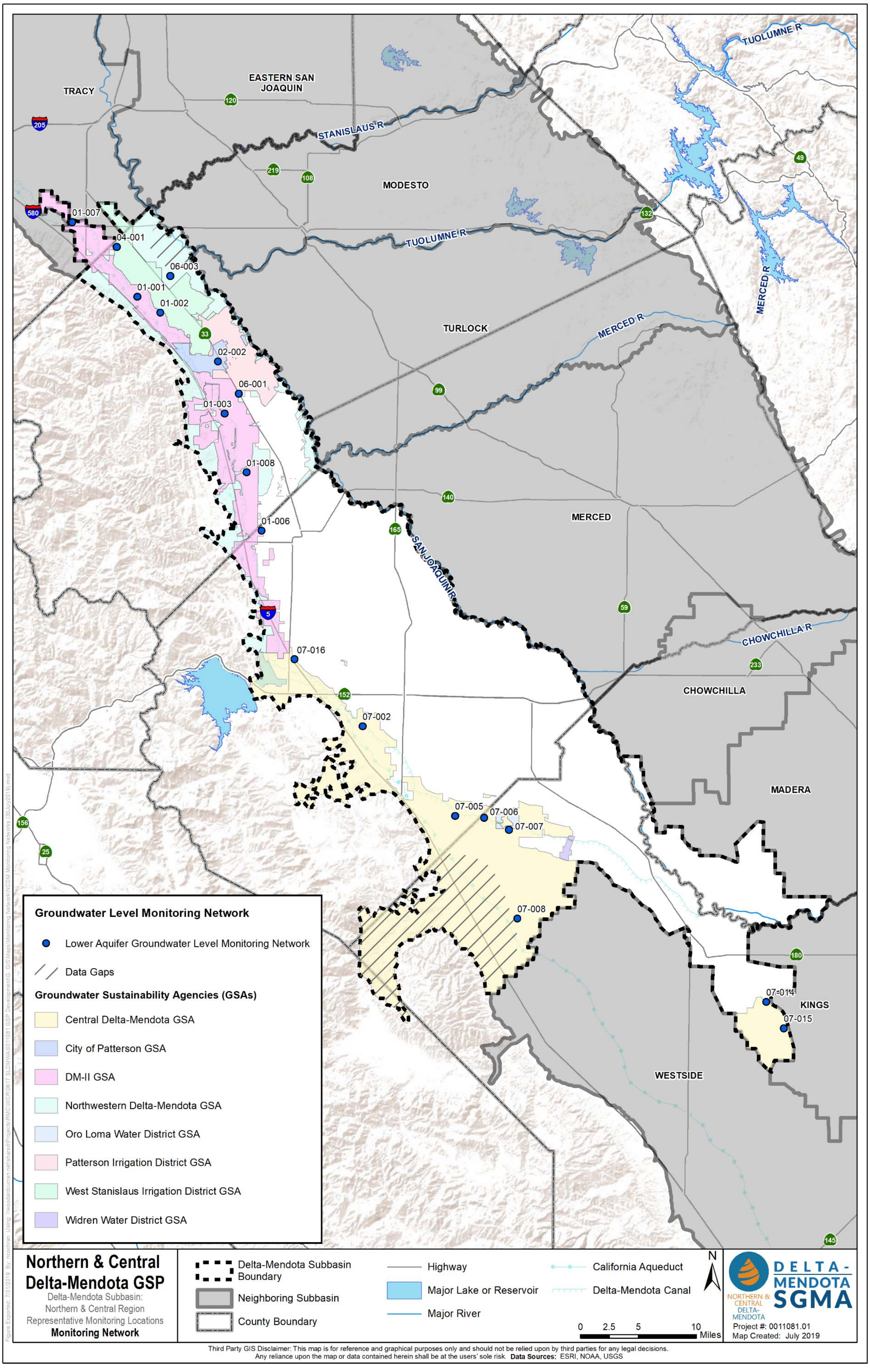

Figure 7-4. Groundwater Level Monitoring Network, Lower Aquifer

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. Adequate Spatial Distribution – As described in Section 7.2.4.2 (*Monitoring Network Subregions*), a minimum of two sites were selected per subregion to ensure adequate spatial coverage of monitoring sites throughout the Plan area. This criterion was applied along with the other criteria listed where greater or fewer than two sites within each subregion may be selected.

8. 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.

9. 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 7.2.4.4. 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.

Measuring Groundwater Elevation

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.

Figure 7-3 and Figure 7-4 reflect the spatial data gaps in groundwater level monitoring networks for the Upper Aquifer and Lower Aquifer within the Delta-Mendota Subbasin. Data gap areas were identified using professional judgement and localized knowledge. The location, reason, and local issues and circumstances that limit or prevent monitoring of these identified data gap areas located within the Northern and Central Delta-Mendota Regions are described below:

1. Portions of the DM-II and West Stanislaus Irrigation District (WSID) GSA neighboring the Tracy Subbasin (Upper Aquifer only) – There are no known wells located within this area with known and verified construction within the Upper Aquifer, therefore monitoring is currently limited in this area.
2. Portion of Northwestern Delta-Mendota GSA neighboring the Modesto Subbasin (Upper Aquifer and Lower Aquifer) - There are no known wells located within this area with known and verified construction within the Upper Aquifer or Lower Aquifer, therefore monitoring is currently limited in this area.
3. Oak Flat Water District area (DM-II GSA) (Upper Aquifer only) – Wells thought to be located in this area are limited to private wells where location, construction, and historical record are unknown and access is limited, thus currently limiting monitoring in this area.
4. Santa Nella County Water District and area surrounding O'Neill Forebay (Upper Aquifer only) - There are no known wells located within this area with known and verified construction within the Upper Aquifer, therefore monitoring is currently limited in this area.
5. Southwestern portion of the Central Delta-Mendota Multi-Agency GSA (Upper and Lower Aquifer) – Local water managers indicate there is *de minimis* or no groundwater use in this area within the Upper and Lower Aquifer and borings for groundwater exploration in the recent drought failed to encounter groundwater at economic quantities and depths, thus monitoring is largely unnecessary.

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.

7.2.5.1.6 Plan to Fill Data Gaps

Data gaps identified in the above section 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) (Figure 7-5 and Figure 7-6). 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. Additionally, four nested wells will be installed with tentative locations between the boundaries of Del Puerto Water District (DM-II GSA), Patterson Irrigation District, and West Stanislaus Irrigation District utilizing future grant funding. For the purpose of monitoring depletions of interconnected surface water, where groundwater levels are used as a proxy, four additional wells with tentative locations have been identified that would also be included in the groundwater level monitoring network. These wells are located within three miles of the San Joaquin River within the Northwestern Delta-Mendota GSA and Patterson Irrigation District GSA. 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 a 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.

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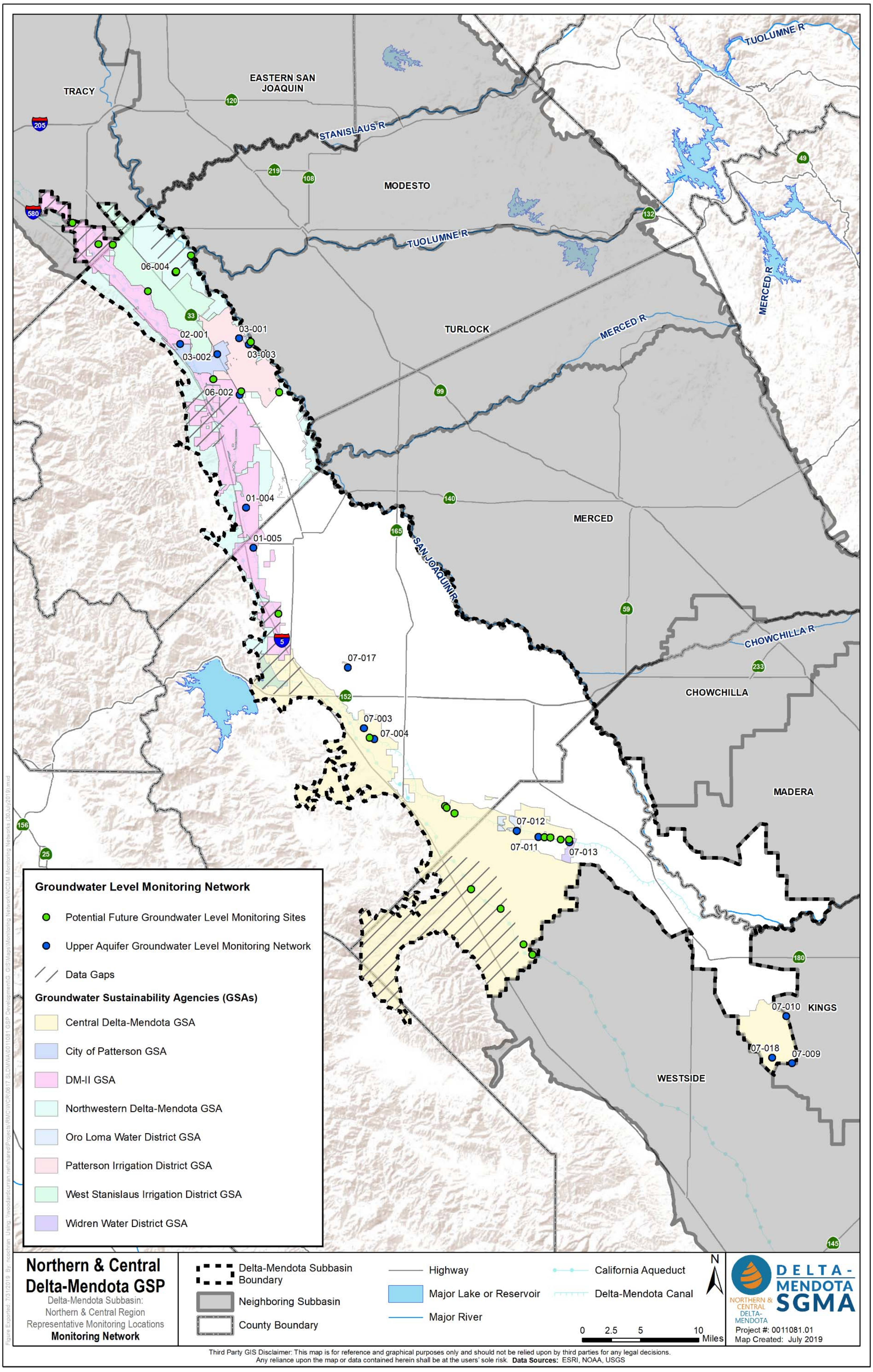

Figure 7-5. Potential Future Groundwater Level Monitoring Sites, Upper Aquifer

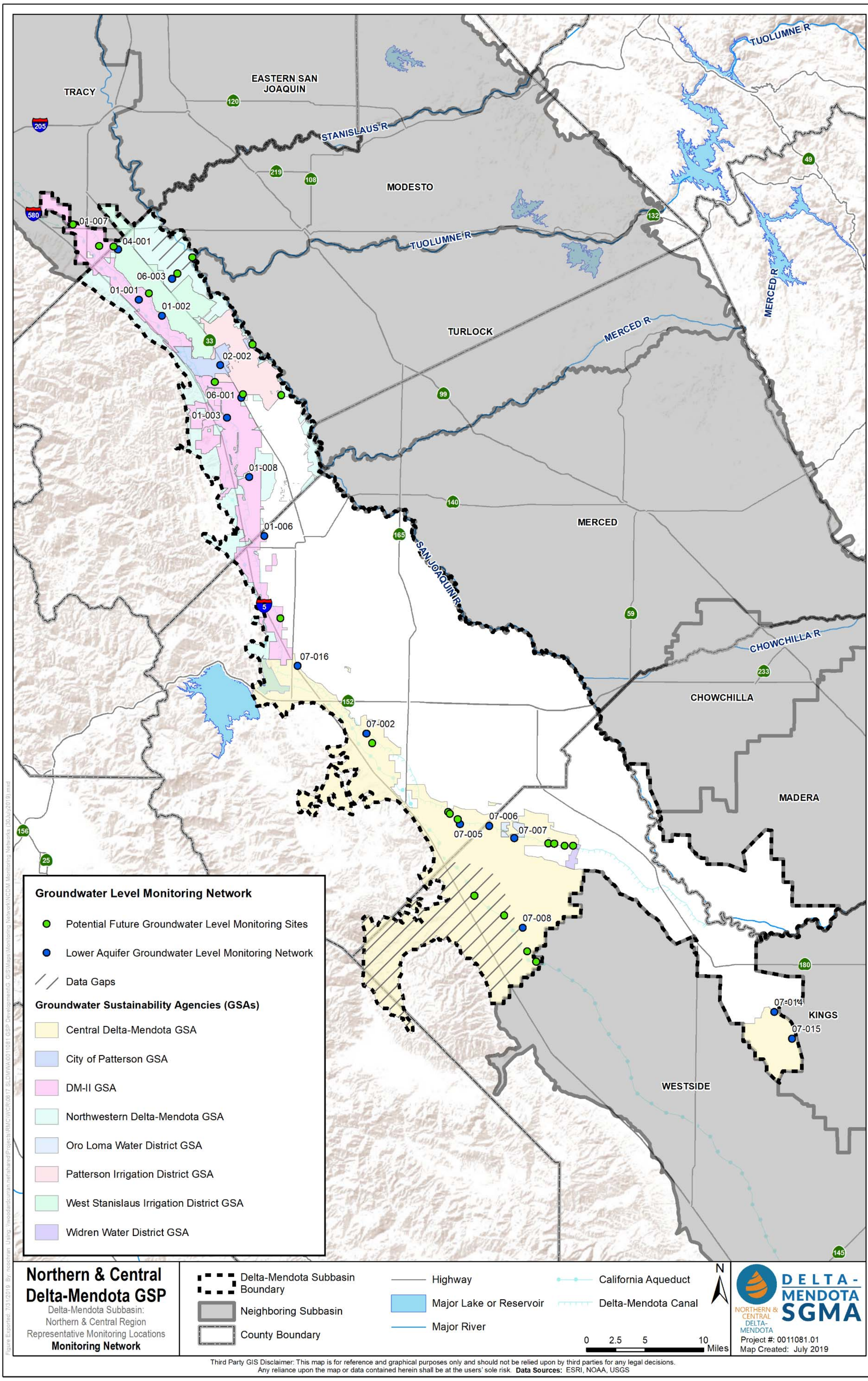

Figure 7-6. Potential Future Groundwater Level Monitoring Sites, Lower Aquifer

7.2.5.2 Groundwater Storage Monitoring Network

Groundwater levels will be used as a proxy for the reduction of groundwater storage sustainability indicator. Therefore, the groundwater storage monitoring network is analogous to the groundwater level monitoring network for both the Upper Aquifer and Lower Aquifer. Refer to Section 7.2.5.1 (*Groundwater Level Monitoring Network*) for more detail on the groundwater level 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, nitrate as N, and boron have been identified by the Northern and Central Delta-Mendota Regions as water quality constituents of concern within the Plan Area.

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

The groundwater quality monitoring network is analogous to the groundwater level monitoring network presented in Section 7.2.5.1. 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 17 wells perforated in the Upper Aquifer (Figure 7-7) and 18 wells in the Lower Aquifer (Figure 7-8).

Since the groundwater quality monitoring network and groundwater level monitoring network include identical sets of wells for the Upper Aquifer and Lower Aquifer, the well selection criteria described in Section 7.2.5.1.1 are also applicable to 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	County	Subregion	Depth (ft)	Screen Intervals (ft)	Constituent(s)	First Measurement Year	Last Measurement Year	Measurement Count
02-001	05S07E15N002M	374934N1211934W001	MP037.32L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Stanislaus	North	360	150-360	Not available	Not available	Not available	Not available
06-004			MP031.31L1-L2Well1	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Stanislaus	North	Unknown	140-160; 200-240	Not available	Not available	Not available	Not available
03-001		375015N1211011W001	MW-2	Active	Monitoring	Patterson Irrigation District	CASGEM (Mandatory)	Stanislaus	North	250	220 - 250	Not available	Not available	Not available	Not available
03-002			MW-3	Unknown	Monitoring	Patterson Irrigation District	Local agency	Stanislaus	North	260	220 - 250	Not available	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)	Stanislaus	North	255	130 - 250	Not available	Not available	Not available	Not available
06-002	06S08E09E003M	374316N1210994W003	P259-3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	North-Central	115	95 - 115	TDS and Nitrate as N	2010	2012	8 (TDS), 4 (Nitrate as N)
01-004	07S08E28R002M	372907N1210875W002	MC10-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	North-Central	135	115 - 135	TDS and Nitrate as N	2011	2012	8 (TDS), 4 (Nitrate as N)
01-005	08S08E15G001M	372424N1210754W001	MP058.28L	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Merced	North-Central	170	120 - 150	TDS, Nitrate as N, and Boron	2001	2017	5 (TDS), 6 (Nitrate as N), 5 (Boron)
07-017			Well 1	Unknown	Public Supply	Volta Community Services District	Local agency	Merced	Central	Unknown	170-253	TDS, Nitrate as N, and Boron	2002	2017	8 (TDS), 16 (Nitrate as N), 2 (Boron)
07-003	10S10E32L002M	370173N1208999W002	MC15-2	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Merced	South-Central	160	150 - 160	Not available	Not available	Not available	Not available
07-004	11S10E04L001M		MP081.08R	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Merced	South-Central	Unknown	140-200 (assumed)	TDS, Nitrate as N, and Boron	2007	2008	3 (TDS), 1 (Nitrate as N), 2 (Boron)
07-011		368835N1206270W001	MP099.24L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Voluntary)	Fresno	South	405	300-390	Not available	Not available	Not available	Not available
07-012	12S/12E-16B		GDA003	Unknown	Irrigation	Grassland Drainage Area Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	Fresno	South	410	270 - 390	Not available	Not available	Not available	Not available
07-013			MP102.04R	Active	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Fresno	South	600	220-240; 280-340	Not available	Not available	Not available	Not available
07-010		366500N1202500W001	KRCDTID02	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	Tranquillity	540	295-535	Not available	Not available	Not available	Not available
07-009		366000N1202300W001	KRCDTID03	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	Tranquillity	543	434-510	Not available	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)	Fresno	Tranquillity	205	165 - 205	Not available	Not available	Not available	Not available

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	County	Depth (ft)	Screen Intervals (ft)	Subregion	Constituent(s)	First Measurement Year	Last Measurement Year	Measurement Count
01-007			MP021.12L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	San Joaquin	Unknown	400-570 (assumed)	North	TDS, Nitrate as N, and Boron	2008	2016	7 (TDS), 14 (Nitrate as N), 7 (Boron)
01-001	04S06E36C001M	375509N1212609W001	MP030.43R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Stanislaus	475	230 - 475	North	TDS, Nitrate as N, and Boron	2013	2016	5 (TDS), 7 (Nitrate as N), 3 (Boron)
01-002	05S07E05F001M	375313N1212242W001	MP033.71L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Stanislaus	510	235 - 475	North	TDS, Nitrate as N, and Boron	2001	2013	5 (TDS), 8 (Nitrate as N), 6 (Boron)
06-003		375774N1212096W001	WSID 3	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	400	280 - 380	North	Not available	Not available	Not available	Not available
02-002			WELL 02 - NORTH 5TH STREET	Unknown	Public Supply	City of Patterson	Local agency	Stanislaus	360	170-356	North	TDS, Nitrate as N, and Boron	2000	2016	12 (TDS), 23 (Nitrate as N), 8 (Boron)
06-001	06S08E09E001M	374316N1210994W001	P259-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	430	390 - 410	North-Central	TDS and Nitrate as N	2010	2010	8 (TDS), 4 (Nitrate as N)
01-003	06S08E20D002M	374061N1211212W001	MP045.78R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Stanislaus	721	218 - 242; 290 - 346; 353 - 358; 418 - 480; 490 - 538; 562 - 550; 600 - 595; 658 - 610	North-Central	Not available	Not available	Not available	Not available
04-001		376129N1212942W001	121	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Stanislaus	600	400 - 570	North-Central	Not available	Not available	Not available	Not available
01-008			MP051.66L	Unknown	Unknown	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR)	Stanislaus	Unknown	290-470 (assumed)	North-Central	TDS, Nitrate as N, and Boron	2007	2016	7 (TDS), 10 (Nitrate as N), 5 (Boron)
01-006		372604N1210611W001	91	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Merced	260	120 - 210	North-Central	Not available	Not available	Not available	Not available
07-016			Well 01	Unknown	Public Supply	Santa Nella County Water District	Local agency	Merced	Unknown	185-225	Central	TDS and Nitrate as N	2000	2017	10 (TDS), 17 (Nitrate as N)
07-002	10S10E32L001M	370173N1208999W001	MC15-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Merced	355	335 - 355	South-Central	Not available	Not available	Not available	Not available
07-005	12S11E03Q001M	369097N1207554W001	MP091.68R	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Merced	615	425 - 455; 495 - 615	South	TDS	1994	1994	1 (TDS)
07-006	12S12E07E001M	369044N1207092W001	MP094.26L	Inactive	Irrigation	San Luis & Delta-Mendota Water Authority	Delta-Mendota Canal Pump-in Program (USBR); CASGEM (Mandatory)	Fresno	840	440 - 600; 640 - 720	South	TDS and Boron	2007	2007	1 (TDS), 1 (Boron)

DMS ID	Primary Well ID	CASGEM ID (if applicable)	Local ID	Status	Well Use	Agency	Program	County	Depth (ft)	Screen Intervals (ft)	Subregion	Constituent(s)	First Measurement Year	Last Measurement Year	Measurement Count
07-007	12S12E16E003M	368896N1206702W001	MC18-1	Active	Monitoring	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	550	530 - 550	South	TDS and Boron	2010	2010	1 (TDS), 1 (Boron)
07-008	13S12E22F001M	367885N1206510W001	PWD 48	Active	Irrigation	San Luis & Delta-Mendota Water Authority	CASGEM (Mandatory)	Fresno	1,002	542 - 982	South	Not available	Not available	Not available	Not available
07-014			TW-4	Unknown	Monitoring	Tranquillity Irrigation District	Local agency	Fresno	690	650-690	Tranquillity	Not available	Not available	Not available	Not available
07-015			TW-5	Unknown	Nested Monitoring	Tranquillity Irrigation District	Local agency	Fresno	630	630-670	Tranquillity	Not available	Not available	Not available	Not available

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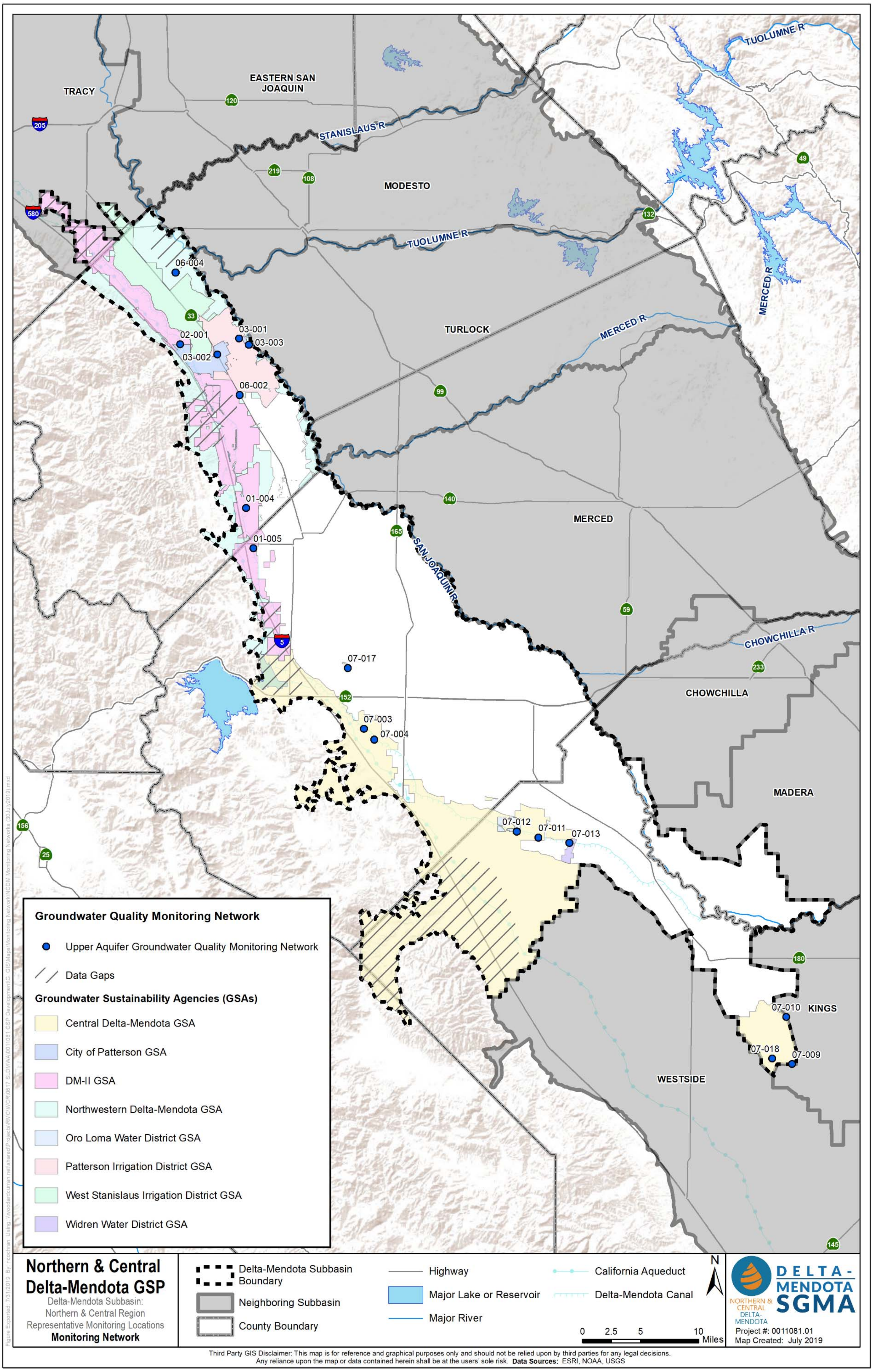

Figure 7-7. Groundwater Quality Monitoring Network, Upper Aquifer

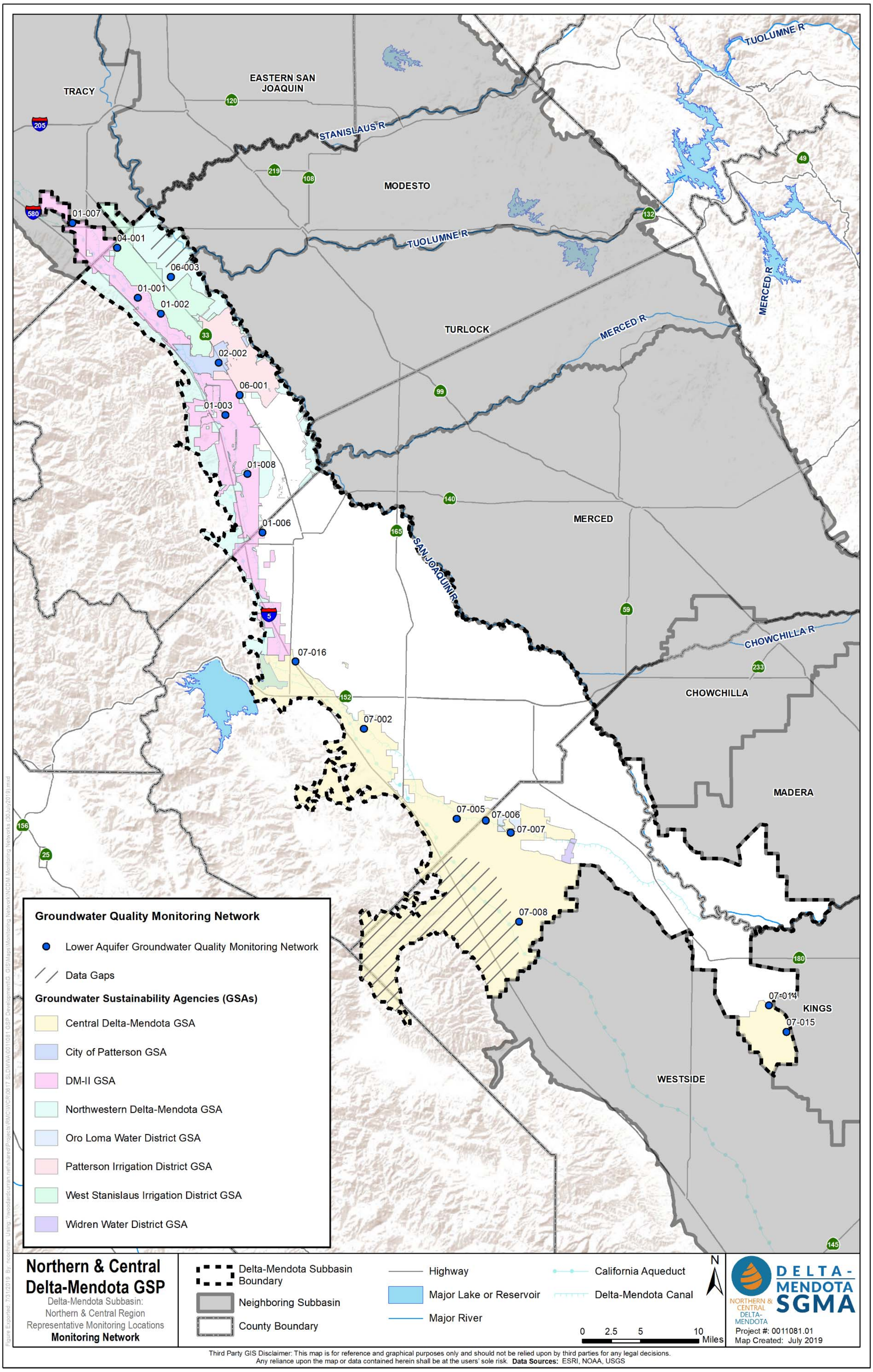

Figure 7-8. Groundwater Quality Monitoring Network, Lower Aquifer

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 7.2.4.4. 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.

<u>Sampling Water Quality Data</u>

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.

<u>Data Reduction, Validation, and Reporting</u>

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 July. 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.

Since the groundwater quality monitoring networks for the Upper Aquifer and Lower Aquifer contain identical sets of wells to the groundwater level monitoring networks for the Upper Aquifer and Lower Aquifer, the spatial density of wells is also the same. Refer to Section 7.2.5.1.4 for more detail regarding spatial density of the groundwater levels and groundwater quality monitoring networks for each principal aquifer.

7.2.5.4.5 Data Gaps

Groundwater quality monitoring data gaps include both temporal and spatial gaps. Since the groundwater level monitoring networks and groundwater quality monitoring networks for the Upper Aquifer and Lower Aquifer are analogous, all data gaps identified and described in Section 7.2.5.1.5 are applicable to the groundwater quality monitoring networks.

7.2.5.4.6 Plan to Fill Data Gaps

The groundwater quality monitoring networks for the Upper Aquifer and Lower Aquifer contain identical sets of wells as the groundwater level monitoring networks for the Upper Aquifer and Lower Aquifer, respectively. Refer to Section 7.2.5.1.6 for the plan to fill data gaps in the groundwater levels and groundwater quality monitoring networks for both principal aquifers. 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 each land subsidence management area (see Section 5.5 *Management Areas* of the *Basin Setting* chapter for more detail regarding management areas).

This section provides information about management areas established for the land subsidence sustainability indicator, 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 Management Areas

Two management areas (MAs) have been established for the inelastic land subsidence sustainability indicator within the Northern and Central Delta-Mendota Regions: the West Stanislaus Irrigation District-Patterson Irrigation District (WSID-PID) MA and the Tranquillity Irrigation District (TRID) MA. Refer to Section 5.5 *Management Areas* of the *Basin Setting* chapter for more detail regarding the reasons these management areas were established. The land subsidence monitoring network has been established in consideration of sufficient quantity and density of monitoring sites to evaluate conditions of the basin setting and sustainable management criteria specific to the designated management areas.

7.2.5.5.2 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, where there are six (6) benchmarks located within the WSID-PID MA and three (3) benchmarks located within the TRID MA. Figure 7-9 shows the locations of each land subsidence monitoring location within the Plan Area.

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. Management Area Coverage – For established MAs, a sufficient quantity and density of monitoring sites were selected to evaluate conditions and manage land subsidence relative to the sustainable management criteria established for each MA.

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.

Table 7-10. Land Subsidence Monitoring Network

DMS ID	Local ID	Monitoring Agency	Site Type	County	Subregion	Management Area	First Measurement Year	Last Measurement Year	Measurement Frequency
02-003	Floragold Well	City of Patterson	Benchmark	Stanislaus	North	N/A	2006	2019	Periodic
02-008	Well 11	City of Patterson	Benchmark	Stanislaus	North	N/A	2006	2019	Periodic
02-005	Well 2	City of Patterson	Benchmark	Stanislaus	North	N/A	2006	2019	Periodic
02-006	Well 4	City of Patterson	Benchmark	Stanislaus	North	N/A	2006	2019	Periodic
02-007	Well 6	City of Patterson	Benchmark	Stanislaus	North	N/A	2006	2019	Periodic
03-004	Locust Avenue Well	Patterson Irrigation District	Benchmark	Stanislaus	North	WSID-PID	Unknown	2019	Periodic
03-005	Pumping Plant No. 2	Patterson Irrigation District	Benchmark	Stanislaus	North	WSID-PID	Unknown	2019	Periodic
03-006	River Station	Patterson Irrigation District	Benchmark	Stanislaus	North	WSID-PID	Unknown	2019	Periodic
01-010	Subsidence Monitoring Point #1	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North	N/A	1984	2018	Periodic
01-011	Subsidence Monitoring Point #2	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North	N/A	1984	2018	Periodic
01-012	Subsidence Monitoring Point #3	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North	N/A	1984	2018	Periodic
01-013	Subsidence Monitoring Point #4	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North	N/A	1984	2018	Periodic
01-014	Subsidence Monitoring Point #5	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North	N/A	1984	2018	Periodic
02-004	Subsidence Monitoring Point #6	San Luis & Delta-Mendota Water Authority, City of Patterson	Benchmark	Stanislaus	North	N/A	1984	2018	Periodic
04-002	WSID 1	West Stanislaus Irrigation District	Benchmark	Stanislaus	North	WSID-PID	Unknown	Unknown	Periodic
04-003	WSID 11	West Stanislaus Irrigation District	Benchmark	Stanislaus	North	WSID-PID	Unknown	Unknown	Periodic
04-004	WSID 21	West Stanislaus Irrigation District	Benchmark	Stanislaus	North	WSID-PID	Unknown	Unknown	Periodic
01-015	Subsidence Monitoring Point #7	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North-Central	N/A	1984	2018	Periodic
06-006	Subsidence Monitoring Point #8	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North-Central	N/A	1984	2018	Periodic
01-016	Subsidence Monitoring Point #9	San Luis & Delta-Mendota Water Authority	Benchmark	Stanislaus	North-Central	N/A	1984	2018	Periodic
01-017	Subsidence Monitoring Point #10	San Luis & Delta-Mendota Water Authority	Benchmark	Merced	Central	N/A	1984	2018	Periodic
07-021	Subsidence Monitoring Point #11	San Luis & Delta-Mendota Water Authority	Benchmark	Merced	Central	N/A	1984	2018	Periodic
01-009	P252	University NAVSTAR Consortium (UNAVCO)	CGPS	Merced	Central	N/A	2005	2019	Daily
07-022	Subsidence Monitoring Point #12	San Luis & Delta-Mendota Water Authority	Benchmark	Merced	South-Central	N/A	1984	2018	Periodic
07-023	Subsidence Monitoring Point #13	San Luis & Delta-Mendota Water Authority	Benchmark	Merced	South-Central	N/A	1984	2018	Periodic
07-020	104.20-R	San Luis Water District	Benchmark	Fresno	South	N/A	1967	2019	Periodic
07-024	Subsidence Monitoring Point #14	San Luis & Delta-Mendota Water Authority	Benchmark	Fresno	South	N/A	1984	2018	Periodic
07-025	Subsidence Monitoring Point #15	San Luis & Delta-Mendota Water Authority	Benchmark	Fresno	South	N/A	1984	2018	Periodic
07-019	AG-24	Tranquillity Irrigation District	Benchmark	Fresno	Tranquillity	TRID	2013	2019	Annual
07-026	TID A	Tranquillity Irrigation District	Benchmark	Fresno	Tranquillity	TRID	2013	2019	Annual
07-027	TID B	Tranquillity Irrigation District	Benchmark	Fresno	Tranquillity	TRID	2013	2019	Annual

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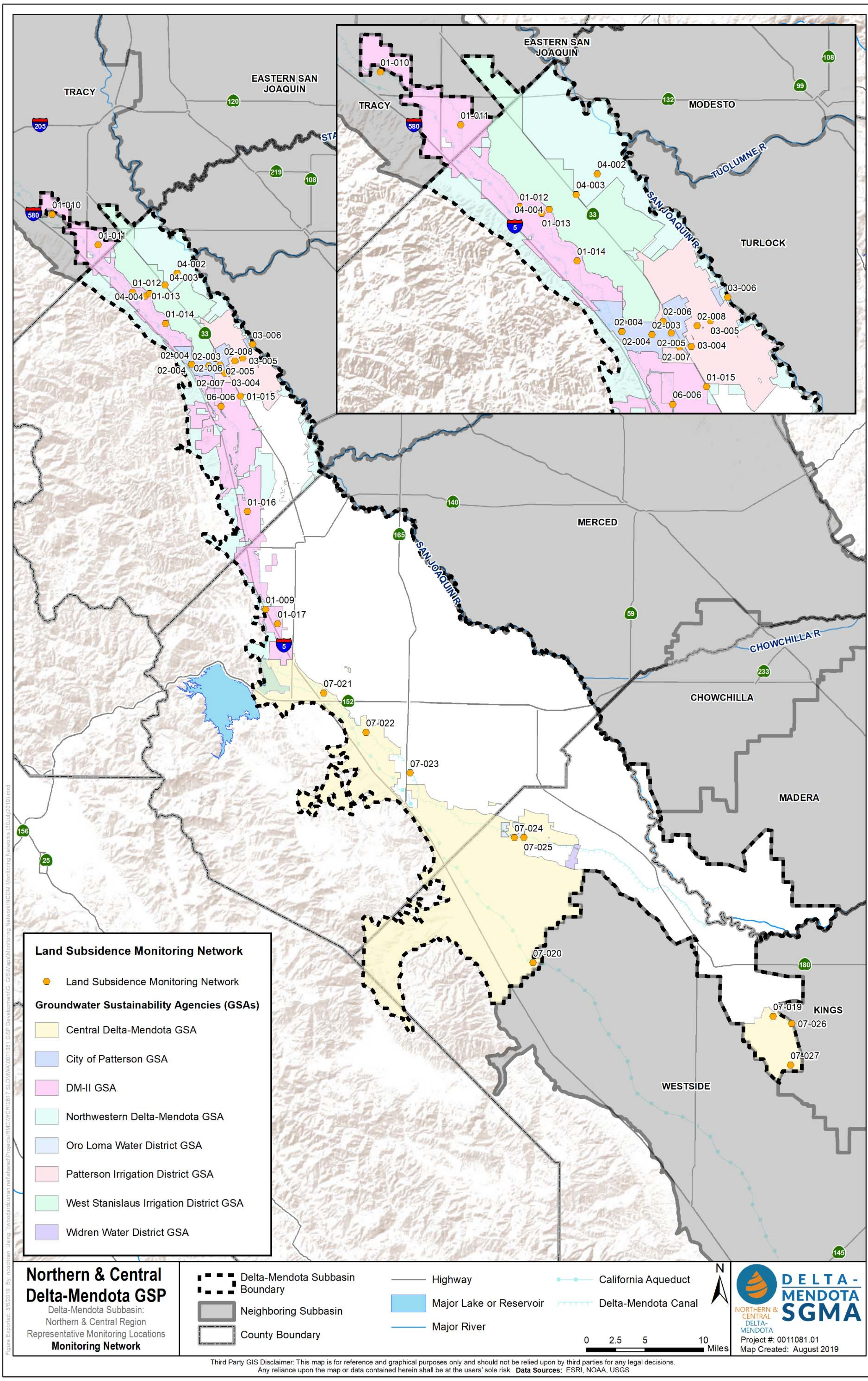

Figure 7-9. Land Subsidence Monitoring Network

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7.2.5.5.3 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 7.2.4.4. 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.

<u>Land Surveying Procedures</u>

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

<u>Data Reduction, Validation, and Reporting</u>

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.

7.2.5.5.4 Frequency and Timing of Monitoring

Land subsidence monitoring sites will be surveyed, and data will be analyzed and recorded at differing frequencies within the established MAs and the remaining Plan Area. In the WSID-PID MA, baseline land surface elevation measurements will be performed during calendar year 2019, and two subsequent surveys will be performed between 2020 and 2025. Elevation surveys will be performed at representative monitoring sites in the WSID-PID MA by the end of calendar year 2020 (in preparation for the 2021 Annual Report) and by the end of calendar year 2023 (in preparation for the 2025 GSP Update). In the TRID MA, elevation surveys will take place annually. Elevation surveys in the WSID-PID and TRID MAs will be performed during the month of May. Refer to Section 5.5 *Management Areas* of the *Basin Setting* chapter for more information about monitoring frequency deemed appropriate for each established MA. Within the remaining Plan area, elevation surveys will be performed every other year with surveys taking place during even years. Elevation surveys within the remaining Northern & Central Region GSP Plan area will be performed 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.

7.2.5.5.5 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 and the two established MAs.

7.2.5.5.6 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 management areas and their respective 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.

7.2.5.5.7 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 7.2.5.5.3 and 7.2.5.5.4.

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 includes a subset of wells from the groundwater level monitoring network for the Upper Aquifer. 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).

Proximity to the portion of the San Joaquin River located within the Northern Delta-Mendota Region, approximately within three miles of the river, was an additional criterion considered in establishing this monitoring network. A distance of three miles was selected based on DWR's *Monitoring Networks and Identification of Data Gaps* BMP (2016a) document, where future data collection and analyses will determine the appropriate distance from the river for monitoring this sustainability indicator. Table 7-11 and Figure 7-10 summarize the two existing representative monitoring locations identified to evaluate short-term, seasonal, and long-term trends in groundwater levels and potential changes in gradient between the wells and the San Joaquin River. Table 7-12 shows the selected stream gauges for use in monitoring for potential changes in gradient between the representative monitoring sites and San Joaquin River head.

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 7.2.4.4. 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.

<u>Protocols for Measuring Streamflow</u>

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.

Table 7-11. Depletions of Interconnected Surface Water Monitoring Network

DMS ID	State Well Number	CASGEM ID (if applicable)	Local ID	Status	Well Use	Monitoring Agency	Monitoring Program	County	Subregion	Depth (ft)	Screen Intervals (ft)	First Measurement Year	Last Measurement Year	Measurement Count
03-001		375015N1211011W001	MW-2	Active	Monitoring	Patterson Irrigation District	CASGEM (Mandatory)	Stanislaus	North	250	220 - 250	2010	N/A – Continuous Monitoring	21
03-003	05S/08E-16R		WSJ003	Unknown	Irrigation	Westside San Joaquin River Watershed Coalition	Groundwater Quality Trend Monitoring Program (ILRP)	Stanislaus	North	255	130 - 250	Not available	Not available	Not available

Table 7-12. Selected Stream Gauges

Stream Gauge ID	Description	Agency	River Discharge			River Stage		
			First Measurement Year	Last Measurement Year	Measurement Frequency	First Measurement Year	Last Measurement Year	Measurement Frequency
SMN	San Joaquin River above Merced River near Newman	United States Geological Survey	2010	present	15-minute intervals (computed)	2010	present	15-minute intervals
NEW	San Joaquin River near Newman	United States Geological Survey	1995	present	15-minute intervals (computed)	1984	present	15-minute intervals
SCL	San Joaquin River near Crows Landing	United States Geological Survey	2004	present	15-minute intervals (computed)	2004	present	15-minute intervals
SJP	San Joaquin River near Patterson	California Data Exchange Center (DWR)	1997	present	15-minute intervals	1997	present	15-minute intervals
MRB	San Joaquin River near Maze Rd Bridge	California Data Exchange Center (DWR)	2006	present	15-minute intervals (computed)	2006	present	15-minute intervals
VNS	San Joaquin River near Vernalis	California Data Exchange Center (DWR) and United States Geological Survey	1984	present	15-minute intervals	1995	present	15-minute intervals
PID Transducer		Patterson Irrigation District	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WSID Pumping Plant 1 Intake Level Sensors	At end of gravity-fed canal, two miles inland from San Joaquin River.	West Stanislaus Irrigation District	Not measured	Not measured	Not measured	2013	present	15-second intervals

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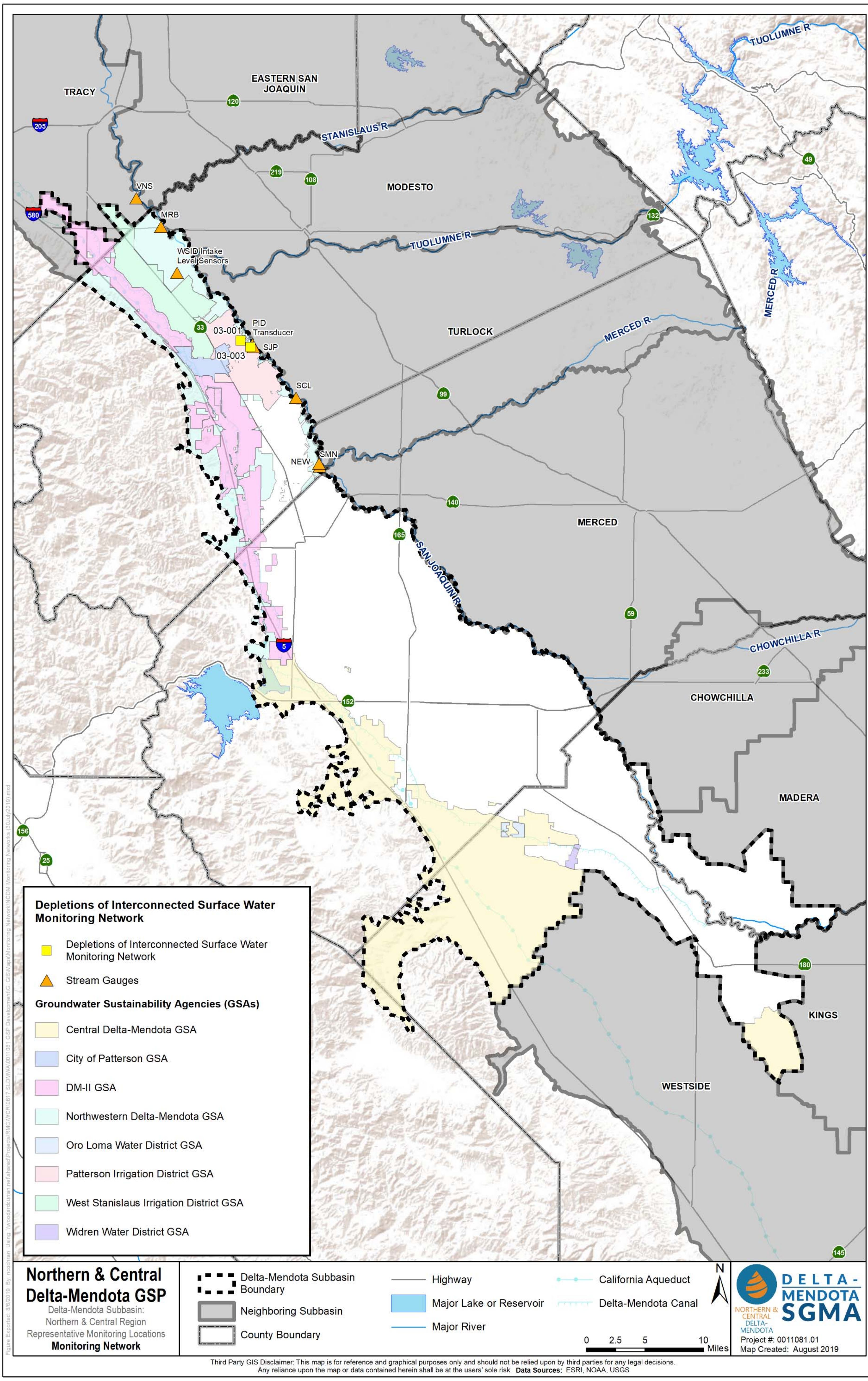

Figure 7-10. Depletions of Interconnected Surface Water Monitoring Network

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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 a proxy, the locations of four (4) clustered or nested wells with tentative locations have been identified (Figure 7-11). These wells are located within three miles of the San Joaquin River within the Northwestern Delta-Mendota GSA and Patterson Irrigation District GSA. 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 currently identified in Table 7-12, 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.

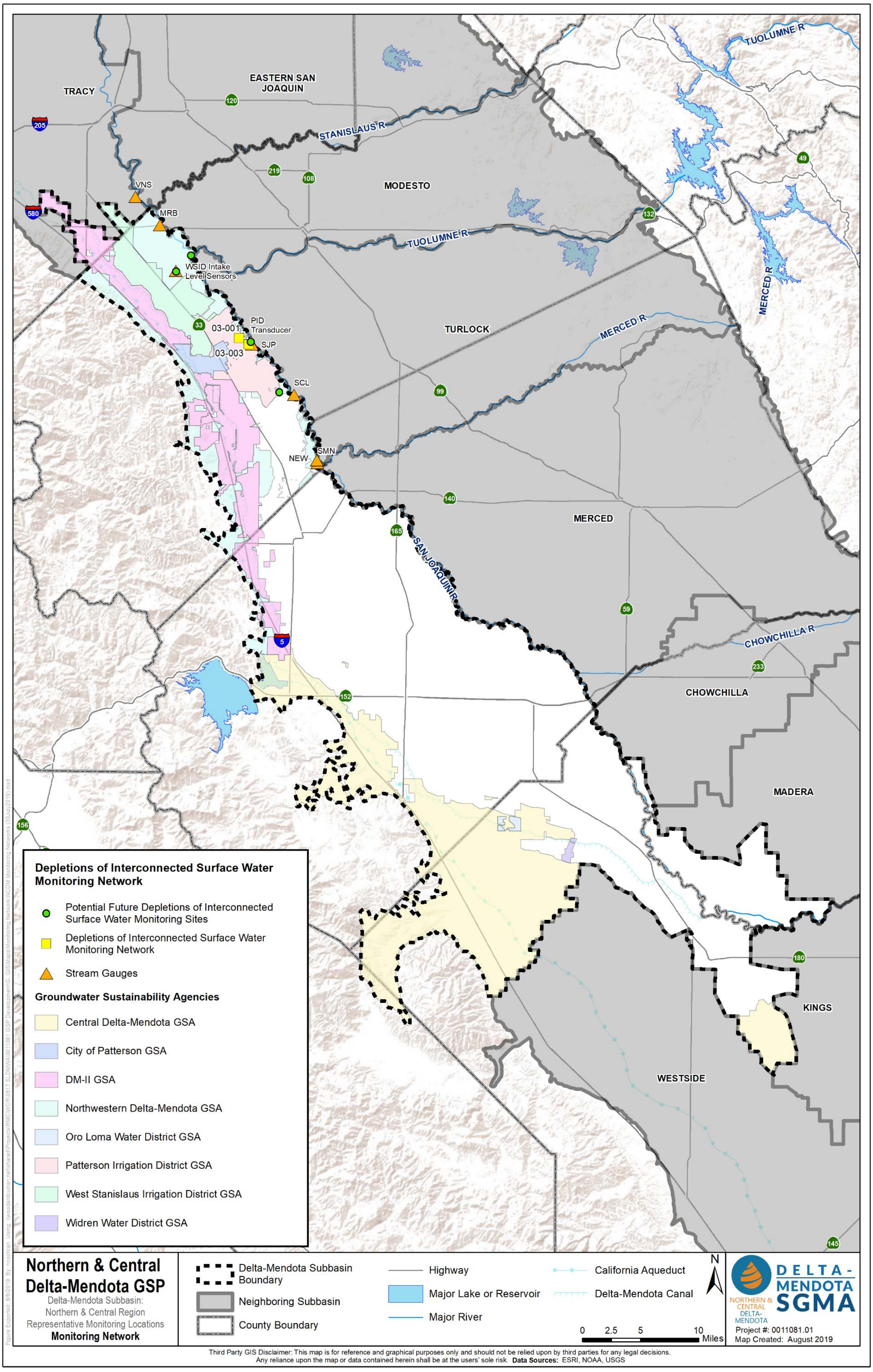

Figure 7-11. Potential Future Depletions of Interconnected Surface Water Monitoring Sites

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