Grassland Groundwater Sustainability Agency

REVISED
Groundwater Sustainability Plan

In Cooperation with:
Merced County Delta-Mendota Groundwater Sustainability Agency

December 2019
Revised July 2022

LIMITATION

In preparation of this revised Groundwater Sustainability Plan (Plan), the professional services of Provost & Pritchard Consulting Group were consistent with generally accepted engineering principles and practices in California at the time the services were performed.

Judgments leading to conclusions and recommendations were made based on the best available information but are made without a complete knowledge of subsurface geological and hydrogeological conditions. This Plan is intended to provide information from readily available published or public sources. We understand that the interpretations and recommendations are for use by the Grassland Groundwater Sustainability Agency (GGSA) in cooperation with the Merced County Delta-Mendota Groundwater Sustainability Agency (MCDMGSA) in assisting the GSAs in making decisions related to potential water supplies and groundwater management activities in light of California's new and evolving Sustainable Groundwater Management Act (SGMA) regulations. Subsurface conditions or variations cannot be known, or entirely accounted for, in spite of significant study and evaluation. Future surface water and groundwater quantity, quality, and availability cannot be known. Trends have been estimated and projected based upon past historical data and events and are used for planning purposes. It should be noted that historic trends may not be indicative of future outcomes. Historic hydrology has been used to identify averages and potential extremes that may be experienced in future years; however, it will be important for the GSAs to continually evaluate all the parameters that make up the water budget. Additionally, the rapidly changing regulatory environment surrounding the SGMA and State regulatory agencies may render any or all recommendations invalid in the future if not implemented and necessary approvals, permits, or rights obtained in a timely manner. Information contained in this GSP should not be regarded as a guarantee that only the conditions reported and discussed are present within the GGSA and MCDMGSA, or that other conditions may exist which could have a significant effect on groundwater availability.

In developing our methods, conclusions, and recommendations we have relied on information that was prepared or provided by others. We have assumed that this information is accurate and correct, unless noted. Changes in existing conditions due to time lapse, natural causes including climate change, operations in adjoining GSAs or subbasins, or future management actions taken by a GSA may deem the conclusions and recommendations inappropriate. No guarantee or warranty, expressed or implied, is made.

REGISTERED PROFESSIONAL ENGINEER
RICHARD B. IGER
No. 38,272
Civil
STATE OF CALIFORNIA

Plan prepared by:

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

DATE SIGNED July 8, 2022

Table of Contents

List of Tables

List of Figures

Appendices

Appendix A – Common Chapter

Appendix B – Kenneth D Schmidt & Associates - HCM and GW Conditions Report

Appendix C – Water Conservation Plan Annual Report

Appendix D – Projected Water Budget

Appendix E – Memorandum of Agreement

Appendix F – Communication and Engagement Plan

Appendix G – Track Changes of Revisions to Grassland GSP and Common Chapter

Appendix H – Response to Comments Received

Abbreviations

AF .... Acre-Feet

AF/YR .... Acre-Feet Per Year

CASGEM .... California Statewide Groundwater Elevation Monitoring

CDEC .... California Data Exchange Center

CDFW .... California Department of Fish and Wildlife

CEQA .... California Environmental Quality Act

CGPS .... Continuous Global Positioning System

CVP .... Central Valley Project

DHS .... Department of Health Services

District .... Grassland Water District

DMB, Subbasin .... Delta-Mendota Groundwater Subbasin

DMS .... Data Management System

DMSDMS .... Delta-Mendota Subbasin Data Management System

DTSC .... Department of Toxic Substances Control

DWR .... Department of Water Resources

EC .... Electroconductivity

EPA .... U.S. Environmental Protection Agency

ET .... Evapotranspiration

FFB .... Freemont Ford Bridge Station

GAMA .... Groundwater Ambient Monitoring and Assessment

GC .... Groundwater Conditions

GDE .... Groundwater Dependent Ecosystem

GEA .... Grassland Ecological Area

GGSA .... Grassland Groundwater Sustainability Agency

GPS .... Global Positioning System
GPD .... Gallons Per Day
GRCD .... Grassland Resource Conservation District
GSA .... Groundwater Sustainability Agency
GSP .... Groundwater Sustainability Plan
GWD .... Grassland Water District
HCM .... Hydrogeological Conceptual Model
ILRP .... Irrigated Lands Regulatory Program
InSAR .... Interferometric Synthetic-Aperture Radar
IRWMP .... Integrated Regional Water Management Plan
KDSA .... Kenneth D. Schmidt & Associates
LiDAR .... Light Detection and Ranging
MCDMGSA .... Merced County Delta-Mendota Groundwater Sustainability Agency
NASA .... National Aeronautics and Space Administration
NAVSTAR .... Navigation Satellite Timing and Ranging
NGWCWQCP .... North Grassland Water Conservation and Water Quality Control Project
NRCS .... Natural Resource Conservation Service
PBO .... Plate Boundary Observatory
Plan Area .... Grassland Plan Area
QAPP .... Quality Assurance Program Plan
RTWQMP .... Real-Time Water Quality Monitoring Program
RWQCB, Regional Board .... Central Valley Regional Water Quality Control Board
SGMA .... Sustainable Groundwater Management Act
SJR .... San Joaquin River
SJRRP, Restoration Program .... San Joaquin River Restoration Program
SJS .... Stevenson Station
SLDMWA .... San Luis & Delta-Mendota Water Authority
SMC .... Sustainable Management Criteria
SOPAC .... Scripps Orbit and Permanent Array Center
SWRCB .... State of California Water Resources Control Board
TDS .... Total Dissolved Solids
UNAVCO .... University NAVSTAR Consortium
USACE .... US Army Corps of Engineers
USBR .... U.S. Bureau of Reclamation
USFWS .... United States Fish and Wildlife Service

USGS .... United States Geological Survey
WDR .... Waste Discharge Requirement
WHPA .... Wellhead Protection Area
WMA .... Wildlife Management Area

Executive Summary

The Grassland Groundwater Sustainability Agency (GGSA) and Merced County Delta-Mendota Groundwater Sustainability Agency (MCDMGSA) have prepared a Groundwater Sustainability Plan (GSP) to comply with the Sustainable Groundwater Management Act (SGMA). The GGSA and MCDMGSA are both located within the Delta-Mendota Groundwater Subbasin (DMB, Subbasin), which consists of six plan areas that encompass 23 GSAs. The following is a summary of the content and layout of the document.

Chapter 1 - Introduction

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act of 2014 (SGMA), which is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management in California that must be achieved during the planning and implementation horizon from 2020 to 2040 and sustained into the future without causing undesirable results. SGMA requires that the following six sustainability indicators must be considered:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The Grassland Plan Area (Plan Area) consists of the GGSA and portions of the MCDMGSA. Both GSAs are governed by their respective GSA boards, and engage in coordination for the development and implementation of the Grassland GSP. In addition to the Grassland GSP coordination, the DMB is overseen by a Coordination Committee that ensures the use of consistent data and methodologies, develops sustainable management criteria (SMC) that are approved by all members of the Subbasin, and manages data from a comprehensive monitoring network for the required sustainability indicators. Compliant with SGMA and the DMB Coordination Agreement, the Grassland GSP participants agree to submit the GSP to the Department of Water Resources (DWR) through the Coordination Committee and Plan Manager. The Grassland GSP is considered complete with the submittal of the Common Chapter (**Appendix A**).

This GSP, including the Common Chapter, has been revised (changes are shown in **Appendix G**) to address items of concern raised by DWR in its initial “Incomplete” Determination Letter dated January 21, 2022. Every effort was made to ensure that this revised GSP and the revised Common Chapter are consistent. In the event of an inconsistency, the revised Common Chapter controls.

The Grassland Plan Area will continue to be sustainable by maintaining the historically balanced groundwater system in order to avoid causing significant and unreasonable undesirable impacts to beneficial users of groundwater as they relate to the six sustainability indicators. The Plan Area participants are committed to continued coordination with neighboring GSP areas and neighboring subbasins in order to aid in the localized and statewide groundwater sustainability goals as defined by each GSP and Subbasin.

Chapter 2 - Plan Area

The Plan Area covers 104,417 acres located within Merced County and is comprised of portions of the MCDMGSA and the entirety of the Grassland Water District (GWD) and the Grassland Resource Conservation District (GRCD), the two of which together form the GGSA. The majority of the Plan Area is located within the 240,000-acre Grassland Ecological Area. The Grassland Plan Area, comprised of GGSA and MCDMGSA, is located in western Merced County (**Figure ES-1**). The Plan Area land use is predominantly managed wetlands, uplands, and riparian corridors (see **Table ES-1**). There are few permanent residents in the Plan Area and no cities or towns. There are no adjudicated areas within the Plan Area.

Table ES-1: DWR 2014 Plan Area Land Use

Land-Use Classification	Percent of Total Area
Managed Wetlands and Uplands	95.39
Agriculture	3.26
Urban/Developed	1.35
Total	100

The Plan Area is bounded by the following GSAs: San Joaquin River Exchange Contractors GSA, MCDMGSA, Central Delta-Mendota Region GSA, City of Los Banos GSA, City of Gustine GSA, Northwestern Delta-Mendota GSA, Merced Subbasin GSA, and Turner Island Water District GSA (**Figure ES-2**). Additionally, the Grassland Plan Area is adjacent to the San Joaquin River which is influenced by the San Joaquin River Restoration Program (SJRRP, Restoration Program).

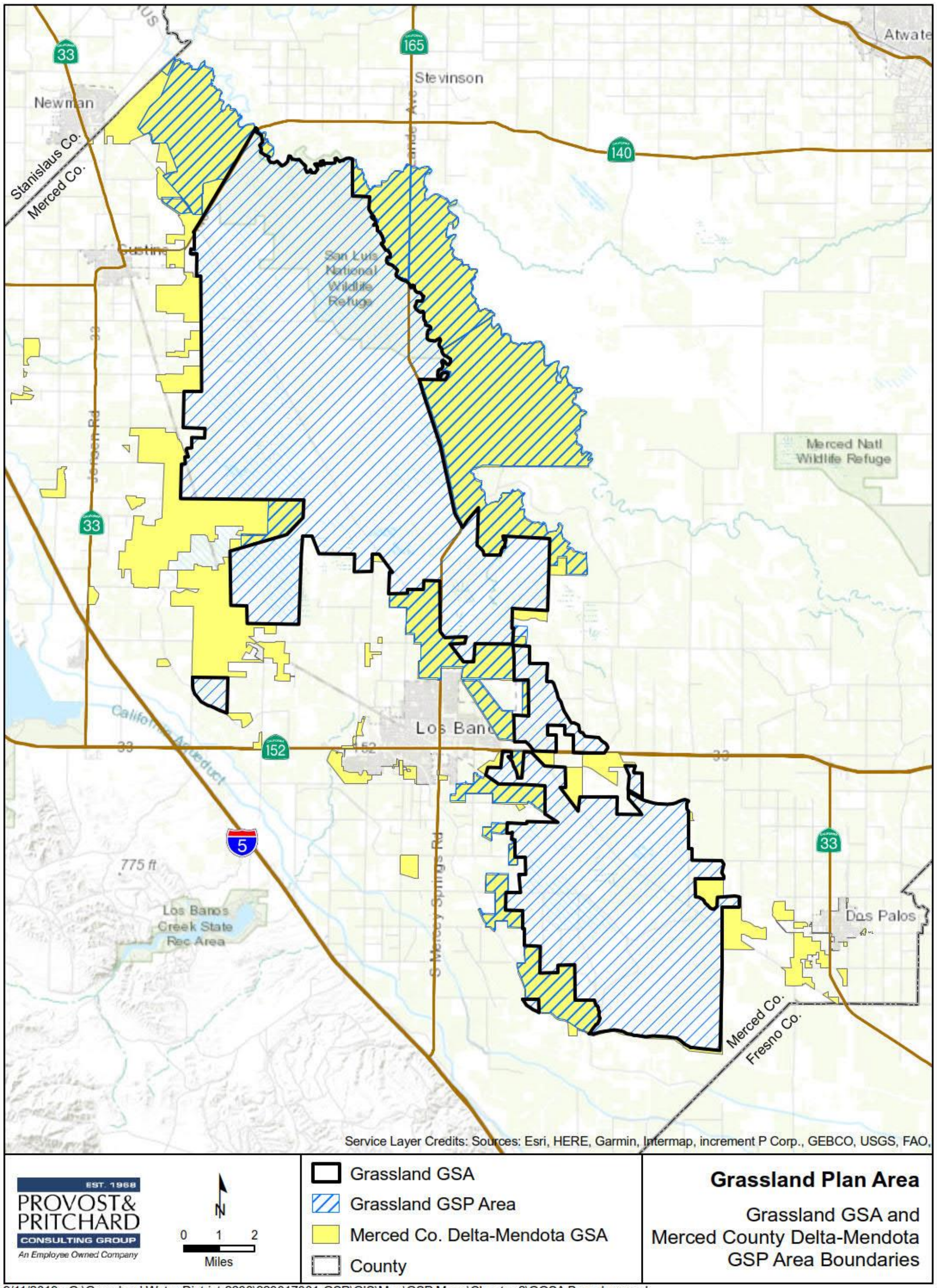


Figure ES-1: Grassland GSA and Extended GSP Area Boundaries

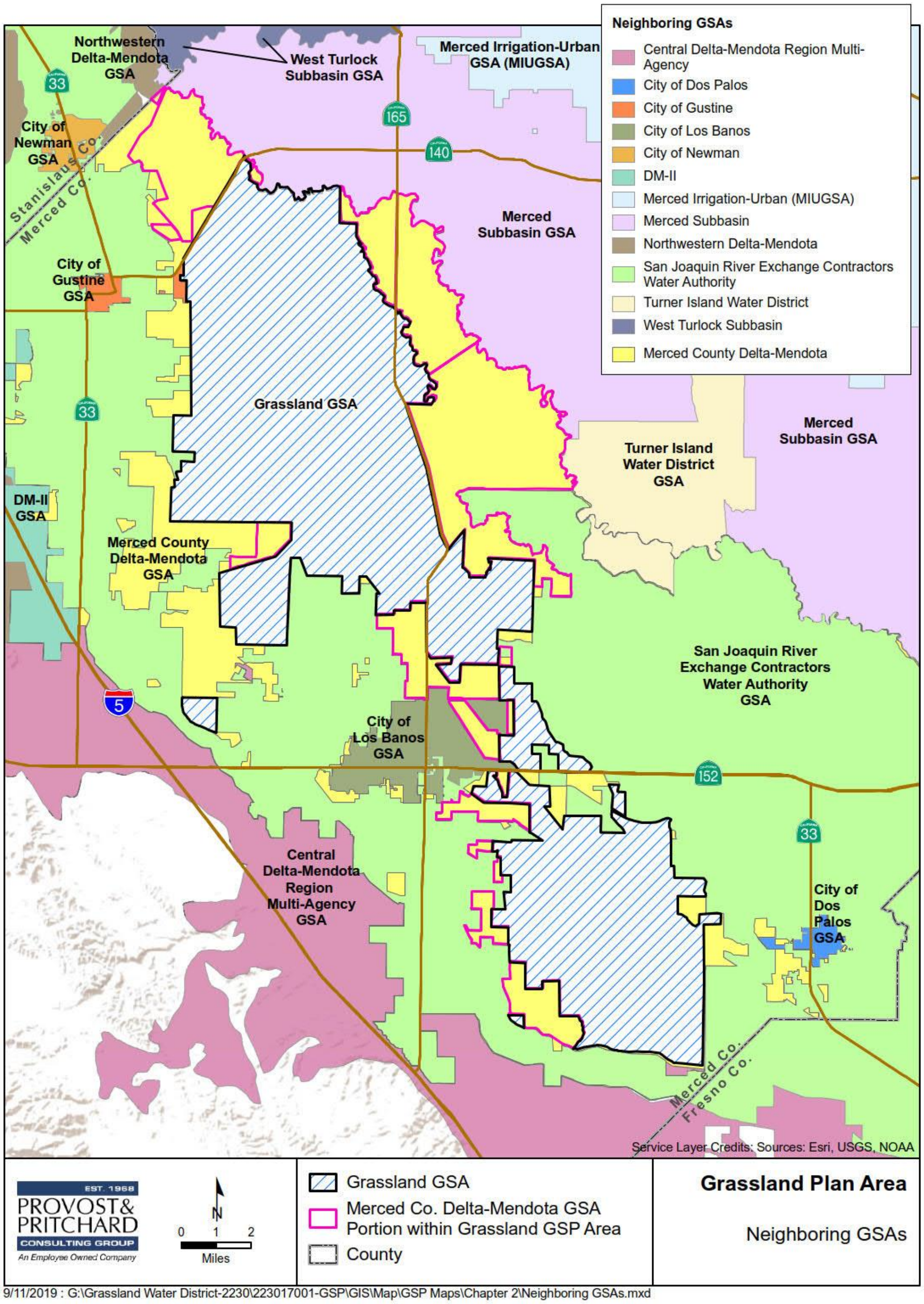


Figure ES-2: Grassland Plan Area - Neighboring GSAs

Chapter 3 - Basin Setting

Hydrogeologic Conceptual Model/Groundwater Conditions

Basin-wide conditions are reviewed in the Common Chapter. For the Grassland GSP area, the Hydrogeologic Conceptual Model (HCM) provides a description of the general physical characteristics of the regional hydrology, geology, geologic structure, water quality, principal aquifers, and principal aquitards in the Subbasin. The overview of Groundwater Conditions (GC) provides a historic, average, and current description of subsurface hydrology, water quality, and subsidence. The HCM/GC provides the best available information and lays the foundation for development of water budgets, monitoring networks, and identification of data gaps. The narrative HCM/GC was developed by Kenneth D. Schmidt & Associates (KDSA) and is attached as **Appendix B**.

Water Budgets

A water budget is an account of all of the water that flows into and out of a specified area and describes the various components of the hydrologic cycle (**Figure ES-3**). A water budget includes all water supplies, demands, modes of groundwater recharge, and non-recoverable losses, making it possible to identify how much water is stored in a system and changes in groundwater storage during a given period.

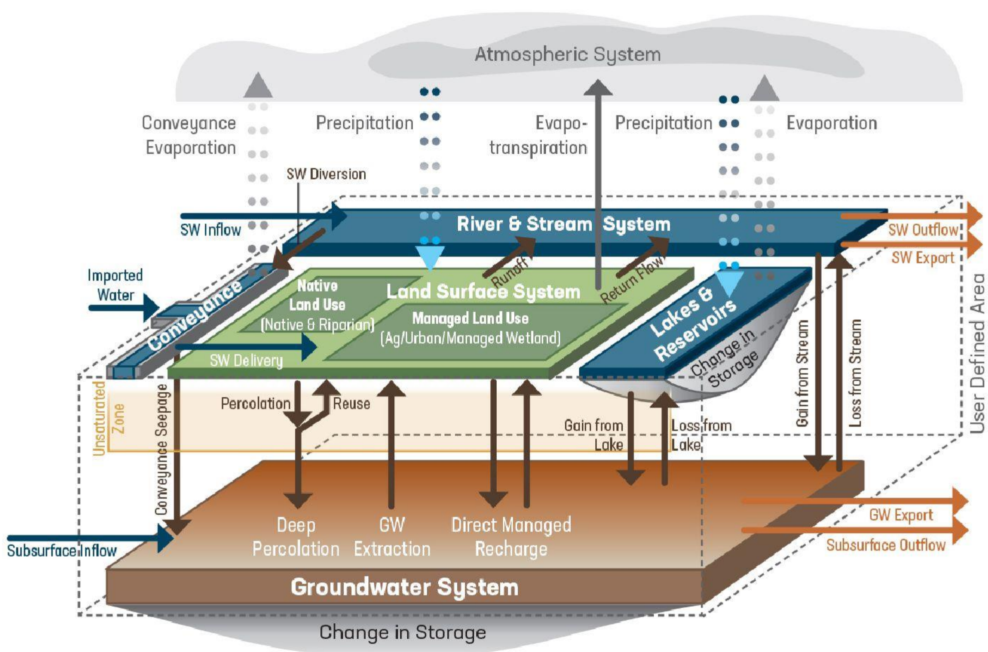


Figure ES-3: DWR Water Budget Graphic

Water budgets were prepared for a historical period (2003-2012, and based on 2013, 2015 and 2017), current period (2013), and future periods (2020-2070). The historical water budget covers a hydrologically average period based on San Joaquin River (SJR) full natural flow to assist in calibration of the water budget. The current water budget assesses the annual average change in storage in 2013 and uses supplemental data from periods of similar conditions to facilitate estimations in instances of missing data. The future water budget is based on numerous assumptions related to climate change, population growth, water use, and future project implementation. The estimated average annual change in groundwater storage for the aquifer underlying the Grassland Plan Area during the historic period was approximately +3,100 acre-feet.

In its January 2022 determination letter for the six Groundwater Sustainability Plans (GSPs) in the Delta-Mendota Subbasin (Subbasin), including the Common Chapter, the California Department of Water Resources (DWR) concluded that the Common Chapter did not adequately explain how each GSP used the same data and methodologies as the others (defined as “Deficiency 1”). DWR pointed to the water budgets contained in the six GSPs and compiled as the Subbasin water budget in the Common Chapter and concluded that the chosen “sum-of-the-parts” approach made it uncertain whether the GSPs utilized the same data and methodologies to develop a Subbasin-wide water budget.

To address this deficiency, the Subbasin’s Groundwater Sustainability Agencies (GSAs) met to develop consistent definitions for their water budget components, and reorganized the data in a more consistent fashion to conform with the component definitions. While the specific data used to develop the water budgets has not changed, the revised water budgets presented in the amended Common Chapter reflect more coordinated Subbasin-wide water budgets using common definitions. A detailed explanation of the coordinated water budget components is also included in the Common Chapter, along with a discussion of the data and methodologies used. The reader is therefore referred to the amended Common Chapter for the SGMA-required historic, current and projected water budgets for the Delta-Mendota Subbasin.

The initial results of the historic, current, and projected water budgets were provided in Chapter 3. However, because some components of the original Grassland GSP water budget were reorganized for consistency with the other GSPs in the Subbasin, the initial water budget is now presented in **Appendix D.** A crosswalk of the reorganization of some components from the initial Grassland GSP water budget and the revised Subbasin wide water budget is shown in **Figure 3-27**.

Chapter 4 - Sustainable Management Criteria

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to assessing the success of the GSP and maintaining sustainability. Several requirements from GSP regulations have been grouped together under the heading of Sustainable Management Criteria, including a Sustainability Goal, Significant and Unreasonable Effects, Undesirable Results, Interim Milestones, Minimum Thresholds, and Measurable Objectives for the various indicators of groundwater conditions shown above. Development of these Sustainable Management Criteria was coordinated at the Subbasin level through the Coordination Committee and Technical Subcommittee.

The six GSP Groups within the Subbasin have been coordinating since 2017 on how to reach and maintain sustainability. Many of the GSAs within the Subbasin have federal Central Valley Project surface water contracts that reduce the reliance on groundwater that leads to subsidence and other undesirable results. The Plan Area encompasses wetland habitat areas identified in the Central Valley Project Improvement Act which receive reliable water allocations similar to the adjacent agricultural San Joaquin River Exchange Contractor Water Authority GSA. These areas collectively supply more than one million acre-feet of surface water to the DMB annually. Coordination efforts between the GSAs have contributed to the development of minimum thresholds and measurable objectives for each monitoring site included in the individual GSPs’ representative monitoring networks as well as the DMB's collective representative monitoring networks in order to achieve sustainability. These values will continue to be monitored and evaluated as additional information is gathered.

In its January 2022 determination letter for the six GSPs in the Subbasin, DWR concluded that the definitions of significant and unreasonable effects, and the Sustainable Management Criteria adopted by each GSP Group, were not adequately coordinated (defined as "Deficiency 2" and "Deficiency 3"). To address these deficiencies, the Subbasin's GSAs met frequently, through the Coordination Committee and Technical Committee, to develop consistent definitions of significant and unreasonable effects, and to establish consistent Sustainable Management Criteria. These changes are also included in the Common Chapter.

Sustainability Goal

The goal of the DMB and Grassland Plan Area is to prevent groundwater management-induced impairments to the beneficial users of groundwater as they relate to the six sustainability indicators.

Undesirable Results

Undesirable Results were broadly defined by SGMA as outlined above. It is the intent of SGMA to allow subbasins and GSAs to define the conditions under which sustainability indicators become significant and unreasonable, thereby causing an undesirable result. As a result of the unique dynamics of the Delta-Mendota Subbasin, a broad definition of Undesirable Results was developed, expanding on DWR's definition. The DMB has defined Undesirable Results as (see Common Chapter – **Appendix A)**:

Groundwater Levels

> *Chronic changes in groundwater levels that diminish access to groundwater, causing significant and unreasonable impacts to beneficial uses and users of groundwater.*

Groundwater Storage Volume

> *A chronic decrease in groundwater storage that causes a significant and unreasonable impact to the beneficial uses and users of groundwater.*

Sea Water Intrusion

> *Not defined – Inapplicable.*

Water Quality

> *Degradation of groundwater quality as a result of groundwater management activities that causes significant and unreasonable impacts to beneficial uses and users of groundwater.*

Subsidence

> *Changes in ground surface elevation that cause damage to critical infrastructure, including significant and unreasonable reductions of conveyance capacity, impacts to natural resource areas, or conditions that threaten public health and safety.*

Interconnected Surface Water

> *Depletions of interconnected surface water as a direct result of groundwater pumping that cause significant and unreasonable impacts on natural resources or downstream beneficial uses and users.*

Defining Sustainable Management Criteria

Significant and unreasonable effects were considered for each of the undesirable results defined in the previous section. Public workshops for the DMB were held to discuss SMCs and significant and unreasonable effects and to familiarize the public with these technical concepts. Considerations were taken for neighboring GSP Groups in regard to significant and unreasonable effects as they are experienced by others outside of the Plan Area. The Grassland Plan Area has historically remained sustainable. Although 2015 drought conditions did not result in significant and unreasonable results, data from the most recent severe drought period served as a useful metric for quantitatively defining the minimum thresholds, measurable objectives, and interim milestones.

Chapter 5 - Monitoring Network

Current monitoring programs and the proposed monitoring network developed by the Grassland Plan Area participants will collect sufficient data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions, ultimately providing information necessary to support the implementation of this GSP, evaluate the effectiveness of the GSP, and aid in decision-making by the GGSA and MCDMGSA.

The six GSPs within the Delta-Mendota Subbasin have established representative monitoring networks for groundwater level/groundwater storage/interconnected surface water, groundwater quality, and land subsidence. The objectives of the various monitoring programs include:

1. Establish a baseline for future monitoring
2. Provide warning of potential future problems
3. Use data gathered to generate information for water resources evaluation
4. Help to quantify annual changes in water budget components
5. Develop meaningful long-term trends in groundwater characteristics
6. Provide comparable data from various locales within the Plan Area and the Subbasin
7. Demonstrate progress toward achieving interim milestones and measurable objectives described in the GSP
8. Monitor changes in groundwater conditions relative to minimum thresholds
9. Monitor impacts to the beneficial uses or users of groundwater

Chapter 6 - Projects and Management Actions

It is the purpose of the GSP regulations to identify projects and management actions that would be implemented to avoid undesirable results and achieve groundwater sustainability goals by 2040. In the case of the Grassland Plan Area, the groundwater system has historically remained sustainable, rendering a unique focus on maintaining those conditions rather than implementing new projects or adaptive management actions. To be conservative, the GSP participants recognize that mitigation measures may be needed in the future due to climate change or neighboring management actions. Therefore, projects are identified and discussed in **Chapter 6**.

Chapter 7 - Plan Implementation

The adoption of the GSP will be the official start of the plan implementation. Both GGSA and MCDMGSA will continue their efforts to engage the public and secure necessary funding to successfully monitor and continue sustainable management of groundwater resources within the Plan Area. While the GSP is being reviewed by DWR, the GGSA and MCDMGSA will coordinate with various stakeholders and beneficial users to improve their monitoring and data collection. The Plan participants intend for the historical trend of groundwater sustainability to continue into the 2040 planning horizon and both GSAs will work with neighbors to encourage improved sustainability.

Costs to implement, monitor, and update the GSP were estimated conservatively at nearly $463,000 annually starting in 2020. Funding for the identified projects and management actions will be acquired through assessments, grant funds, and other public funds when available. As the GSP is implemented and projects are developed, costs will be refined. The schedules and estimates presented in the GSP are initial estimates and will likely change as the plan is periodically evaluated.

Successful implementation of this GSP over the planning and implementation horizon (2020-2040) will require ongoing efforts to engage stakeholders and the general public in the sustainability process; communicating the statutory requirement, the objectives of the GSP, and progress toward each identified interim milestone and measurable objective. The Plan participants will report the results of SMC monitoring including annual groundwater levels, extraction volume, surface water use, total water use, groundwater storage change, subsidence, and progress of GSP implementation to the public and DWR on an annual basis in cooperation with the other GSAs in the Subbasin. The Delta-Mendota Subbasin has developed a data management system to help store and evaluate groundwater-related data. In addition, the Plan participants will provide updated information and amend the GSP at least every five years. The update will include the results of Subbasin monitoring and progress toward achieving sustainability, including current groundwater conditions, status of projects and management actions, evaluations of undesirable results relating to measurable objectives and minimum thresholds, changes in monitoring networks, summaries of enforcement or legal actions, and agency coordination efforts.

1 Introduction

1.1 Purpose of Groundwater Sustainability Plan

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act of 2014 (SGMA), which is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management in California that must be achieved during the planning and implementation horizon and sustained into the future without causing undesirable results. SGMA requires that the following six sustainability indicators must be considered:

(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
(2) Significant and unreasonable reduction of groundwater storage
(3) Significant and unreasonable seawater intrusion
(4) Significant and unreasonable degraded water quality
(5) Significant and unreasonable land subsidence
(6) Depletions of interconnected surface water that have significant and unreasonable impacts on beneficial uses of surface water

SGMA requires governments and water agencies of high and medium priority basins to halt groundwater overdraft and bring groundwater basins into balanced levels of pumping and recharge without causing significant and unreasonable undesirable results related to the six sustainability indicators. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically overdrafted high priority basins, including the Delta-Mendota Groundwater Subbasin (Delta-Mendota Subbasin, Subbasin, or DMB) that the Grassland Plan Area (Plan Area) area is part of, the deadline for achieving sustainability is 2040.

In his signing statement, Governor Brown emphasized that “groundwater management in California is best accomplished locally.” The Groundwater Sustainability Agencies (GSAs) within the DMB are working cooperatively together to achieve basin-wide sustainability. With local funding and ongoing financial and technical assistance from the Department of Water Resources (DWR), the Grassland Plan Area participants are collaborating with neighboring agencies to achieve groundwater sustainability for the DMB at the local level.

1.2 Sustainability Goal

The sustainability goal for the Delta-Mendota Subbasin was established to succinctly state the objectives and desired conditions of the Subbasin that will culminate in the absence of undesirable results by 2040. The sustainability goal of the Subbasin and by extension the Grassland Plan Area is as follows:

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

The following definitions of "undesirable results" were agreed upon by DMB Groundwater Sustainability Plan (GSP, Plan) participants for the following applicable sustainability indicators (undesirable results for seawater intrusion were not defined because this is not an applicable sustainability indicator for the DMB):

- **Chronic lowering of groundwater levels** -
  Chronic changes in groundwater levels that diminish access to groundwater, causing significant and unreasonable impacts to beneficial uses and users of groundwater.

- **Reduction in groundwater storage** -
  A chronic decrease in groundwater storage that causes a significant and unreasonable impact to the beneficial uses and users of groundwater.

- **Degraded water quality** -
  Degradation of groundwater quality as a result of groundwater management activities that causes significant and unreasonable impacts to beneficial uses and users of groundwater.

- **Land subsidence** -
  Changes in ground surface elevation that cause damage to critical infrastructure, including significant and unreasonable reductions of conveyance capacity, impacts to natural resource areas, or conditions that threaten public health and safety.

- **Depletions of interconnected surface water** -
  Depletions of interconnected surface water as a direct result of groundwater pumping that cause significant and unreasonable impacts on natural resources or downstream beneficial uses and users.

- ***Seawater intrusion** – The Grassland Plan Area is located approximately 55 miles from the Pacific Ocean and separated by the Coastal Range. Considering the distance separating the Plan Area from the Pacific Ocean, saltwater intrusion from the ocean into the freshwater aquifer is not a concern for the area and not applicable for analysis in the GSP.*

The sustainability goal will be met by balancing water demand with available water supply and stabilizing the long-term trend of declining groundwater levels in the DMB without significantly or unreasonably impacting groundwater storage, water quality, land subsidence, or interconnected surface water.

The Delta-Mendota Subbasin, identified by the DWR as groundwater Subbasin Number 5-022.07, is located within the San Joaquin River Hydrologic Region and the Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin. The Delta-Mendota Subbasin has been recognized as being in a state of groundwater overdraft prior to the adoption of SGMA and the State recently identified the DMB as a "high priority, critically overdrafted" subbasin. This designation is primarily attributed to considerable subsidence in parts of the Subbasin; however, the Grassland Plan Area has not historically experienced the rates of significant subsidence that other DMB GSP participants have (see Chapter 3 and Delta-Mendota Subbasin Common Chapter **(Appendix A**). Additionally, the Grassland

Plan Area historical change in groundwater storage has been sustainable. **Chapter 3** of this GSP discusses the sustainability and water budget for the Grassland Plan Area in greater depth. The Delta-Mendota Subbasin Common Chapter (**Appendix A**) further explores the variability in historic overdraft across the DMB GSP participants.

To that end, this GSP recognizes measures to continue sustainability trends and work with neighboring GSP groups and subbasins to support and encourage the reaching of the collective goals of SGMA and the respective subbasins.

As part of the process to accomplish this overarching goal, this GSP identifies undesirable results, which are outcomes that could be realized should the plan's strategies be ineffective or be ineffectively implemented. Undesirable results are marked by minimum thresholds: identified conditions which if not met will be interpreted as an indication that an undesirable result has occurred. Unlike GSP groups that have historically experienced undesirable results or are in a position of unsustainable overdraft trends, the positive outcomes defined in this GSP will require maintaining the system and improving neighbor coordination, rather than undergoing significant projects or management action implementation. The measurable objectives in this GSP are quantitative and are reflective of achieving the sustainability goal in 2040. The associated five-year interim milestones (interim goals) have been defined to gauge progress during the intervening years. The interim milestones help assure not only that the Grassland Plan Area is moving toward its sustainability goals, but that the rate of progress is as planned and is sufficient to meet the overall implementation schedule.

Significant and unreasonable undesirable results, minimum thresholds, and measurable objectives to meet the sustainability goal of the Grassland Plan Area are all defined and discussed in detail in **Chapter 4** of this GSP.

1.3 Coordination Agreements

This section includes a description of intra-basin coordination agreements, which are required in the circumstance that there is more than one GSP to be implemented in a groundwater basin, pursuant to the SGMA Regulations Article 8, Interagency Agreements, § 357.4.

Legal Requirements:

§ 357.4. Coordination Agreements
(a) Agencies intending to develop and implement multiple Plans pursuant to Water Code Section 10727(b)(3) shall enter into a coordination agreement to ensure that the Plans are developed and implemented utilizing the same data and methodologies, and that elements of the Plans necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting.
(b) Coordination agreements shall describe the following:
(1) A point of contact with the Department.
(2) The responsibilities of each Agency for meeting the terms of the agreement, the procedures for the timely exchange of information between Agencies, and procedures for resolving conflicts between Agencies.
(3) How the Agencies have used the same data and methodologies for assumptions described in Water Code Section 10727.6 to prepare coordinated Plans, including the following:
(A) Groundwater elevation data, supported by the quality, frequency, and spatial distribution of data in the monitoring network and the monitoring objectives as described in Subarticle 4 of Article 5.
(B) A coordinated water budget for the basin, as described in Section 354.18, including groundwater extraction data, surface water supply, total water use, and change in groundwater in storage.
(C) Sustainable yield for the basin, supported by a description of the undesirable results for the basin, and an explanation of how the minimum thresholds and measurable objectives defined by each Plan relate to those undesirable results, based on information described in the basin setting.
(c) The coordination agreement shall explain how the Plans, implemented together, satisfy the requirements of the Act and are in substantial compliance with this Subchapter.
(d) The coordination agreement shall describe a process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations.
(e) The coordination agreement shall describe a coordinated data management system for the basin, as described in Section 352.6.
(f) Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department. If an Agency forms in a basin managed by an Alternative, the Agency shall evaluate the agreement with the Alternative prepared pursuant to Section 358.2 and determine whether it satisfies the requirements of this Section.
(g) The coordination agreement shall be submitted to the Department together with the Plans for the basin and, if approved, shall become part of the Plan for each participating Agency.
(h) The Department shall evaluate a coordination agreement for compliance with the procedural and technical requirements of this Section, to ensure that the agreement is binding on all parties, and that provisions of the agreement are sufficient to address any disputes between or among parties to the agreement.
(i) Coordination agreements shall be reviewed as part of the five-year assessment, revised as necessary, dated, and signed by all parties.

The Delta-Mendota Subbasin Coordination Agreement (Coordination Agreement), effective as of December 12, 2018, has been signed by all participating agencies in the Delta-Mendota Subbasin. The Coordination Agreement can be found as Appendix A of the Common Chapter (**Appendix A**). This Coordination Agreement defines how the coordination efforts will be achieved and documented and sets out the process for identifying the Plan Manager.

The Coordination Agreement for the Delta-Mendota Subbasin covers the following topics:

1. Purpose of the Agreement, including:
    a. Compliance with SGMA
    b. Description of Criteria and Function
2. General Guidelines, including:
    a. Responsibilities of the Parties
    b. Adjudicated or Alternative Plans in the Subbasin
3. Role of San Luis & Delta-Mendota Water Authority (SLDMWA), including:
    a. Agreement to Serve
    b. Reimbursement of SLDMWA
    c. Termination of SLDMWA's Services
4. Responsibilities for Key Functions, including:
    a. Coordination Committee
    b. Coordination Committee Officers
    c. Coordination Committee Authorized Action and Limitations
    d. Subcommittees and Workgroups
    e. Coordination Committee Meetings
    f. Voting by Coordination Committee
5. Approval by Individual Parties
6. Exchange of Data and Information, including:
    a. Exchange of Information
    b. Procedure for Exchange of Information
7. Methodologies and Assumptions, including:
    a. SGMA Coordination Agreements
    b. Pre-GSP Coordination
    c. Technical Memoranda Required
8. Monitoring Network
9. Coordinated Water Budget
10. Coordinated Data Management System
11. Adoption and Use of the Coordination Agreement, including:
    a. Coordination of GSPs
    b. GSP and Coordination Agreement Submission
12. Modification and Termination of the Coordination Agreement, including:
    a. Modification or Amendment of Exhibit "A" (Groundwater Sustainability Plan Groups including Participation Percentages)
    b. Modification or Amendment of Coordination Agreement
    c. Amendment for Compliance with Law
13. Withdrawal, Term, and Termination
14. Procedures for Resolving Conflicts
15. General Provisions, including:
    a. Authority of Signers
    b. Governing Law
    c. Severability
    d. Counterparts
    e. Good Faith
16. Signatories of all Parties

Department of Water Resources (DWR) Point of Contact
The point of contact for the Delta-Mendota Subbasin is:
Christopher Olvera
Department of Water Resources
Christopher.Olvera@water.ca.gov
(559) 230-3373

Agency Responsibility
In meeting the terms of the Coordination Agreement, all Delta-Mendota Subbasin GSAs agree to work collaboratively to meet the objectives of SGMA and the Coordination Agreement. Each Party to the Agreement is a GSA and acknowledges that it is bound by the terms of the Coordination Agreement as an individual party. More information regarding agency responsibility can be found in the Common Chapter (**Appendix A**).

Coordinated Data and Methodology
To ensure the Coordination Agreement requirements for coordinated data and methodology were achieved, the Delta Mendota Subbasin GSP participants formed a technical subcommittee of technical staff from all or some of the parties. Through this effort, items required or helpful for coordination were discussed, and coordinated data and methodologies were agreed upon. More information regarding common data and methodologies can be found in the Common Chapter and the accompanying Technical Memoranda (**Appendix A**).

Dispute Resolution
The Coordination Agreement outlines a path to dispute resolution, should it arise. The Common Chapter summarizes the method for resolution as follows:

> *The disputing Party or Parties are to provide written notice of the basis of the dispute to the other Parties within thirty (30) calendar days of the discovery of the events giving rise to the dispute. Within thirty (30) days after such written notice, all interested Parties are to meet and confer in good faith to informally resolve the dispute. All disputes that are not resolved informally shall be settled by arbitration. In such an event, within ten (10) days following the failed informal proceedings, each interested Party is to nominate and circulate to all other interested Parties the name of one arbitrator. Within ten (10) days following the nominations, the interested Parties are to rank their top three among all nominated arbitrators, awarding three points to the top choice, two points to the second choice, and one point to the third choice and zero points to all others. Each interested Party will then forward its tally to the Secretary, who tabulates the points and notifies the interested Parties of the arbitrator with the highest cumulative score, who shall be the selected arbitrator. The Secretary may also develop procedures for approval by the Parties for selection of an arbitrator in the case of tie votes or in order to replace the selected arbitrator in the event such arbitrator declines to act. The arbitration is be administered in accordance with the procedures set forth in the California Code of Civil Procedure, Section 1280, et seq., and of any state or local rules then in effect for arbitration pursuant to said section. Upon completion of arbitration, if the controversy has not been resolved, any Party may exercise all rights to bring legal action relating to the controversy.*

Plan Implementation and Submittal
Compliant with the SGMA and the Coordination Agreement, the Plan Area participants agree to submit the GSP to DWR through the Coordination Committee and Plan Manager. The Grassland GSP is considered complete with the incorporation of the Common Chapter and appended Technical Memoranda. GSPs implemented together satisfy the requirements of SGMA for the entire Subbasin.

The Coordination Agreement does not otherwise affect each Party's responsibility to implement the terms of its respective GSP in accordance with SGMA. Rather, the Coordination Agreement is the mechanism through which the participating GSAs will coordinate their respective GSPs to the extent necessary to ensure that such GSP coordination complies with SGMA. Each GSA and respective GSP group are responsible for ensuring that its own GSP complies with the statutory requirements of SGMA including but not limited to the filing deadline.

The Coordination Committee is responsible for assuring the submittal of annual reports and providing five-year assessments recommending any needed revisions to the Coordination Agreement. More information on GSP implementation and submittal can be found in the Common Chapter and Coordination Agreement (**Appendix A**).

<u>Adjudicated Areas and Alternative Plans</u>
There are no adjudicated areas within the Delta-Mendota Subbasin and no Alternative Plans have been submitted by the local agencies within the Subbasin.

1.4 Inter-basin Agreements

This section includes a description of inter-basin coordination agreements, which are optional agreements between neighboring groundwater subbasins, pursuant to the SGMA Regulations Article 8, Interbasin Agreements, § 357.2.

Legal Requirements:

§ 357.2. Interbasin Agreements
Two or more Agencies may enter into an agreement to establish compatible sustainability goals and understanding regarding fundamental elements of the Plans of each Agency as they relate to sustainable groundwater management. Interbasin agreements may be included in the Plan to support a finding that implementation of the Plan will not adversely affect an adjacent basin's ability to implement its Plan or impede the ability to achieve its sustainability goal. Interbasin agreements should facilitate the exchange of technical information between Agencies and include a process to resolve disputes concerning the interpretation of that information. Interbasin agreements may include any information the participating Agencies deem appropriate, such as the following:

(a) General information:
(1) Identity of each basin participating in and covered by the terms of the agreement.
(2) A list of the Agencies or other public agencies or other entities with groundwater management responsibilities in each basin.
(3) A list of the Plans, Alternatives, or adjudicated areas in each basin.
(b) Technical information:
(1) An estimate of groundwater flow across basin boundaries, including consistent and coordinated data, methods and assumptions.
(2) An estimate of stream-aquifer interactions at boundaries.
(3) A common understanding of the geology and hydrology of the basins and the hydraulic connectivity as it applies to the Agency's determination of groundwater flow across basin boundaries and description of the different assumptions utilized by different Plans and how the Agencies reconciled those differences.
(4) Sustainable management criteria and a monitoring network that would confirm that no adverse impacts result from the implementation of the Plans of any party to the agreement. If minimum thresholds or measurable objectives differ substantially between basins, the agreement should specify how the Agencies will reconcile those differences and manage the basins to avoid undesirable results. The Agreement should identify the differences that the parties consider significant and include a plan and schedule to reduce uncertainties to collectively resolve those uncertainties and differences.
(c) A description of the process for identifying and resolving conflicts between Agencies that are parties to the agreement.
(d) Interbasin agreements submitted to the Department shall be posted on the Department's website.

The sole interbasin agreement in the DMB is a data sharing agreement between SLDMWA and Westlands Water District. SLDMWA, on behalf of the Northern and Central Delta-Mendota Regions, executed an inter-basin data sharing agreement with Westlands Water District in April 2018. The purpose of the agreement is to establish a set of common assumptions regarding groundwater conditions on either side of the boundary between Westlands Water District's service area and the Delta-Mendota Subbasin to be used for the development of GSPs in support of SGMA implementation.

The Grassland Plan Area did not directly engage in an interbasin agreement with another subbasin; however, the data provided under the agreement allowed the Plan Area participants access to the shared information from Westlands Water District. Additional interbasin agreements may be developed during GSP implementation.

1.5 Agency Information

Legal Requirements:

§354.6(a) The name and mailing address of the Agency

This GSP covers the Grassland Groundwater Sustainability Agency (GGSA) and a portion of the Merced County Delta-Mendota Groundwater Sustainability Agency (MCDMGSA). The MCDMGSA area includes state and federal wildlife refuges and some private habitat and agricultural lands that lie adjacent to the GGSA. The aggregate of the areas covered by this GSP is referred to as the Grassland Plan Area. The mailing addresses for the GGSA and MCDMGSA are as follows:

Grassland GSA
Grassland Water District
200 W. Willmott Avenue
Los Banos, CA 93635

Merced County Delta-Mendota GSA
County of Merced
2222 M Street
Merced, CA 95340

1.5.1 Organization and Management Structure of the GSA

Legal Requirements:

§354.6(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan. **§354.6(c)** The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.

In accordance with the Coordination Agreement discussed in **Section 1.3**, the Delta-Mendota Subbasin Plan Manager is recognized as:

John Brodie
Water Resources Program Manager
San Luis & Delta-Mendota Water Authority
842 6th Street
Los Banos, CA 93635
(209) 826-1872
john.brodie@sldmwa.org

The Grassland GSP covers the GGSA and a portion of the MCDMGSA. The GGSA was formed by the Grassland Resource Conservation District (GRCD) and the Grassland Water District (GWD) pursuant to a 2016 Memorandum of Agreement (MOA), which established terms and conditions for the formation and administration of the multi-agency GGSA and the preparation and implementation of this GSP. Pursuant to the MOA, the GWD assumed principal responsibilities for administering the GGSA and developing and implementing the GSP. The governing body of the GRCD and the GWD each appointed two of their members to a GGSA Advisory Committee, and the General Manager of the GWD serves as the fifth member of that committee. Approval by both the GRCD and GWD is required for certain financial decisions, GSP adoption, enforcement actions, and other specified activities. Meetings of the GGSA and its Advisory Committee are noticed and open to the public in accordance with the Ralph M. Brown Act, California Government Code section 54950.

The MCDMGSA was formed by the County of Merced. The Merced County Board of Supervisors serves as the governing body for the MCDMGSA. Meetings of the MCDMGSA are noticed and open to the public in accordance with the Ralph M. Brown Act, California Government Code section 54950.

The GGSA and MCDMGSA executed a Memorandum of Understanding (MOU) in 2018 to coordinate the preparation of a GSP and SGMA implementation and enforcement. The MOU addresses data sharing, monitoring, the treatment of federal lands, GSP development and implementation, basin-wide coordination, and cost sharing.

Persons with management authority for implementation of this GSP include the following:

Ricardo Ortega, Coordinator
Grassland GSA
200 W. Willmott Avenue
Los Banos, CA 93635
(209) 826-5188
rortega@gwdwater.org

Lacey McBride, Water Resources Coordinator
Merced County Delta-Mendota GSA
2222 M Street
Merced, CA 95340
(209) 385-7654

Lacey.McBride@countyofmerced.com

1.5.2 Legal Authority of the GSA

Legal Requirements:

§354.6(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the plan.
§354.6(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The GGSA is not a separate legal entity from its constituent agencies. Pursuant to the MOA between the GRCD and the GWD, the GGSA exercises the collective powers of its two member agencies, with the GWD assuming primary responsibility. The GWD is a California Water District formed pursuant to Division 13 of the California Water Code. The GRCD is a California Resource Conservation District formed pursuant to Division 9 of the Public Resources Code. The GWD oversees a groundwater program for managed wetland habitat within the GGSA. It also collects annual assessments and water delivery fees from landowners. It has the legal authority to manage water within its boundaries.

The MCDMGSA was formed by the Merced County Board of Supervisors and is not a separate legal entity. It exercises the powers of the County of Merced, which include the management and regulation of groundwater resources, and authorities granted to a GSA by SGMA. Merced County is a political subdivision of the State of California. Accordingly, both the GGSA and the MCDMGSA have been deemed the local agencies within the designated territory endowed with powers to comply with SGMA.

The SGMA legislation requires a GSA to develop and implement a GSP in order to achieve groundwater sustainability management within its territory in compliance with specific mandates and timelines. In the case of the Grassland Plan Area, both the GGSA and MCDMGSA coordinated to develop and implement a single GSP.

Pursuant to the existing powers of the GWD, GRCD, and Merced County and Chapter 8 of Part 2.74 of Division 6 of the Water Code, the GGSA and MCDMGSA may impose a variety of fees as they determine to be necessary, including, but not limited to, permit fees and fees on groundwater extraction or other regulated activities; fees to fund the costs of a groundwater sustainability program, including, but not limited to, preparation, adoption, and amendment of a GSP; and investigations, inspections, compliance assistance, enforcement, and program administration during implementation of the GSP, including a prudent reserve. An estimate of the cost of implementing the GSP and a general description of how the GGSA and MCDMGSA plan to meet those costs is provided in **Chapter 1**.

1.6 GSP Organization and Preparation Checklist

The Grassland GSP is organized in accordance with the Emergency SGMA Regulations in a format similar to the outline provide by DWR.

- **Executive Summary** provides a summary of what will be included in the GSP.
- **Chapter 1** describes the Introduction, including purpose of the GSP, sustainability goal, agency information, and GSP organization.
- **Chapter 2** describes the Plan area, including geographic setting, existing water resources planning and programs, relationship of the GSP to other general plan documents within the Agency boundary, and additional GSP components.
- **Chapter 3** describes the Basin setting. It includes a detailed discussion of the hydrogeologic conceptual model used to prepare the GSP, current and historical groundwater conditions, and a discussion of the area groundwater budget.
- **Chapter 4** sets forth the adopted sustainability goals, addresses the mandated Undesirable Results, defines Minimum Thresholds for each Undesirable Result, and sets Measurable Objectives for both intermediate plan years (Interim Milestones) and for the Plan's complete implementation.
- **Chapter 5** describes the network of monitoring wells and other facilities identified by the GGSA and MCDMGSA to measure Plan outcomes and assesses the need for improvements to the network in order to provide fully representative data. Monitoring protocols and data analysis techniques are also addressed.
- **Chapter 6** lists and describes each project and management action that will be evaluated and may be adopted by the GGSA and MCDMGSA in pursuit of sustainability. The section includes such project details as Measurable Objectives, required permits, anticipated benefits, project costs, project schedule, and required ongoing management operations, along with management actions that may be implemented.
- **Chapter 7** describes the Plan implementation process, including estimated costs, sources of funding, an overall preliminary schedule through full implementation, description of the required data management system, methodology for annual reporting, and how progress evaluations will be made over time.

- **Chapter 8** summarizes the references and sources used to prepare and document this Plan.

In December 2016, DWR published a Preparation Checklist for GSP Submittal. The checklist includes references to applicable GSP regulations and Water Code sections, as well as a brief description of the required GSP information. The checklist also contains a column for GSAs to record the page number or section of the GSP where the information for that particular requirement is found. The preparation checklist is presented below in **Table 1-1** and was used to develop a GSP consistent with the requirements of the GSP regulations and SGMA. *[The checklist is presented here in draft form and will be completed prior to adoption of this GSP.]*

Table 1-1: Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 5.3 Section 5.1.4
354.4		General Information	• Executive Summary • List of references and technical studies	Section ES Section 8
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	Section 1.5 Section 1.5.1 Section 1.5.1 Section 1.5.2 Section 7.1
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative • Jurisdictional boundaries of federal or State land • Existing land use designations • Density of wells per square mile	Section 2.1, Figure 2-1 Section 2.1, Figures 2-1 and 2-4 Section 2.1, Figure 2-5 Section 2.1, Figure 2-6
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	Section 2.2
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	• Description of water resources monitoring and management Description of programs • Description of how the monitoring networks of those plans will be incorporated into the GSP	Section 2.3 Section 2.3.1
354.8(f)	10727.2(g)	Land Use Elements of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water	Section 2.4.1 Section 2.4.2

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
			demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.4.3 Section 2.4.4 Section 2.4.5
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** • Control of saline water intrusion • Wellhead protection • Migration of contaminated groundwater • Well abandonment and well destruction program • Replenishment of groundwater extractions • Conjunctive use and underground storage • Well construction policies • Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity • Impacts on groundwater dependent ecosystems	Section 2.5.1 Section 2.5.2 Section 2.5.3 Section 2.5.4 Section 2.5.5 Section 2.5.8 and 2.3.3 Section 2.5.7 Section 2.5.8 and 6 Section 2.5.9 Section 2.2.1 and 2.5.10 Section 2.5.11 Section 2.5.12, Figures 2-10, 2-11, and Table 2-4

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
354.10		Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Section 2.6.1 Section 2.6.2, Table 2-5 Section 2.6.2, Appendix H Section 2.6.3 Section 2.6.4, Appendix F Section 2.6.5 Section 2.6.5
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled cross-sections • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Section 3.1 Section 3.1.3.7, Figures 3-10 through 3-14 Section 3.1.2, Figure 3-1, 3-2, 3-3, 3-4, and 3-5
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Section 3.2.3, Figure 3-19
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.2.3
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues • Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	Section 3.2.2 and Appendix A Section 3.2.6 Section 3.1.1 Section 3.2.8 Section 3.2.7 Section 3.2.9 Section 3.1.1
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	Section 3.3.2 and Appendix A Section 3.3.3 and Appendix A Section 3.3.3.2 and Appendix A Section 3.3.4 and Appendix A

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 3.1.2.4, Figure 3-4
354.20		Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	Section 3.4
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	Section 4.1 and Appendix A
354.26		Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Section 4.3 and Appendix A Section 4.3.2 and Appendix A Section 4.3.3 and Appendix A Section 4.3.4 and Appendix A
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Section 4.4.1 and Appendix A Section 4.4.1.4 and Appendix A Section 4.4.1.7 and Appendix A Section 4.4.1.8 and Appendix A Section 4.4.1.9 and Appendix A
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1)	Measurable Objectives	• Description of establishment of the measurable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measurable objective	Section 4.5 and Appendix A

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
	10727.2(d)(2)		• Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rational (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone • Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including	Section 5.1 Section 5.1.1 Section 5.1.3 Section 5.1.4 and Appendix A Section 5.1.5, Table 5-5 Section 5.1.6.1 Section 5.1.6.2 Section 5.1.6.3, 5.4, and Appendix A Sections 5.1.3 and 5.2, Figures 5-1,5-2, and 5-3

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
	10727.2(d)(2) 10727.2(e) 10727.2(f)		information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used • Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 5.1.6.2 and 5.3, and Appendix A
354.36		Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators • Adequate evidence demonstrating site reflects general conditions in the area	Section 5.4.1 Section 5.4.2 Section 5.4
354.38		Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Section 5.5.1 Section 5.5.2 Section 5.5.3 Sections 5.1.5 and 5.5.4, Table 5-5
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44		Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal • Measurable objective that is expected to benefit from each project and management action • Circumstances for implementation • Public noticing • Permitting and regulatory process • Timetable for initiation and completion, and the accrual of expected benefits • Expected benefits and how they will be evaluated • How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included. • Legal authority required • Estimated costs and plans to meet those costs	Section 6.1.1, 6.2.1, 6.3.1 Section 6.1.2, 6.2.2, 6.3.2 Section 6.1.3, 6.2.3, 6.3.3 Section 6.1.4, 6.2.4, 6.3.4 Section 6.1.5, 6.2.5, 6.3.5 Section 6.1.6, 6.2.6, 6.3.6 Section 6.1.7, 6.2.7, 6.3.7 Section 6.1.8, 6.2.8, 6.3.8 Section 6.1.9, 6.2.9, 6.3.9 Section 6.1.10, 6.2.10, 6.3.10

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
			• Management of groundwater extractions and recharge	
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	Section 6.4, Table 6-1
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** • A point of contact • Responsibilities of each Agency • Procedures for the timely exchange of information between Agencies • Procedures for resolving conflicts between Agencies • How the Agencies have used the same data and methodologies to coordinate GSPs • How the GSPs implemented together satisfy the requirements of SGMA • Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations • A coordinated data management system for the basin • Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department	[Section 1.3, Appendix A and Appendix G

2 Plan Area

Legal Requirements:

§354.8 Each Plan shall include a description of the geographic areas covered, including the following information:
(a) One or more maps of the basin that depict the following, as applicable:
(1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
(2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.
(3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.
(4) Existing land use designations and the identification of water use sector and water source type.
(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the department, as specified in section 353.2, or best available information.

2.1 Plan Area Description

This Groundwater Sustainability Plan (GSP, Plan) covers the Grassland Groundwater Sustainability Agency (GGSA) and portions of the Merced County Delta-Mendota GSA (MCDMGSA). The MCDMGSA area includes adjacent state and federal wildlife refuges and some private habitat and agricultural lands that lie adjacent to the GGSA. Together the GGSA area and the MCDMGSA area are referred to as the Grassland Plan Area or Plan Area (See **Figure 2-1)**. The Plan Area is located within the Delta-Mendota Groundwater Subbasin (DMB, Subbasin). There are twenty-three GSAs in the DMB, drafting six individual GSPs. This GSP will address the basin-wide planning of the DMB coordinated effort and specific Plan Area efforts. GSP methodologies and data are coordinated and approved through the DMB technical committee and the DMB coordination committee respectively to ensure consistency among GSPs.

2.1.1 Groundwater Basin Boundary

The DMB is part of the San Joaquin Valley Groundwater Basin which lies within the San Joaquin River Hydrologic Region. The DMB is bounded on the west by the Coast Range. The northern, southern, and eastern boundaries about the Tracy, Modesto, Turlock, Merced, Chowchilla, Madera, Kings, and Westside Subbasins (See **Figure 2-2**).

The DMB boundary is defined in the Department of Water Resources (DWR) Bulletin 118 as DWR Subbasin No. 5-22.07. The Subbasin covers 1,170 square miles (747,000 acres). DWR estimated in 1995 that the groundwater storage for the DMB is about 26.6 million acre-feet (AF) to a depth of 300 feet (DWR Bulletin 118, 2003). Additional details on the DMB are included in **Appendix A -** Delta-Mendota Subbasin Coordinated Chapter developed by the Delta-Mendota Technical Committee and approved by the Delta-Mendota Coordination Committee.

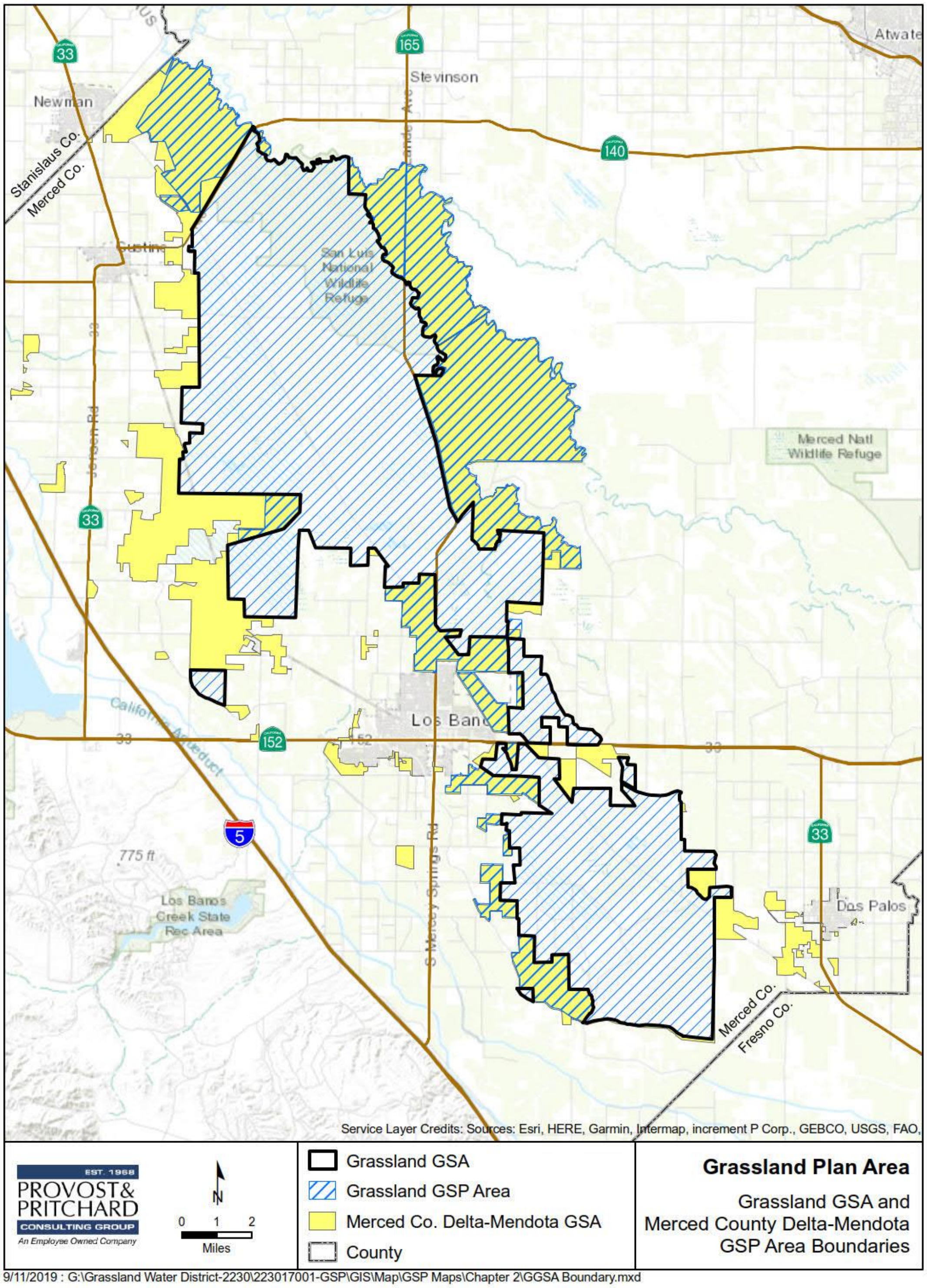


Figure 2-1: Grassland GSA and Extended GSP Area Boundaries

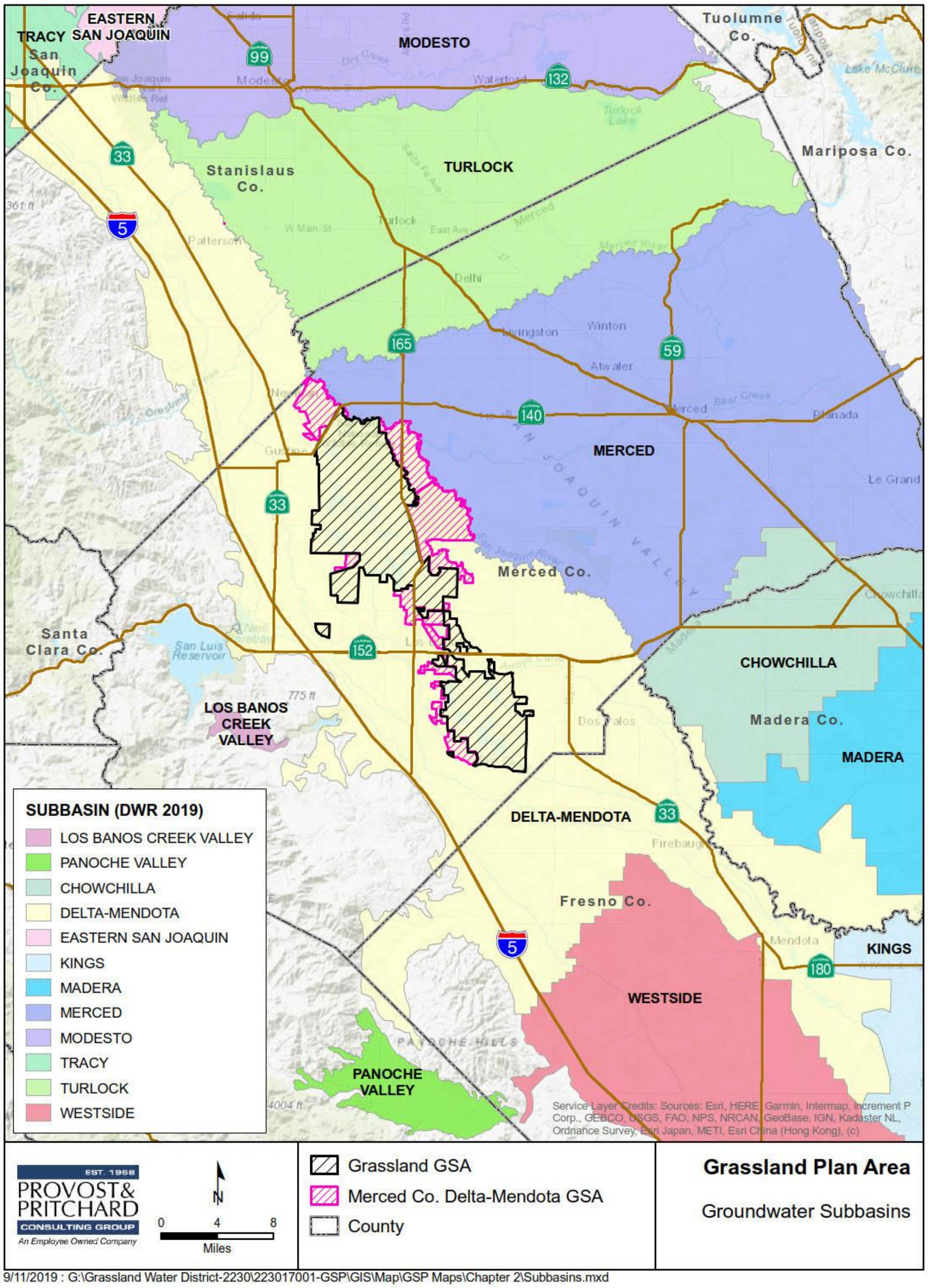


Figure 2-2: Groundwater Subbasins

2.1.2 Groundwater Sustainability Plan Area

The Plan Area consists of the GGSA area and the MCDMGSA area (See **Figure 2-3**). The GGSA area is comprised of the Grassland Resource Conservation District (GRCD) and the Grassland Water District (GWD) service areas. The GRCD occupies approximately 75,000 acres and includes most of the GWD, which encompasses approximately 50,000 acres. GRCD and GWD have elected to jointly form the GGSA in order to sustainably manage groundwater in that portion of the DMB that lies within the districts' boundaries in the Plan Area. The GGSA is located in the Grassland Ecological Area (GEA), which is recognized internationally as a critical wetland ecosystem of hemispheric significance for migratory birds. GGSA lands are referred to as Monitoring Zone1, which consists of a combination of privately managed wetland habitat, state wildlife areas, and national wildlife refuges, along with a small amount of agricultural lands.

The Plan Area also includes un-districted lands adjacent to the GGSA area (known as white areas), which are under Merced County's (County) jurisdiction. These white areas are part of the Merced County Delta-Mendota GSA. The GGSA has agreed to include the identified areas in the Plan in partnership with Merced County. Other white areas in the MCDMGSA have been included in the San Joaquin River Exchange Contractors Water Authority GSP. The Merced County white areas are referred to as Monitoring Zone 2 or the MCDMGSA area. The MCDMGSA area consists of approximately 30,000 acres of privately managed wetland habitat, state wildlife areas, and national wildlife refuges located in the GEA, along with a small amount of agricultural lands adjacent to GWD conveyance channels that participate in groundwater programs for delivery to habitats in the GGSA area. The GGSA and MCDMGSA Plan area have been separated into two respective Monitoring Zones for ease of monitoring and calculating water budgets.

The GEA hosts more than 200 species of birds and significant numbers of mammals, reptiles, amphibians, fish, insects, and plants, some of which are threatened or endangered. Each year it serves as a major overwintering ground for millions of waterfowl, shorebirds, and other waterbirds. Migratory waterfowl include 19 duck species, including green-winged teal, northern shoveler, mallard, gadwall, wigeon, cinnamon teal, northern pintail, ring-necked duck, canvasback, and ruddy duck, and six goose species, such as snow, Ross's, white-fronted, and Aleutian cackling geese. The majority of waterfowl remain until late March before beginning their journey north to breeding areas. However, some species including mallard, gadwall, shorebirds, and raptors breed and raise young in the GEA.

More than 25 species of shorebirds have been documented at the GEA. It is estimated that a half million shorebirds, including sandpipers and plovers, migrate through the wetlands of the GEA in the fall and again in the spring. Large flocks of dunlin, dowitchers, and sandpipers can be seen feeding in these shallow seasonal wetlands, and flocks of long-billed curlews are found using the wetlands, uplands, and adjacent alfalfa and range lands. Other wildlife that can be found in the Plan Area include western pond turtles, raccoons, coyote, striped skunks, beaver, muskrats, tricolored blackbirds, and giant garter snakes.

The Plan Area has very few permanent residents and lies outside the boundaries of the City of Los Banos or any other incorporated communities. There are no adjudicated areas within the Plan Area. The Plan Area is bounded by the following GSAs: San Joaquin River Exchange Contractors GSA, MCDMGSA, Central Delta-Mendota Region GSA, City of Los Banos GSA, City of Gustine GSA, Northwestern Delta-Mendota GSA, Merced Subbasin GSA, and Turner Island Water District GSA (See **Figure 2-4**).

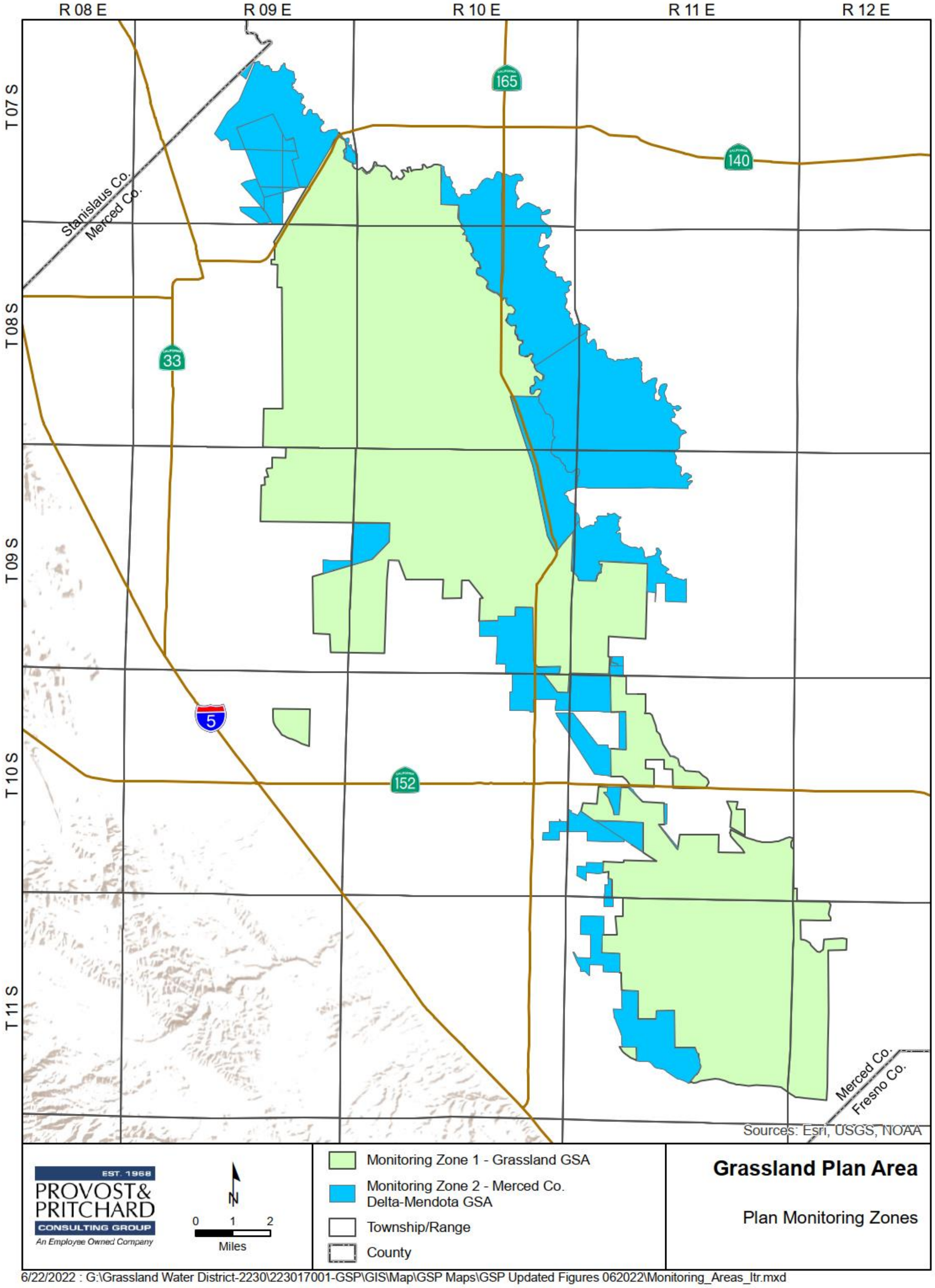


Figure 2-3: Plan Monitoring Zones

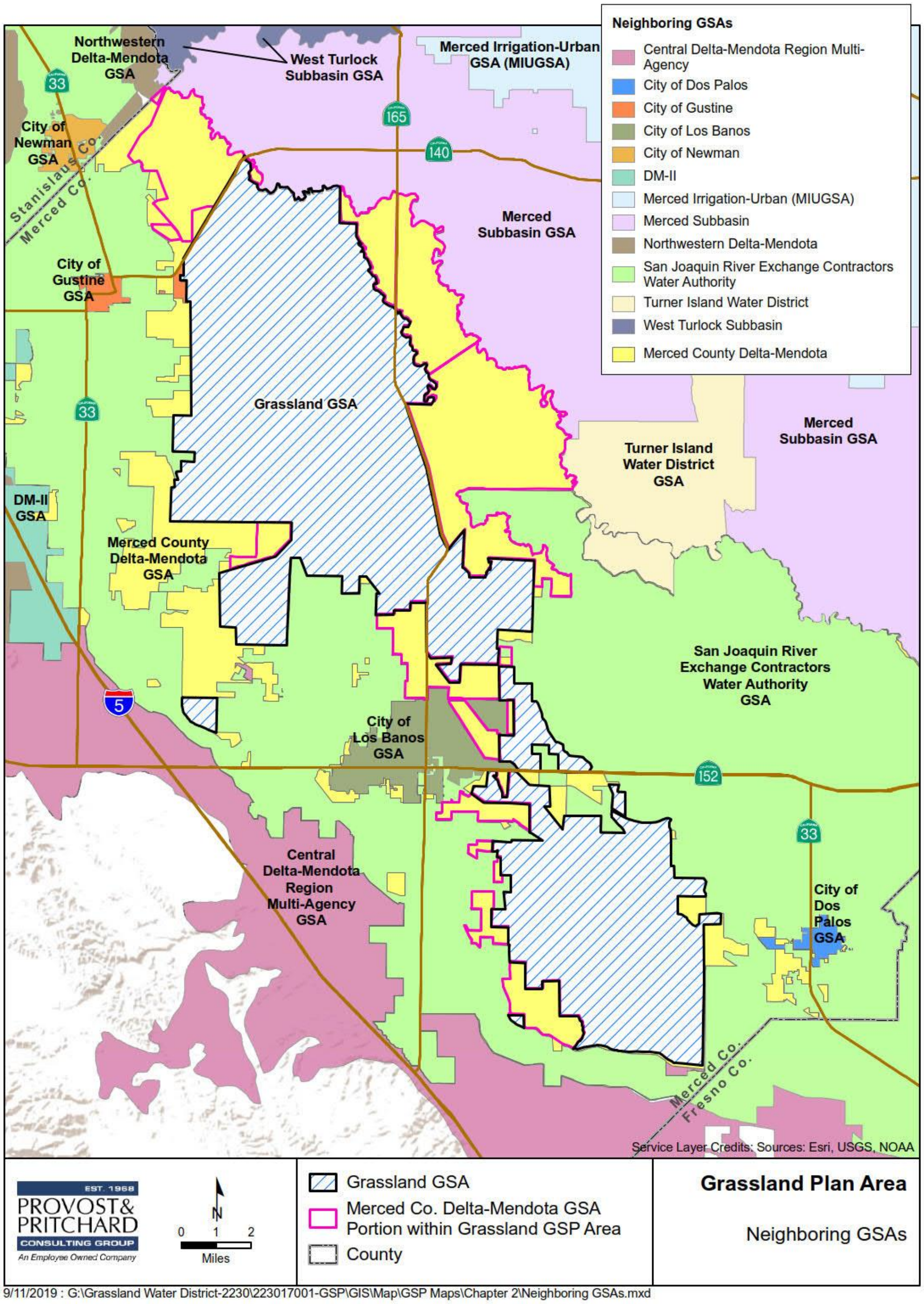


Figure 2-4: Neighboring GSAs

2.1.3 Land Use

DWR's land use survey for Merced County was last updated in 2014 and the general survey classifications can be seen in **Table 2-1.** However, due to the inaccuracy of the DWR land use survey, additional sources including the CropScape data layer, Ducks Unlimited land use and wetland data layers, aerial verification using Google Earth, and ground truthing were combined to develop a more refined and accurate catalogue of land uses in the Plan Area **(Table 2-2)**.

Table 2-1: DWR 2014 Plan Area Land Use

Land-Use Classification	Percent of Total Area
Managed Wetlands and Uplands	95.39
Agriculture	3.26
Urban/Developed	1.35
Total	100

Table 2-2: Verified Land Use

Land Use Classification	Monitoring Zone 1 (acre)	Monitoring Zone 2 (acre)	% of total
Field & Row Crops	2633	2102	5%
Vines & Nuts	0	836	1%
Urban/Developed	860	748	2%
Open Water	1123	269	1%
Idle	424	1029	1%
Managed Wetlands	60240	15118	72%
Grassland-Upland	8994	9574	18%

About 90% of the Plan Area consists of managed wetlands and grassland/upland areas. Agricultural and urban land uses together comprise less than 10% of the Plan Area. Farm operations within the Plan Area include mixed pasture, alfalfa, wheat, cotton, and almonds. **Figure 2-5** shows crop types and land uses from the United States Department of Agriculture's (USDA) online mapping data base known as CropScape. The land surrounding the Plan Area is also used for agricultural purposes (See Common Chapter Figure CC-21).

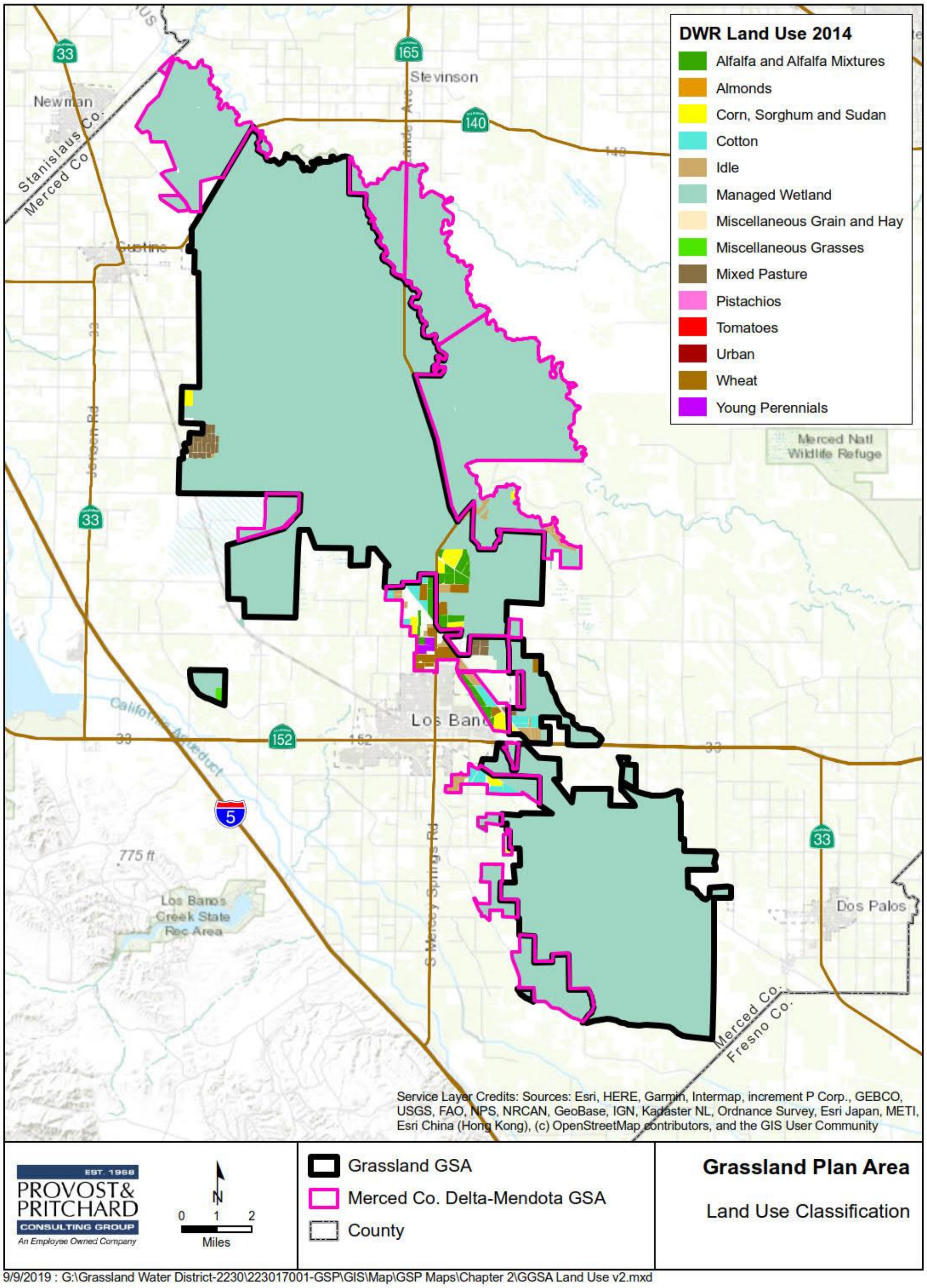


Figure 2-5: Land Use Classification

2.1.4 Water Sources and Use

Surface water for the GGSA and a large portion of the MCDMGSA area is obtained through federal contracts with the United States Bureau of Reclamation (USBR). USBR is required to deliver surface water from the Central Valley Project (referred to as Refuge Level 2 supply) as well as water acquired from voluntary sources (referred to as Refuge Incremental Level 4 supply) under the terms of the Central Valley Project Improvement Act (CVPIA). The full combined volume of Level 2 and Incremental Level 4 surface water supplies is referred to as Refuge Level 4 supply. The federal Delta-Mendota Canal conveys water southeast along the west side of the San Joaquin Valley (Westside) to the Mendota Pool to offset water supply that has been lost from the San Joaquin River due to the construction of Friant Dam. The Mendota Pool is located at the confluence of the San Joaquin River and the north fork of the Kings River and is the major delivery point and holding reservoir for agricultural and wetland irrigation supply on the Westside. Irrigation water can be diverted directly from the Delta-Mendota Canal, although water can also be delivered to the Plan Area from the Mendota Pool via canals that run north to agricultural water districts and wetland water supply contractors. Wetlands in the Plan Area are typically inundated with shallow ponded water starting in late August or September and retained through early spring. This cycle mimics historical hydrologic periods in order to provide foraging and loafing habitats for migratory waterfowl, shorebirds, and other resident wildlife.

Surface water is delivered to private, state, and federal wetlands within a large portion of the Plan Area through GWD's Agatha Canal, Camp 13 Ditch, Santa Fe Canal, San Luis Canal, and Almond Drive Ditch; Henry Miller Reclamation District's Arroyo and C Canals; Central California Irrigation District's Main Canal; USBR's Volta Wasteway; and Los Banos Creek, among others. The GGSA coordinates with USBR to source an Incremental Level 4 supply by using groundwater to supplement surface water in years when surface water deliveries are not adequate to meet full Level 4 wetland demand. The groundwater is pumped from privately-owned wells within the Plan Area and delivered to the GGSA area wetlands under groundwater acquisition and monitoring agreements. In addition to groundwater, GWD also receives operational spill and storm water from neighboring lands in order to meet demands within the Plan Area. The wetlands are drained in the spring (when soil temperatures are optimal for seed germination and subsequent wetland plant growth) to initiate the growing season. Waters drained from these wetlands are conveyed to Los Banos Creek and Mud and Salt Sloughs, which are tributaries to the lower San Joaquin River above the Merced River confluence.

State and federal lands within Monitoring Zone 2 also receive federally contracted surface water. This surface water is delivered by GWD and other neighboring districts. Private lands in Monitoring Zone 2 do not receive federally contracted surface water but may receive storm water, operational spill water from adjacent districts, and flooding from Los Banos and Garzas creeks. Private lands in Monitoring Zone 2 rely primarily on groundwater pumping to meet demands. As shown in **Figure 2-5** above, the vast majority of lands in the Plan Area are managed seasonal wetlands. Water is primarily used to provide overwintering wetland habitat for migratory waterfowl, shorebirds, and other species. In the spring, water is also used for irrigation purposes in order to grow grasses for migratory birds and to provide habitat for local breeding birds and other wildlife, including threatened and endangered species. Approximately half of the agricultural lands in the Plan Area are located in Monitoring Zone 2.

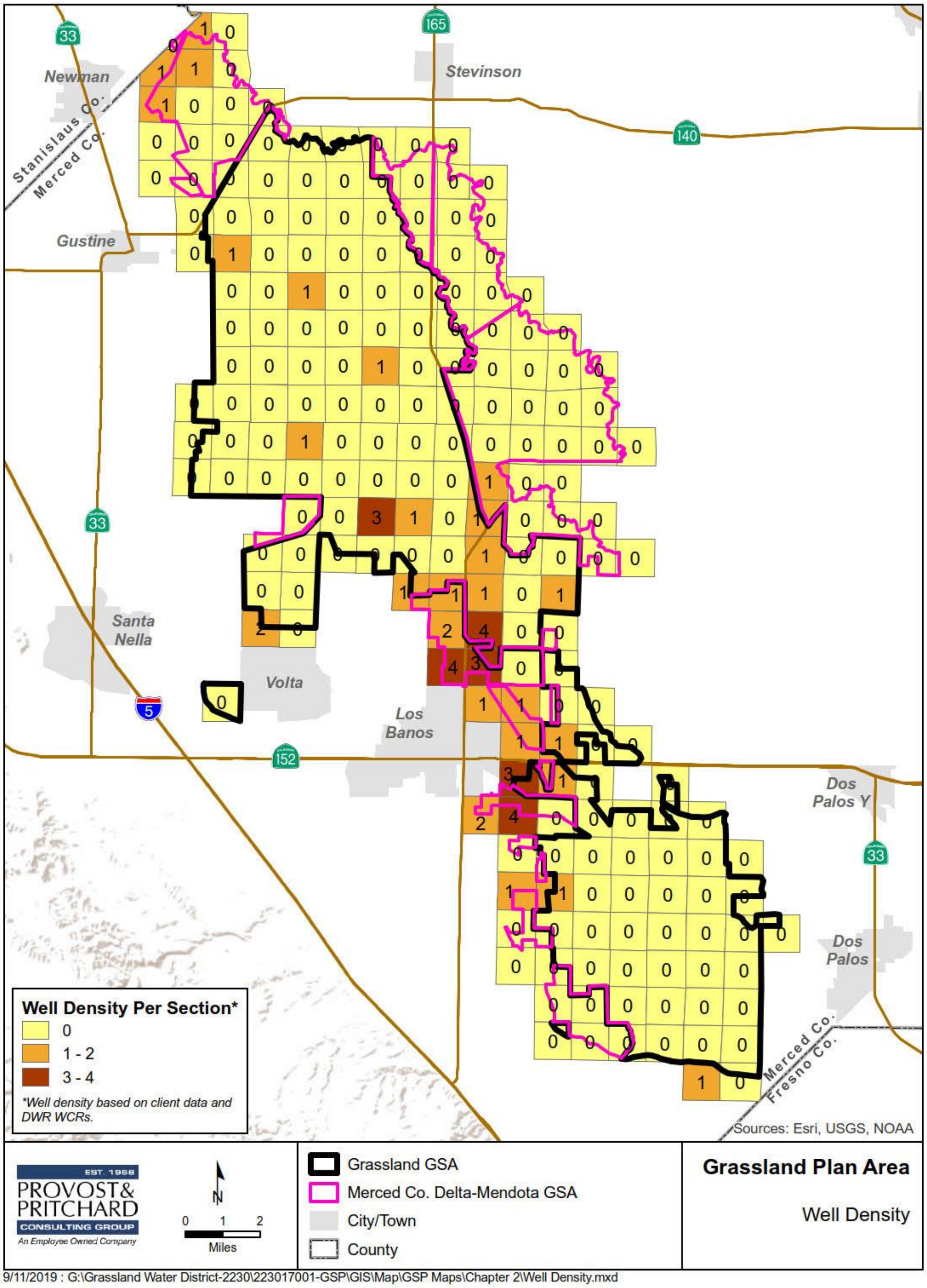


Figure 2-6: Well Density

2.1.5 Well Density

Well density was determined using known locations of Plan Area wells and verified using the online database of DWR well completion reports. Shown in **Figure 2-6** is the well density of all known production wells in the Plan Area, active or inactive. It is important to note that domestic wells may not be represented accurately in **Figure 2-6** due to gaps in well completion report data from DWR. Domestic wells qualify as "de minimis extractors" under SGMA and will be excluded from certain regulatory requirements of the GSP. There are no municipal wells and the only known publicly owned water systems are the wetland water delivery systems owned and operated by GWD, the California Department of Fish and Wildlife (CDFW), and the United States Fish and Wildlife Service (USFWS). These systems do not provide drinking water and therefore do not qualify as "public water systems" under state law. One publicly available groundwater connection serves drinking water to visitors at the San Luis National Wildlife Refuge visitor center.

2.2 Summary of Jurisdictional Areas and Other Features

Legal Requirements:

§354.8(b) A written description of the Plan Area, including a summary of the jurisdictional areas and other features depicted on the map.

The Plan Area is located within Merced County and covers 104,417 acres, including portions of the MCDMGSA. The majority of the Plan Area is located within the 240,000-acre GEA (**Figure 2-7**). This vast network of freshwater marshes (both permanent and seasonal), alkali grassland, and riparian thickets is the result of decades of wetland preservation, restoration, and collaborative conservation agreements between private duck clubs, California State Parks (Great Valley Grasslands), CDFW (Volta, Los Banos, and North Grasslands State Wildlife Areas), and USFWS (San Luis National Wildlife Refuge and the larger Grasslands Wildlife Management Area). **Figure 2-8** provides a map of the plan area and the various plan participants. Additionally, wildlife refuges and wetland habitat in the Plan Area and DMB are depicted in **Figure C-11** of the Common Chapter (**Appendix A**).

These land managers cooperate with several wetland-related conservation organizations that provide direct services to the wetlands, including the installation of water control structures, development of drainage swales, habitat improvements, and water management and efficiency improvements and techniques. Organizations that assist landowners include Ducks Unlimited, California Waterfowl Association, Natural Resource Conservation Service, Wildlife Conservation Board, USFWS, and CDFW. These agencies are instrumental in securing funding for wetland habitat improvements.

The GEA contains the largest remaining block of freshwater wetlands in the western United States. The area has received numerous designations and protections, including a Wildlife Management Area designation by Congress, a Wetland of International Importance designation under the Ramsar Convention, an Important Bird Area designation by the Audubon Society, and a Site of International Importance designation by the Western Hemispheric Shorebird Reserve Network.

2.2.1 Plan Participants and Jurisdictional Areas

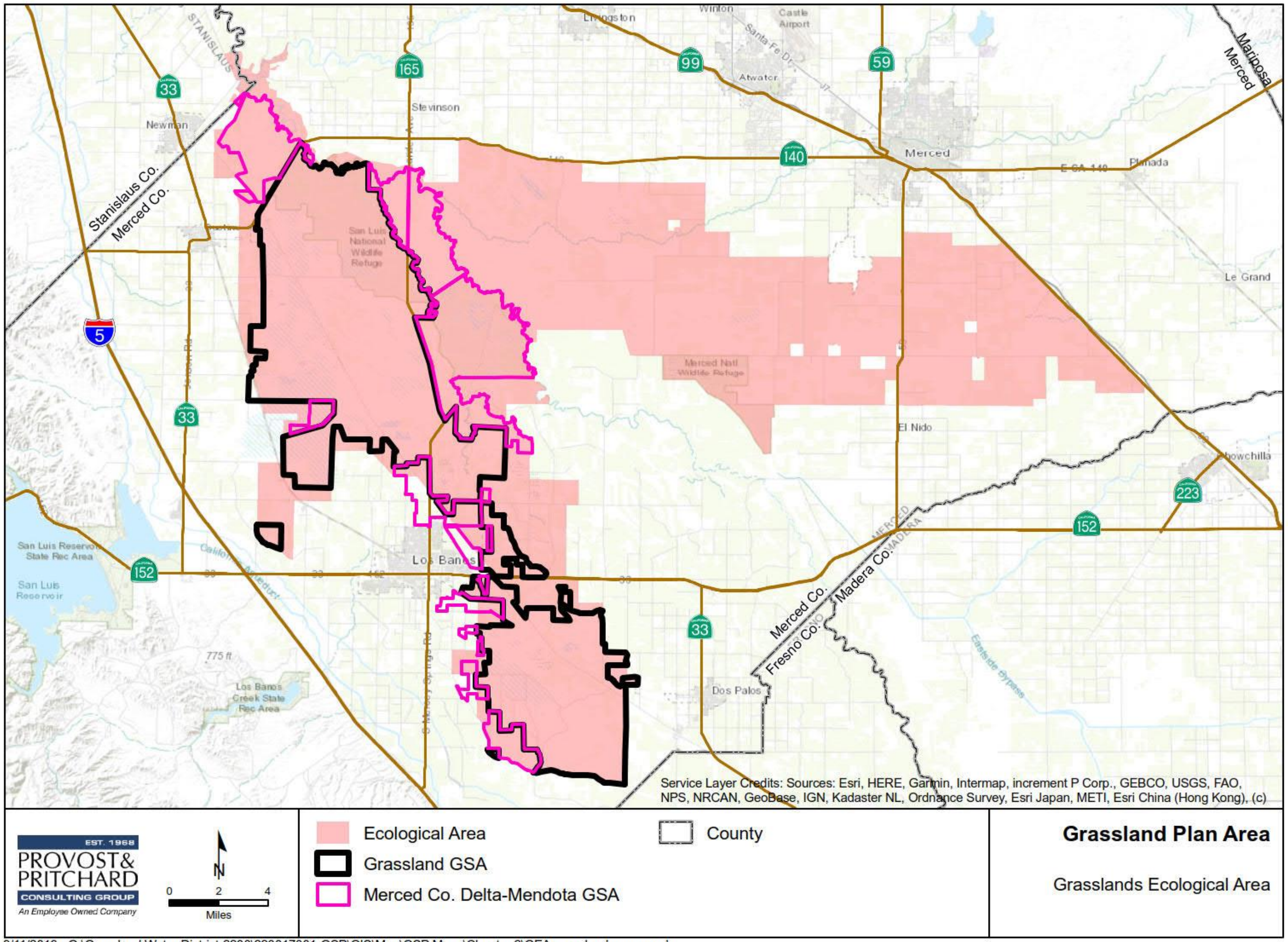
The following is a summary of Plan participants and the jurisdictional areas within the Plan Area (See **Figure 2-8**).

Grassland Water District / Grassland Resource Conservation District
The GRCD occupies 75,000 acres and includes most of the GWD, which encompasses approximately 50,000 acres. Both the GRCD and GWD are located in the southwestern San Joaquin Valley within the GEA. GRCD and GWD have elected to jointly form the GGSA in order to sustainably manage groundwater for those portions of the Delta-Mendota Subbasin that lie within the combined service area of the Districts.

The GWD is a California Water District formed pursuant to California Water Code Section 34000 et seq. The GWD's primary function is to protect, secure, and deliver water to the critical wetland habitat within its boundaries and within the larger GRCD. The GWD also conveys water to adjacent state and federal wildlife refuges on behalf of the USBR. The GWD adopted its first Groundwater Management Plan in 2011 and manages a conjunctive use groundwater program for wetland habitats within the GWD and GRCD in cooperation with the USBR. A five-member GWD Board of Directors is elected by landowners within the GWD. The GWD collects annual assessments and water delivery fees from landowners.

The GRCD, which encompasses the GWD, is a California Resource Conservation District formed under Division 9 of the California Public Resources Code. The GRCD works closely with the CDFW and the USFWS to maximize food and habitat availability in order to meet the needs of the migratory birds utilizing the pacific flyway. Ninety percent of the GRCD is preserved under permanent wetland conservation easements. The GRCD was identified as one of the 19 refuges in the federal Central Valley Project Improvement Act, which directed the Secretary of the Interior and the State of California to provide adequate and reliable water supplies to these critical wetlands. A five-member GRCD Board of Directors is elected by residents within the GRCD. The GRCD does not collect annual assessments or fees from landowners and cooperates with the GWD regarding landowner outreach and groundwater management.

Almost all land within the GRCD and GWD is privately owned and maintained as wetland habitat, primarily within waterfowl hunting clubs. In the 1920s duck hunting began to become prevalent, and by the 1950s duck hunting became the predominant use of the land within the Plan Area. Clubs began to develop shallow open water in order to attract wintering waterfowl by mimicking historic wetlands and hydroperiods. Approximately 70% of managed wetlands in California are on private property and most of that land is owned and maintained by duck hunting clubs. Currently there are approximately 200 individual clubs in the Plan Area that rely on gravity flow water to operate and maintain year-round wetland habitat for wildlife. The majority of these clubs are located within the GRCD and GWD.



9/11/2019 : G:\Grassland Water District-2230\223017001-GSP\GIS\Map\GSP Maps\Chapter 2\GEA map_landscape.mxd

Figure 2-7: Grasslands Ecological Area

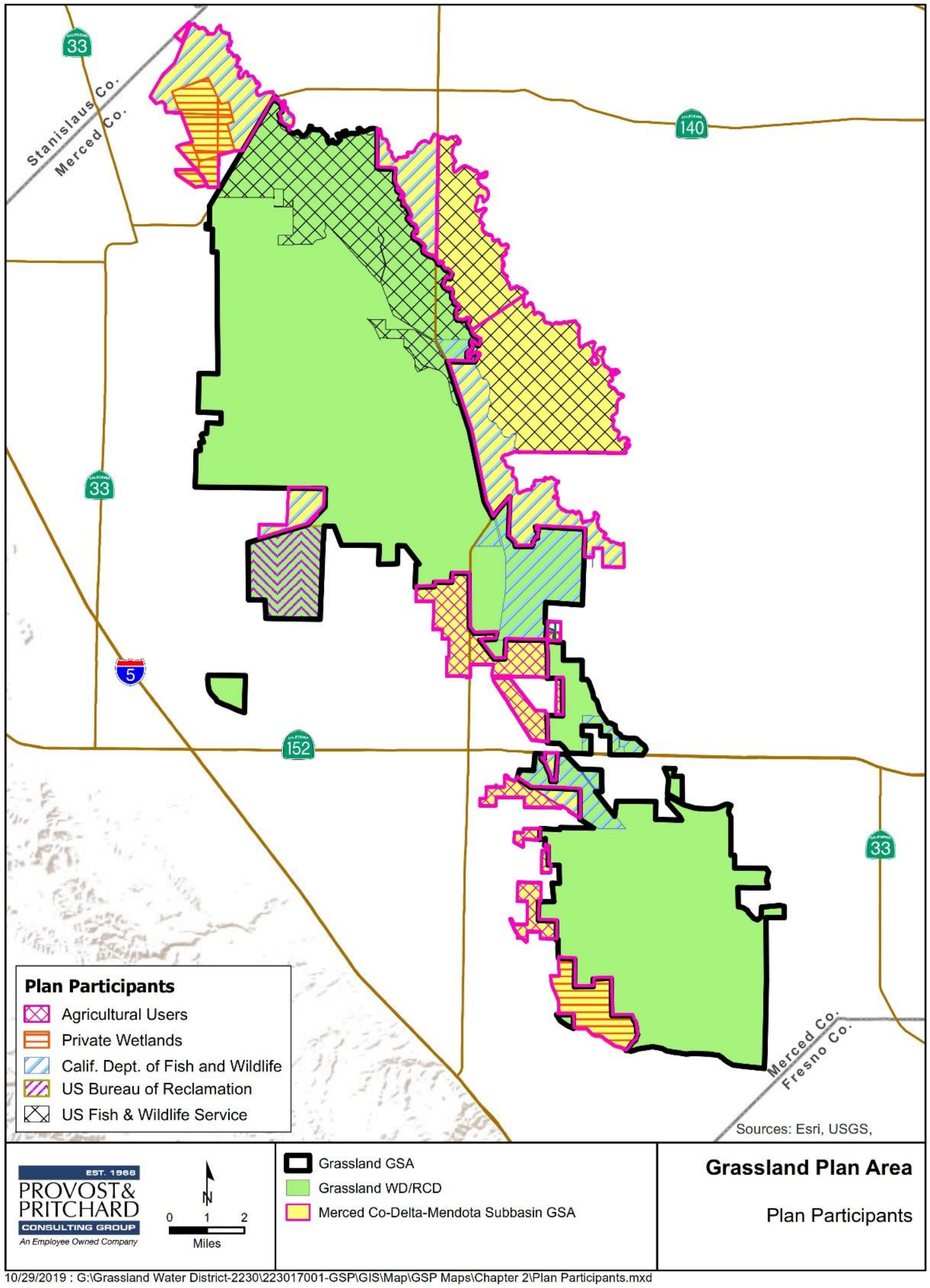


Figure 2-8: Plan Participants

Merced County

Merced County was formed in 1855 and includes the incorporated cities of Atwater, Dos Palos, Gustine, Livingston, Los Banos, and Merced. The County has a total area of 1,238,974 acres, or 1,935 square miles, of which 98.1% is unincorporated land according to the Merced County General Plan Background Report. Approximately 87,500 acres of grassland marsh in western Merced County provide unique wetland habitat for migratory waterfowl. This area represents 6.9% of the total area within the County. Approximately 87,000 acres of this grassland marsh is permanently protected by conservation agreements as part of the Grasslands Wildlife Management Area (approximately 7% of the County). In addition, more than 101,000 acres in Merced County (8% of the total land area) are protected as National Wildlife Refuges and state Wildlife Areas.

Merced County is located in the central portion of the San Joaquin River drainage basin with several major tributaries flowing from the west slope of the Sierra Nevada, including the Merced River, Bear Creek, Owens Creek, Mariposa Creek, Deadman Creek, and the Chowchilla River along the County's southern border. The San Joaquin River flows from southeast to northwest with approximately 9,520 square miles of upstream San Joaquin River drainage in Merced County. The Merced River carries runoff from the Sierra Nevada year-round with roughly 1,276 square miles of drainage area flowing east to west through the northern portion of the County. Major water supply and diversion dams, reservoirs, and hydroelectric power projects regulate and control flow along the San Joaquin and Merced Rivers. Agricultural consumers account for the highest percent of surface water use in the County. Additional uses of surface water include municipal, domestic, and industrial.

Merced County overlays four groundwater subbasins within the larger San Joaquin Valley Groundwater Basin. Groundwater flow in the County is generally towards the Central Valley trough, west of the Sierra Nevada and east of the Diablo Range towards the San Joaquin River. Private agricultural pumping represents more than 80% of total groundwater use. Additional uses of groundwater in Merced County include municipal and domestic supply, industrial service and process supply, and wetland habitat supply.

Within the Plan Area, about 29,781 acres (approximately 28.5% of the Plan Area) are located outside of the service areas of GWD and GRCD and constitute the County's MCDMGSA area. The Sustainable Groundwater Management Act at Water Code §10724(a) addresses unmanaged areas ("white spaces" or "white areas") within a groundwater basin through the presumption that the overlying county(s) will become responsible for these areas. The MCDMGSA and the GGSA entered into a Memorandum of Understanding (MOU) for the purposes of developing this Plan and implementing SGMA in portions of the MCDMGSA that are adjacent to the GGSA and within the Delta-Mendota Subbasin. Under the MOU, Merced County is partnering with the GGSA to coordinate Plan preparation, implementation, and enforcement, including but not limited to the establishment of monitoring protocols, data exchange, fee recovery, and enforcement mechanisms.

California Department of Fish and Wildlife (CDFW)

Prior to 1840, Native Americans known as the Yokut occupied most of the San Joaquin River basin. They lived as a hunting and gathering culture in the areas that are now managed as state Wildlife Areas by the CDFW as well as throughout the surrounding vicinity. Settlers used the area for commercial, subsistence, and recreational hunting from the time they first entered the area until new laws and a lack of wildlife curtailed the first two activities.

North Grasslands Wildlife Area
Most of this land was historically flooded, and as a result occupancy was limited to high spots and was seasonal at best. As waters of the San Joaquin were diverted, flooding was curtailed, thus making the cattle business practices of the past increasingly more dependent on artificially maintained surface water. The North Grasslands Wildlife Area was designated as a wildlife area by the Fish and Game Commission in 1992. It consists of approximately 7,400 acres in three distinct units: China Island, Gadwall, and Salt Slough.

China Island Unit
China Island has historically been used for cattle grazing and recreational waterfowl hunting. The northern portion was fenced and graded to support irrigated pasture. The southern portion remained predominantly as a San Joaquin River floodplain. The China Island Unit was acquired by the state in 1990 to implement the San Joaquin Basin Action Plan/Kesterson Mitigation Plan. In wet years the San Joaquin River breaches its banks and floods the majority of the China Island Unit, providing much needed food and nutrients back to the San Joaquin River and South Delta in addition to providing habitats for many species of fish and wildlife.

Gadwall Unit
The Gadwall Unit encompasses 1,600 acres of managed seasonal wetlands and is the southernmost unit of the North Grasslands Wildlife Area. The known historical uses on this unit were cattle grazing and duck hunting. The property was operated as a viable private duck club prior to its purchase by the California Department of Fish and Wildlife. The Gadwall Unit was expanded by 158 acres through the acquisition of the Ramacciotti Unit, which was restored in the summer of 2013 from rangeland into the Widell-Ramacciotti Marsh.

Salt Slough Unit
Prior to the 1930s, this land was altered to improve grazing by the Miller & Lux Corporation and was operated as a cattle ranch until it was acquired by the CDFW in 1990 to implement the San Joaquin Basin Action Plan/Kesterson Mitigation Plan. Since this area is adjacent to the Salt Slough, fishing and hunting also took place in or around this area.

Los Banos Wildlife Area
Purchased in 1929, the Los Banos Wildlife Area was the first of a series of state wildlife refuges established throughout California to manage habitat primarily for overwintering waterfowl. Expanded from its original 3,000 acres, there are now approximately 6,200 acres of wetland habitat that includes lakes, sloughs, and marsh. The wildlife area lies partially within a large Mexican land grant called Sanjon de Santa Rita that was granted by the Governor of Mexico in 1841. In 1863, Henry Miller purchased 8,000 acres, and by 1870, Miller had purchased the rest of the land grant for agricultural use.

In 1929, the Fish and Game Commission purchased 3,000 acres that had been used in a natural condition to graze livestock. The rest of the wildlife area was purchased from lands that were converted to farming by owners subsequent to Miller’s purchase. The property was designated as a wildlife area by the Fish and Game Commission in 1954. The Los Banos Wildlife Area contains a 2.5-mile birding trail for wildlife viewing from late February through mid-June and houses the Grassland Environmental Education Center, which provides free-of-charge outdoor educational programming for children.

Mud Slough Unit
The Mud Slough Unit of the Los Banos Wildlife Area encompasses 455 acres of restored wetland habitat rehabilitated from cotton production in the early 1990s. Forty-two percent of the Mud Slough unit is managed for moist soil habitat, the majority of which is swamp timothy covering 77 acres.

Volta Wildlife Area
Volta Wildlife Area is approximately 3,800 acres and contains 1,300 acres of moist soil habitat. Beginning in 1949, a series of meetings were held throughout California to discuss the acquisition of wetlands for state-owned waterfowl management areas. Purposes for acquisition included an economic necessity to protect agricultural crops from waterfowl depredation, recognition of a need to protect waterfowl overwintering habitat, and a desire to accommodate public waterfowl hunting. The Volta Wildlife Area was approved in concept at these meetings.

The Volta Wildlife Area is owned by the USBR. In 1952, a lease agreement was initiated for CDFW to manage the property. This property is managed primarily as seasonally flooded wetland in order to provide for the habitat needs of migratory waterfowl and associated species. It was designated as a state Wildlife Area by the California Fish and Game Commission in 1973.

California Department of Parks and Recreation

Great Valley Grasslands State Park
This 2,826-acre park preserves one of the few intact examples of native grasslands on the floor of the Central Valley. Several rare and endangered plant and animal species inhabit the park. Springtime wildflower displays, fishing, and wildlife watching attract visitors to this undeveloped park, which also encompasses the former Fremont Ford State Recreation Area. In wet years the Great Valley Grasslands State Park can be flooded by the San Joaquin River, creating a vast shallow lake teaming with invertebrates; an ideal floodplain habitat for many species of fish and wildlife.

U.S. Fish and Wildlife Service (USFWS)
SGMA requires that federally reserved water rights to groundwater shall be respected in full and encourages voluntary participation by federal agencies in the SGMA planning and implementation process (Water Code § 10720.3.) The USFWS has participated in the GSP development by providing requested data for analysis and plan development.

San Luis National Wildlife Refuge
The San Luis National Wildlife Refuge (NWR) encompasses 26,878 acres of wetlands, riparian forests, native grasslands, and vernal pools. A thriving population of the endemic tule elk resides on the refuge. The USFWS purchased the first refuge parcel in 1966 using federal Duck Stamp funds to provide a sanctuary for migratory waterfowl and the refuge was officially established in 1967. The refuge has steadily grown in size and today is comprised of six contiguous units, five of which are within the Plan Area: the San Luis, West Bear Creek, Freitas, Blue Goose, and Kesterson units. The San Joaquin River bisects the eastern portion of the refuge outside of the Plan Area, where the East Bear Creek unit is located. The refuge is part of the larger San Luis NWR Complex, which includes the Merced NWR and San Joaquin River NWR, both of which are also located outside of the Plan Area.

San Luis Unit

The San Luis Unit contains the LEED Platinum-certified San Luis NWR Complex Visitor Center and Headquarters, which includes an exhibit hall and provides a launching point to explore the refuge complex. The unit contains two automobile tour routes and five nature trails for wildlife observation. This unit also offers public hunting and fishing opportunities.

West Bear Creek Unit

The West Bear Creek Unit contains an automobile tour route and two nature trails for wildlife observation and offers public waterfowl hunting opportunities.

Freitas Unit

The Freitas Unit offers boat-in waterfowl hunting along Salt Slough and upland pheasant hunting opportunities.

Blue Goose Unit

The “Blue Goose” is the symbol of the National Wildlife Refuge System and has been used on refuge boundary markers, entrance signs, brochures, and exhibits since 1936. The Blue Goose Unit provides public waterfowl hunting opportunities.

Kesterson Unit

The Kesterson Unit offers public waterfowl and pheasant hunting opportunities during the hunting season and “free-roam” nature hiking from February 15 through September 15 when the waterfowl hunting season is closed. This unit contains a portion of the historic San Joaquin River floodplain and is home to a unique community of plants and animals adapted to its alkaline soils. The Kesterson Unit was formerly called the Kesterson NWR and contained the Kesterson Reservoir, a series of evaporation ponds for agricultural drainage water that was closed in 1986 to protect wildlife.

Grasslands Wildlife Management Area

The Grasslands Wildlife Management Area (WMA) was approved by Congress and established by the USFWS in 1979 and is located in western Merced County within the San Joaquin River Basin. Nearly coextensive with the GEA, the Grasslands WMA has a 230,000-acre “acquisition boundary” for the USFWS to acquire conservation easements on privately-owned parcels that complement the two National Wildlife Refuges and four state Wildlife Areas within the WMA. These easements preserve wetland and grassland habitats as well as wildlife-beneficial agricultural lands. The preservation of these areas prevents conversion of the land to uses not compatible with migratory birds and other wildlife while still allowing daily management to remain under the landowners’ control.

The Grasslands WMA is divided into eastern and western divisions separated by the San Joaquin River. In the heart of the western division is the GRCD, an area of 75,000 acres of private wetlands and associated grasslands and over 30,000 acres of National Wildlife Refuges and state Wildlife Areas. These wetlands constitute 30% of the remaining wetlands in California's Central Valley and are extremely important to Pacific Flyway waterfowl populations and other bird species.

The Grasslands WMA contains diverse habitats including seasonally flooded wetlands, semi-permanent wetlands, riparian habitats, wet meadows, vernal pools, native uplands, pastures, and native grasslands. In addition to waterfowl, these habitats support shorebirds, wading birds, songbirds, raptors, and other wildlife species. Several federal and state-listed endangered and threatened plants and animals are present in the area and benefit from the habitat protection provided by the easement program. To date, the USFWS holds more than 190 conservation easements on private lands totaling approximately 87,000 acres within the Grasslands WMA. Habitat management assistance is available to all Grasslands WMA landowners who request it, whether they participate in the easement program or not.

In 1987, the USFWS initiated the Partners for Fish & Wildlife cost-share program, which pays landowners up to 50% of the funding necessary to accomplish wetland restoration and enhancement projects on their properties. This program provides landowners with the opportunity to perform wildlife habitat improvements they might not be able to afford without financial assistance. Typical projects that have been cost-shared in the past include the installation of new water control structures, the construction of swale drains that increase efficiency of habitat management practices, and the construction of levees and waterfowl loafing islands.

The Plan Area contains a small number of acres of privately-owned wetlands that are not within the GRCD/GWD or a state Wildlife Area or National Wildlife Refuge. These wetlands are within the Grasslands WMA and most are preserved through USFWS conservation easements.

Agricultural Users

There are agricultural lands in the Plan Area that are adjacent to GWD conveyance infrastructure and participate in refuge water supply groundwater pumping programs. The majority of these agricultural water users are in the MCDMGSA and rely primarily on operational spill, groundwater, and surface water transfers. There are approximately 4,700 acres of agricultural land in the Plan Area (See **Table 2-2**).

2.3 Water Resources Monitoring and Management Programs

Legal Requirements:

§354.8(c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan. **§354.8(d)** A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.

2.3.1 Monitoring and Management Programs

There are several existing monitoring and management programs that have provided the needed data for development of the GSP and will help the GGSA and MCDMGSA to comply with annual reporting requirements in the future. Existing programs were particularly useful in determining historic and current conditions for both surface and groundwater and for development of the historic and current water budgets. Existing monitoring and management activities will continue to be utilized within the Plan Area as a source of data for tracking progress in GSP implementation. Existing management activities will be coordinated between the Plan participants and stakeholders to ensure consistent and accurate data collection. The GGSA will continue to collaborate with MCDMGSA and landowners to avoid the duplication of efforts. Existing monitoring and management programs are described below. Monitoring for data collection and GSP reporting is described in further detail in **Chapter 5** – Monitoring Network.

2.3.1.1 Groundwater Level Monitoring

GWD maintains a groundwater level monitoring program that includes pre- and post-pumping seasonal water level measurements. Monitoring began in 2008 under a Monitoring Plan approved by USBR and data is reviewed annually. The monitoring program is intended to track depth to groundwater trends, help collaboration with other agencies, and identify and help avoid third-party impacts as a result of groundwater pumping for wetland habitat use. Depth to groundwater measurements are made at multiple wells above and below the Corcoran Clay approximately 4 times a year. Measurements (which include ambient, drawdown, and recovery levels) are made in the spring prior to spring-summer wetland irrigation pumping (ambient), again prior to the end of the spring-summer pumping period (drawdown), and at least 24 hours after well shutdown (recovery). Additionally, in the fall, levels are again taken prior to the beginning of the fall-winter pumping period (ambient), prior to the end of the pumping period (drawdown), and at least 24 hours after well shutdown (recovery). More information regarding GWD's monitoring program can be found in **Chapter 4**.

The majority of the pumping in the Plan Area is done in the fall and winter outside of the surrounding agricultural irrigation and groundwater pumping season. Water level measurements are taken using electronic well sounders and measured from an identified reference point at each well. CDFW also collects groundwater elevation data from observation wells on a weekly basis and has and will continue to provide that data to the GGSA.

GWD also works with the San Luis & Delta-Mendota Water Authority (SLDMWA) to monitor several wells for inclusion in the SLDMWA groundwater monitoring program. Data is entered into an electronic database and submitted to the SLDMWA for inclusion in the CASGEM program. Additionally, there are four DWR wells within the Plan Area that are monitored regularly by DWR. Data for these wells is available on the Water Data Library and the CASGEM websites. Annual summaries of groundwater level trends are reviewed by the District's Board of Directors and provided to the USBR, CDFW, SWRCB, and USFWS in annual and semi-annual reports.

2.3.1.2 Groundwater Extraction Monitoring

All wells in the Plan Area that are pumped for Refuge Incremental Level 4 water supply are equipped with flow meters. Meters within the GGSA are monitored and data recorded on a weekly basis, while meters on state and federal lands within Monitoring Zones 1 and 2 are monitored monthly. Groundwater pumped for the limited amount of agricultural production within the Plan Area is likely not metered and is not currently monitored by the GGSA. However, pursuant to the Merced County Groundwater Mining and Export Ordinance, all new wells constructed in Merced County must be metered with an approved water measuring device and report pumping amounts to the Merced County Department of Public Health, Environmental Health Division (MCDEH). Furthermore, all persons extracting groundwater within the County from wells permitted under the Groundwater Mining and Export Ordinance of Merced County, adopted in March 2015, must submit annual reports to MCDEH including water level and pumping data.

2.3.1.3 Groundwater Quality Monitoring

Water quality samples are collected from all wells being utilized for Incremental Level 4 refuge water supply and analyzed for electroconductivity (EC), total dissolved solids (TDS), selenium, and boron. Laboratory analysis provides specific correlation ratios to convert EC to TDS for each well. EC is measured weekly at each well site using hand-held multi-parametric sensors.

Results are evaluated in relation to refuge water quality requirements and compared to historic data to identify and track trends. GWD has observed that wellhead water quality is stable, enabling the development of minimum flow requirements to maintain surface water objectives. Annual summaries of groundwater quality trends are reviewed by the GWD Board of Directors and submitted to the USBR, CDFW, SWRCB, and USFWS in annual and semi-annual reports.

Current groundwater monitoring plans also require GWD to monitor water in surface water channels where groundwater is introduced. The Central Valley Regional Water Quality Control Board (CVRWQCB) has established a maximum surface water concentration of 2 µg/L of selenium for Grassland wetlands and delivery channels. Although there is no adopted surface water quality objective for boron within the GRCD, the program will cease pumping if surface water exceeds the CVRWQCB's 4 mg/L boron objective for the San Joaquin River. Surface water quality sampling and analysis is conducted upstream and downstream of well discharges to help ensure compliance with surface water quality objectives set by the CVRWQCB. If a surface water quality objective is exceeded, groundwater pumping is curtailed until additional high-quality surface water is routed into the receiving conveyance channel and surface water quality objectives are again met.

Weekly monitoring of EC, pH, and temperature upstream and downstream of each well discharge is also conducted. The CDFW also conducts and shares weekly EC measurements from 19 supply and drainage locations to the Los Banos Wildlife Area and Volta Wildlife Area. These monitoring efforts help ensure that high-quality water is provided to the wetland habitat within the Plan Area in accordance with wetland water quality standards adopted by GWD and other wetland management agencies.

Surface water quality monitoring is also relevant to this GSP since groundwater is blended with surface water in the Plan Area. Since the mid-1980s GWD has collected and recorded water quality data on surface inflows, deliveries, and drainage leaving the district. These sites continue to be monitored monthly throughout each water year for TDS, EC, boron, and selenium. Grab sampling occurs on a monthly basis at major drainages and at delivery locations to state and federal refuges, coinciding with monthly Irrigated Lands Regulatory Program sampling efforts.

GWD's Real Time Water Quality Monitoring Network (RTWQMN) currently consists of approximately 30 real-time monitoring stations located at key inflow, delivery, and drainage points that continuously measure surface water flow, EC, temperature, and pH. Real-time surface water monitoring is required under the CVRWQCB's Salt and Boron Total Maximum Daily Load (TMDL) requirement for the lower San Joaquin River, which took effect in 2006. GWD cooperates with the USBR, the San Luis Drainage Authority, and the Grassland Basin Drainers group to implement the program. GWD is currently updating its RTWQMN stations with new sensors, modems, and loggers with funding from the USBR and DWR.

2.3.1.4 Land Surface Subsidence Monitoring

Land subsidence can result from compaction of underlying formations that are affected by water level decline. Although significant subsidence has been measured within the Delta-Mendota Subbasin, most of it has occurred outside of the Plan Area boundaries and has been associated with pumping from the lower aquifer, beneath the Corcoran Clay (See Section 4.2.6 of the Common Chapter, Land Subsidence). Water production wells within the Plan Area primarily pump from the upper zone, above the Corcoran Clay. Therefore, groundwater pumping activities within the Plan Area have not and are not expected to contribute to land subsidence.

The SLDMWA, USBR, and San Joaquin River Exchange Contractors Water Authority (SJRECWA) maintain land subsidence monitoring programs. GWD will continue to monitor the results of these established monitoring programs, collaborate with the aforementioned agencies to identify problems associated with land subsidence, and participate in the development of both intra-and inter-basin solutions.

The Plan Area has not been identified as a critical land subsidence area. GWD and several other water districts collaborated with the SLDMWA and the SJRECWA, which maintain local land subsidence monitoring programs, to help develop a Groundwater Level and Subsidence Monitoring Plan as a part of USBR's Environmental Assessment for Refuge Groundwater Acquisitions. The USBR annually reviews the results of these monitoring programs and works with the monitoring agencies to the extent practical to address any regional problems associated with land subsidence.

2.3.1.5 Grassland Bypass Project

Under an agricultural drainage improvement program by the USBR, sub-surface agricultural drainage from a large portion of the 370,000-acre Grasslands Watershed west of the San Joaquin River in Merced County has been shifted from discharging into wetland areas to discharging to the San Luis Drain and Mud Slough, a tributary to the San Joaquin River. The Grassland Bypass Project improves water quality in the Plan Area's wildlife refuges and wetlands, sustains the productivity of 97,000 acres of farmland to the south of the Plan Area, and fosters cooperation between area farmers and regulatory agencies in drainage management and the reduction of selenium and salt loading. The project is operated by the San Luis Drainage Authority, the Grassland Basin Drainers group, USBR, and the SLDMWA.

The project has gradually reduced discharges of agricultural drainage water, and there are no such discharges to the San Joaquin River currently. Beginning in January 2020, the CVRWQCB will require that discharges of agricultural drainage water permanently cease, and the Grassland Bypass Project is thereafter proposed for continued management as a storm water bypass project. Agricultural drainage water will continue to be reused to grow salt-tolerant crops as part of the San Joaquin River Improvement Project (SJRIP), located south of the Plan Area. The Drainage authority has agreed to install 5 monitoring wells along the common boundary between the GGSA and the SJRIP, also known as the drainage reuse area, to begin to monitor subsurface groundwater conditions. Monitoring results will be incorporated into future GSP updates.

2.3.1.6 Irrigated Lands Regulatory Program

The CVRWQCB's Irrigated Lands Regulatory Program (ILRP) addresses discharge of wastes (e.g., sediments, pesticides, nitrates) from irrigated lands. These wastes can harm aquatic life or make water unusable for drinking or agricultural uses. The goal of the ILRP is to protect surface water and groundwater and to reduce impacts of irrigated discharges to waters of the State. In 1999, the California Legislature passed Senate Bill 390, which eliminated a blanket waiver for agricultural waste discharges. The bill required the SWRCB to develop a program to regulate irrigated lands under the Porter-Cologne Water Quality Control Act. In 2003, the CVRWQCB adopted conditional Waiver of Waste Discharge Requirements (WDRs) to regulate agricultural and managed wetland discharges to surface waters. In December 2012, the CVRWQCB started adopting WDRs that addressed discharges to both surface water and groundwater, thus requiring ILRP enrollment for all irrigated agricultural and wetland operations. Surface water quality has been monitored for several years and, in the future, groundwater quality will be monitored.

Under the ILRP rules, growers may form “third party” coalitions to assist with required monitoring, reporting, and education requirements for irrigated lands. GWD is a participant in the Westside San Joaquin River Watershed Coalition’s (Westside Coalition) program to implement the requirements of the CVRWQCB’s Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. GWD pays annual fees to cover the cost of compliance within the GGSA. The Westside Coalition was organized under the San Joaquin Valley Drainage Authority (Drainage Authority), a California joint powers authority, to administer the Irrigated Lands Regulatory Program. Governance, budgeting, and administration are implemented through an activity agreement between the Drainage Authority and public agency participants.

An updated Irrigated Lands Regulatory Program Waste Discharge Requirements General Order for Growers within the Western San Joaquin River Watershed was adopted on January 9, 2014, by the CVRWQCB. All owners of irrigated lands within the Plan Area, including managed wetlands, are required to enroll in the ILRP program and must submit annual reports to the CVRWQCB.

2.3.1.7 Central Valley Project Drought Contingency Plan

The Central Valley Project (CVP) Drought Contingency Plan (DCP) was developed by the USBR and DWR in 2016 to address mounting environmental and economic issues resulting from multiple years of drought conditions. The DCP considered the supply needs of all users and the best approaches for balancing all needs without creating undue hardships. The DCP defines allocations to CVP water users when faced with what is known as a Shasta Critical Year. Needs were ranked with municipal health and safety first, preservation of Sacramento-San Joaquin Delta water quality second, and finally the protection of threatened and endangered habitats. The remainder of water contractors, including agricultural users, were considered last. Under the CVP refuge water supply contracts that provide surface water to wetland habitat areas in the Plan Area, Level 2 surface water deliveries are cut back by up to 25% in a Shasta Critical Year. In practice, Incremental Level 4 supplies are also cut back significantly, as there is little water available for voluntary acquisitions or transfers in a critically dry year.

2.3.2 Impacts to Operational Flexibility

The presence of several different existing water monitoring and management programs constitute constraints that could impact operational flexibility and water operations within the Plan Area. These programs are illustrated in **Figure 2-9**, followed by a description of each program and possible adaptation measures.

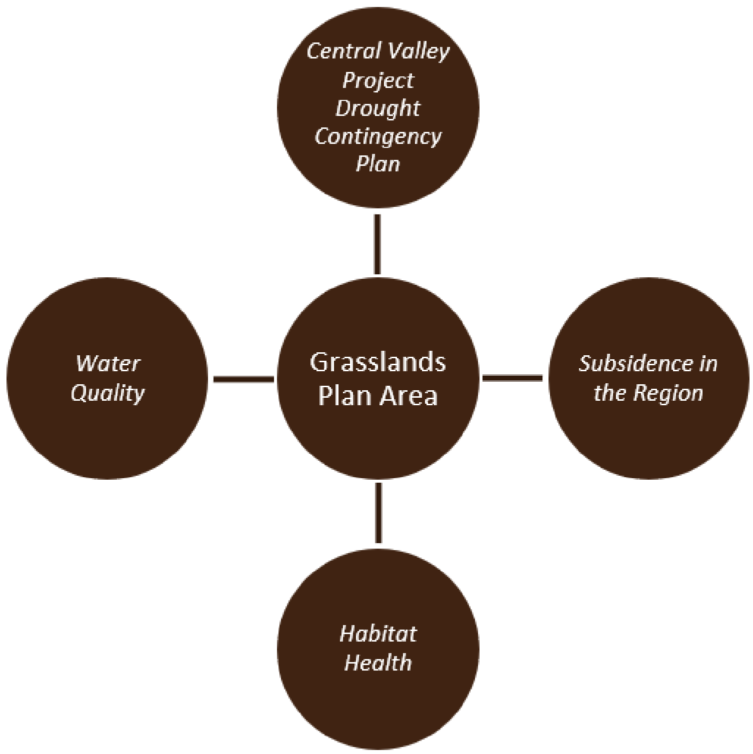


Figure 2-9: Impacts to Operational Flexibility

2.3.2.1 Central Valley Project Drought Contingency Plan

During Shasta Critical years, the GGSA and the MCDMGSA members with federal water contracts that supply water to wetland habitat are subject to water supply reductions. As a result, the Plan Area may rely more on groundwater to supplement their supply during these years. Historically, the Plan Area lands with federal water supply contracts have not experienced stresses to the groundwater system following years with surface water shortages. See Chapter 3.3 – Historic Water Budget.

The Plan Area has been in the process of implementing a conjunctive use groundwater program that allows refuge contractors to increase groundwater pumping when surface water supplies are reduced in critically dry years. See **Section 2.3.3** for details on conjunctive use programs within the Plan Area.

2.3.2.2 Water Quality Standards

Water Quality is a limiting factor in the Plan Area’s operational flexibility. Both surface and groundwater quality have the potential to reduce the amount of water that can be used for application. Water quality is discussed in detail in **Section 2.3.1.3**. If groundwater exceeds limits on TDS or Selenium, it cannot be pumped into the distribution system. Surface water may also require additional dilution if water quality exceeds concentrations designated in the monitoring plan.

2.3.2.3 Subsidence in the Region

Subsidence is currently a critical concern in the DMB regarding SGMA implementation. Although subsidence in the Plan Area itself is minimal, it remains an issue for other GSAs in western Madera County, western Fresno County, and in southern Merced County. Land subsidence has been occurring in these counties for decades. Historically, subsidence has been centered near the Eastside/Chowchilla Bypasses and in the El Nido and Red Top areas, east of the Plan Area. However, in the past ten years, land subsidence has become more pronounced and the subsidence has extended west of the Eastside/Chowchilla Bypasses to at least the San Joaquin River. This increase in subsidence is considered to be a result of the development of hundreds of new wells which tap the lower aquifer. Increased pumping from the lower aquifer has increased the rate of subsidence, which in turn has affected the elevations of the San Joaquin River, water delivery infrastructure, and local canals. See Section 4.2.6 of the Common Chapter for more details on land subsidence.

Although water management practices in the Plan Area are unlikely to contribute to subsidence, the effects of subsidence directly affect the Plan Area. Actions taken to address this subsidence primarily entail measures to decrease lower aquifer pumpage in neighboring GSAs and subbasins. This can be done by reducing lower aquifer pumpage, relying more on upper aquifer pumpage in conjunction with increased intentional recharge, and by increasing in-lieu recharge.

2.3.2.4 Habitat Health

The primary purpose of the GGSA and many of the Plan Area lands is to protect the health of the wetland habitats that provide food and shelter for a variety of migratory waterfowl and other species. Should a decline in habitat health be evident, GGSA would take the necessary precautions to rectify the situation. No changes in habitat health due to local groundwater trends are anticipated, but groundwater extraction in the DMB could affect water supply and drainage conveyance and associated infrastructure.

2.3.3 Conjunctive Use Programs

Legal Requirements:

§354.8(e) A description of conjunctive use programs in the basin.

Conjunctive use of water is defined as the combined use of ground and surface water to minimize the undesirable effects of both water sources and to optimize water demand. Higher water reliability can be achieved by augmenting groundwater in wet years so that stored groundwater can function as a buffer for periods of water scarcity. The idea of this management approach is to use surface water when available in lieu of groundwater. Surface water should also be used for groundwater recharge in areas that allow surface water to be stored in the aquifer for use later. This would be especially important as a buffer function for mitigating impacts of groundwater overdraft.

The GWD pilot groundwater pumping project began in the fall of 2008 as a means of assessing whether utilizing existing wells to pump groundwater into the GWD conveyance system for the purpose of meeting unmet water needs would cause adverse impacts to water quality or groundwater levels. From the early 1990s up until this pilot project there had been no significant groundwater usage within the GWD. Wells drew from the upper zone above the Corcoran Clay at depths from 250 to 350 feet. The pilot project demonstrated that water levels remained consistent and pumping-related subsidence was not experienced in the area, indicating that no short-term or long-term adverse impacts were occurring from pumping up to 10,000 acre-feet per year (AFY) of groundwater under the program.

The pilot program is now a long-term groundwater acquisition program administered by GWD and USBR, which now includes more groundwater wells within the Plan Area that can produce up to 29,000 AFY to supplement inadequate Incremental Level 4 refuge water supplies. USBR analyzed the impacts including cumulative effects to local groundwater and geologic resources from pumping wells under the program. This aquifer impact analysis is included in USBR's existing NEPA Environmental Assessment for *the 5-Year Groundwater Acquisitions for South of Delta Central Valley Project Improvement Act Refuges Project* dated December 2015, and the associated Finding of No Significant Impact dated January 26, 2016.

The Volta Wildlife Area pilot project began developing groundwater in the fall of 2011. The Volta wells collectively can produce up to 6,600 AFY of groundwater of acceptable quality to be conveyed to wildlife refuges. USBR analyzed the impacts to local groundwater and geologic resources from pumping the Volta wells, including the cumulative effects when combined with the pumping of other local wells. This groundwater level and aquifer impact analysis is included in USBR's existing NEPA Environmental Assessment for the *Volta Wildlife Area Level 2 Diversification / Incremental Level 4 Development Pilot Project* dated May 2010, and associated Finding of No Significant Impact dated June 1, 2010.

Approximately 30,000 - 50,000 AFY of groundwater is pumped and used within the Plan Area. This pumping includes the pumping of state, federal, and private refuge lands as well as the limited agricultural lands in the Plan Area. Historically, GWD's refuge water supply pumping can be up to 28,262 AF in below normal or critical years. Pumping is reduced significantly during wet years when other sources of surface water are available for use in the Plan Area.

Table 2-3: Grassland Water District Total Groundwater Production

Grassland Water District Total Groundwater Production	
Groundwater Production (Acre-feet)	
Water Year 13 (Dry)	7,627.11
Water Year 14 (Critical)	18,898.76
Water Year 15 (Critical)	19,989.45
Water Year 16 (Below Normal)	28,262.14
Water Year 17 (Wet)	306.13
Total WY 13-17	**75,083.59**

In addition, the state and federal refuges in the Plan Area pump a limited amount of groundwater in order to supplement their surface water supplies. Groundwater pumping on the China Island Unit, San Luis National Wildlife Refuge, Los Banos Wildlife Area, and Salt Slough

Unit is metered monthly. Total annual pumping ranges from approximately 1,100 AF to 7,600 AF annually depending on the water year type. An additional approximate amount of 30,000 AF is assumed to be extracted by MCDMGSA stakeholders without federal water contracts for private wetlands and agricultural and transfer purposes. Since limited historic pumping data is available for MCDMGSA stakeholders, uncertainty in groundwater pumping volumes for Monitoring Zone 2 is high. Greater detail on the breakdown of groundwater pumping is included in the Chapter 3.3 of the GSP.

2.4 Relation to General Plans

Legal Requirements:

§354.8(f) A plain language description of the land use elements or topic categories of applicable general plans that include the following: (1) A summary of general plans and other land use plans governing the basin.

2.4.1 Summary of General Plans/Other Land Use Plans

The California Government Code (§§ 65350-65362) requires that each county and city in the state develop and adopt a General Plan. The General Plan is a comprehensive, long-term framework for the protection of agricultural, natural, and cultural resources and for development in the county or city. Designed to meet the state requirements, it outlines policies, standards, and programs and sets out plan proposals to guide day-to-day decisions concerning a county or city’s future. Each General Plan must include the vision, goals, and objectives of the city or county in terms of planning and development within eight different “elements” defined by the state: land use, housing, circulation, conservation, noise, safety, open space, and environmental justice. The General Plan may be adopted in any form deemed appropriate or convenient by the legislative body of the county or city, including the combining of elements.

Merced County is the only agency within the Plan Area that has a general plan: the 2030 Merced County General Plan. However, the Plan Area is adjacent to the City of Los Banos and it is important to consider its General Plan as well, as it is one of the fastest growing cities within the State of California. The Delta-Mendota Groundwater Subbasin as a whole encompasses several counties and cities. However, only those directly affecting the Plan Area necessitate further discussion.

Although outside of the GGSA Plan Area, as discussed in the prior paragraph, the City of Los Banos, which is entirely groundwater-dependent, extracts groundwater from the Delta-Mendota Subbasin to meet the City’s water demand (City of Los Banos 2030 General Plan Update, 2009). The Land Use Element of The City of Los Banos 2030 General Plan Update provides insight into future areas of urban expansion that may affect water resources in the vicinity. The City of Los Banos 2030 General Plan Update was adopted in 2009, well before the enactment of SMGA (the City of Los Banos has now formed its own GSA). The Land Use Element contains the framework for land use planning in Los Banos to the year 2030, and the Public Facilities and Utilities Element addresses projected water demand and water quality issues for the same time period.

2.4.2 Impact of the General Plan on Water Demands

Legal Requirements:

§354.8(f) (2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.

Merced County General Plan

Merced County depends heavily on groundwater for water supply and the Water Element of the General Plan indicates that "the use of surface water supplied by the irrigation districts is decreasing during droughts, while the pumping of groundwater for irrigation has been increasing" (Note that the 2030 Merced County General Plan was adopted in 2013, prior to the enactment of SGMA and development of this GSP). According to the Merced County General Plan Background Report (2013), the County's population also increased from 178,919 to 240,925 between 1990 and 2005, which corresponds to a growth rate of approximately 2%. By 2030, the total population of Merced County is projected to be 390,167.

Based on these projections, 63% of this population growth is expected to be concentrated within existing incorporated cities; therefore, it is anticipated that incorporated cities will also absorb approximately 63% of the projected 54,600 new housing units to be added countywide by 2030. Job forecasts included in the Merced County General Plan Background Report (2013) anticipate growth in the service and retail industries and a significant decrease in farming and agricultural positions. According to these projections, which encompass the 25-year planning period from 2005 to 2030, "over half of new jobs will require additional acreage of retail and other uses." Projections include a 25-year demand of 74 acres for general office space, 262 acres for industrial uses, and 195 acres for retail establishments. Total commercial demand is estimated to be 530 acres over the 25-year planning period, an average of 21 acres per year. Institutional space demand is estimated at 64 acres over this same period, an average of 2.6 acres per year (Merced County General Plan Background Report, 2013).

Incorporated cities within the County will absorb a significant portion of this projected employment-related development. The UC Merced campus and the Mid-California International Trade District at Castle, both located within the County but outside of the Delta-Mendota Subbasin, are also projected to spur economic growth. The UC Merced campus has a projected buildout year of 2030 and is expected to generate approximately 42,000 new residents and a demand of 222 acres of commercially developed land in the County, aside from the campus. Plans for the 1,900-acre Mid-California International Trade District at Castle include 8 million square feet of industrial development.

The Merced County General Plan Background Report (2013) used community and urban development plans and an assumed buildout rate of 2,000 gallons per day per acre to calculate an estimated future urban water demand of 147,994 AFY by 2030. According to the 2030 Merced County General Plan Environmental Impact Report (2013), projected urban development is expected to require up to an additional 92,000 AFY under full buildout conditions, and the preservation and promotion of agricultural lands under the General Plan would also likely increase water demand.

The Merced County General Plan Background Report also recognizes the importance of the GEA and the benefits of protecting it from incompatible land uses: "Wise planning, which incorporates measures to buffer the GEA, the East Merced Vernal Pool Grasslands, the Merced River riparian corridor, and the San Joaquin River Corridor from incompatible land uses such as residential housing and commercial development, is key to ensuring the perpetuation of this irreplaceable and economically important resource for future generations." (Merced County General Plan Background Report, 2013). The General Plan incorporates procedures by which the County must consult with GWD, CDFW, USFWS, and waterfowl organizations when a potentially incompatible land use is proposed within or near the GEA. The County's commitment to maintaining habitat values and compatible land uses within the Plan Area means that water demands in the Plan Area are unlikely to significantly increase in the future.

<u>City of Los Banos General Plan</u>
The largest community adjacent to the Grassland Plan Area is the City of Los Banos located to the west. Portions of the Grassland Plan Area lie within the City of Los Banos sphere of influence and planning area. Los Banos is entirely dependent on groundwater, and the City's water supply consists exclusively of extracted groundwater from the Delta-Mendota Subbasin. According to the City of Los Banos 2030 General Plan Update, projected water demand for the year 2030 is 20,787 AFY. Annual pumping currently exceeds 8,000 AFY. The City is also concerned with the quality of its potable water. The primary constituent of concern is arsenic, although other constituents of concern include TDS, boron, chloride, and organic compounds (City of Los Banos 2030 General Plan Update, 2009).

According to the Land Use Element of the City of Los Banos 2030 General Plan Update, total population for the City of Los Banos is projected to grow 4.1-4.2% to reach 90,400 residents and 27,470 households by the year 2030. Furthermore, buildout by the year 2030 is expected to include development up to 3.7 million square feet of office space, up to 8.9 square feet of retail and commercial space, and up to 10.4 million square feet of industrial and employment park space. Although the latest official U.S. Census data is from 2010, the U.S. Census Bureau provides an estimated population of 39,183 residents in the City of Los Banos for the year 2017, which comprises an 8.9% growth rate from 2010 to 2017.

<u>Other Nearby Communities</u>
The Cities of Newman and Gustine are within a few miles of the northwestern part of the Plan Area. The City of Dos Palos lies to the southeast.

2.4.3 Impact of GSP on Land Use Plan Assumptions

Legal Requirements:

§354.8(f) (3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.

As mentioned above, there is only one General Plan within the Plan Area. The General Plan section that covers water supply is summarized in this section.

Merced County General Plan

Water is a critical resource for the Merced County economy and for the quality of life of its residents. Future growth and agricultural production are dependent upon surface and groundwater supplies. Like the majority of California, regions within Merced County have experienced problems with water supply and quality. The Water Element of the General Plan addresses water resource issues, such as water supply, water quality, and watershed management. Goals and policies within the Water Element are organized under the following headings: Water Supply, Water Quality, Water Reuse and Conservation, Watershed Management, and Interagency Coordination. The relevant policies are listed below:

- Policy W-1.1: Countywide Water Supply (MPSP/IGC) - Ensure that continued supplies of surface and groundwater are available to serve existing and future uses by supporting water districts and agencies in groundwater management and water supply planning; requiring that new development have demonstrated long-term water supply; and assisting both urban and agricultural water districts in efforts to use water efficiently.
- Policy W-1.3: Agricultural Water Study (MPSP/IGC) - In cooperation with local water agencies and districts, maintain the detailed General Plan study of countywide water use and needs for agriculture with periodic updates and with information that can be widely shared and publicized.
- Policy W-1.5: New Well Guidelines (RDR/IGC) - Coordinate with the cities and special districts in developing Countywide guidelines regarding the location and construction of new water wells.
- Policy W-1.6: Surface Water Storage (SO) - Support water agencies in the exploration of additional surface water storage opportunities.
- Policy W-1.8: Single User Well Consolidation (IGC) - Encourage consolidation of single user wells into local water districts (with management plans) where feasible.
- Policy W-3.1: Water Availability and Conservation (SO/PI) - Support efforts of water agencies and districts to prevent the depletion of groundwater resources and promote the conservation and reuse of water.
- Policy W-5.1: Countywide Water Supply Study (RDR/MPSP/PSR) - Prepare and regularly update a comprehensive water supply study that includes all four groundwater basins and three hydrologic zones and takes into consideration activities in neighboring counties and the region. The plan shall consider reductions in Federal and State water deliveries in the western part of the County and anticipated reductions in water supplies due to climate change.
- Policy W-5.2: Master Plan Development (IGC) - Coordinate with all agricultural and urban water districts to develop water supply master plans to guide future groundwater basin water supplies through regional solutions.
- Policy W-5.3: Water Forum (IGC/FB) - Support a countywide water forum to coordinate long-term water demand and supply programs that emphasize sustainability in the County consistent with approved Interagency Regional Water Management Plans.

Nothing in this Plan will adversely affect or alter the assumptions and policies in the County General Plan. Coordination between the GGSA and the County will be ongoing, especially in light of the Memorandum of Understanding between the MCDMGSA and GGSA to coordinate SGMA implementation and enforcement.

2.4.4 Permitting New or Replacement Wells

Legal Requirements:

§354.8(f) (4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.

Within the boundaries of the GGSA, the Merced County Department of Public Health, Division of Environmental Health (MCDEH) manages well permitting programs pursuant to Sections 9.27 and 9.28 of the Merced County Code.

Section 9.27 of the Merced County Code contains the Groundwater Mining and Export Ordinance which prohibits the unpermitted construction of wells. The Ordinance recognizes that the export of groundwater from inside Merced County to outside of the groundwater basin in which it originates may yield adverse economic and physical impacts to beneficial users of groundwater, stemming from increased groundwater overdraft, land subsidence (if pumping from the lower aquifer), and uncontrolled movement of inferior quality groundwater. Any proposal for such groundwater "mining" and export requires a permit from the County. Furthermore, all new wells must be metered with an approved water measuring device and all persons extracting groundwater within the County from wells permitted under 2015's Groundwater Mining and Export Ordinance of Merced County, including public water agencies, must submit water level and pumping data annually to MCDEH.

Section 9.28 of the Merced County Code contains the Well Ordinance which further describes the permitting process for water well construction, modification, or destruction. Specifically, a permit will not be issued unless all of the required information is provided, and the well design is in compliance with all of the adopted standards set forth in Section 9.27 and 9.28 of the Merced County Code. These standards are based on the DWR Bulletin 74-81, "Water Well Standards," and State of California Bulletin 74-90, "Monitoring Well Standards and Cathodic Protection Well Standards."

Well Construction and Destruction Permit Applications and instructions for completion are available on the MCDEH's website (http://www.co.merced.ca.us/2247/Well-Systems). The well permit application is a 6-page document which requires attachment of a detailed, scaled plot plan. Completed applications are reviewed by MCDEH to determine the purpose of the well, the proposed pumping volume, and any potential environmental impacts. Permit review time varies by project complexity, and projects with potential for environmental impacts or projects requiring additional analysis may be subject to environmental review pursuant to the California Environmental Quality Act (CEQA).

2.4.5 Land Use Plans Outside the Basin

Legal Requirements:

§354.8(f) (5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

There are no general plans outside the Basin that would affect the Plan Area.

2.5 Additional GSP Components

Legal Requirements:

§354.8(g) A description of any of the additional Plan elements included in the Water Code Section 10727.4 that the Agency determines to be appropriate.

2.5.1 Saline Water Intrusion

Saltwater intrusion is the induced flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast and is a major concern commonly found in coastal aquifers around the world. Where groundwater is being pumped from aquifers that are in hydraulic connection with the sea, induced gradients may cause the migration of saltwater from the sea toward a well, making the freshwater well unusable.

Given the distance separating the Plan Area from the Pacific Ocean, saltwater intrusion from the ocean into the freshwater aquifer is not a concern. However, groundwater with naturally occurring elevated concentrations of salts does exist in the local aquifers. As part of the Grassland Bypass Project, the GGSA and the Grassland Basin Drainers plan to install new groundwater monitoring wells along the common boundary between the Plan Area and the San Joaquin River Improvement Project to the south. The results of this monitoring will be incorporated into future GSP updates.

Another factor to consider is the interface between the freshwater zone and the saline water zone. This represents a flow divide and defines the bottom of the fresh groundwater system in the basin. The base of freshwater, or the depth at which elevated specific conductance is encountered, has been characterized as the boundary where the concentration of specific conductance is over 3,000 µS/cm (Page, 1973). The base of freshwater varies throughout the basin and is discussed in detail in Section 3.1 – Hydrogeologic Conceptual Model.

2.5.2 Wellhead Protection

A Wellhead Protection Area (WHPA) is defined by the federal Safe Drinking Water Act Amendments of 1986 as "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds, which can be easily determined from topography, WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics.

The Federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land use controls, usually applied at the local level, and other preventative measures can protect groundwater.

The 1996 federal Safe Drinking Water Act Amendments require each state to develop and implement a Source Water Assessment Program. Section 11672.60 of the California Health and Safety Code requires the Department of Health Services (DHS, the precursor to the California Department of Public Health) to develop and implement a program to protect sources of drinking water, specifying that the program must include both a Source Water Assessment Program and a wellhead protection program. In response to both legal mandates, DHS developed the Drinking Water Source Assessment and Protection (DWSAP) Program. California's DWSAP Program addresses both groundwater and surface water sources. The groundwater portion of the DWSAP Program serves as the state's Wellhead Protection Program. DHS submitted the DWSAP Program to the U.S. Environmental Protection Agency (EPA) in January 1999. The EPA approved the DWSAP as California's Wellhead Protection Program in January 1999. In November 1999, the EPA gave final approval of the DWSAP Program as California's source water assessment and protection program. DHS was responsible for the completion of all assessments by May 2003. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

Wellhead protection is performed primarily during design and can include requiring annular seals at the well surface, providing adequate drainage around wells, constructing wells at high locations, and avoiding well locations that may be subject to nearby contaminated flows. Wellhead protection is required for potable water supplies and is recommended but not generally required for agricultural wells.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the wellhead. The well is the direct supply source to the water user, and as such, contaminants entering the well could be pumped out and discharged directly into the distribution system. Therefore, proper well design, construction, and site grading are essential to any wellhead protection program in order to prevent intrusion of contaminants into the well from surface sources.

Wells constructed in the Plan Area are designed and constructed in accordance with DWR Bulletin 74-81 and 74-90. A permit is needed from the County to construct a new well. DWR Bulletins 74-81 and 74-90 provide specifications pertaining to wellhead protection, including:

- Methods for sealing the well from intrusion of surface contaminants.
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism.
- Site grading to assure drainage is away from the wellhead.

2.5.3 Migration of Contaminated Groundwater

Groundwater can become contaminated from natural sources or numerous types of human activities. Residential, municipal, commercial, industrial, and agricultural activities can all affect groundwater quality. Contaminants may reach groundwater from activities on the surface, such as releases or spills from stored industrial wastes; from sources below the surface but above the water table, such as septic systems or leaking underground petroleum storage systems; from structures beneath the water table, such as wells; or from contaminated recharge water. Depending on its physical, chemical, and biological properties, a contaminant that has been released into the environment may move within an aquifer in the same manner that groundwater moves (Some contaminants, because of their physical or chemical properties, do not always follow groundwater flow). It is possible to predict, to some degree, the transport within an aquifer of those substances that move along with groundwater flow. For example, both groundwater and certain contaminants flow in the direction of the topography from recharge areas to discharge areas. Soils that are porous and permeable tend to transmit water and certain types of contaminants with relative ease to an aquifer below.

Just as groundwater generally moves slowly, so do contaminants in groundwater. As a result, contaminants tend to remain concentrated in the form of a plume that flows along the same path as the groundwater. The size and speed of the plume depends on the amount and type of contaminant, its solubility and density, and the velocity of the surrounding groundwater. Contaminants can also move into the groundwater system through macro-pores—root systems, animal burrows, abandoned wells, and other systems of holes and cracks that supply pathways for contaminants. In areas surrounding pumping wells, the potential for contamination increases because water from the zone of contribution, a land area larger than the original recharge area, is drawn into the well and the surrounding aquifer. Under certain conditions, pumping can also cause the groundwater (and associated contaminants) from another aquifer to enter the one being pumped. This phenomenon is called inter-aquifer leakage. Thus, properly identifying and protecting the areas affected by well pumping is crucial to maintaining groundwater quality.

Contamination of groundwater can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. Several federal laws help protect groundwater quality:

- The Safe Drinking Water Act (SDWA) establishes three drinking water source protection programs: the Wellhead Protection Program, the Sole Source Aquifer Program, and the Source Water Assessment Program, which also call for regulation of the use of underground injection wells for waste disposal and provide EPA and the states with the authority to ensure that drinking water supplied by public water systems meets minimum health standards.
- The Clean Water Act regulates groundwater that is shown to have a connection with surface water. It sets standards for allowable pollutant discharges to surface water.
- The Resource Conservation and Recovery Act (RCRA) regulates the treatment, storage, and disposal of hazardous and nonhazardous wastes.
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) authorizes the government to clean up contamination or sources of potential contamination from hazardous waste sites or chemical spills, including those that threaten drinking water supplies. CERCLA includes a “community right-to-know” provision.
- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates pesticide use.
- The Toxic Substances Control Act (TSCA) regulates manufactured chemicals.

In addition, several State of California online databases provide information and data on known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells:

California Water Resources Control Board: The State of California Water Resources Control Board (SWRCB) maintains an online database that identifies known contamination cleanup sites, known leaky underground storage tanks, and permitted underground storage tanks. The online database contains records of investigation and actions related to site cleanup activities at http://geotracker.waterboards.ca.gov.

The Department of Toxic Substance Control: The State of California Department of Toxic Substances Control (DTSC) provides an online database with access to detailed information on permitted hazardous waste sites and corrective action facilities, as well as existing site cleanup information. Information available through the online database includes investigation, cleanup, permitting, and/or corrective actions that are planned, being conducted, or have been completed under DTSC's oversight. The online database can be accessed at http://www.envirostor.dtsc.ca.gov.

Groundwater Ambient Monitoring and Assessment Program: The State Water Resources Control Board GAMA (Groundwater Ambient Monitoring and Assessment) program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles collected data into a publicly accessible online database. The online database can be accessed at http://geotracker.waterboards.ca.gov/gama/.

The Plan Area does not include any urban or industrial areas and the risk of groundwater contamination from chemical spills or leaks is not considered significant. Delivered water must meet specific quality requirements for managed wetlands. However, adjacent to and upgradient of the southern boundary of the Plan Area lies the 97,000-acre Grassland Basin Drainers (GBD). The GBD agricultural lands historically drained their subsurface drainage (tile) water to GWD for use in managing the wetlands in the District. This practice was terminated in 1986 with the discovery of bird deformities caused by elevated concentrations of selenium in the water. Since 1986 the GBD have disposed of their drainage water in the San Joaquin River through use of the San Luis Drain and Mud Slough (the Grassland Bypass Project). The agreement for use of the San Luis Drain for drainage water expires at the end of 2019, and because of this, the GBD have developed a project called the San Joaquin River Improvement Project (SJRIP).

The SJRIP includes the irrigation of salt-tolerant crops with drainage water on approximately 6,000 acres of land that is adjacent to and upgradient from the Plan Area. GWD has worked closely with the GBD to manage the use of drainage water in a manner that minimizes impacts to the habitat in the District. This cooperation includes the development of a series of monitoring wells that are to be installed in 2019. The wells will be used to monitor the quality and movement of groundwater along the southern border of the Plan Area and to identify and minimize any potential problems that could occur due to possible migration of groundwater containing elevated concentration of salt and selenium. There is a potential for contamination of usable groundwater supplies and impacts on the habitat, which if found to be occurring must be monitored and mitigated. As the monitoring wells are installed, they will be added to the monitoring well network of the GGSA.

2.5.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well that is no longer used or unusable. Well destruction includes completely filling in a well in accordance with standard procedures. Proper well abandonment and destruction are necessary to protect groundwater resources and public safety. Improperly abandoned or destroyed wells can provide a conduit for surface or near-surface contaminants to reach the groundwater. In addition, undesirable mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

California Well Standards, published as DWR Bulletin 74, represent minimum standards for well construction, alteration, and destruction in order to protect groundwater. In California, cities, counties, and water agencies have regulatory authority over wells and can adopt local well ordinances that meet or exceed the statewide Well Standards. In Merced County, well construction and destruction programs are permitted and managed by the Merced County Department of Public Health pursuant to Section 9.28 of the Merced County Code, which requires that all abandoned wells be destroyed according to State standards documented in DWR Bulletins 74-81 and 74-90.

2.5.5 Replenishment of Groundwater Extractions

During the hydrologic cycle, replenishment occurs naturally when rain, stormwater, and the flow from rivers, streams, and creeks seep into an aquifer. Water also soaks into the ground as farmers irrigate fields and orchards and as wetland managers supply water to habitat. Replenishment within the context of groundwater management is accomplished through recharge at a rate that exceeds baseline conditions and maintains or improves groundwater elevation levels. Two recharge methods can be used: direct spreading and aquifer injection. There is also in-lieu recharge in which an alternative source is provided to users who would normally use groundwater, thereby leaving groundwater in place for later use and increasing the potential to improve groundwater levels.

Most of the Plan Area wetlands are managed to simulate historic wetland cycles. Prior to development in the Central Valley, wetlands were abundant and standing water was common in the valley floodplains. Unlike some other water users in the state, the GGSA does not need to engage in additional groundwater recharge projects to replenish the aquifer, given the current and historic low level of pumping. Management of the land in the Plan Area essentially acts as one large recharge system. The entire water conveyance system consists of unlined open canals which provide a mechanism for recharge. Water contained in duck ponds and other managed wetlands also contributes to groundwater replenishment. For specific information on recharge and replenishment of groundwater in the GGSA and MCDMGSA areas, refer to **Chapter 3** – Basin Setting.

The neighboring agencies with surface water infrastructure or access to surface water include the SJRECWA (Central California Irrigation District, Henry Miller Reclamation District, Firebaugh Canal Company, and Columbia Canal Company), and members of the SLDMWA including San Luis Water District, Del Puerto Water District, and Panoche Water District. It is significant that neighboring agencies have access to reliable surface water as this reduces overall dependence on groundwater in the region. Having a regional reliable surface water supply reduces the fringe effects of nearby groundwater use. Each neighboring district may implement and manage their own groundwater recharge projects to contribute to the overall replenishment of the aquifers.

2.5.6 Conjunctive Use

See **Section 2.3.3.**

2.5.7 Well Construction Policies

Proper well construction is important to ensure well reliability and longevity and the protection of groundwater resources from contamination. All of the Plan Area members follow Merced County's well construction standards (MCC 9.28.060) when constructing municipal and agricultural wells. Merced County has adopted a well construction permitting program consistent with State Well Standards (DWR Bulletins 74-81 and 74-90) with any differences intended to reflect the unique conditions and needs of Merced County in order to help assure proper construction of private wells. The County maintains records of all wells drilled in the Plan Area. Private domestic or agricultural wells can be drilled with a county permit. State well standards address annular seals, surface features, well development, water quality testing, and various other topics. Refer to DWR Bulletins 74-81 and 74-90 for more details. Well construction policies intended to ensure proper wellhead protection are discussed in **Section 2.5.2**.

2.5.8 Groundwater Projects

The two member agencies of the GGSA coordinate together to develop projects to meet wetland water demands and will develop future projects to meet and maintain sustainability goals. These agencies have a shared responsibility for development and operation of water sources, recharge, storage, conservation, recycling, and extraction projects within the Plan Area. Projects to develop and secure additional water storage and surface water supplies are key to ensuring wetland and irrigation water demands can be met without compromising groundwater sustainability. Chapter 6 provides descriptions, estimated costs, and estimated yield for numerous proposed projects. The GGSA will also support measures to identify funding and implement regional projects that help the Plan Area and the Subbasin, including adjacent state and federal wildlife refuges and private lands, achieve groundwater sustainability.

CDFW is working on projects that will improve infrastructure and monitoring efforts. CDFW is replacing and installing infrastructure (which includes radial gates) at the Volta Wildlife Area. Measurement flumes are being installed along Los Banos Creek and Salt Slough in four locations to assist with monitoring and reporting.

2.5.9 Efficient Water Management Practices

There are no urban communities or residential areas within the Plan Area, and there are very few agricultural water users. Merced County's Groundwater Ordinance requires all new wells to be metered and users to provide annual water-use reports. Furthermore, all wells that are pumped to provide water for wetland habitat in the GGSA are already metered and monitored. The refuge agencies in the GGSA strive to utilize water efficiently since they rarely receive their full entitlement under federal law, which is needed to optimally manage the habitat. Under their water supply contracts with the USBR, the three refuge water agencies are required to submit Water Management Plans (WMP) every five years and also to provide annual reports on water usage. The GWD WMP details the usage of water in the GRCD as well as provides information on the water conservation and efficiency efforts of the District. Water use efficiency projects include the replacement of aging water delivery infrastructure with modern facilities that enable the water operators to minimize spill from the conveyance system while improving the ability to meet demands. The GWD is also in the process of constructing a water recirculation project (North Grasslands Water Conservation and Water Quality Control Project) that will save the District approximately 14,000 AFY. The latest WMP is included in **Appendix C** and provides further detail on GWD's water management practices and its efforts to conserve and efficiently use its limited surface water supply.

CDFW land management within the Plan Area has included the implementation of water conservation and reuse projects dating back to the early 1980s. A summary of those efforts by Management Unit is included below.

Los Banos Wildlife Area (LBWA): The LBWA is located within both GWD and San Luis Canal Company (SLCC). Water supplies received from SLCC are made up of a combination of CVP contract water and operational spill into the Boundary Drain and Salt Slough. Projects to conserve and reuse available water include:

1. Underground pipeline distribution systems installed throughout the area to conserve conveyance and evaporative losses. These systems irrigate wetlands, upland grassland habitat, and grain crops grown for wildlife nesting habitat and wildlife food resources.
2. Recirculation and reuse at LBWA include four low-lift pumps that divert both contract water and operational spill from the Boundary Drain and Salt Slough. Recirculation and reuse are also accomplished by two low-lift pump stations in Button Willow Lake. These pumps allow the reuse of 10-15% of the total water used. The "field 9" low-lift pump allows for water to be moved into Ruth Lake and pumped into the San Luis Canal, benefiting both CDFW lands and Grassland wetlands.
3. Water measurement is being improved by the installation of 4 Replogle flumes being installed along the GWD San Luis Canal.

Mud Slough Unit:
The Mud Slough Unit was restored from agricultural production to managed wetlands in the early 1990s. Using the existing water infrastructure, it was designed to maximize water conservation, recirculation, and reuse of available water supplies. Three recirculation pump stations combined with pipelines allow for recirculation of 40% or more of the CVP contract water deliveries received from GWD and SLCC.

Volta Wildlife Area: Recirculation is accomplished at Volta by returning water from managed wetlands on the west side to "field 10." This water is then used to flood and maintain habitat in the Volta expansion unit to the north. The expansion unit also has a low-lift pump located at the northern boundary, which can recirculate or lift water delivered from the GWD Mosquito Ditch into the expansion lands. An estimated 40% of the water delivered to Volta can be reused.

North Grassland Wildlife Area (NGWA): The NGWA is comprised of three distinct units. The Salt Slough and Gadwall Units are located within the GRCD and the China Island Unit is located outside the GRCD.

Salt Slough Unit:
CVP contract surface water is delivered by GWD through the San Luis Canal. Water distribution in the unit includes one recirculation pump, 3 low-lift diversion pumps along Salt Slough, and pipelines for irrigation. A Replogle weir has been installed at the San Luis Canal turnout for improved water measurement and management. The three Salt Slough low-lift pumps allow for reuse of water discharged from upstream users including CDFW, USFW, and SLCC. An estimated 80% of this water can be reutilized by lifting it out of the Wolfsen Drain and redistributing it for irrigation on uplands. The low-lift pump located on Wolfsen Drain can

recirculate water from the west side of Salt Slough into pipelines that go to the north end which are used to irrigate an estimated 260 acres of seasonal wetlands and 320 acres of uplands.

China Island Unit:
Surface water supplies are delivered by the Central California Irrigation District to the J lateral canal for distribution. Water distribution includes three low-lift pumps, a holding reservoir, and a pump station. Water used on managed wetlands within the management area is pumped and returned to the main distribution ditch (J lateral) and reused. The pumping station is used to move water onto the San Joaquin River flood plain. Although China Island does not divert water from the San Joaquin River, it does flood periodically in wet years. Reuse accounts for 25% of the unit's water use.

Gadwall Unit:
Surface water is delivered to the Gadwall Unit by GWD via the San Luis Canal and the Gadwall Deep Channel for distribution. Three low-lift pumps recirculate water for use in the unit. Reuse accounts for 25% of the unit's water use. Planned future projects by CDFW to maximize water use are limited at this time to installing Repogle weirs to improve water measurement.

2.5.10 Relationships with State and Federal Agencies

A list of plan participants in **Section 2.2.1** outlines all of the state and federal entities that hold interests in the GGSA or MCDMGSA area described in this Plan. The Plan Area also has ties to other state and federal agencies not listed in **Section 2.2.1**. Those relationships that are common to all water agencies, such as regulation under SGMA by DWR, are not discussed here.

One other relationship that has unique ties to the Plan Area is the United States Bureau of Reclamation (USBR). USBR is the lead agency managing the Central Valley Project (CVP), a complex, multi-purpose network of dams, reservoirs, canals, hydroelectric power plants, and other facilities. The CVP both provides flood protection and supplies domestic and industrial water in the Central Valley. Private, state, and federal lands in the Plan Area have long-term contracts with USBR to receive CVP water for habitat management under the requirements of the CVPIA.

2.5.11 Land Use Planning

Apart from the land that is managed by state and federal wildlife agencies, Merced County is the only participating agency with direct land-use planning authority. However, all participating agencies have an interest in land-use planning policies and how they will impact continued water supplies. **Figure 2-5** is a map showing land uses in the Plan Area.

Land-use policies are documented in various reports such as General Plans, Specific Plans, and plans for proposed developments. Updating some of these plans is a multi-year process and not all of the plans could be fully updated concurrently with GSP development. These plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP.

2.5.12 Impacts to Groundwater Dependent Ecosystems

GDEs are defined under SGMA as ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface (23 CCR § 351(m)). GDEs are characterized in two primary categories: Wetland GDEs and Vegetative GDEs. A Wetland GDE is characterized by the presence of hydric soils, independent of wetland vegetation being present. Vegetative GDEs indicate the presence of (1) obligate wetland species that are dependent on hydric soils, and in some instances, (2) facultative species occurring in wetlands. Facultative species occur in wetlands in 67 to 99 percent of cases but can sustain in upland environments. The Vegetative GDE characterization for facultative species is limited to only the facultative species that are dependent on groundwater to survive. A Ducks Unlimited (DU) wetland delineation dataset was used to develop a Wetland GDE map within the Plan Area and the Nature Conservancy's Natural Communities Dataset Viewer (NC Dataset Viewer) was used to evaluate Vegetative GDEs. (**Figure 2-10** and **Figure 2-11**). Many of the possible GDEs in **Figure 2-10** and **Figure 2-11** occur within habitat managed by GWD, GRCD, and state and federal entities within the Plan Area. The managed habitat relies on applied water to meet evapotranspiration (ET) demands and hydrology influencing the GDEs is anticipated to be better understood with future monitoring as outlined in Chapter 5.

The Vegetative GDE map conservatively estimates that all vegetation types identified by The Nature Conservancy (TNC) as natural communities commonly associated with groundwater (NCCAG) are possible GDEs. Not all Wetland NCCAGs identified by TNC were included on the Wetland GDE map because (1) ponded wetlands within the Plan Area are surface-water dependent and generally contain very shallow-rooted plan species that are unlikely to access groundwater and (2) wetland data for the Plan Area is out-of-date, inconsistent, and inaccurate. Wetland delineations produced by DU were used to better define the Wetland GDEs in the Plan Area. Wetland NCCAGs identified by TNC following sloughs in the northeastern portion of the Plan Area were also included as possible wetland GDEs, supplementing the DU wetland delineations. Historically, the shallow groundwater levels in the Plan Area are generally stable and are projected to continue a sustainable trend into the planning horizon; therefore, groundwater pumping is not anticipated to have a significant impact on GDEs. GDEs and their relationship to the groundwater conditions will continue to be evaluated, and revisions will be made in future GSP updates if appropriate.

Table 2-4: Groundwater-Dependent Ecosystem Acreage

Possible Groundwater Dependent Ecosystems – Acreage[1]		
Grassland Plan Area		
GGSA Area (Monitoring Zone 1)	**Possible Wetland GDE Acreage**	**Possible Vegetative GDE Acreage**
Managed Wetlands	38,047	9,057
San Luis National Wildlife Refuge Unites	1,657	1,074
CA State Wildlife Area Units	4,210	1,484
MCDMGSA GSP Area		
MCDMGSA Area (Monitoring Zone 2)	**Possible Wetland GDE Acreage**	**Possible Vegetative GDE Acreage**
Agricultural Land	338	213
San Luis National Wildlife Refuge Units	3,483	2,416
CA State Wildlife Area Units	2,687	510
Private Wetlands	1,494	849
[1]Many acres of possible wetland GDEs overlap with acres of possible vegetative GDEs.		

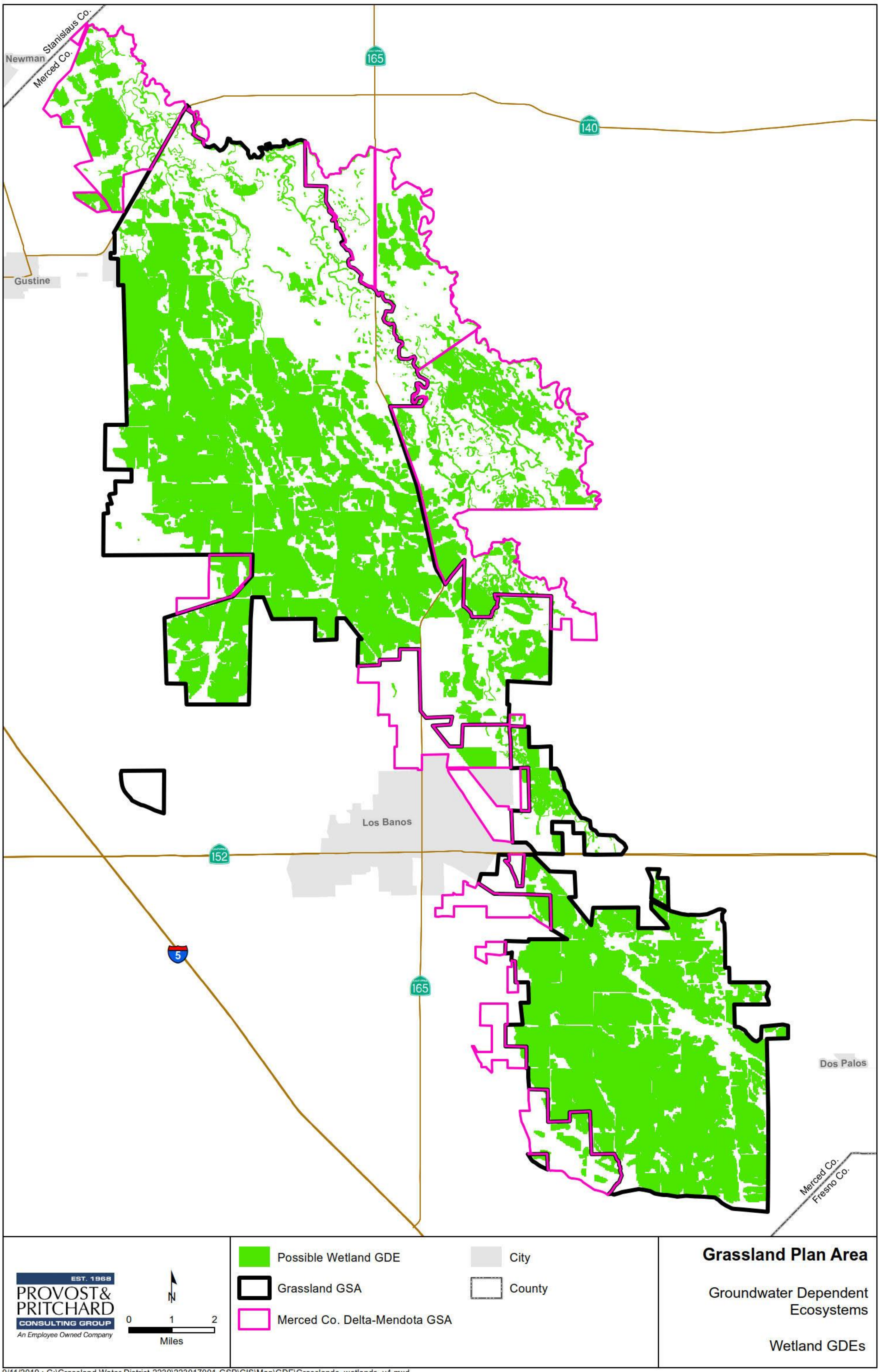


Figure 2-10: Wetland Groundwater Dependent Ecosystem Map

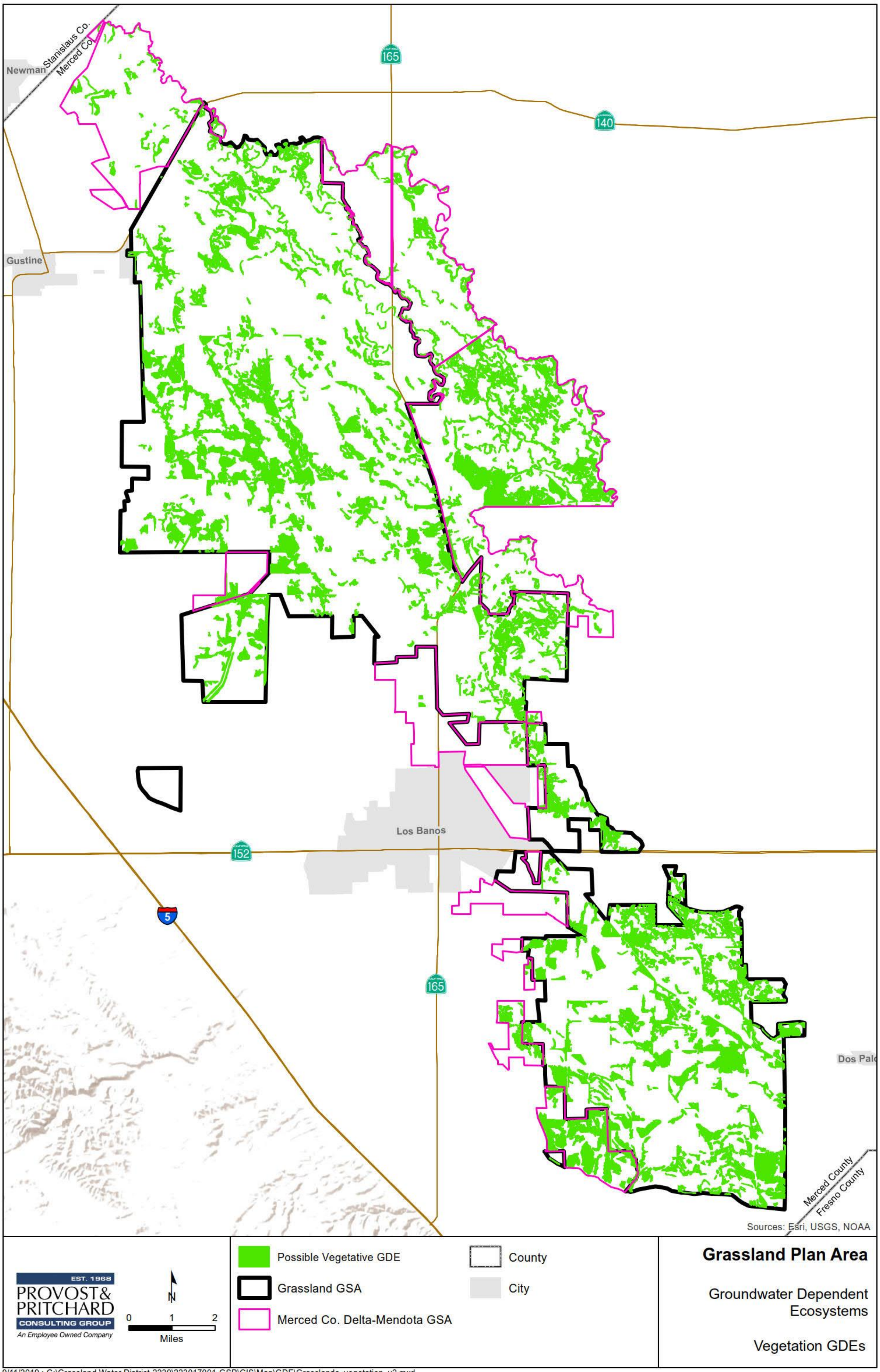


Figure 2-11: Vegetative Groundwater Dependent Ecosystem Map

2.6 Notice and Communication

2.6.1 Description of Beneficial Uses and Users

Legal Requirements:

> **§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:**
> **(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.**

Pursuant to California Water Code Section 10723.2, each GSA shall consider the interests of all beneficial uses and users of groundwater as well as those responsible for implementing a GSP.

Agricultural Users – There are a limited number of agricultural water users within the Grassland Plan Area. As described in **Table 2-2**, active agricultural land uses account for approximately 5,571 acres (6% of the Plan Area) while managed wetlands, uplands, and open water account for approximately 95,318 acres (91% of the Plan Area). Many of the agricultural users rely on groundwater to meet their irrigation demands, and all of them have preexisting relationships with the agencies developing this Plan.

Domestic Well Users – There are a limited number of domestic wells within the Plan Area; most of which supply nonpotable water to temporary residences on seasonal recreational properties that have access to alternate supplies of potable water. The small number of domestic wells qualify as “de minimis extractors” under SGMA and will be excluded from certain regulatory requirements of the GSP.

Municipal Well Operators – There are no municipal wells within the Plan Area. Nearby municipal well operators within the Subbasin include the Cities of Los Banos, Newman, Gustine, and Dos Palos; the South Dos Palos County Water District, North Dos Palos Water District, Volta Community Services District, and Santa Nella County Water District. The GGSA consulted with the closest of these municipal well operators, the adjacent City of Los Banos, when forming the GSA and preparing this GSP.

Public Water Systems – The USFWS San Luis NWR headquarters and visitor center provides the only known supply of groundwater for public use within the Plan Area. The wetland water delivery systems owned and operated by GWD, CDFW, and USFWS do not provide drinking water and therefore do not qualify as a “public water system” under state law.

Local Land-Use Planning Agencies – The Plan Area lies entirely within Merced County and is adjacent to the City of Los Banos. The Districts consulted with Merced County when forming the GSA and signed a MOU with the MCDMGSA for development of this Plan. Other counties within the Subbasin include the Counties of San Joaquin, Stanislaus, Madera, and Fresno.

Environmental Users of Groundwater – The primary use of groundwater within the Plan Area is the limited environmental use of groundwater on both public wildlife refuges managed by CDFW and USFWS and private wetlands owned by landowners. Environmental users of groundwater have preexisting relationships with the member agencies of the GGSA. The Boards of Directors of the GWD and GRCD are each comprised of five members representing environmental users of water within the

GGSA Area. The Districts and Merced County consulted with CDFW and USFWS, as well as with USBR when forming the GSA and preparing the GSP.

Surface Water Users– GWD, CDFW, and USFWS hold the surface water rights that are used within the Plan Area.

Federal Government – USFWS and USBR own federal lands within the Plan Area. The GGSA consulted with both agencies when forming the GSA and preparing the GSP. Both GWD and the state and federal lands within the Plan Area have a contractual relationship with USBR and will continue to work with the federal government to meet federal water supply delivery mandates.

California Native American Tribes – There are no Native American Tribes within or adjacent to the Plan Area.

Disadvantaged Communities – Nearby disadvantaged communities include the Cities of Newman, Gustine, Los Banos, and Dos Palos, and the Census Designated Places of Santa Nella, Volta, Dos Palos Y, and South Dos Palos.

Entities listed in Water Code section 10927 that are monitoring and reporting groundwater elevations in all or part of a groundwater basin to be managed by the GGSA – The SLDMWA monitors groundwater elevations within the Subbasin. The GGSA consulted with SLDMWA when forming the GSA and preparing the GSP.

2.6.2 GSP Planning Process

§354.10 (b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

Engagement with groundwater users occurs in the following phases of the development and implementation of the GSP:

Formation of the GSAs

GSA Formation and Coordination has been completed. The Plan Area includes all of the GGSA and portions of the MCDMGSA. They have agreed to draft a single GSP to help facilitate sustainable groundwater management in the area. More information on the GSAs can be found on the SGMA Portal: https://sgma.water.ca.gov/portal/#gsa.

Grassland Groundwater Sustainability Agency

This phase stretched from 2015 through 2016 and consisted of forming the GGSA and establishing and maintaining the List of Interested Parties. Stakeholder input was utilized during the GSA formation phase, as beneficial users and stakeholders with interests in groundwater usage within the GGSA boundary participated in the GGSA Formation Public Hearing and GWD Board Meetings. Public meetings were noticed in the Merced Sun-Star on November 8 and 15, 2016. The Public Hearing was held on Tuesday, November 22, 2016, at 3:00 p.m. at the GWD office.

Merced County Delta-Mendota Groundwater Sustainability Agency
The MCDMGSA resolution for formation was adopted by the County of Merced Board of Supervisors on March 21, 2017 and encompasses lands both within the Grassland Plan Area and the San Joaquin River Exchange Contractor GSA Plan Area. The County of Merced Board of Supervisors held a GSA formation public hearing on March 21, 2017, at 10:00 a.m. at the County Administration Building where beneficial users and stakeholders with interests were able to participate. The public hearing was noticed in the Merced Sun-Star on March 7 and 14, 2017.

Development of the Draft GSP
GSP development spanned from 2017 through 2020. With the objective of having the draft GSP by the third quarter of 2019, 2018 and 2019 consisted primarily of the technical development of the Plan, while simultaneously working with stakeholders for feedback and input. During this phase, the Communication & Engagement Plan was developed to outline communication efforts for the GSP development, public review, and implementation phases. During 2018 and 2019, direct interaction with stakeholder groups and other industry organizations and entities were held with the purpose of educating and informing stakeholders about SGMA and the GSP process during Delta-Mendota Subbasin Public Workshops while also soliciting feedback and input from these groups to mitigate as much as possible the negative impacts to beneficial users of groundwater. The Technical and Coordination Committees for the Delta Mendota Subbasin meet weekly at a minimum and meetings are open to the public.

Activities in the Plan Area are coordinated between the GGSA and the MCDMGSA as well as the other Basin GSAs. Coordination at the Basin level for GSP development is noted in the common chapter, which includes all decisions that have been voted on and agreed to by all Basin participants. The common chapter can be found in **Appendix A** with specific reference to coordination in **Section 8.5, Subbasin Decision Making Process**.

The GGSA and MCDMGSA public outreach efforts in which SGMA was discussed are identified in **Table 2-5** and **Table 2-6**. These efforts consisted of public GSA Board meetings, stakeholder meetings, informational fliers, and Delta-Mendota Subbasin Public Workshops.

Table 2-5: GSA Public Outreach

Grassland GSP Public Outreach		
GGSA Outreach		
November 22, 2016 Public Hearing to form GGSA Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635	February 13, 2018 GGSA Board of Directors Meeting Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635	May 19, 2018 GGSA Stakeholder Meeting Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635
August 28, 2018 GGSA Board of Directors Meeting Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635	September 8, 2018 CDFW Public Outreach Meeting Los Banos Wildlife Area 18110 Henry Miller Road Los Banos, CA 93635	May 17, 2019 GGSA Board of Directors Meeting Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635
May 18, 2019 GGSA Stakeholder Meeting Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635	October 1, 2019 GGSA Board of Directors Meeting Grassland Water District 200 W Willmott Ave, Los Banos, CA 93635	
MCDMGSA Public Outreach		
March 21, 2017 Public Hearing to form MCDMGSA Merced County Administration Building 2222 M Street Merced, CA 95340	August 29, 2017 MCDMGSA Board Meeting Merced County Administration Building 2222 M Street Merced, CA 95340	July 31, 2018 Merced County Board of Supervisor's Meeting Merced County Administration Building 2222 M Street Merced, CA 95340
September 18, 2018 MCDMGSA Board Meeting Merced County Administration Building 2222 M Street Merced, CA 95340	January 29, 2019 MCDMGSA Board Meeting Merced County Administration Building 2222 M Street Merced, CA 95340	Merced County Property Tax bills included an informational flyer regarding SGMA Implementation in 2017, 2018, and 2019.
May 8-10, 2019 Merced County SGMA informational and public workshop mailer to all landowners in the MCDMGSA, the Merced County portions of the Central Delta-Mendota Region GSA, and the Northwestern Delta-Mendota GSA.		

Finalization of the GSP

During mid-2019, GSP review and evaluation was the primary focus of communication and engagement efforts. After the GSP was completed in the third quarter of 2019, the public review process began. The GGSA held a public meeting to present the draft GSP on October 1, 2019. A 30-day comment period was held from October 30 to November 29, 2019, with the GSP draft posted on the GSAs' webpages for stakeholders to conveniently download and review.

Once the public review period was complete, public comments were taken into consideration and incorporated into the final version of the Grassland Plan Area GSP. The revised Grassland GSP was presented to and adopted by the GGSA and the MCDMGSA at public hearings held on December 10, 2019. The GSP was submitted to the DWR by the January 31, 2020 deadline. Following submittal, stakeholders were given a second 60-day comment period through the DWR's SGMA portal at http://sgma.water.ca.gov/portal/. Comments were posted to the DWR's website prior to the state agency's evaluation, assessment, and approval. Response to these comments are shown in **Appendix H**.

On January 21, 2022, DWR issued an "Incomplete" Determination Letter, which identified four main deficiencies in the six GSPs for the Subbasin. This initiated a 180-day period for the GSP Groups to address the deficiencies and revise their GSPs. On June 20, 2022, revisions were approved by the Subbasin Coordination Committee and recommended for adoption by individual GSAs. The revised Grassland GSP is scheduled to be presented to the GGSA at a public hearing on July 12, 2022, and is scheduled to be presented to the MCDMGSA at a public hearing on July 19, 2022. The GSP will be submitted to the DWR by the July 20, 2022 deadline. Following submittal, stakeholders will be given a comment period through the DWR's SGMA portal at: http://sgma.water.ca.gov/portal/. Comments will be posted to the DWR's website prior to the state agency's evaluation, assessment, and approval.

Implementation of the GSP

Implementation and reporting will begin once the plan is submitted in January 2020. Even while DWR is reviewing the GSP, implementation must proceed at the GSA level. During the implementation phase, communication and engagement efforts will be shifted to educating on and increasing awareness of the requirements and processes of reaching groundwater sustainability. Active involvement of all stakeholders is encouraged during this phase and public notices are required prior to imposing or increasing any fees.

Table 2-6: Delta-Mendota Subbasin Public Workshops

<table>
<tr><th colspan="4">Delta-Mendota Subbasin GSP Public Workshops</th></tr>
<tr><th colspan="4">Spring 2018 – Workshop #1</th></tr>
<tr><td>Los Banos
Monday, May 14,
4:00 – 6:00 PM
SLDMWA Los Banos Administrative Office
842 6th Street, Los Banos</td><td>Patterson
Wednesday, May 16,
4:00 – 6:00 PM
Hammon Senior Center
1033 W Las Palmas Ave, Patterson</td><td colspan="2">Mendota
Thursday, May 17,
4:00 – 6:00 PM
Mendota Public Library
1246 Belmont Ave, Mendota</td></tr>
<tr><th colspan="4">Fall 2018 – Workshop #2</th></tr>
<tr><td>Firebaugh
Monday, October 22, 5:00 - 7:00 PM
Firebaugh Middle School MPR
1600 16th St, Firebaugh</td><td>Los Banos
Wednesday, October 24, 4:00 - 6:00 PM
College Greens Building
1815 Scripps Drive, Los Banos</td><td colspan="2">Patterson
Thursday, October 25, 4:00 - 6:00 PM
Hammon Senior Center
1033 W Las Palmas Ave, Patterson</td></tr>
<tr><th colspan="4">Winter 2019 – Workshop #3</th></tr>
<tr><td>Los Banos
Tuesday, February 19, 4:00 - 6:00 PM
College Greens Building
1815 Scripps Drive, Los Banos, 93635</td><td>Patterson
Wednesday, February 20, 4:00 - 6:00 PM
Patterson City Hall
1 Plaza Circle, Patterson, CA 95363</td><td colspan="2">Santa Nella
Monday, March 4, 6:00 - 8:00 PM
Romero Elementary School MPR
13500 Luis Ave, Gustine, CA 95322</td></tr>
<tr><th colspan="4">Spring 2019 – Workshop #4</th></tr>
<tr><td>Patterson
Monday, May 20, 4:00 - 6:00 PM
Patterson City Hall
1 Plaza Circle, Patterson, CA 95363</td><td>Los Banos
Tues, May 21, 4:00 - 6:00 PM
College Greens Building
1815 Scripps Drive, Los Banos, 93635</td><td>Santa Nella
Weds, May 22, 6:00 - 8:00 PM
Romero Elementary School MPR
13500 Luis Ave, Gustine, CA 95322</td><td>Mendota
Thurs, May 23, 6:00 – 8:00 PM
Mendota Public Library
1246 Belmont Ave, Mendota 93640</td></tr>
</table>

Public Comment and Response Management:

A system for managing public comments and responses will be developed to help track all comments received and comment status. The system will outline issues by topic category to help track all feedback received. A tracking document will be maintained by GGSA staff to ensure all comments are recorded.

2.6.3 Decision-Making Process

Legal Requirements:

§354.10 (d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency's decision-making process.

The decision-making responsibility for the GSP lies with the GGSA Board of Directors at the guidance of the general manager and legal counsel. The MOA executed by GWD and GRCD on November 22, 2016, gives primary responsibility to GWD for administrating the GSA and developing and implementing this GSP. The MOA authorizes the formation of an Advisory Committee comprised of representatives from both agencies. Both GWD and GRCD approval is required for adoption of a GGSA budget, adoption of this GSP, SGMA implementation activities, enforcement actions, fees, and similar matters. The GSP was adopted during the December 10, 2019 public board meeting as Resolution 2019-001. A Revised GSP was adopted during the July 12, 2022 public board meeting as Resolution 2022-006.

The Merced County Board of Supervisors is responsible for the review, approval, and adoption of the GSP on behalf of the MCDMGSA. The GSP was adopted at the December 10, 2019 public hearing. A revised GSP was adopted during the July 19, 2022 public board meeting as Resolution XX-XXX.

2.6.4 Public Engagement/Public Outreach Plan

Legal Requirements:

§354.10 (d)(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.

The Grassland GSA Communication & Engagement (C&E) Plan addresses how stakeholders within the GSA's boundary will be engaged through stakeholder education and opportunities for input and public review during the development and implementation of the GSP. This plan will be updated throughout the phases. The C&E provides an overview of the Grassland GSA, its stakeholders, and decision-making processes; identifies opportunities for public engagement and discussion of how public input and responses will be used; describes how the Grassland GSA encourages the active involvement of diverse, social, cultural, and economic elements of the population within the GSA boundary; and the methods the GSA will use to inform the public stakeholders about the progress of GSP development, public review, and implementation.

The C&E is attached as **Appendix F**.

2.6.5 Encouraging Active Involvement

Legal Requirements:

§354.10 (d) (3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin. (4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

To promote diverse public involvement for the Delta-Mendota Subbasin GSPs, public workshops were held at various locations evenly distributed throughout the Basin. See

Table 2-6. The Delta Mendota Subbasin hosts an online website http://deltamendota.org/ and distributes a monthly progress newsletter that describes progress and decisions made at the Basin and Plan Area level. The GGSA also provides a link and information on its website http://gwdwater.org/sustainability-agency/sustainability-board-who-we-are/ about SGMA developments.

The GWD, GRCD, and GGSA Board of Directors' meetings provide opportunities for stakeholders and the public to comment on aspects of the GSP development. The GWD Board of Directors' meetings are held on the second Tuesday of each month at 3 p.m., and the GRCD Board of Directors' meetings are held on the fourth Tuesday of each month at 1:30 p.m. Both agencies' board meetings are held at the Grassland Water District office located at 200 W. Wilmott Avenue in Los Banos and are open to the public. GGSA meetings are also noticed in accordance with the Brown Act and are held at regular intervals.

The MCDMGSA meets when necessary at the County of Merced Administration Building at 2222 M Street in Merced, CA in conjunction with County of Merced Board of Supervisor Meetings. Board of Supervisor meetings are held approximately twice a month at 10:00 a.m. on Tuesdays in the Board Room.

Public outreach and meetings in which SGMA implementation within the Plan Area was actively discussed are listed in **Table 2-5**.

3 Basin Setting

3.1 Hydrogeologic Conceptual Model

3.1.1 Introduction

Legal Requirements:

§354.14(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin. **§354.16(g)** Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or best available information **§354.16(c)** Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

The purpose of a Hydrogeologic Conceptual Model (HCM) is to provide an easy-to-understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principle aquitards in the basin setting. Once developed, an HCM is useful in providing the context needed to develop water budgets and monitoring networks and to identify data gaps.

An HCM is not a numerical groundwater model or a water budget model; rather, an HCM is a written and graphical description of the hydrologic and hydrogeologic conditions that will lay the foundation for future water budget models. Refer to **Section 3.3** for information on the GSAs' water budgets. The narrative HCM description provided in this chapter is accompanied by graphical representations of the Grassland Plan Area portion of the Delta-Mendota Subbasin that portray the geographic setting, regional geology, basin geometry, and general water quality. This HCM has been prepared utilizing published studies and resources. It will be periodically updated as data gaps are addressed, and new information becomes available.

A scientific primer is offered in the HCM for the five applicable sustainability indicators in the Plan Area. Seawater intrusion is not applicable due to the Plan Area's physical distance and the geologic barriers from the Pacific Ocean. Groundwater dependent ecosystems are not addressed in the HCM, as they are identified and discussed in **Chapter 2, Section 2.5.12 Impacts to Groundwater Dependent Ecosystems**.

The following section was adapted from a report prepared by Kenneth D. Schmidt & Associates (KDSA) in December 2018 and incorporated into the GSP prepared by Provost & Pritchard Engineering Group (**Appendix B**).

This report is intended to satisfy Sections 354.14 (Hydrogeological Conceptual Model) and Section 354.16 (Groundwater Conditions) of a GSP for the GGSA and portions of the MCDMGSA. The Plan Area is split into two divisions. The North Division is north of Highway 152 and is generally bounded to the east by the San Luis Drain. Three federal wildlife refuges are located adjacent to the Northern Division and are included in the area evaluated. The South Division is located south of Highway 152 and east and north of the Central California Irrigation

District (CCID) Main Canal. The other areas include 1) private wetlands, 2) agricultural lands, 3) the San Luis National Wildlife Refuge (NWR), and 4) state refuges located in the MCDMGSA.

3.1.2 Surficial Characteristics of Basin

3.1.2.1 Topography

Legal Requirements:

§354.14(d)(1) Physical characteristics of the basin shall be represented on one or more maps that depict topographic information derived from the U.S. Geological Survey or another reliable source.

Figure 3-1 shows topographic conditions in the basin. The land generally slopes to the northeast towards the San Joaquin River. Major drainages that pass through the area are Los Banos Creek, San Luis Creek, Mud Slough, and Salt Slough. The San Joaquin River bounds the San Luis NWR to the north and Los Banos Creek joins the river north of Highway 140. Land surface elevations range from about 130 to 140 feet above mean sea level along the Main Canal south of the Southern Division to about 70 feet above mean sea level near the Highway 140 crossing of the San Joaquin River at Fremont Ford.

3.1.2.2 Surficial Geology

Legal Requirements:

§354.14(d)(2) Physical characteristics of the basin shall be represented on one or more maps that depict surficial geology derived from a qualified map including the locations of cross-sections required by this Section.

Hotchkiss and Balding (1971, Plate 1) mapped the surficial geology of the Tracy-Dos Palos Area, which includes the area evaluated. **Figure 3-2** shows the part of their map that covers the area evaluated. Except in the southwest edge of the Plan Area, surficial deposits are mapped as flood basin deposits. These are unconsolidated clay, silt, sand, and gravel deposits on the floodplain of the San Joaquin River. Alluvial deposits are present along the southwest edge of the Plan Area, primarily along the San Luis Creek and Los Banos Creek alluvial fans. These are also unconsolidated clay, silt, sand, and gravel.

3.1.2.3 Topsoils

Legal Requirements:

§354.14(d)(3) Physical characteristics of the basin shall be represented on one or more maps that depict soil characteristics as described by the appropriate Natural Resource Conservation Service soil survey or other applicable studies.

Figure 3-3 is taken from the U.S. Soils Conservation Service report on soil in the Los Banos area and shows the major types of topsoils in the area evaluated. The soils have been divided into coarse-grained, intermediate-textured, and clay and silty clay. Most of the coarse-grained soils are in the north part of the area. In the south part of the area the predominant soils are clay and silty clay, and few coarse-grained soils are present.

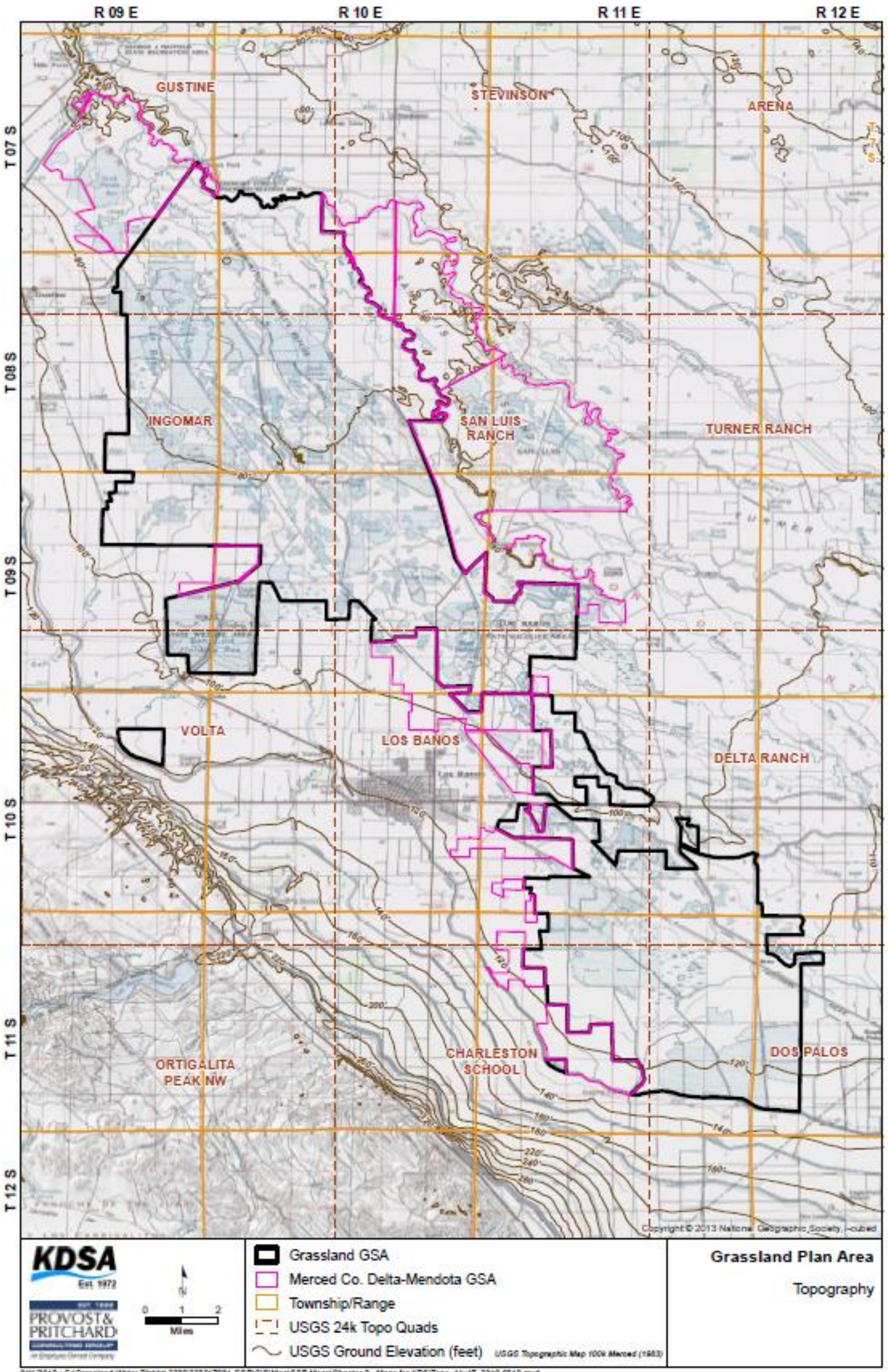


Figure 3-1: Topography

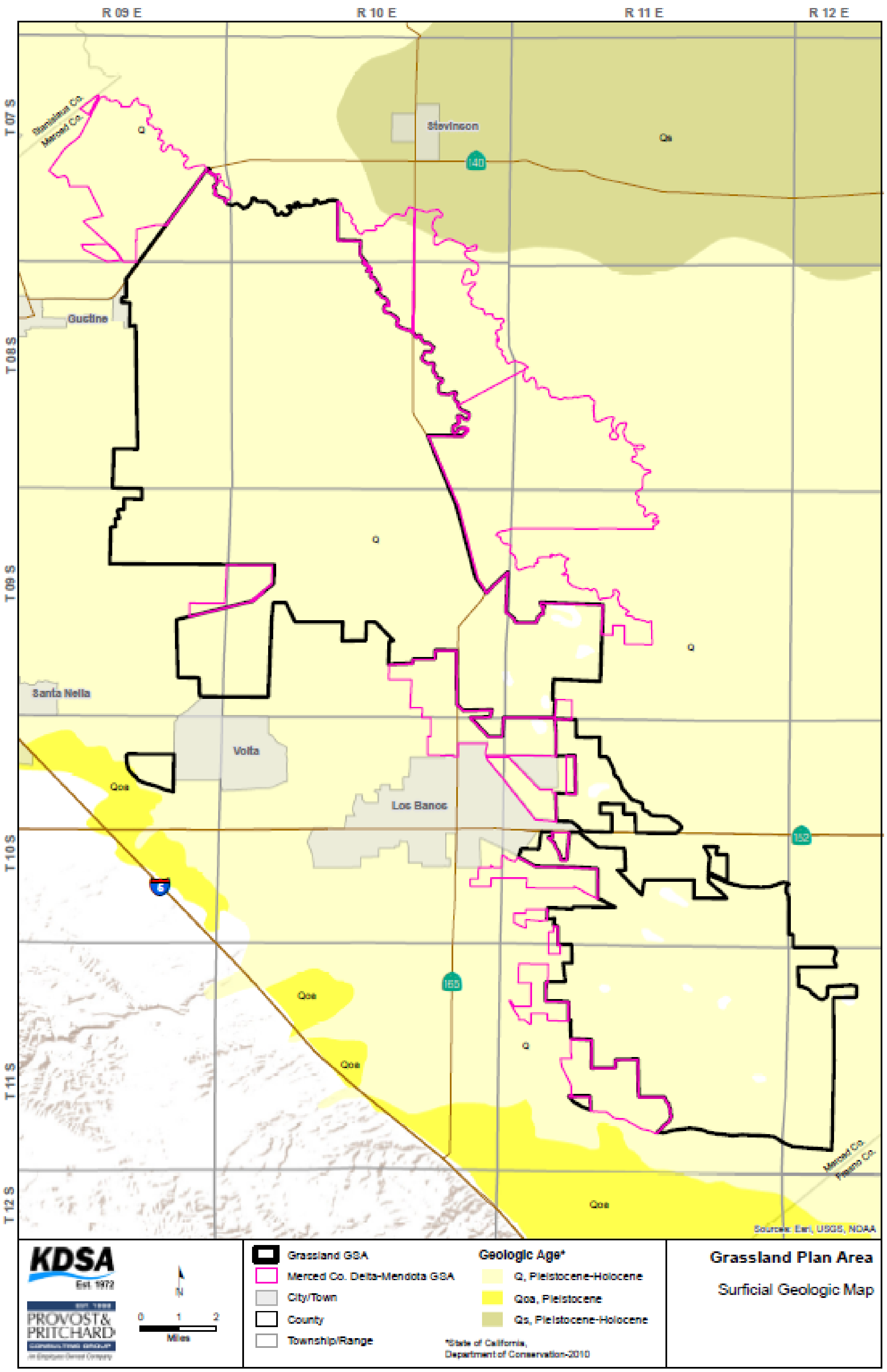


Figure 3-2: Surficial Geologic Map

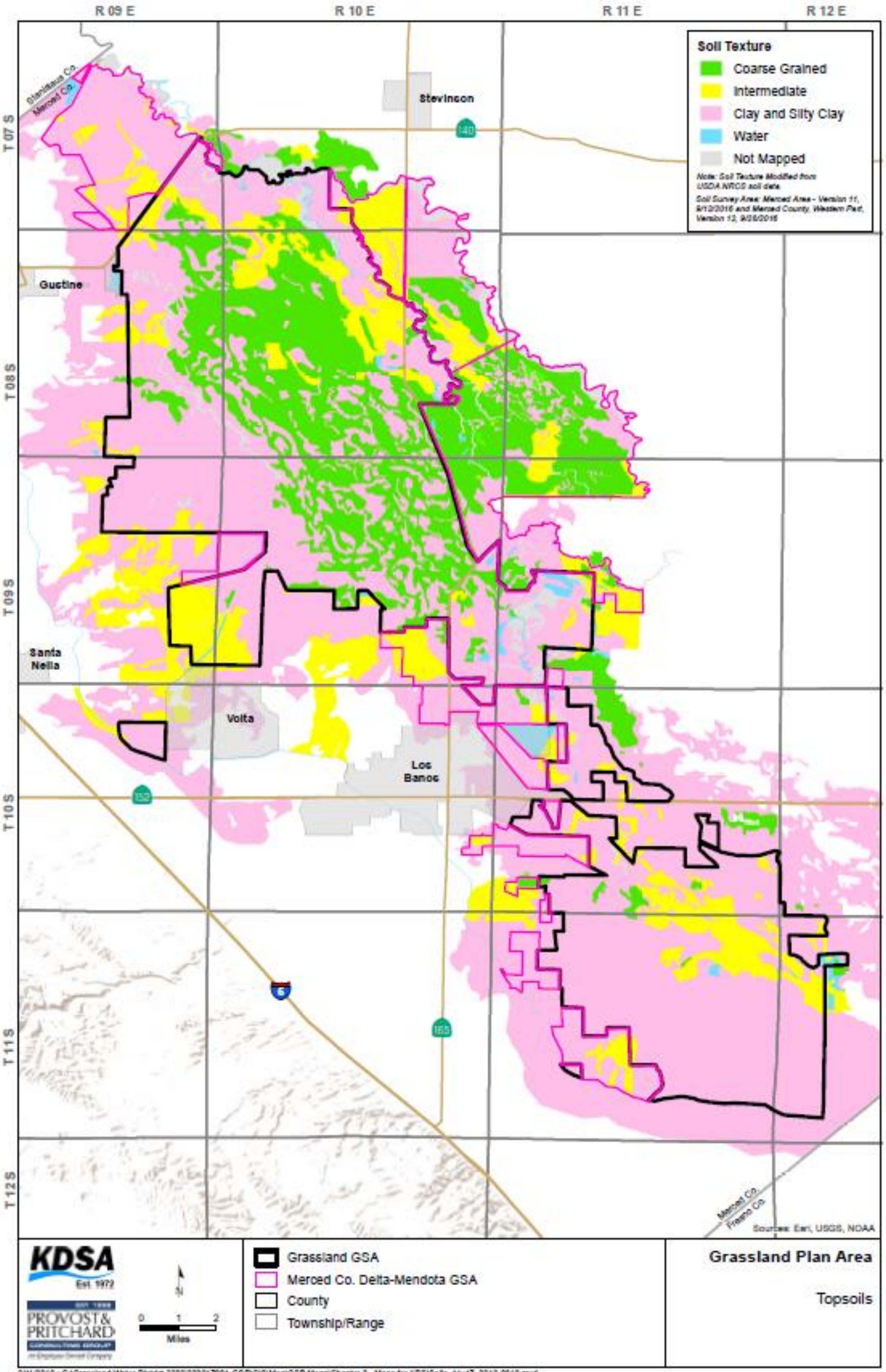


Figure 3-3: Topsoils

3.1.2.4 Surface Water Bodies

Legal Requirements:

§354.14(d)(5) Physical characteristics of the basin shall be represented on one or more maps that depict surface water bodies that are significant to the management of the basin. **§354.14(d)(6)** Physical characteristics of the basin shall be represented on one or more maps that depict the source and point of delivery for imported water supplies.

Figure 3-4 shows the location of surface water bodies in the area evaluated. Streams on the west side are San Luis Creek and Los Banos Creek, both of which have been dammed, and Garzas Creek and Ortigalita Creek. Other drainages in the area are Mud Slough and Salt Slough. Los Banos Creek and Mud Slough join the San Joaquin River near or north of the north boundary of the San Luis NWR. Major canals in the area include the Delta-Mendota Canal (DMC) and the CCID's Main and Outside Canals, which are located upslope and to the southwest of the GRCD. Other important canals are the Santa Fe and San Luis Canals. The San Luis Drain was designed to carry storm water and surface and subsurface agricultural drainage flows, which formerly were discharged to Mud Slough, located just east of the northern part of the Northern Division. Lakes and reservoirs are shown as of April 5, 2001, from the California Department of Fish and Game (now CDFW). **Figure 3-5** represents the source and point of delivery for surface water supplies.

3.1.3 Subsurface Geologic Conditions

Hotchkiss and Balding (1971) described the geology, hydrology, and water quality of the Tracy-Dos Palos Area, which includes the area evaluated. In addition, Kenneth D. Schmidt & Associates (KDSA 1997a) provided a report for the CCID on groundwater conditions in the area between Mendota and Crows Landing. These reports provided significant information on subsurface geologic conditions.

3.1.3.1 Regional Geologic and Structural Setting

Legal Requirements:

§354.14(b)(1) The hydrogeologic conceptual model shall be summarized in a written description that includes the regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.

The area evaluated is within the San Joaquin Valley, which is a topographic and structural trough bounded on the east by the Sierra Nevada fault block and on the west by the folded and faulted Coast Ranges. Both mountain blocks have contributed to marine and continental deposits in the Valley. In the west-central part of the valley, more than 12,000 feet of sediments are present. Groundwater is present in alluvial deposits that dip slightly toward the trough of the valley (the San Joaquin River).

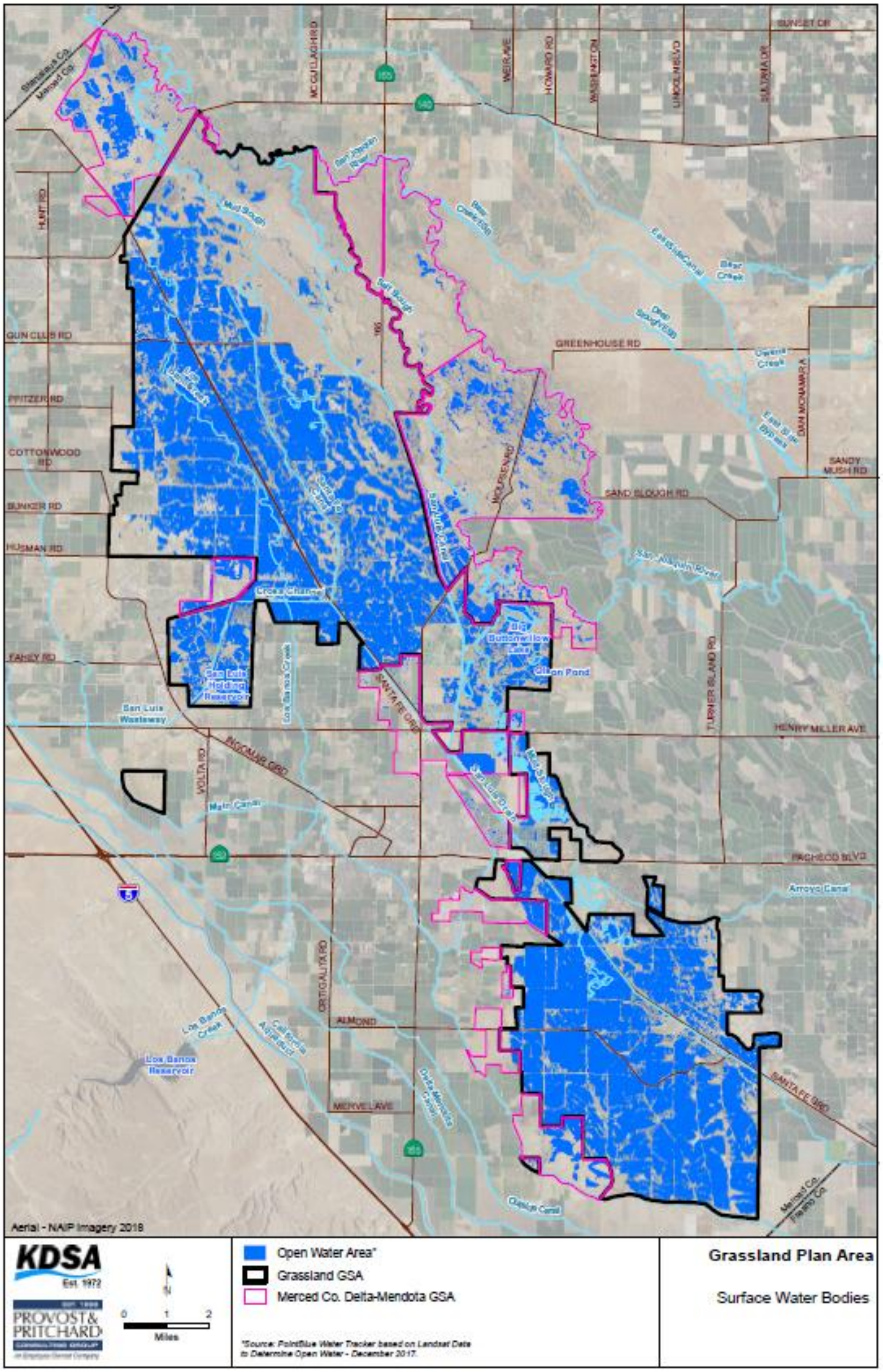


Figure 3-4: Surface Water Bodies

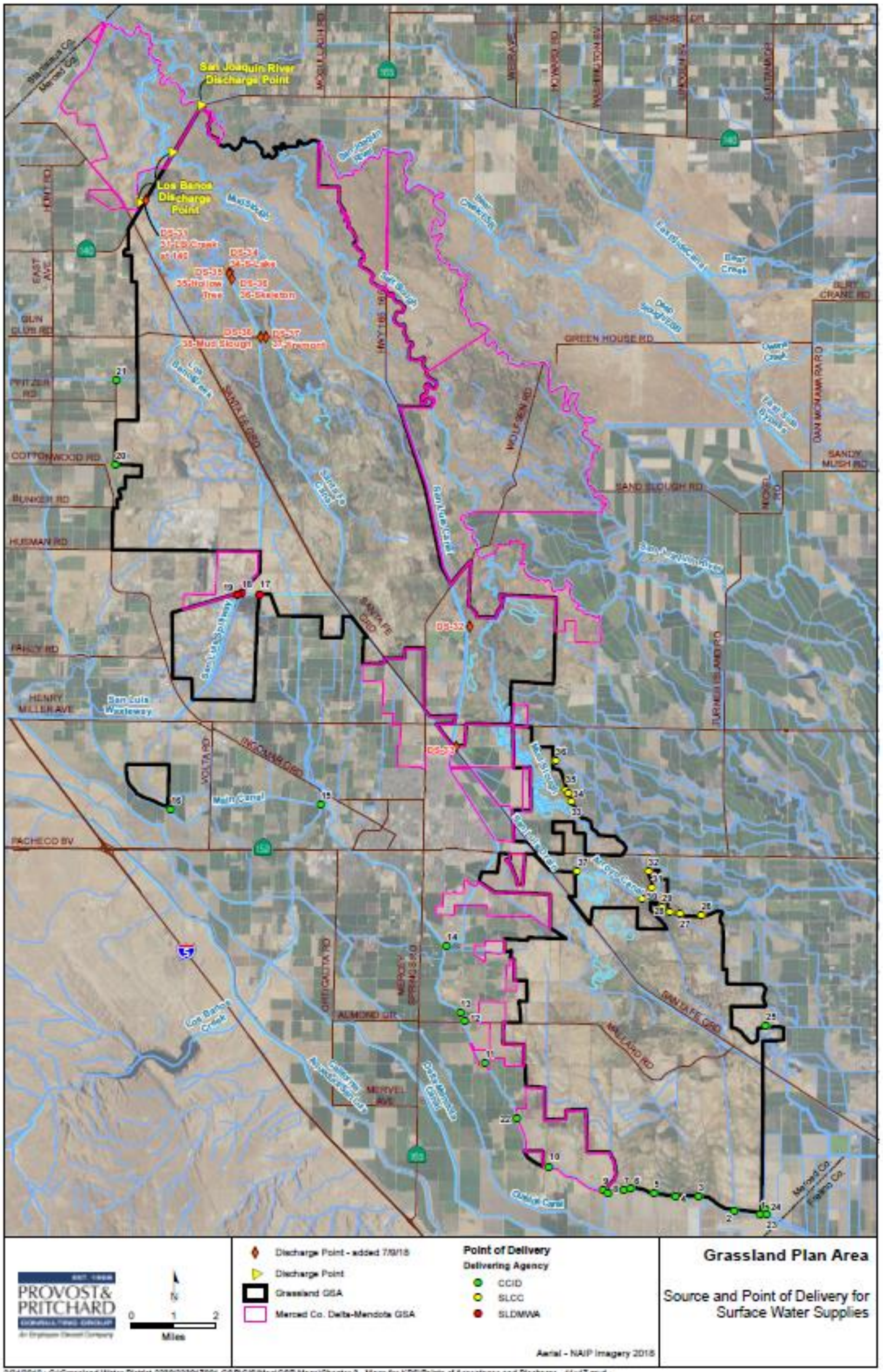


Figure 3-5: Source and Point of Delivery for Surface Water Supplies

3.1.3.2 Lateral Boundaries

Legal Requirements:

§354.14(b)(2) The hydrogeologic conceptual model shall be summarized in a written description that includes lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

Figure 2-1 shows the boundaries of the Plan Area. The Plan Area boundaries include the San Joaquin River on the north end and the CCID Main Canal on the south end. The west boundary of most of the area evaluated is a political boundary with the CCID, whereas the east boundary of the part of the basin north of Highway 152 is the Salt Slough or the San Joaquin River. For the part farther south, the east boundary is the CCID or the San Luis Canal Co. The entirety of the Plan Area is in Merced County. Three national wildlife refuges and a number of State wildlife areas are also included in the area evaluated.

3.1.3.3 Definable Bottom of the Basin

Legal Requirements:

§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

Figure 3-6 shows the definable bottom of the basin. Historically, the U.S. Geological Survey (Page, 1973) used an electrical conductivity of about 3,000 micromhos per centimeter at 25°C to delineate the regional base of the fresh groundwater in the San Joaquin Valley. The underlying groundwater is termed "connate water" and is of higher salinity. Page indicated that the base of the fresh groundwater ranged from about 800 to 1,000 feet deep in most of the area evaluated. As part of this evaluation, electric logs for a number of deep holes were obtained from the California Division of Oil & Gas. A review of these logs indicated depths to the base of the fresh groundwater ranging from about 860 to 1,160 feet. For most of the area, the base of the fresh groundwater was less than 1,070 feet deep. When considering depths of the deepest water supply wells in the area (about 800 to 900 feet), this range is reasonable. Deeper deposits are either primarily clay and/or contain brackish groundwater.

3.1.3.4 Formation Names

§354.14(b)(4)(a) Formation names, if defined.

Hutchkiss and Balding (1971) divided the unconsolidated deposits in the Tracy-Dos Palos area into flood basin deposits (normally less than 50 feet thick), Quaternary alluvium (usually less than 200 feet thick), and the Tulare Formation (up to almost 1,000 feet thick). The Tulare Formation has a thinner upper section above the Corcoran Clay, and a thicker lower section below the clay. The Corcoran Clay is a regional confining bed which divides the groundwater into an upper aquifer and lower aquifer. Deposits in the west part of the area evaluated are generally tan in color and are termed the Diablo Range deposits. Deposits to the east are brown, gray, or white in color and are termed the Sierra deposits. These deposits are shown on a number of subsurface geologic cross sections that are presented later in this report.

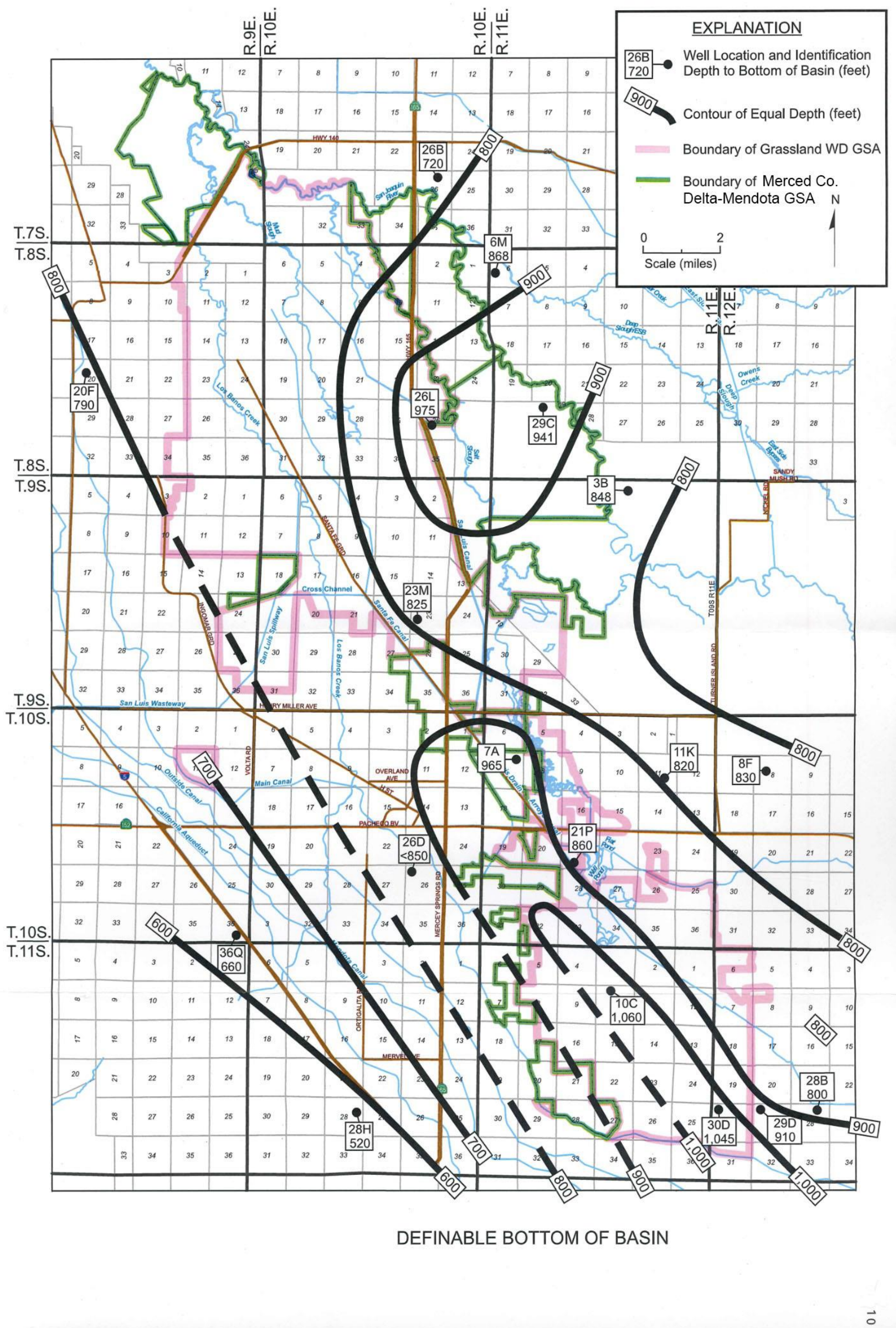


Figure 3-6: Definable Bottom of Basin

3.1.3.5 Confining Beds

Legal Requirements:

§354.14(b)(4)(c) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

The Corcoran Clay is indicated as the most important confining bed in the area evaluated. **Figure 3-7** shows the depth to the top of the Corcoran Clay, which was mapped for this evaluation and primarily based on electric logs and geologic logs for test holes and wells. The depth to the top of this clay is generally the greatest in the central-southern part of the area evaluated. The shallowest depth (about 200 feet) is along the west and east edges of the area evaluated. The shallowest depth along the east edge is about 185 feet. North of Highway 152, the depths to the top of the Corcoran Clay in the central part of the area range from about 250 to 300 feet. South of Highway 152, the depths to the top of the clay range from about 200 to 350 feet. The depths to the top of the Corcoran Clay essentially define the base of the upper aquifer.

The thickness of the Corcoran Clay also tends to be less towards the west and east edges of the area evaluated (**Figure 3-8**). For the area north of Highway 152, the thinnest area of Clay (less than 40 feet thick) is beneath the northeast part. The Corcoran Clay ranges from about 35 to 50 feet thick along the east edge of the area evaluated, and from about 65 to 120 feet along the west edge. In the area south of Highway 152, the thinnest clay (about 80 feet thick) is along the east edge of the area evaluated, and along the west edge south of Almond Drive Ditch. The thickest area (greater than 120 feet) is west of South Dos Palos. There are no known geologic faults that restrict groundwater flow.

3.1.3.6 Principal Aquifers

Legal Requirements:

§354.14(b)(4) The hydrogeologic conceptual model shall be summarized in a written description that includes the principal aquifers and aquitards.

Based on subsurface geologic cross sections (presented in **Section 3.1.3.7**) and water well drillers' logs and completion reports, the upper aquifer is the principal aquifer in most of the area adjoining the Plan Area (i.e., in the CCID and San Luis Canal Co. service areas). However, in the Panoche Water District, the lower aquifer is the principal aquifer. There are two aquifers in the Plan Area, the upper unconfined aquifer which serves as the primary source aquifer and the lower confined aquifer.

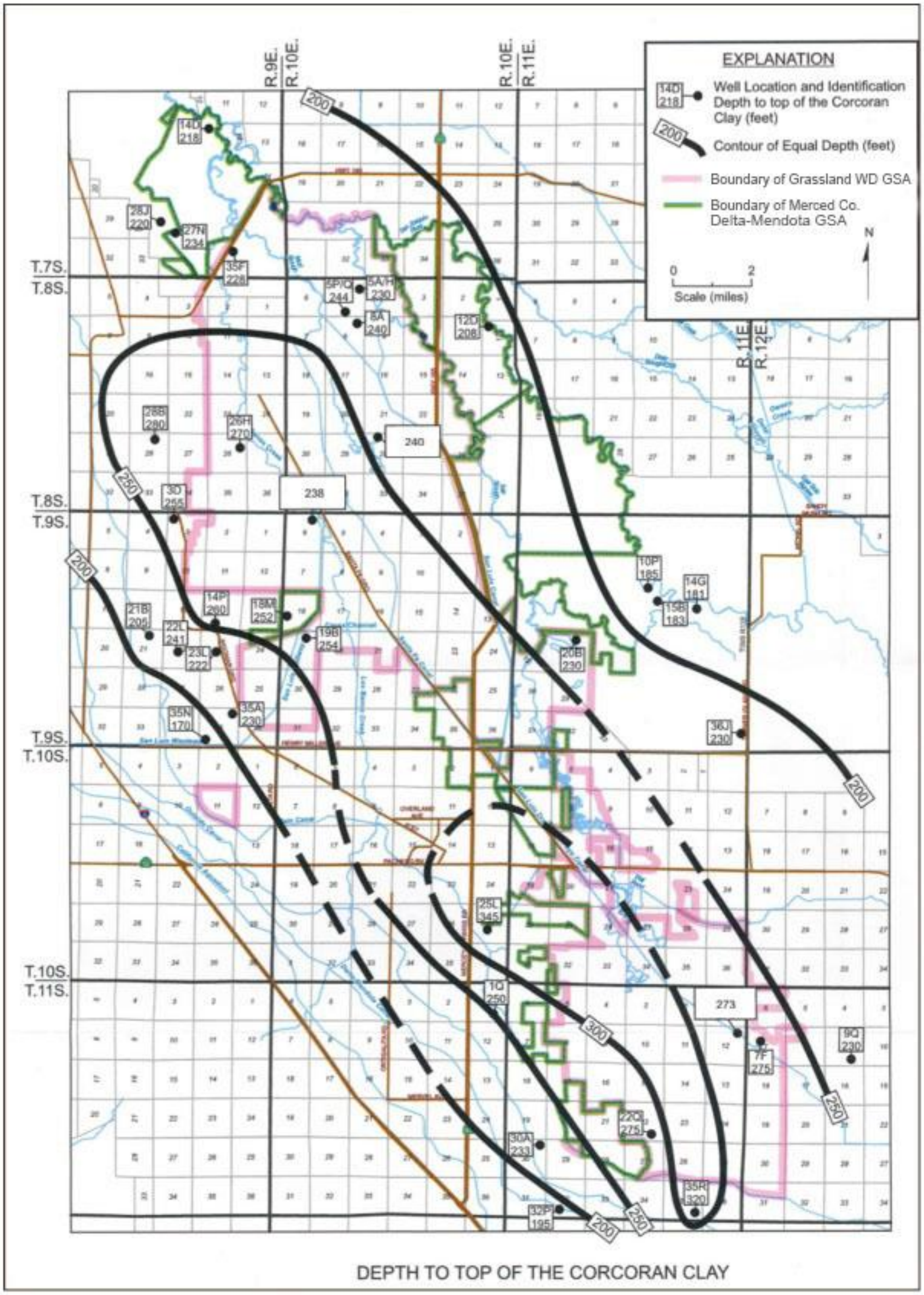


Figure 3-7: Depth to Top of the Corcoran Clay

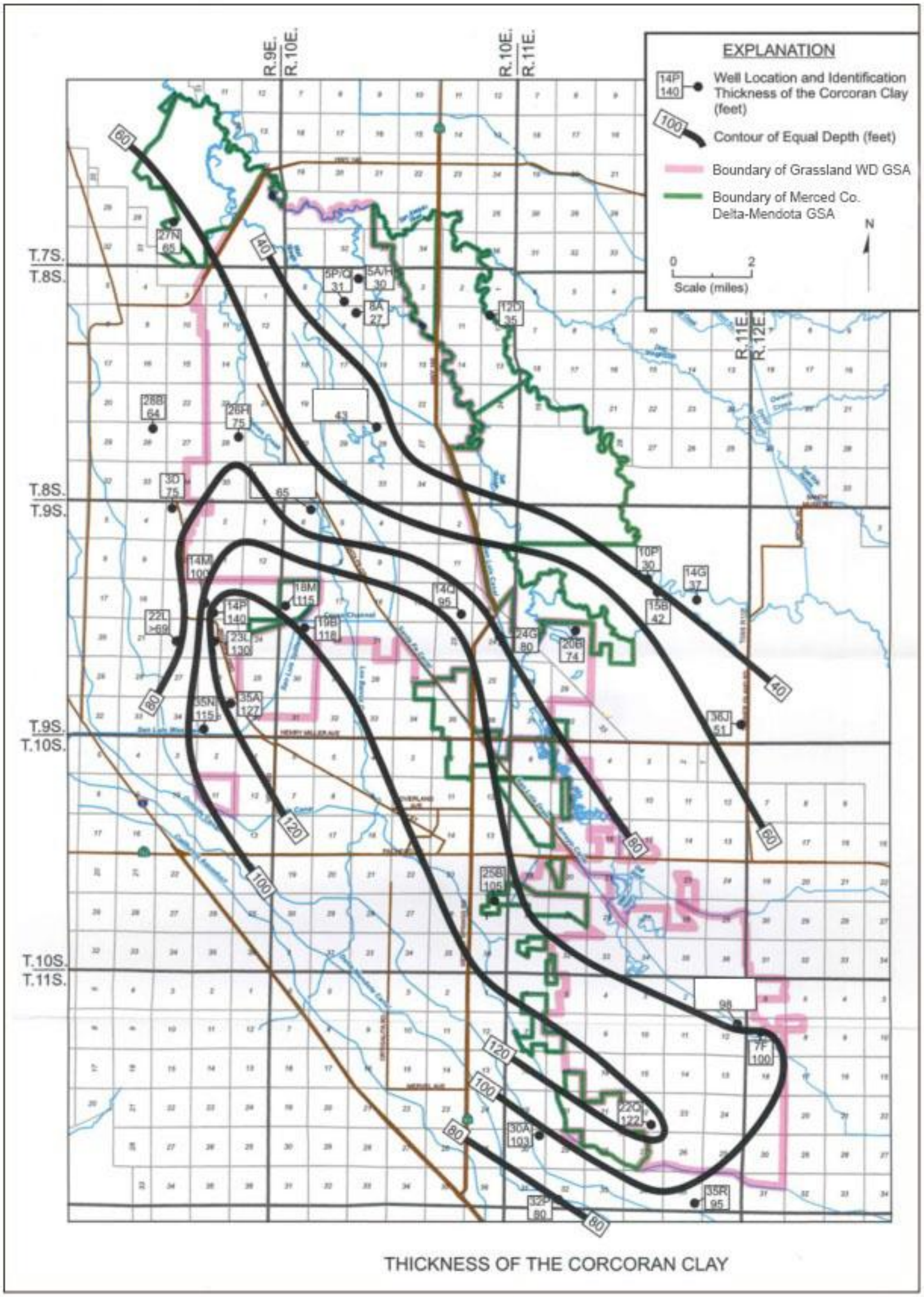


Figure 3-8: Thickness of the Corcoran Clay

3.1.3.7 Subsurface Geological Cross Sections

Legal Requirements:

§354.14(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.

The subsurface geologic cross sections presented in this report were either from Hotchkiss and Balding (1971) and modified by KDSA, or prepared by KDSA for the CCID and City of Los Banos (KDSA, 1997 and 2013). Locations of the cross sections are provided on **Figure 3-9**.

Northern Area

For the area north of Highway 152, three subsurface cross sections are provided. Cross Section A-A' extends from north of Highway 140 on the north end to the south and southeast, to near the Merced County-Fresno County line (**Figure 3-10**). This section is generally near the west edge of the area evaluated. The base of the unconsolidated deposits (base of the aquifer) ranges from about 800 to 1,000 feet along this section and Diablo Range deposits are predominant. The Corcoran Clay is at an average elevation of about 200 feet below sea level along the section. Along the west edge of the Northern Division north of Husman Road, Diablo Range deposits are predominant above the Corcoran Clay, whereas farther south, Sierra deposits are predominant along this section. Below the Corcoran Clay, Sierra deposits are only predominant above a depth of about 600 feet in the area north of Husman Road. Otherwise, Diablo Range deposits are predominant.

Cross Section B-B' (**Figure 3-11**) extends from near Husman Road and about half a mile east of the boundary between R9E and R10E to the northeast near the San Joaquin River. The former Kesterson Reservoir is located near the northeast edge of the section. This cross section illustrates well the predominance of the Sierra deposits both above and below the Corcoran Clay in most of the area within the Northern Division and the adjacent San Luis NWR. The Diablo Range deposits are only significant above the Corcoran Clay beneath the west part of the Northern Division along this section, and within the lower 100 to 200 feet of unconsolidated deposits beneath the Sierra deposits.

Cross Section C-C' (**Figure 3-12**) was modified from Cross Section A-A'. The part of this section northeast of the City of Los Banos Well No. 8 was used and the section was extended to the northeast past the San Joaquin River. The Corcoran Clay is shallower to the northeast along this section and sand strata above the Corcoran Clay are more extensive to the southwest. Sand strata are common above and below the clay along the southwest and northeast parts of the section.

Southern Area

Cross Section D-D' (**Figure 3-13**) was modified from Meade (1968). This cross section extends from southeast of Los Banos to the south to near Eagle Field. The top of the consolidated deposits deepens to the south along the section, and ranges from about 900 to 1,000 feet deep beneath the Southern Division. The Corcoran Clay averages about 200 feet deep along the part of the section in the Southern Division. Deposits above the Corcoran Clay are primarily Sierra floodplain deposits. Deposits below the clay along the north part of this section in the Southern

Division are primarily Sierra floodplain deposits, whereas beneath the south part, Diablo floodplain deposits are predominant.

Subsurface Geologic Cross Section E-E' (**Figure 3-14**), modified from Hotchkiss and Balding (1971), extends from the northeast near Copa De Oro Avenue and Brito Road to the southwest near Delta Road and the boundary of T11S and T12S, between the Outside Canal and the DMC. The Corcoran Clay dips to the northeast along the southwest part of the section, and to the southwest along the northeast part. Sierra deposits are predominant above the Corcoran Clay whereas Diablo Range deposits are predominant below the Corcoran Clay along this section. A thin wedge of Sierra deposits is present at a depth of about 600 feet along the east part of the Southern Division along this section.

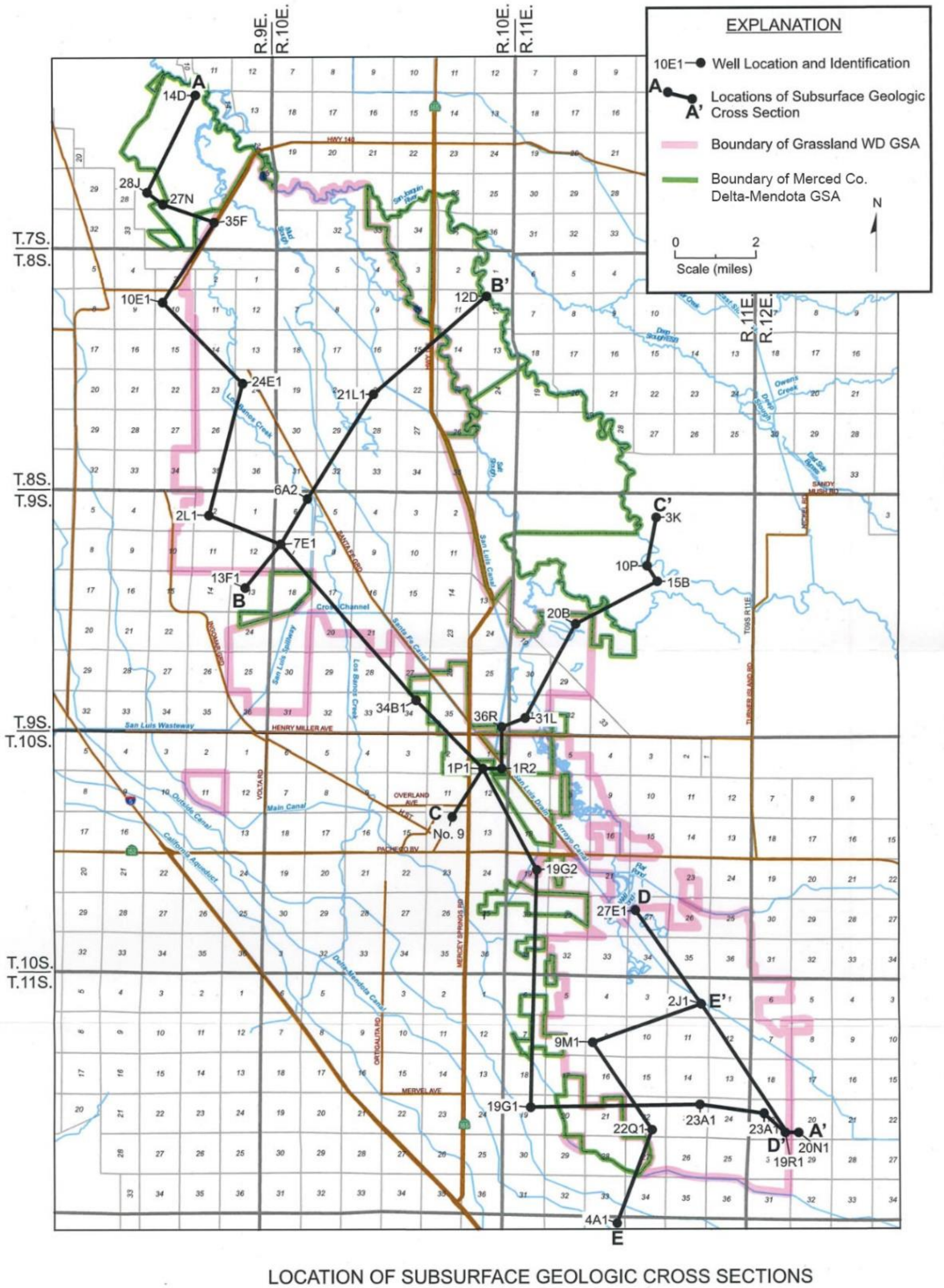


Figure 3-9: Location of Subsurface Geologic Cross Section

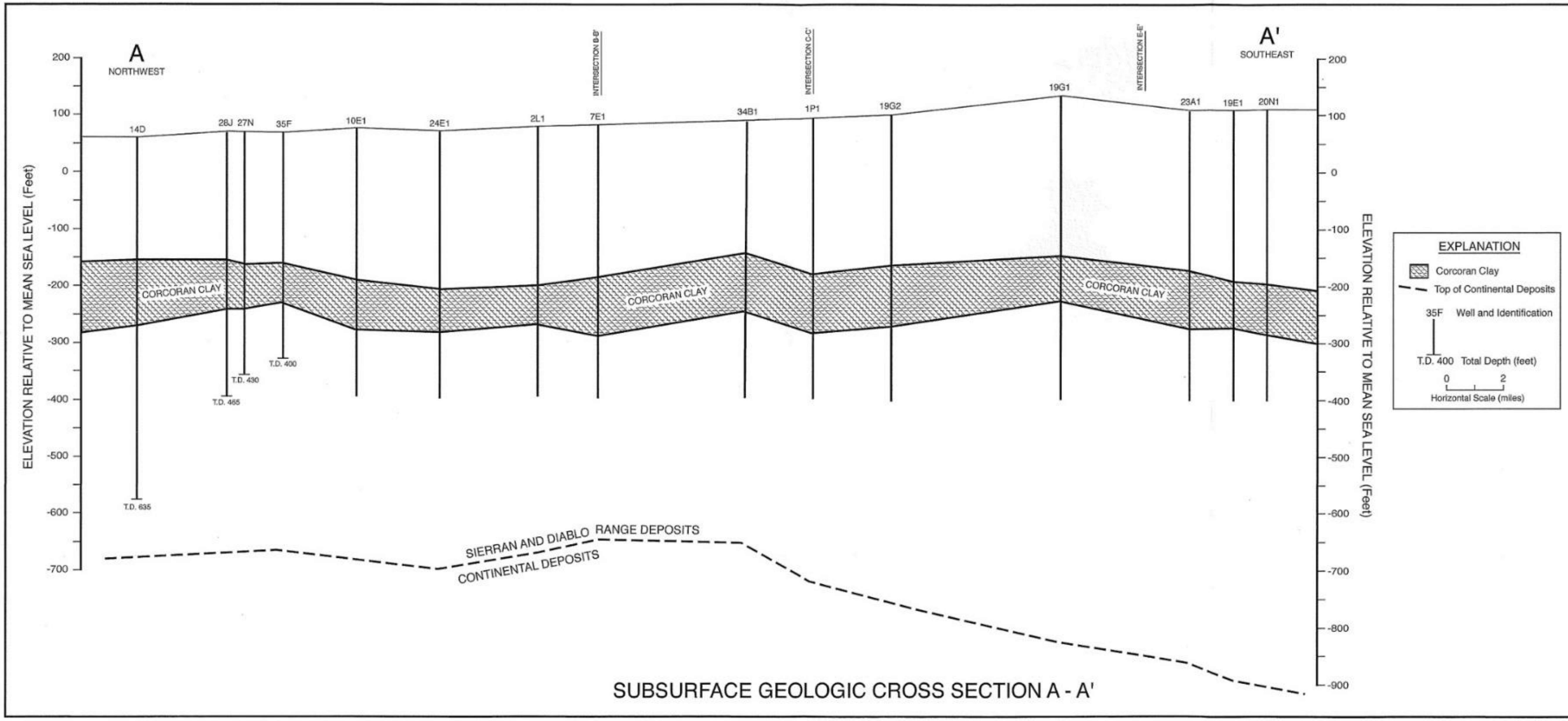


Figure 3-10: Subsurface Geologic Cross Section A-A'

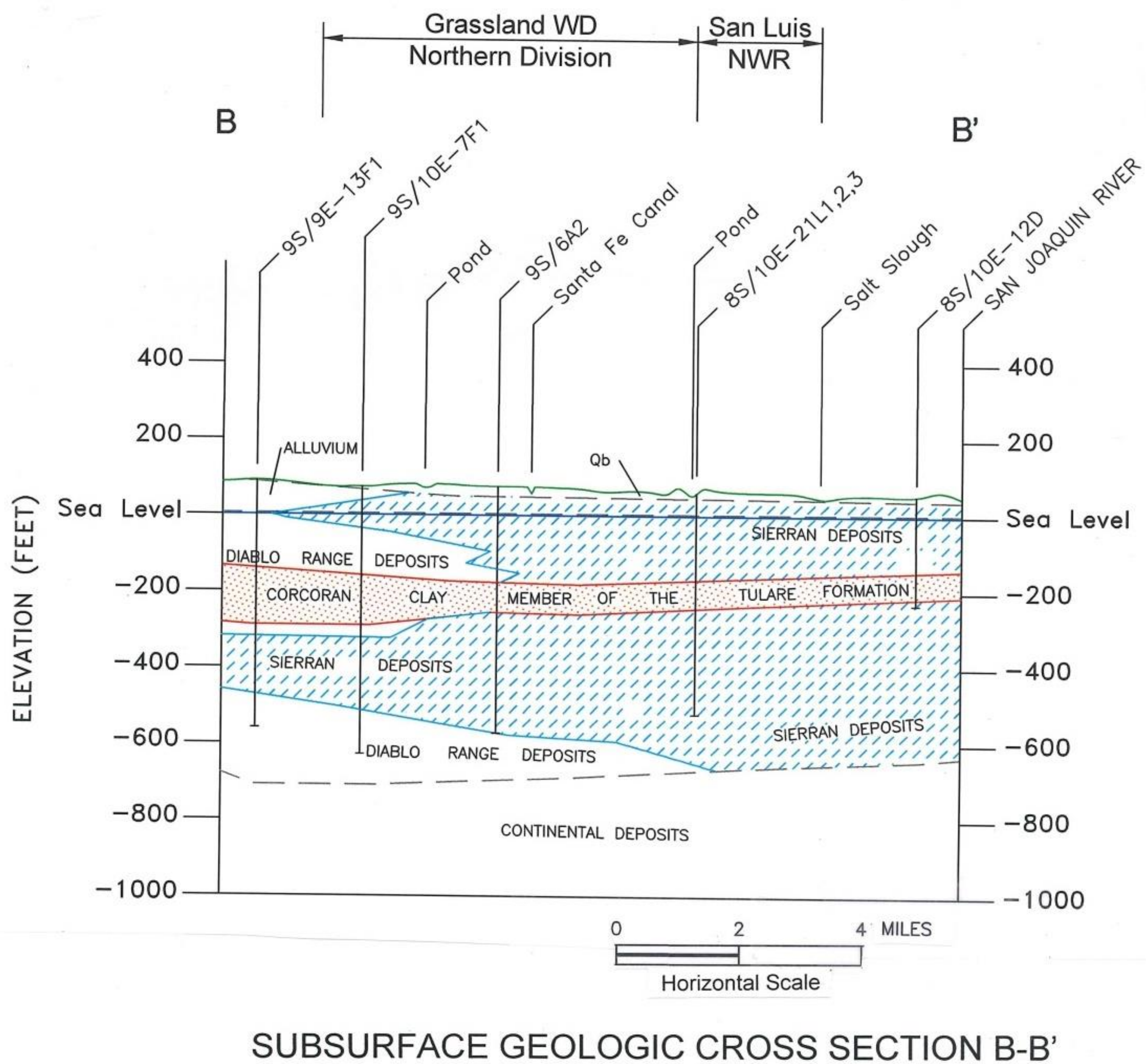


Figure 3-11: Subsurface Geologic Cross Section B-B'

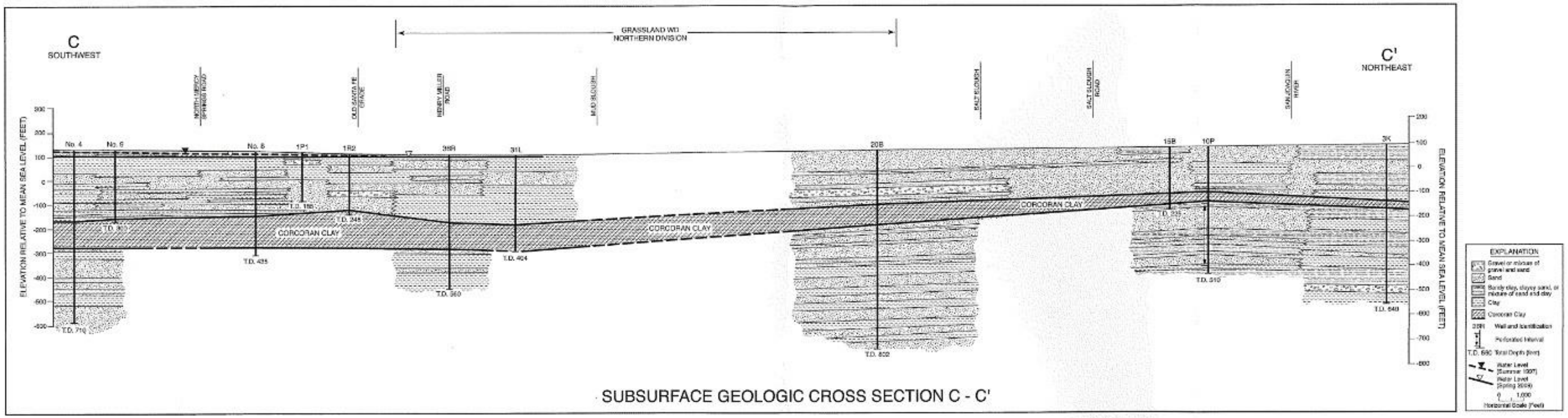


Figure 3-12: Subsurface Geologic Cross Section C-C'

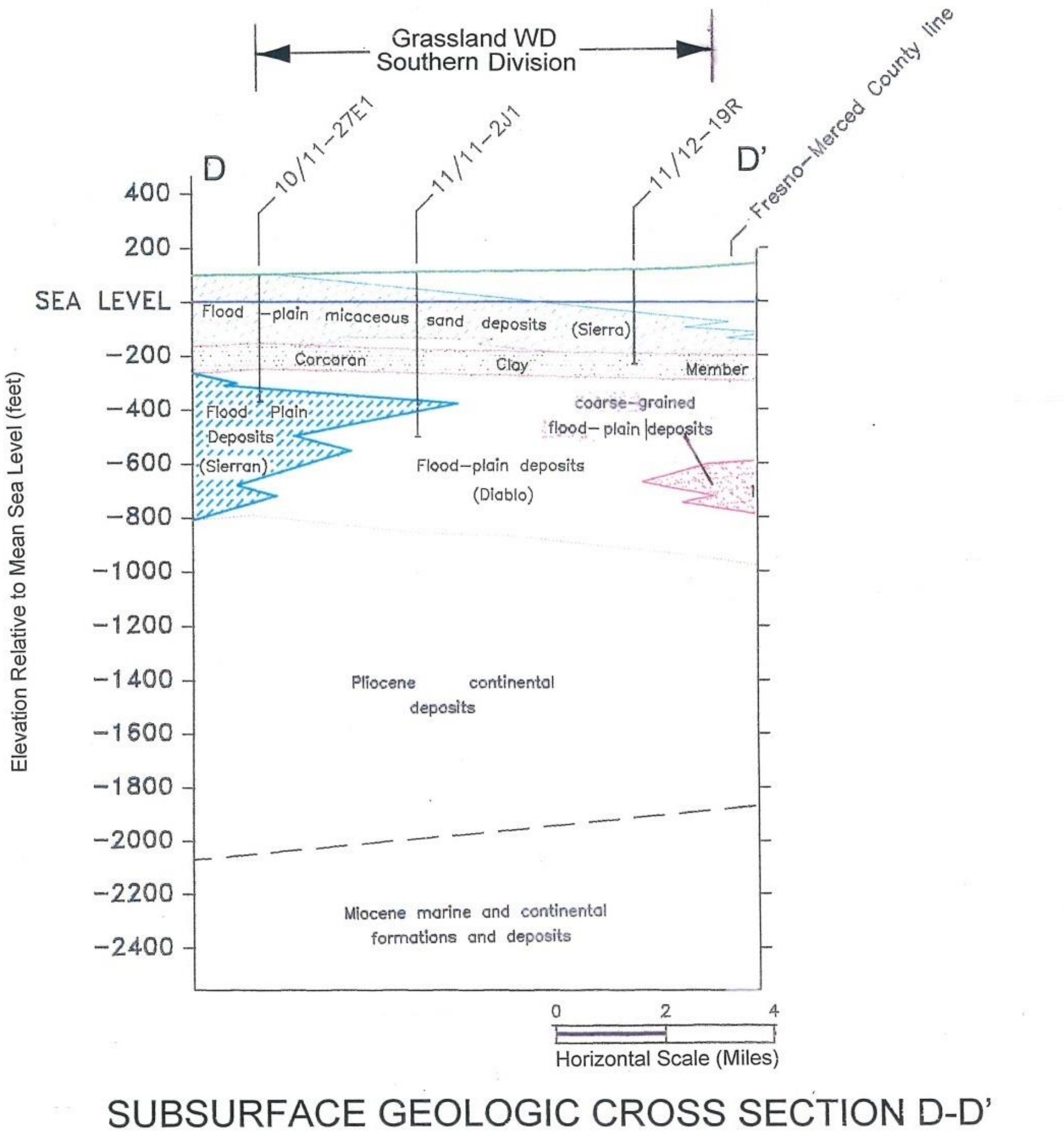


Figure 3-13: Subsurface Geologic Cross Section D-D'

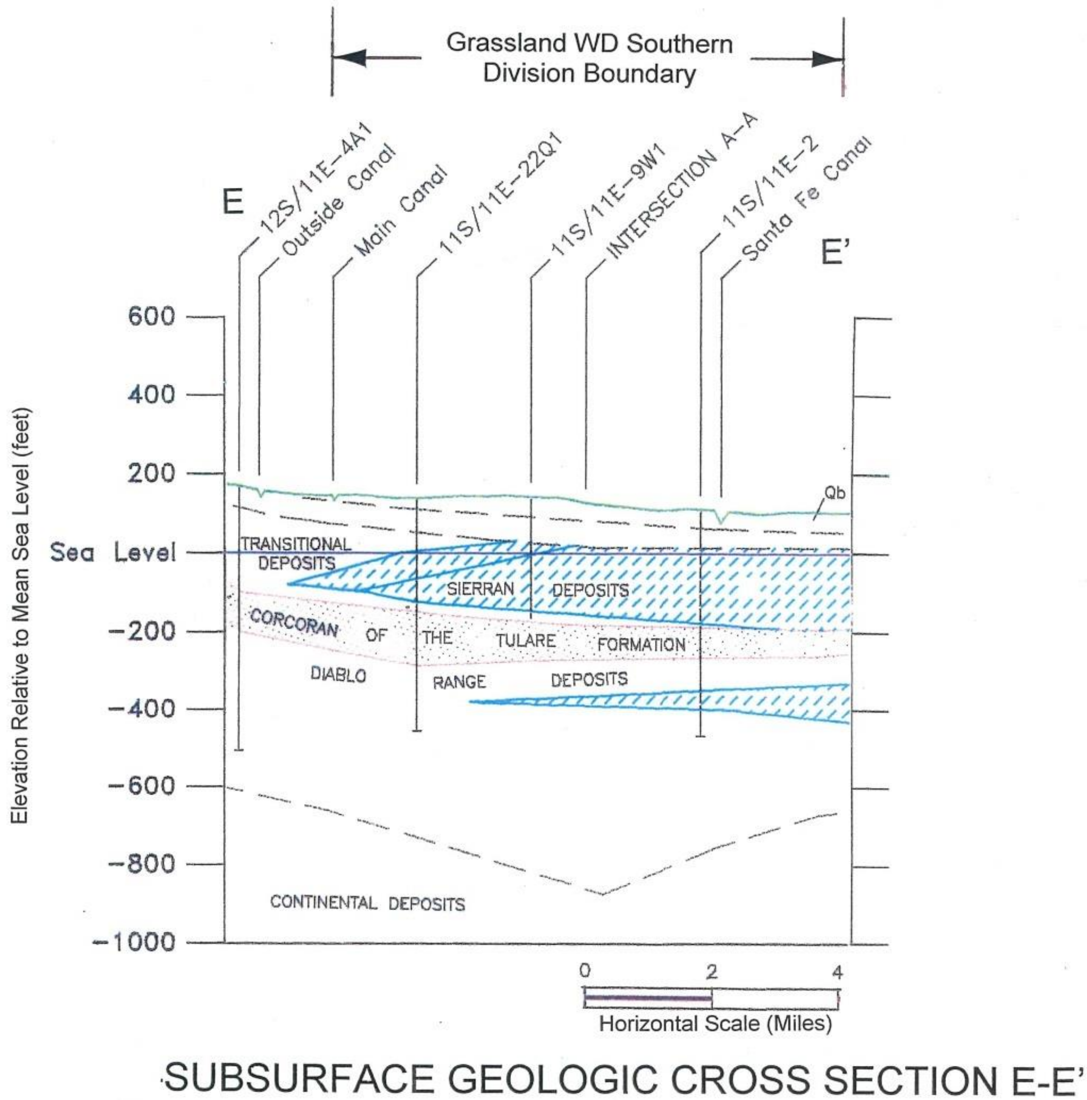


Figure 3-14: Subsurface Geologic Cross Section E-E'

3.2 Groundwater Conditions

3.2.1 Groundwater Use and Well Data

3.2.1.1 Primary Uses of Each Aquifer

Legal Requirements:

§354.14(b)(4)(e) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.

The GGSA provided driller's logs and electric logs for test holes and water supply wells in and near the Plan Area. Logs for the federal wildlife refuges, state refuges, and other areas were obtained from the DWR. Most upper aquifer wells generally extend to near the top of the Corcoran Clay, and thus range from about 200 to 300 feet deep. The deepest water supply wells with records in the north part of the area are from about 780 to 870 feet deep. The deepest water supply wells with records in the south part of the area are about 600 to 700 feet deep. Most water supply wells either tap the upper aquifer or lower aquifer. Wells are primarily used for managed wetlands and crop irrigation. One publicly available groundwater connection serves drinking water to visitors at the San Luis National Wildlife Refuge visitor center. There are a limited number of domestic wells in the Plan Area ("de minimis extractors" under SGMA) that supply water to seasonal recreational properties.

3.2.2 Water Levels

Legal Requirements:

§354.16(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:
(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

Water-level records are available from three primary sources in the area evaluated. Included are records from DWR, GGSA, and the SJRECWA.

3.2.2.1 Depth to Water

In Spring 2018, the GGSA installed shallow monitor wells at ten sites to allow monitoring of shallow water levels. In early March 2018, the depth to water in these wells ranged from about one to five feet. Except for two of these wells, depth to water was 2.5 feet or less. In August-September 2018, depth to water in these wells ranged from 4.2 to 9 feet. Except for two wells, depth to water ranged from about 5.0 to 7.0 feet. These measurements indicate that the groundwater is shallow enough, particularly in the spring and early summer, to be directly evaporated. The GGSA provided a report on February 1, 2016 entitled Incremental Level 4 Groundwater Development Project Initial Study and Negative Declaration. This project allows the Grassland Water District to acquire up to 29,000 acre-feet per year of privately held groundwater supplies and/or exchange a portion of its surface water for such groundwater supplies. Data for 21 wells were provided in that report, most of which are along the Santa Fe Canal and tap the upper aquifer. Records for this project indicate that static water levels in most upper aquifer wells were from about 10 to 20 feet deep during 2012-14. On the other hand, static water levels in two lower aquifer wells ranged from about 80 to 100 feet deep.

In Fall 2015, nested monitor wells were installed at three sites in the GGSA. Two nested well sites are located in the North Division near the San Luis Drain and Taglio Road and the Santa Fe Canal and Cottonwood Road, respectively. An additional nested wells site is located in the South Division near Santa Fe Grade and north of Charleston Avenue. The static water level in one Northern Division upper aquifer monitor well was 16 feet deep in Fall 2015. The static water levels in two upper aquifer wells at the Southern Division site were about 26 feet deep at that time. The static level in three lower aquifer wells at a Northern Division site ranged from about 50 to 100 feet deep in Fall 2015. The static water levels in four lower aquifer wells at the other Northern Division site ranged from about 80 to 90 feet deep at that time.

3.2.2.2 Water Level Elevations and Direction of Flow

Water level elevation and direction of groundwater flow maps for both the upper aquifer and lower aquifer have been prepared by KDSA for the SJRECWA service areas, and these maps extend into part of the area evaluated. These maps were prepared to show both normal (Fall 1981) and drought conditions (Spring 1992).

Upper Aquifer

For the north part of the area, water level elevations in Fall 1981 ranged from about 60 to 90 feet above sea level and indicated a north to north-northeasterly direction of groundwater flow. Groundwater was moving from the CCID west of the North Division through the Northern Division toward the San Joaquin River. The water level elevations and direction of groundwater flow in Spring 1992 were essentially the same, indicating little variation in groundwater flow direction with climatic conditions. For the south part of the area, water level elevations in Fall 1981 ranged from about 90 to 120 feet above mean sea level. The direction of groundwater flow was primarily to the north or northwest. The groundwater in the upper aquifer was flowing toward the Northern Division. Groundwater inflow was coming from the CCID, Pacheco Water District, and Panoche Water District. The water level elevations and directions of groundwater flow in Spring 1992 were essentially the same, again indicating little variation with climatic conditions.

Figure 3-15 shows water level elevations and the direction of groundwater flow for the upper aquifer for Spring 2015. Essentially, the same water level elevations and direction of groundwater flow were present beneath the area north of Highway 152 and south of Highway 152 as in Fall 1981. Water level elevations exceeded 130 feet above mean sea level near the south boundary of the area evaluated (Merced Avenue) and were less than 70 feet near the north boundary. A cone of depression was located east and northeast of Los Banos, coincident with the locations of numerous wells which pump into the GWD water system.

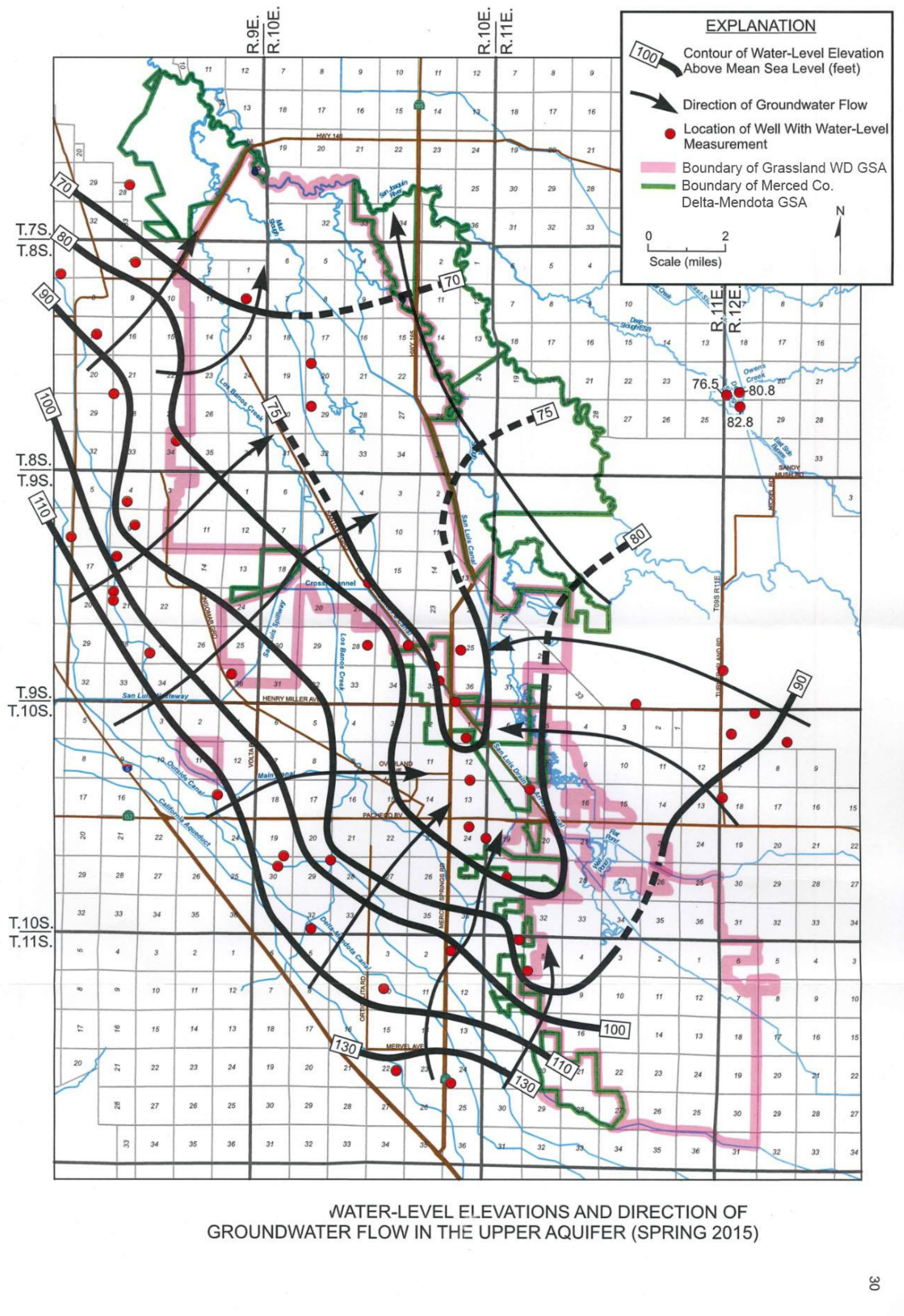


Figure 3-15: Water Level Elevation and Direction of Groundwater Flow in the Upper Aquifer (Spring 2015)

Groundwater in the Southern division of the Plan Area was primarily moving to the north towards this depression. In the Northern Division and south of the Cross Channel, groundwater was also moving toward the northwest. There was a groundwater divide north of Henry Miller road in the east part of the area evaluated. Northeast of this divide, groundwater moved towards the San Joaquin River.

Lower Aquifer

For the Northern Division, water level elevations ranged from less than 40 feet above mean sea level to about 60 feet in Fall 1981. There was a depression cone indicated beneath the Northern Division. Groundwater inflow was coming from the CCID on the west and northwest, the CCID and Plan Area Southern Division to the south, and the San Luis Canal Company, Turner Island W. D., and an undistricted area to the northeast.

For the Southern Division, water-level elevations in Fall 1981 ranged from about 60 feet above mean sea level east of Los Banos to 30 feet near the south end of the Plan Area. Groundwater was flowing into the Southern Division from the northeast and north-northeast, primarily from the San Luis Canal Company and CCID. Groundwater outflow was to the south and southwest toward the Pacheco Water District and Panoche Water District. Water level elevations in Spring 1992 ranged from about 65 feet above mean sea level east of Los Banos to about 10 feet near the south end of the Southern division. The lower water levels to the south compared to Fall 1981 were likely due to higher amounts of lower aquifer pumpage in the Panoche Water District and nearby areas during the drought.

Figure 3-16 shows water elevations and the direction of groundwater flow for the lower aquifer in Spring 2015. There was a groundwater divide near Henry Miller Avenue. North of the divide, groundwater flowed into a depression beneath the north part of the area. South of the divide, groundwater flowed to the south into the Panoche Water District and Westlands Water District. In the north part of the area, water levels in the lower aquifer were about 60 to 90 feet deeper than in the upper aquifer. In the south part of the area, water levels in the lower aquifer were about 50 to 110 feet deeper than in the upper aquifer.

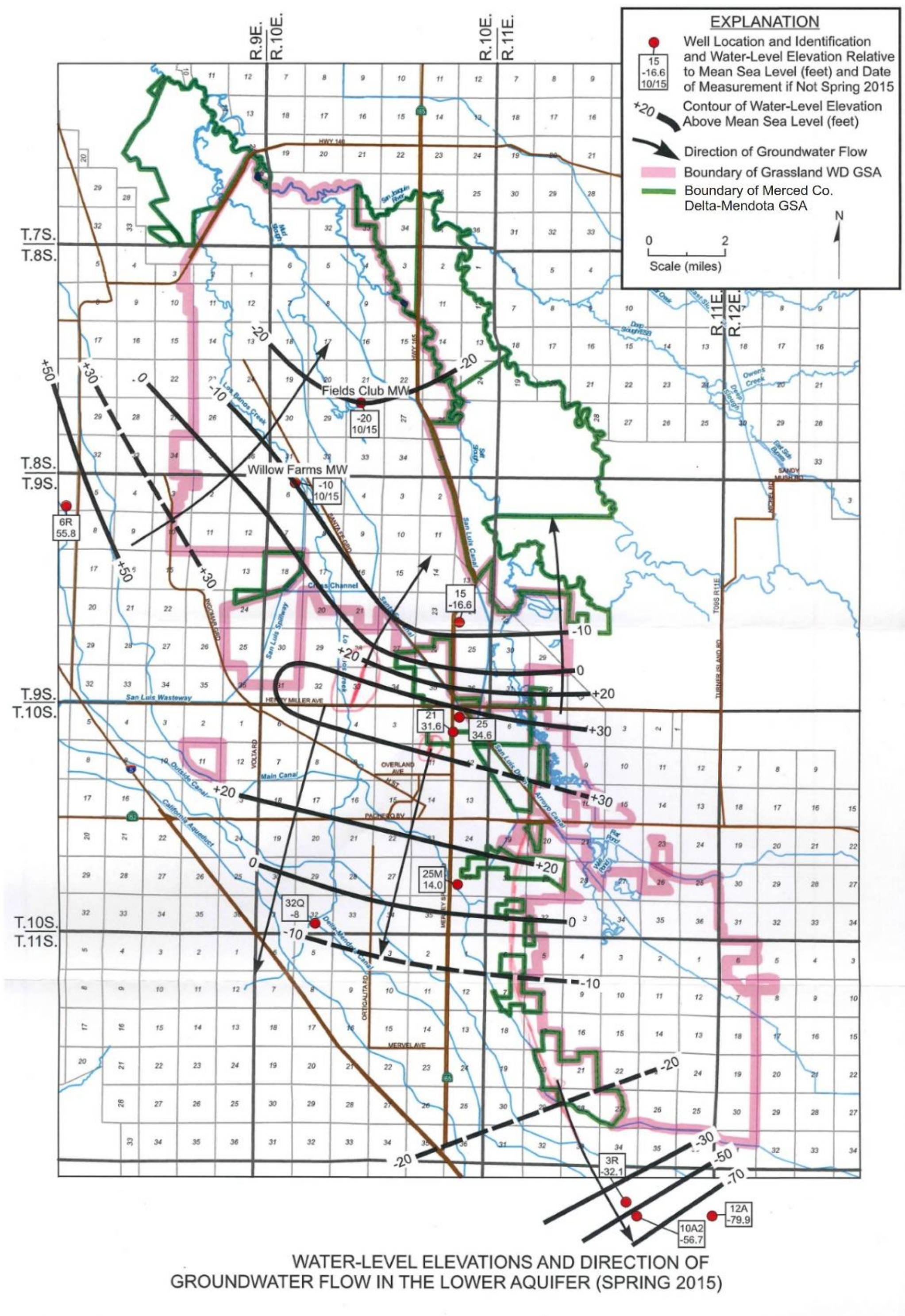


Figure 3-16: Water Level Elevations and Direction of Groundwater Flow in the Upper Aquifer (Spring 2015)

3.2.2.3 Water Level Fluctuations

Water level measurements and hydrographs for wells in and near the Plan Area were obtained from DWR websites and from the CCID. In addition, the GGSA provided water-level data for a number of wells for 2012-14.

Upper Aquifer

Long-term water level records are available for seven upper aquifer wells within or near the Northern Division:

T8S/R9E-10E1, 13E1, and 34G1
T8S/R10E-17N2 and 30E1
T9S/R9E-3C1 and 36P1

Water levels in five of these wells have risen over the long-term, extending back to the 1960s or 1970s. Water levels in two of these wells were relatively stable. **Figure 3-17** shows representative water level hydrographs for CASGEM wells in the Northern Division. Water levels in the wells have temporarily fallen during drought periods such as the early 1990s and then have recovered.

Long-term water level records are available for 13 upper aquifer wells in or near the Southern Division.

T1OS/R10E-1M1
T1OS/R11E-17E1, 32N1, and36A1
T11S/R11E-4N1, 6B1, 12P1, 12P3, 17E1, and 17E2
T11S/R12E-8C1, 30H1, and 30H2

Figure 3-18 shows representative water level hydrographs for two CASGEM wells in or near the Southern Division. Water levels in these wells have either risen or been relatively stable during the past several decades. Levels appear to be recovering from slight declines during the recent severe drought, in particular 2014 and 2015.

Static water levels in a number of upper aquifer wells in the Plan Area were measured prior to pumping and about a day after pumping stopped for the wetlands during 2012-14. Water level differences between pre-pumping and post-pumping were generally only several feet. In a number of cases, the post-pumping water levels were shallower than those prior to pumping. The upper aquifer water level fluctuations are indicative of an unconfined aquifer. They indicate that there has been no groundwater overdraft in the Plan Area as a whole. This is consistent with conditions in the surrounding parts of the CCID and San Luis Canal Co. service areas.

Lower Aquifer

Depth to water in lower aquifer wells has been substantially deeper than in upper aquifer wells, commonly from 50 to 100 feet deep. Long term water level records aren’t available for wells solely tapping the lower aquifer in the Plan Area. However, continuous records from 2011-2016 are available for two Volta area wells which tap both the upper and lower aquifers. Records for these wells indicate very quick water level recovery after pumping stops. In 2012, water levels were much shallower after pumping stopped than they were prior to pumping.

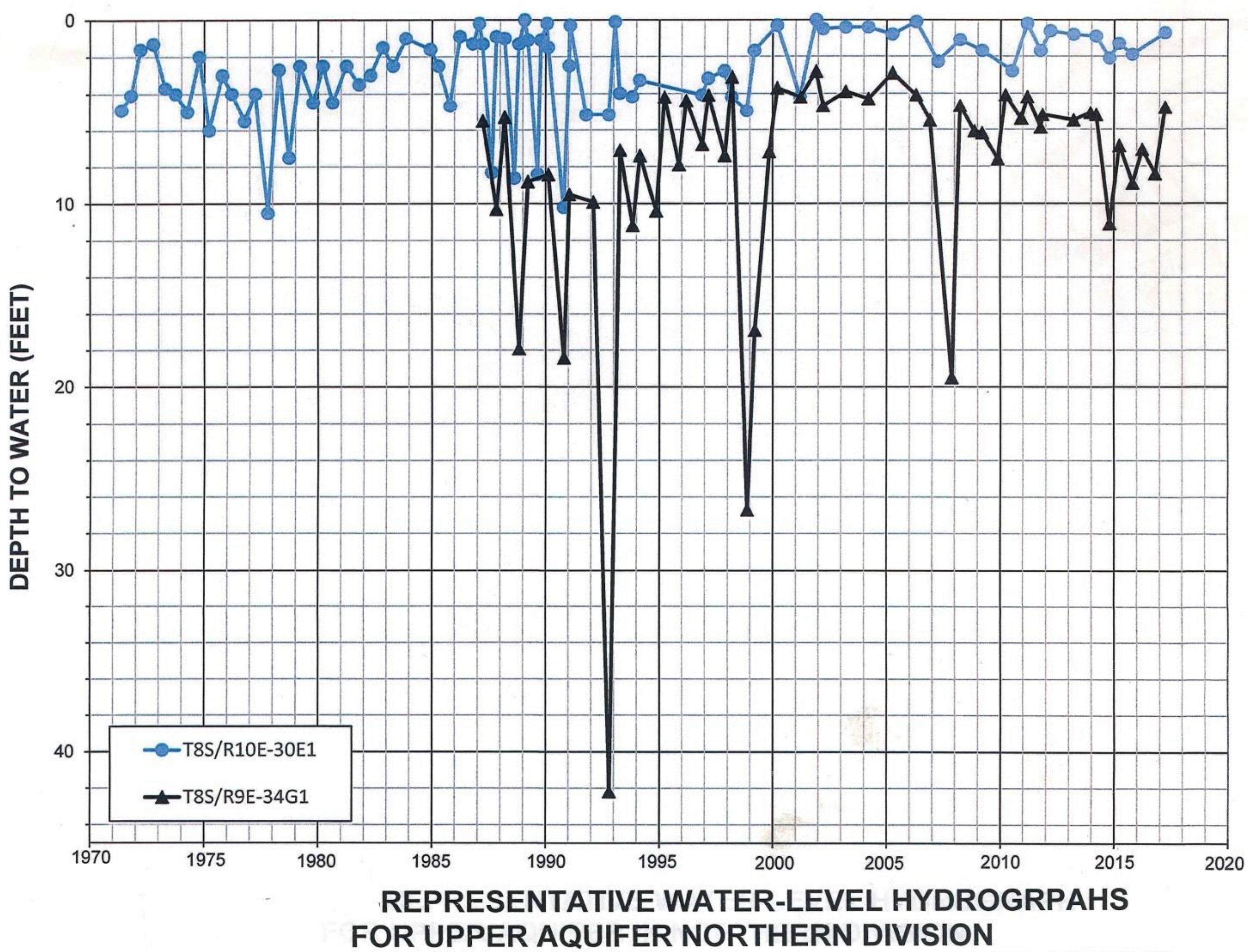


Figure 3-17: Water Level Hydrographs for Upper Aquifer Northern Division

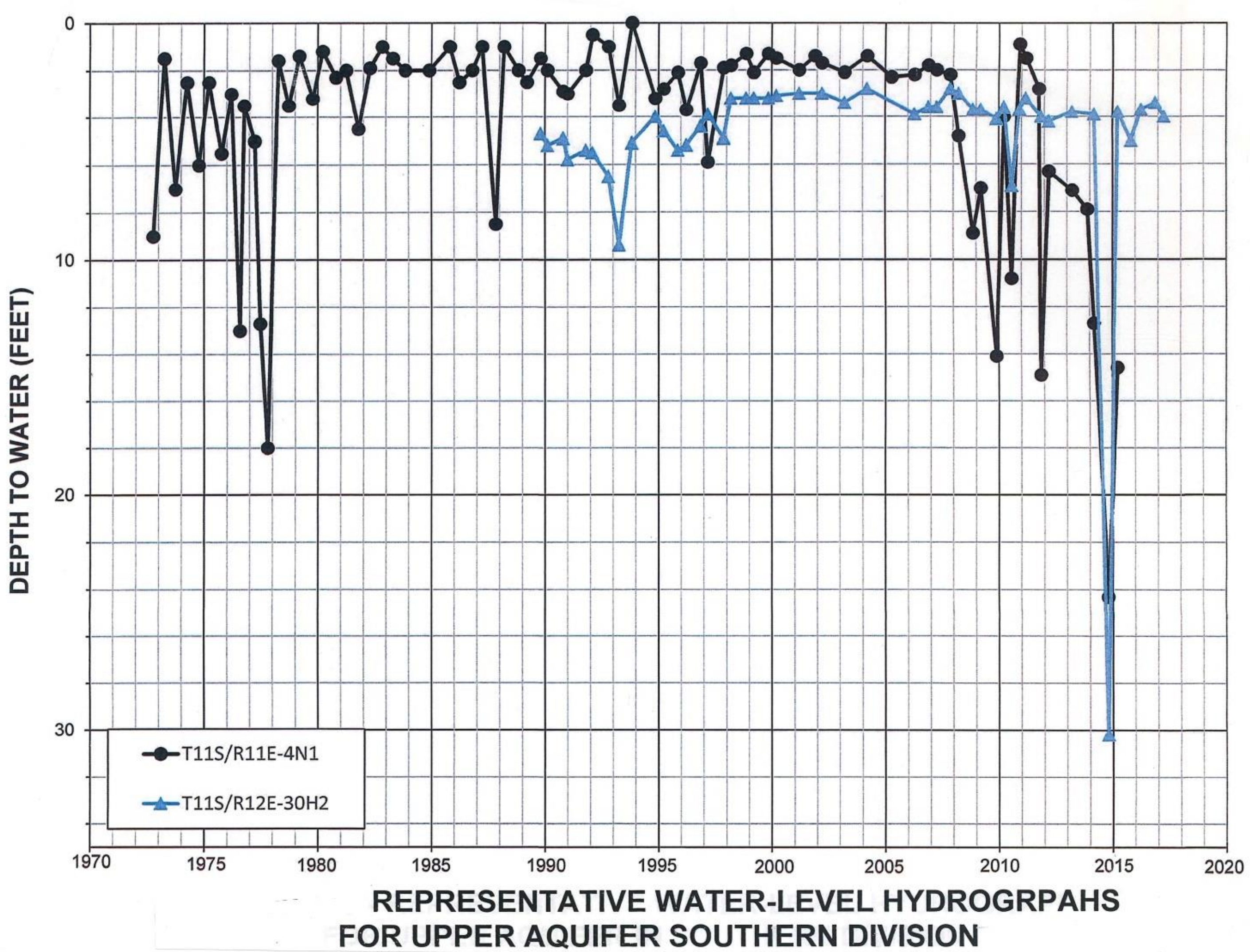


Figure 3-18: Water Level Hydrographs for Upper Aquifer Southern Division

3.2.3 Potential Sources of Groundwater Recharge

Legal Requirements:

§354.14(d)(4) Physical characteristics of the basin shall be represented on one or more maps that depict delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

Figure 3-19 shows major potential sources of recharge to groundwater in the area evaluated, including wetlands and agricultural lands. The major sources of recharge are groundwater inflow, seepage from conveyance facilities, and deep percolation from the wetlands. The Plan Area has imported an average of 150,000 acre-feet per year of Central Valley Project refuge water supplies from the DMC (see **Figure 3-5)** for associated water delivery points). Summers Engineering estimated that an average of about 29,000 acre-feet per year have been recharged through unlined conveyance canals within the District. For the upper aquifer, groundwater inflow is primarily from the southwest and south. For the lower aquifer, groundwater in the Northern Division flows into the Plan Area from almost all directions. In the Southern Division, groundwater inflow was from the north-northwest and northeast. Also, because hydraulic heads are lower in wells tapping the lower aquifer than in those tapping the upper aquifer, there is a trend for downward flow of groundwater through the Corcoran Clay. Amounts of this downward flow in the SJREC service area were estimated by KDSA (1997b).

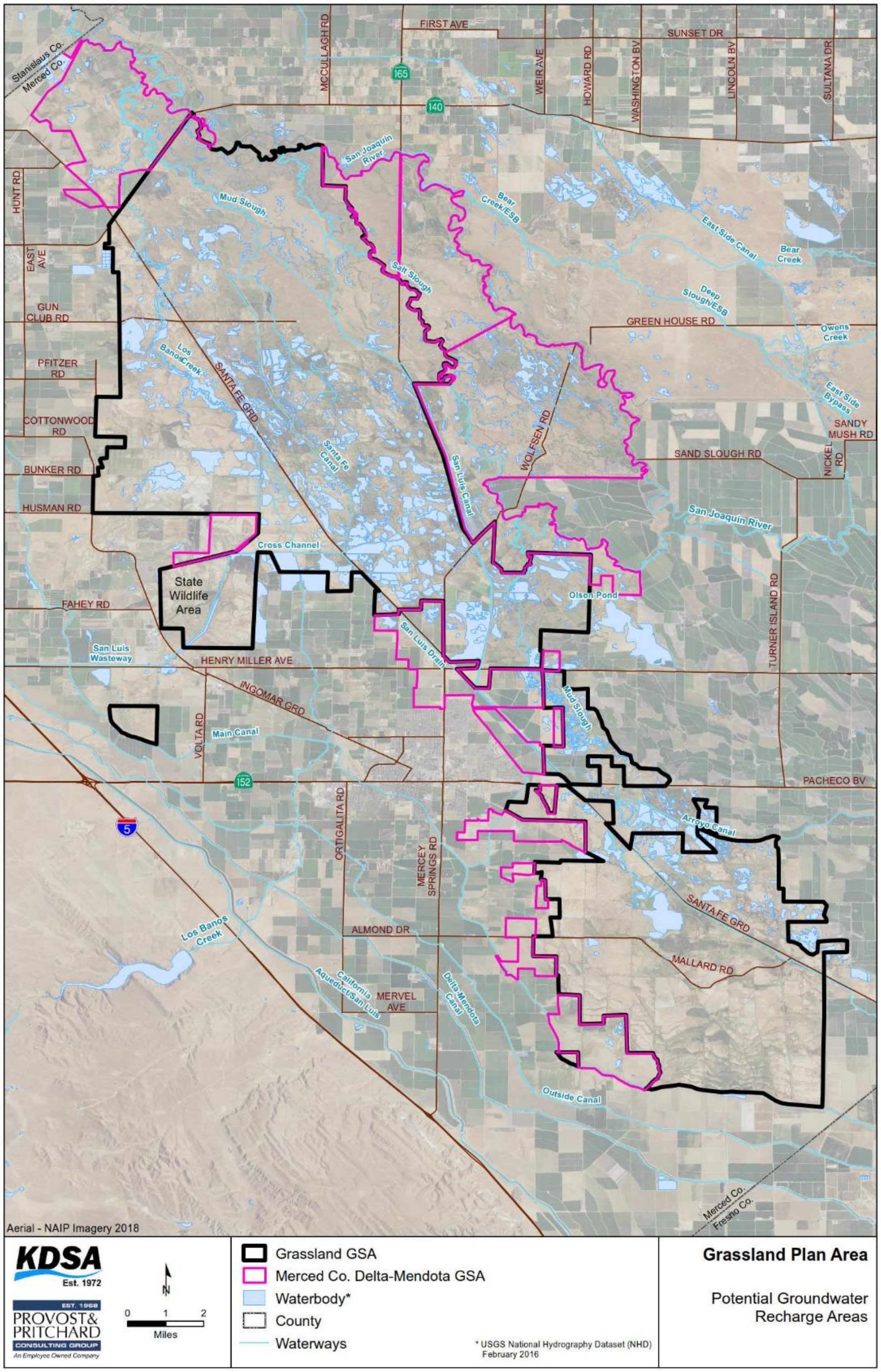


Figure 3-19: Potential Groundwater Recharge Areas

3.2.4 Potential Sources of Groundwater Discharge

Legal Requirements:

§354.14(d)(4) Physical characteristics of the basin shall be represented on one or more maps that depict delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

Groundwater is discharged from the upper aquifer through pumping wells, groundwater outflow toward the San Joaquin River, downward flow of groundwater through the Corcoran Clay, and through evaporation or evapotranspiration of shallow groundwater. Groundwater discharge from the lower aquifer is primarily from pumping wells and groundwater outflow from the Southern Division.

3.2.5 Aquifer Characteristics

Legal Requirements:

§354.14(b)(4)(b) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

The GGSA provided pumping rates for 23 wells in the GWD groundwater pilot program. Pumping rates ranged from about 500 to 3,700 gpm. Pumping rates for most of these wells ranged from about 1,350 to 2,300 gpm. Pump tests are available for some of these wells.

3.2.5.1 Transmissivities

Aquifer transmissivities were assembled based on aquifer tests on wells in or near the area evaluated. Specific capacities for upper aquifer wells can be multiplied by a factor of 1,500 to estimate the transmissivity for areas where aquifer tests aren't available. Similarly, specific capacities for lower aquifer wells can be multiplied by 2,000 to estimate the transmissivity[1]. In addition to these estimates, KDSA (2018) determined transmissivities for specific flow estimates along some of the boundaries within the Plan Area. For the upper aquifer, these included several inflow segments on the west side, segments near the south and east side of the Northern Division, and two inflow segments near the southwest side of the Southern Division. For the lower aquifer, transmissivity values were developed for segments northwest, west, south, and northeast of the Northern Division.

Outflow segments were developed for areas south and southeast of the Northern Division. KDSA (2018) determined aquifer transmissivities for the upper and lower aquifers from the results of aquifer tests and specific capacity values for wells in the SJRECWA service areas. KDSA (2018) indicated that transmissivities for the various segments for upper aquifer flow ranged from about 100,000 to 190,000 gallons per day (gpd) per foot. The highest values were generally along the area near the southwest boundary and along the east edge of the southern part of the area evaluated. For the lower aquifer, transmissivities ranged from about 60,000 to 160,000 gpd per foot.

[1] Thomasson et al. (1960) developed conversion factors between specific capacity and transmissivity in U.S. Geological Survey Water-Supply Paper 1464.

3.2.5.2 Vertical Hydraulic Conductivities

The vertical hydraulic conductivity of the Corcoran Clay at this location was determined to be less than 0.001 gpd per square foot. For the SJRECWA service areas, an average vertical hydraulic conductivity for the Corcoran Clay was estimated to be 0.0075 gpd per square foot. This higher value was indicated to be due to thinner Corcoran Clay in many areas compared to that at the leaky aquifer test site (110 feet) and to the presence of more well conduits compared to those near the leaky aquifer test site.

3.2.5.3 Storativity

Values for the specific yield from textural descriptions of deposits tapping the upper aquifer are the best way to estimate specific yields. The USGS has estimated specific yields in many parts of the San Joaquin Valley. Based on the subsurface geologic cross sections available, an average specific yield of 12 percent is used for the upper aquifer. Storage coefficients for strata confined by the Corcoran Clay are sparse in this area. However, a one-week long leaky aquifer test was conducted using wells located along the DMC near Russell Avenue in January 1997 (KDSA, 1997b). This best value for storage coefficient for the lower aquifer for the test was 0.001.

3.2.6 Changes in Groundwater Storage

Legal Requirements:

§354.16(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

Changes in storage for coarse-grained deposits in the lower aquifer are shown to be insignificant, as the aquifer remains full of water despite water level declines. However, land subsidence has occurred due to compaction of clays and the volume of land subsidence can be used to estimate the decrease in storage for confining beds in the lower aquifer, including the Corcoran Clay. For the upper aquifer, long-term water level changes can be used to determine storage changes during periods when the water levels declined significantly. Due to the relatively small changes in storage, year-to-year changes are often insignificant (except during severe droughts). Water levels in upper aquifer wells have slightly risen over the long-term. Thus, two changes in storage for the upper aquifer were evaluated: 1) annual decreases in storage during droughts, and 2) long-term increases in storage.

Northern Division

Annual water level declines during the 1987-93 drought averaged 1.4 feet per year. For an acreage of about 72,000 acres and an average specific yield of about 12 percent, the annual loss in groundwater storage was about 12,000 acre-feet per year. As in most areas, water level hydrographs for wells showing these declines indicated full recovery within several years after the drought ended. Long term water level hydrographs for the area evaluated indicate an average water level rise of about 0.04 foot per year. This equates to an increase in groundwater storage averaging about 350 acre-feet per year. Over a 30-year period, this would total about 10,500 acre-feet.

Southern Division

Annual water level declines during the droughts of 1987-93 and 2008-14 indicate average annual water level declines of 1.7 feet per year. For an area of about 32,000 acres and an average specific yield of about 12 percent, this annual loss in groundwater storage was about

6,500 acre-feet per year. It should be noted that water-level hydrographs for the period following the first of these droughts generally indicate full recovery within a few years. Long-term hydrographs indicate an average water level rise of about 0.04 foot per year. The increase in groundwater storage would be about 150 acre-feet per year. Over a 30-year period, this would total about 4,500 acre-feet.

3.2.7 Land Subsidence

Legal Requirements:

§354.16(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or best available information.

Historically, there was little subsidence monitoring throughout most of the Plan Area. However, land surface elevations were periodically measured along Highway 152 between Los Banos and Highway 99 (**Figure 3-20**). Near Los Banos, little subsidence was indicated, due to the paucity of pumpage from the lower aquifer in this area. Prior to about 2000, most of the land subsidence along Highway 152 was east of the Eastside Bypass, where numerous wells were present that pumped from the lower aquifer. Starting in about 2008, many more wells tapping the lower aquifer were constructed south of Red Top, both east and west of the Bypass. Pumping of these wells had caused significant land subsidence as of 2016. **Figure 3-21** shows land subsidence determined by the USBR for July 2012-December 2016.

Using this data, subsidence contours were developed by KDSA, and are shown for the area evaluated and to the east. Near the west edge of the north part of the area evaluated, subsidence was about 0.05 foot. Near the eastern edge of the north part of the area evaluated, subsidence was averaged to be about 0.5 foot. Near the west edge of the south part of the area evaluated, subsidence was about 0.3 foot and about 0.6 foot near the east edge. In both divisions, subsidence increased to the east-northeast. There is some pumpage from lower aquifer wells in the area evaluated and adjoining areas. To the east of the area evaluated, the subsidence increased to more than 2.0 feet for July 2012-December 2016. Land subsidence in part of that area decreased after December 2016 due to mitigating measures that were enacted.

3.2.8 Groundwater Quality

Legal Requirements:

§354.14(b)(4)(d) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

Recent information on the chemical quality of groundwater in the area evaluated was derived primarily from the GWD report of February 1, 2016 on the Incremental Level 4 Groundwater Development Project and from the installation of the nested monitor wells at the three sites. Monitoring plans require that the GWD have samples from the District's surface water channels analyzed. The GWD's Board of Directors has adopted a surface water quality objective for TDS of 2,500 mg/l.

Figure 3-22 shows recent groundwater quality data for the area evaluated. The 22 supply wells with chemical analyses generally indicated the quality of groundwater acceptable for pumping into the GGSA system. Much worse quality groundwater is present at some locations; however, only in certain depth intervals that are not tapped by these wells.

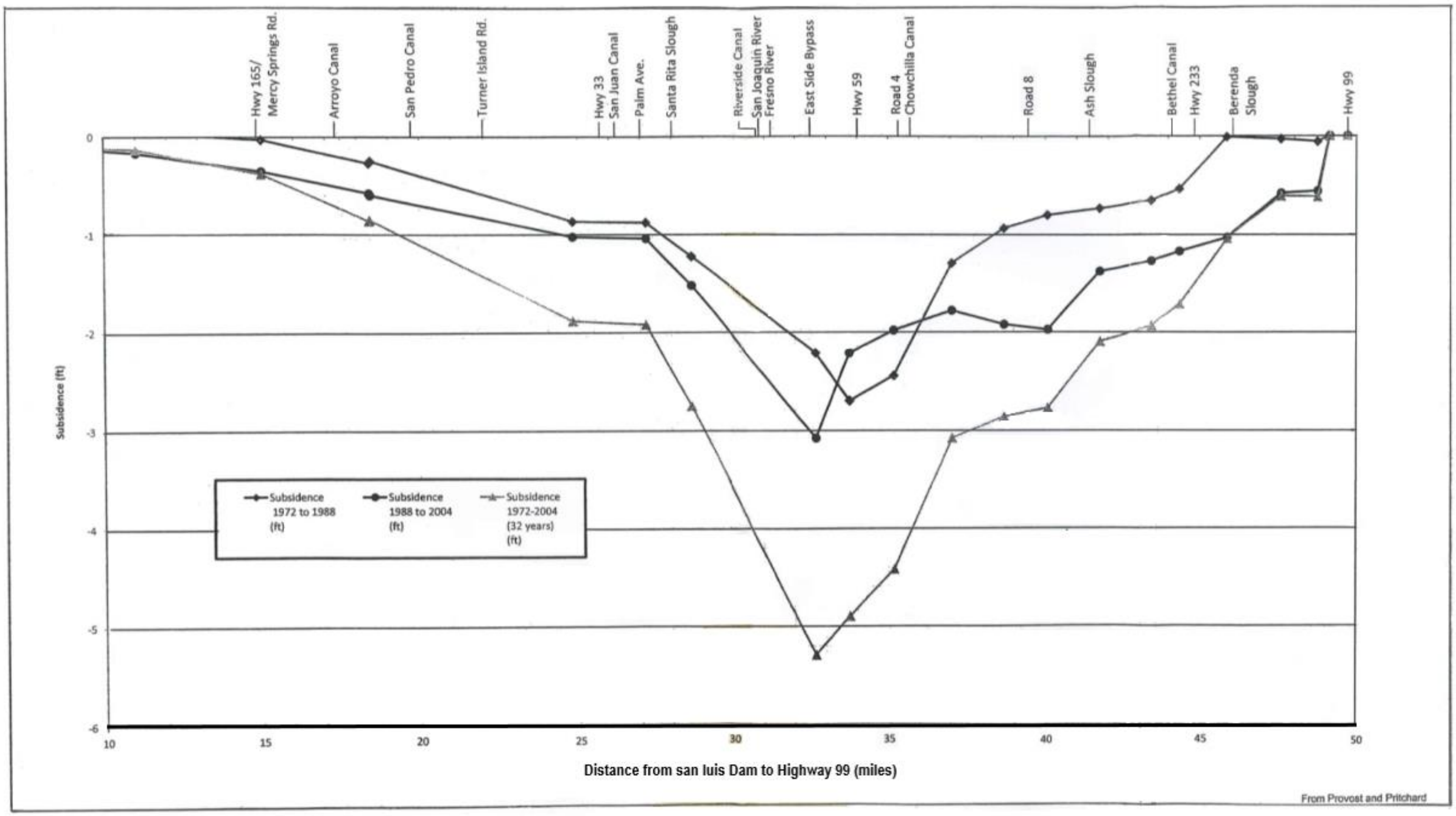


Figure 3-20: Historical Land Surface Elevations Along Highway 152 Transect

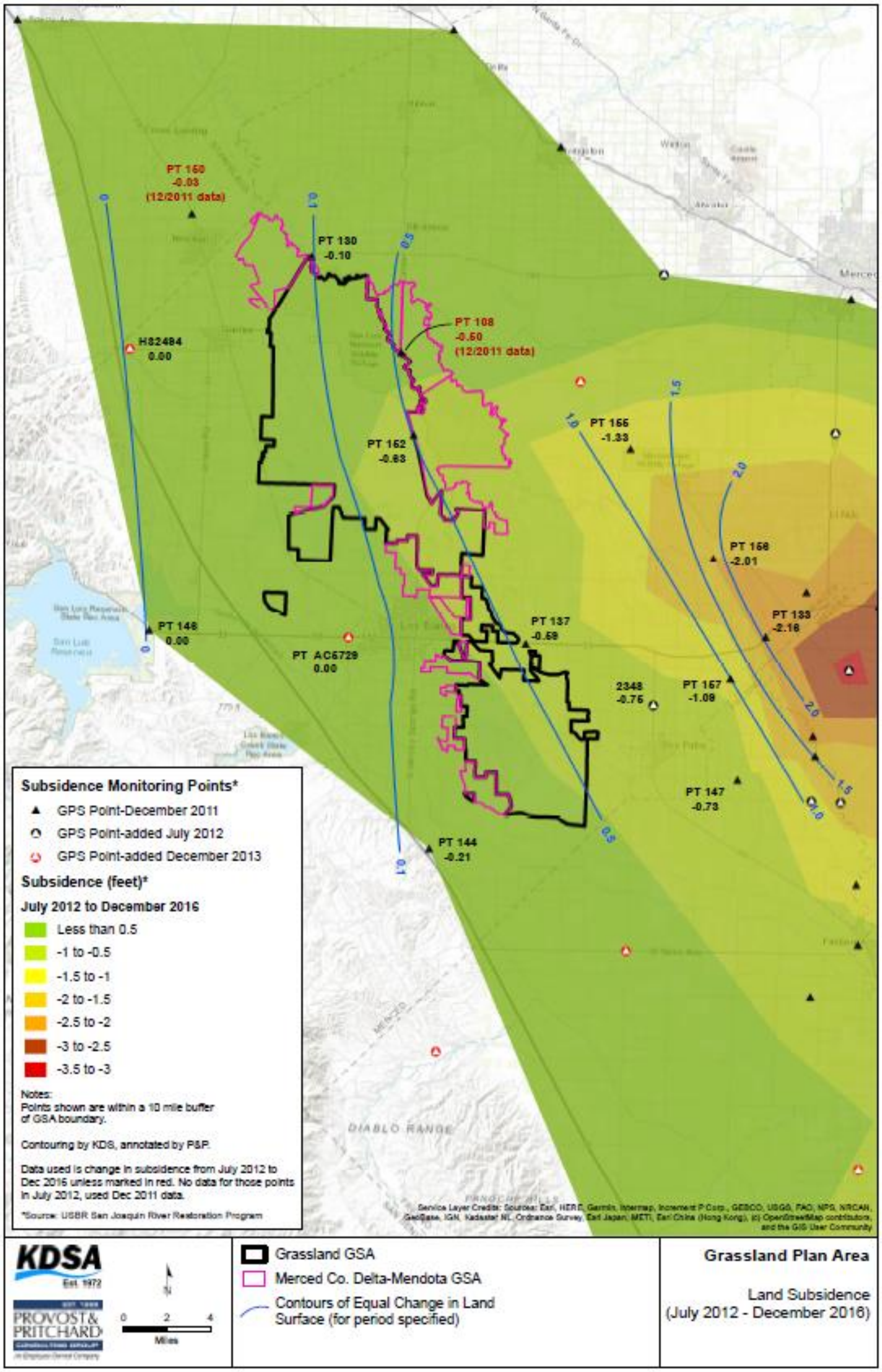


Figure 3-21: Land Subsidence

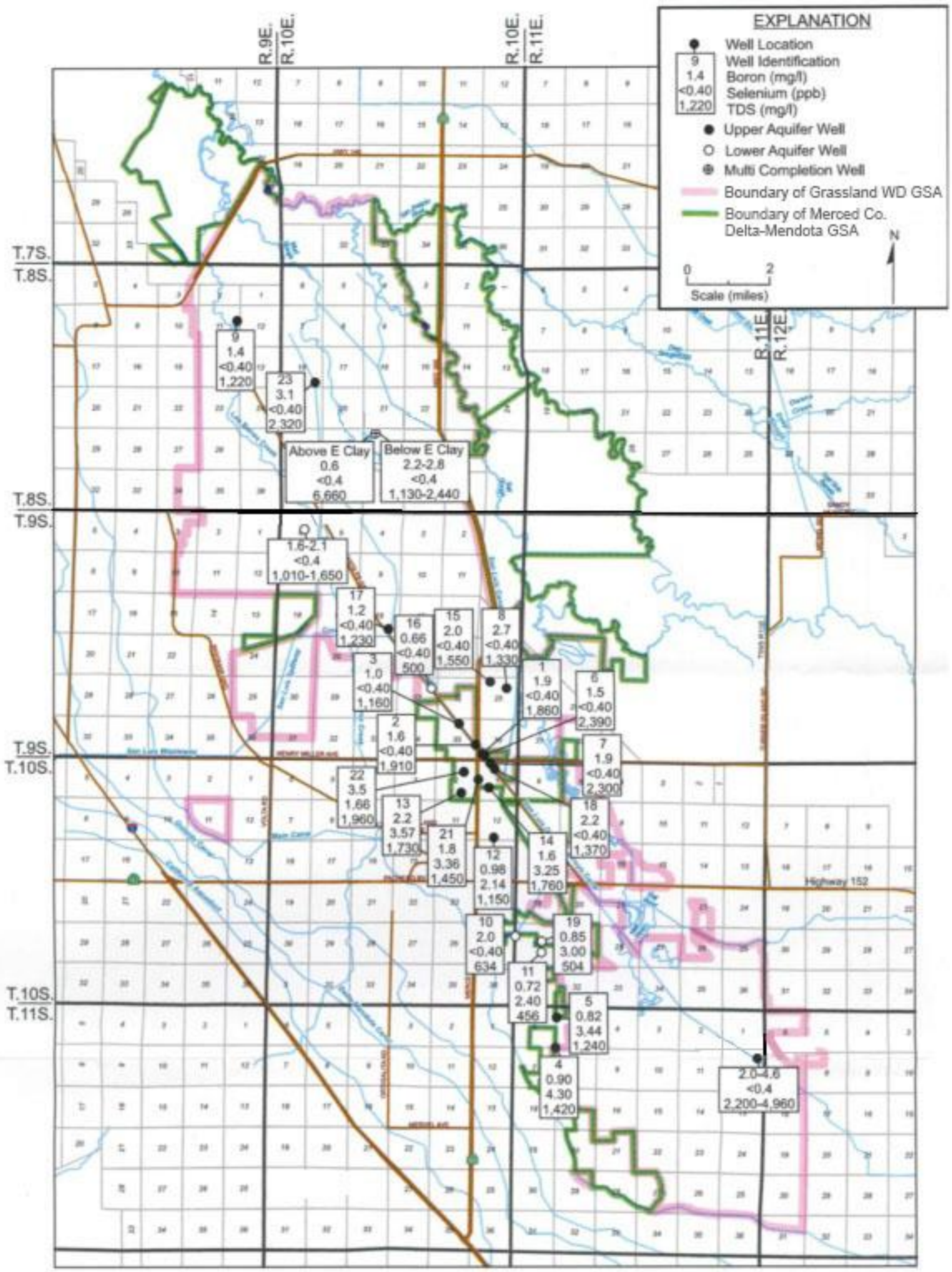


FIGURE 23 - GROUNDWATER QUALITY IN THE GWD

Figure 3-22: Groundwater Quality

Northern Division

Most of the chemical analyses for the Northern Division are of wells within about five miles of Los Banos. Data is also included from the two sites where nested monitor wells were installed. TDS concentrations in water from upper aquifer supply wells north of Highway 152 ranged from 1,160 to 2,390 mg/l. TDS concentrations exceeding 2,000 mg/1 were present in water from a well near Gun Club Road and two other wells near Henry Miller Road and the Santa Fe Canal. TDS concentrations of less than 1,500 mg/1 were present in water from a well near Carnation Road near the north edge of the Plan Area and from six other wells between Highway 152 and Husman Road.

Water from a lower aquifer well north of China Camp Road and near the Santa Fe Canal had a TDS concentration of 500 mg/1.

At one site, water samples were collected from both above and below the Corcoran Clay. The water sample from above the Corcoran Clay had a TDS concentration of 6,660 mg/1. For water samples collected from below the Corcoran Clay, TDS concentrations ranged from 1,130 to 2,440 mg/1.

At one site, water samples were collected only from below the Corcoran Clay as brackish groundwater was indicated above the clay. TDS concentrations ranged from 1,010 to 1,650 mg/1.

Southern Division

All five of the sampled supply wells in the Southern Division were located along the west side of the Plan Area between Pioneer and Almond Drive Road. Two of these wells were upper aquifer wells and three were lower aquifer wells. TDS concentrations in water from the upper aquifer wells ranged from 1,240 to 1,470 mg/l. Three wells that tapped the lower aquifer had TDS concentrations ranging from 456 to 634 mg/l.

At the sites, water samples were collected from two depth intervals above the Corcoran Clay. TDS concentrations ranged from 2,200 to 4,960 mg/1. The electric log for the test hole at the site indicated high salinity groundwater in the lower aquifer below the Corcoran Clay. A similar situation has been found in groundwater elsewhere in the Dos Palos area and to the southeast.

3.2.9 Interconnected Surface and Groundwater Systems

Legal Requirements:

§354.16(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or best available information.

The only locations in the area evaluated where groundwater is known to be in direct hydraulic communication with a stream is along a nine-mile-long reach of the San Joaquin River on the north edge of the San Luis NWR (**Figure 3-4**). A series of shallow monitoring wells have been installed by Reclamation as part of the SJRRP. Water level maps indicate that groundwater in the upper aquifer discharges to the river along this reach. The GGSA has installed a network of shallow (10 to 20 feet deep) observation wells in the District. Monitoring of these wells will provide more definitive information on the relationship between shallow groundwater and streamflow at these same locations.

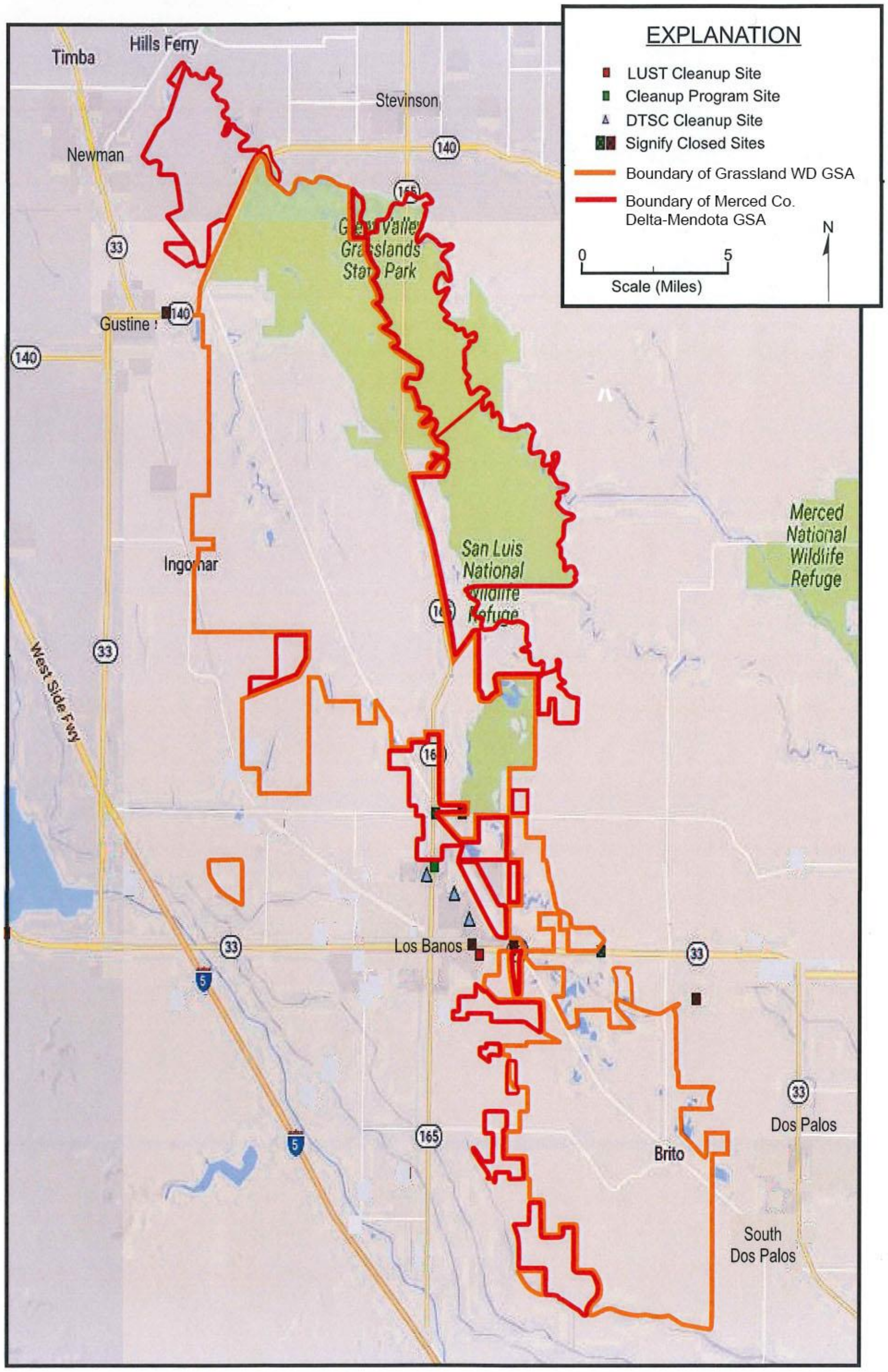
3.2.10 Known Contamination Sites

Legal Requirements:

§354.16(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.

Figure 3-23 shows known groundwater contamination sites within the vicinity of the area evaluated, as taken from the Central Valley Regional Water Quality Control Board Geotracker website. There are very few sites within the Plan Area, and they are listed as closed sites.

55



KNOWN CONTAMINATION SITES

Figure 3-23: Known Contamination Sites

3.3 Water Budget Information

Legal Requirements:

§354.18
(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

A water budget is crucial to sustainable groundwater management. Quantifying historic, current, and projected conditions and overdraft allows a deeper understanding of water use and, in turn, allows GSAs to set supply augmentation and demand mitigation objectives if necessary. The water budget for the Grassland Plan Area was developed using information gathered from various sources including the hydrogeologic conceptual model and groundwater conditions report, precipitation and evapotranspiration databases, measurements of inflows and outflows to the system, and other relevant data. This information was coordinated at the Subbasin level to develop a consistent methodology for a Subbasin wide water budget (see Common Chapter – **Appendix A**).

GSP regulations stipulate the need to use the best available information and the best available science to quantify the water budget for the basin. Best available information is common terminology that is not defined under SGMA or the GSP Regulations. Best available science, as defined in the GSP Regulations, 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, which is consistent with scientific and engineering professional standards of practice. The best available information at the time the GSP is developed may be limited spatially and temporally. It is the intention of the GSAs within the Plan Area to continue to evaluate data gaps, compile data, seek additional sources, and improve means and methods of analyzing data moving forward in order to provide a clear and accurate description of the annual Groundwater Conditions and development of future Water Budgets.

3.3.1 Description of Groundwater Model

Legal Requirements:

§354.18
(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.
(f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.

GSP Regulations do not require the use of a numerical computer model to quantify and evaluate water budget conditions and the potential impacts to beneficial uses and users of groundwater. However, if a model is not used, the GSA is required to describe in the GSP an equally effective method, tool, or analytical model to evaluate projected water budget conditions.

There is a lack of sufficient data regarding water use and cropping patterns in some parts of the Plan Area during the historically average period chosen by the Subbasin. In order to gain a greater understanding of operational and natural conditions in the Plan Area, the GSAs decided to use an analytical accounting tool to quantify the water budget conditions for specific year types where data was prevalent. This allowed the Plan Area to project historic trends into the future using actual data while incorporating factors that may alter these trends such as climate change and land use. The analytical accounting tool was also chosen to alleviate costs, to provide clarity in assumptions and data that were used, and to prevent the need to use unrealistic assumptions in order to calibrate a computer model. Such models can be very complicated and commonly produce results well outside of the expected range of error when limited data is available for analysis. This is especially true when dealing with systems like groundwater and land subsidence. The development of these complex groundwater models requires the results of local data, contour maps, trusted external data sets and equations, and physical observation and surveys.

Numerical groundwater models must be calibrated with actual data to determine their accuracy. The Central Valley Hydrologic Model Version 2 (CVHM2) numerical groundwater model was initially considered by other GSP Groups in the Subbasin to develop the required water budgets. However, it was determined that the model was not adequately calibrated within the Subbasin and did not provide an accurate estimate of actual conditions. The Plan Area participants chose instead to utilize available data and develop an analytical spreadsheet model for water budget accounting. Using actual data under these circumstances represents the best available information. Within the Subbasin this method is considered equally effective, if not more effective, than the numerical model. The GSAs will consider using an adequately calibrated groundwater model once their datasets are developed, if a model would be likely to produce more accurate results. It should be noted that existing models were referenced during the development of this water budget.

The complete water budget, including historic, current, and projected, for the Plan Area was developed using information from the hydrogeologic conceptual model and the groundwater conditions summary developed by Kenneth D. Schmidt & Associates and discussed earlier in this chapter along with data from sources such as the California Irrigation Management Information System (CIMIS), DWR, Irrigation Training & Research Center (ITRC), and California Data Exchange Center (CDEC), among others. Data from these sources as well as internal monitoring data and other publicly available information were utilized. The water budget methodology and data collection were coordinated with the other Delta-Mendota GSAs through the implementation of the Coordination Agreement and associated Coordination Committee and Technical Subcommittee.

In its January 2022 determination letter for the six the Delta-Mendota Subbasin (Subbasin), including the Common Chapter, the California Department of Water Resources (DWR) concluded that the Common Chapter did not adequately explain how each GSP used the same data and methodologies as the others (defined as “Deficiency 1”). DWR pointed to the water budgets contained in the six GSPs and compiled as the Subbasin water budget in the Common

Chapter and concluded that the chosen "sum-of-the-parts" approach made it uncertain whether the GSPs utilized the same data and methodologies to develop a Subbasin-wide water budget.

To address this deficiency, the GSAs in the Subbasin met to develop consistent definitions for their water budget components and reorganized the data in a more consistent fashion to conform with the component definitions. While the specific data used to develop the water budgets has not changed, the revised water budgets presented in the Revised Common Chapter reflect more coordinated Subbasin-wide water budgets using common definitions. A detailed explanation of the coordinated water budget components is also included in the Common Chapter, along with a discussion of the data and methodologies used. The reader is therefore referred to the amended Common Chapter for the SGMA-required historic, current and projected water budget for the Delta-Mendota Subbasin. A clean copy of the Revised Common Chapter is presented in **Appendix A** and a track changes version of the Revised Common Chapter is presented in **Appendix G.**

3.3.1.1 Period of Record

The period of record chosen to analyze the historic data was water year (WY) 2003 to 2012, covering an average hydrologic period. In August 2018, the Delta-Mendota Subbasin Coordination Committee approved the coordinated historic period of WY 2003 to 2012 and the current year of 2013 for the Subbasin. The projected water budget was analyzed from 2014 – 2070. The hydrologically average period was developed using San Joaquin River – Full Natural Flow (SJR FNF) data, the DWR water year index, and precipitation data at nearby gaging stations. A 50-year average of SJR FNF runoff was evaluated from 1966 to 2015, which was approximately 1.83 million AF. An alternative period from 1990 – 2015 was considered for potential analysis. A series of analyses were done for periods ranging from 1990-2015, but the period between 2003 and 2012 was chosen because:

- The average represented nearly 100% of the 50-year average for hydrological conditions (**Table 3-4**).
- The period was recent and reflects recent land use and regulatory conditions.
- It met the minimum 10-year requirement.
- The period did not end in a severe drought.
- It had a balanced number of water-year types.
- The data for the period would be more readily available given it is relatively recent.

Additional detail on the development of the historic water budget and hydrological average period can be found in **Appendix D**.

3.3.1.2 Representative Water Years

Because of the limited data in the Plan Area, representative years were chosen for specific water year types: 2013 for the average/dry year, 2015 for the critical year, and 2017 for the wet year. Water year types were determined using the DWR water-year index. Data from these years were compiled to develop an annual water budget and then used as surrogates for the 2003-2012 water years. They were also used as surrogates for the projected water budget. Average and dry years were combined into a single category because surface water allocations and groundwater pumping tend to be unchanged during these year types. Changes in groundwater pumping only occur during wet years when there is surplus water available, reducing the need to pump supplemental groundwater, and during critical years when surface water allocations are reduced increasing the need for additional groundwater extraction.

3.3.1.3 Changes in Land Use

The extensive managed wetlands within the Grassland Plan Area form a landscape that changes from month to month. The Plan Area is made up of private managed wetlands, federal and state wildlife refuge, and a small amount of farmland. Unlike most geographical areas where agricultural and urban land uses remain fairly static, the Plan Area is dynamic, changing as wetlands are flooded, drained, and irrigated. Because of this, evapotranspiration and seepage were analyzed in greater detail on a monthly timescale. Shapefile data provided by Point Blue Conservation Science and Ducks Unlimited were used to develop monthly maps of the extent of the wetland ponding, in acres (see **Figure 3-24** and **Figure 3-25**). This helped to determine which types of wetland vegetation were present monthly, for accurate estimates of evapotranspiration of vegetation and water surfaces. Changes in the wetland area required seepage from wetland ponds to be also analyzed monthly.

3.3.1.4 Aquifer Significance

There are two principal aquifers in the Plan Area: the upper unconfined and the lower confined aquifer, separated by the Corcoran Clay, which are described in the aquifer characteristics portion of the HCM. Groundwater is pumped from both the upper and lower aquifer, with very little water pumped from the lower aquifer within the Plan Area. Only total pumping is calculated, and the water budgets do not differentiate between upper and lower aquifer contributions. Further investigations will be needed to separate upper aquifer pumping from lower aquifer pumping. This will require development of a Plan Area-wide database to log well completion, perforation locations, and the volume of water pumped. The database will require interpretation by an experienced hydrogeologist. Groundwater monitoring will help quantify each aquifer's total amounts of groundwater extracted and the recovery of the both aquifers over time. Hydrographs, contour maps, and subsidence trends were used to calculate change in storage and sustainable yield for each aquifer and these are provided in the corresponding sections of this GSP.

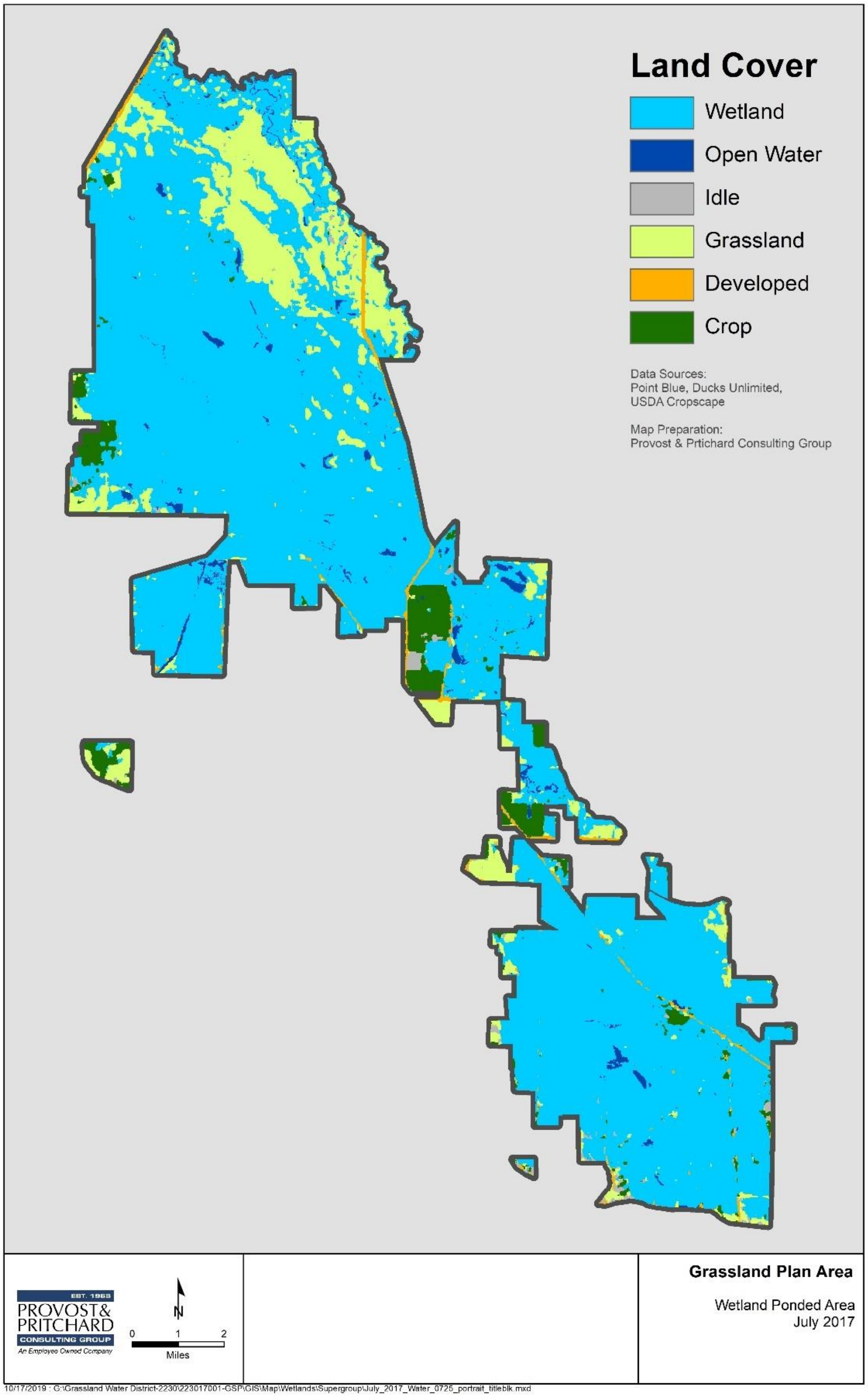


Figure 3-24: Wetland Ponded Area – July 2017

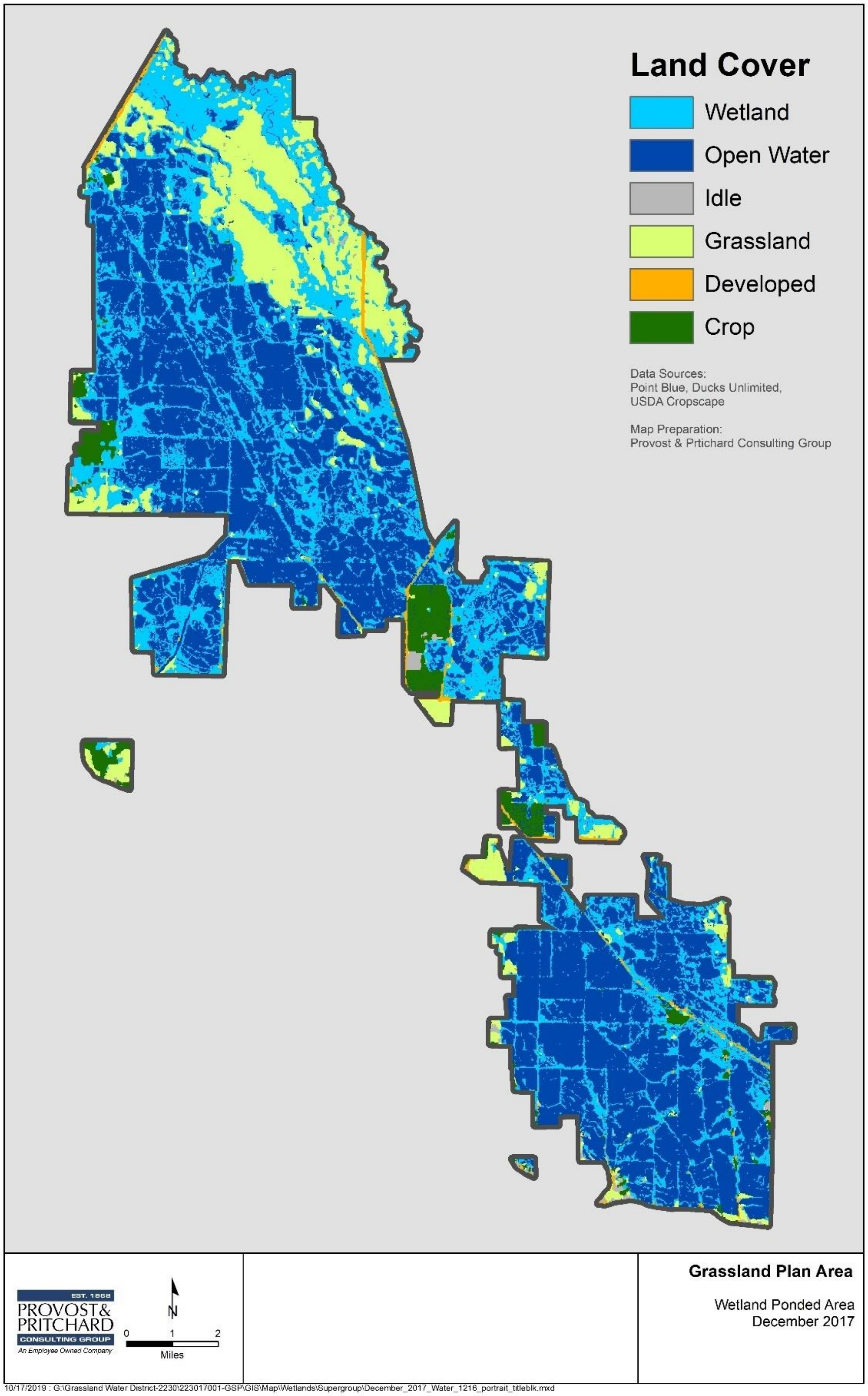


Figure 3-25: Wetland Ponded Area – December 2017

3.3.2 Method for Quantification of Inflows and Outflows

Legal Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(1) Total surface water entering and leaving a basin by water source type.
(2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.
(3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

Quantification of inflows and outflows to the Plan Area were necessary to develop the historic, current, and projected water budgets. Some variables were estimated, using the best available science and methods, due to a lack of measured data. Inflows and outflows were broken down by water source and use. Each of the parameters described below is incorporated into the water budget spreadsheet tool. DWR's diagram displaying typical inflows and outflows for the atmospheric system, land surface system, and groundwater system is shown in **Figure 3-26**. For the purposes of the Grassland GSP's water budget, the analysis looks at the land surface system and the groundwater system, any losses to or gains from the atmospheric system are accounted for in the land surface system as evaporation or precipitation.

In its January 2022 determination letter for the six Groundwater Sustainability Plans (GSPs) in the Delta-Mendota Subbasin (Subbasin), including the Common Chapter, the California Department of Water Resources (DWR) concluded that the Common Chapter did not adequately explain how each GSP used the same data and methodologies as the others (defined as "Deficiency 1"). DWR pointed to the water budgets contained in the six GSPs and compiled as the Subbasin water budget in the Common Chapter, and concluded that the chosen "sum-of-the-parts" approach made it uncertain whether the GSPs utilized the same data and methodologies to develop a Subbasin-wide water budget.

To address this deficiency, the Subbasin's Groundwater Sustainability Agencies (GSAs) met to develop consistent definitions for their water budget components, and reorganized the data in a more consistent fashion to conform with the component definitions. While the specific data used to develop the water budgets has not changed, the revised water budgets presented in the amended Common Chapter reflect more coordinated Subbasin-wide water budgets using common definitions. A detailed explanation of the coordinated water budget components is also included in the Common Chapter, along with a discussion of the data and methodologies used. The reader is therefore referred to the amended Common Chapter for the SGMA-required historic, current and projected water budget for the Delta-Mendota Subbasin.

The initial results of the historic, current, and projected water budget were provided in subsequent sections of this chapter. However, because some components of the original Grassland GSP water budget were reorganized for consistency with the other GSPs in the Subbasin, the initial water budget is now presented in **Appendix D**. A crosswalk of the reorganization of some components from the initial Grassland GSP water budget and the revised Subbasin wide water budget is shown in **Figure 3-27(a) and (b)**.

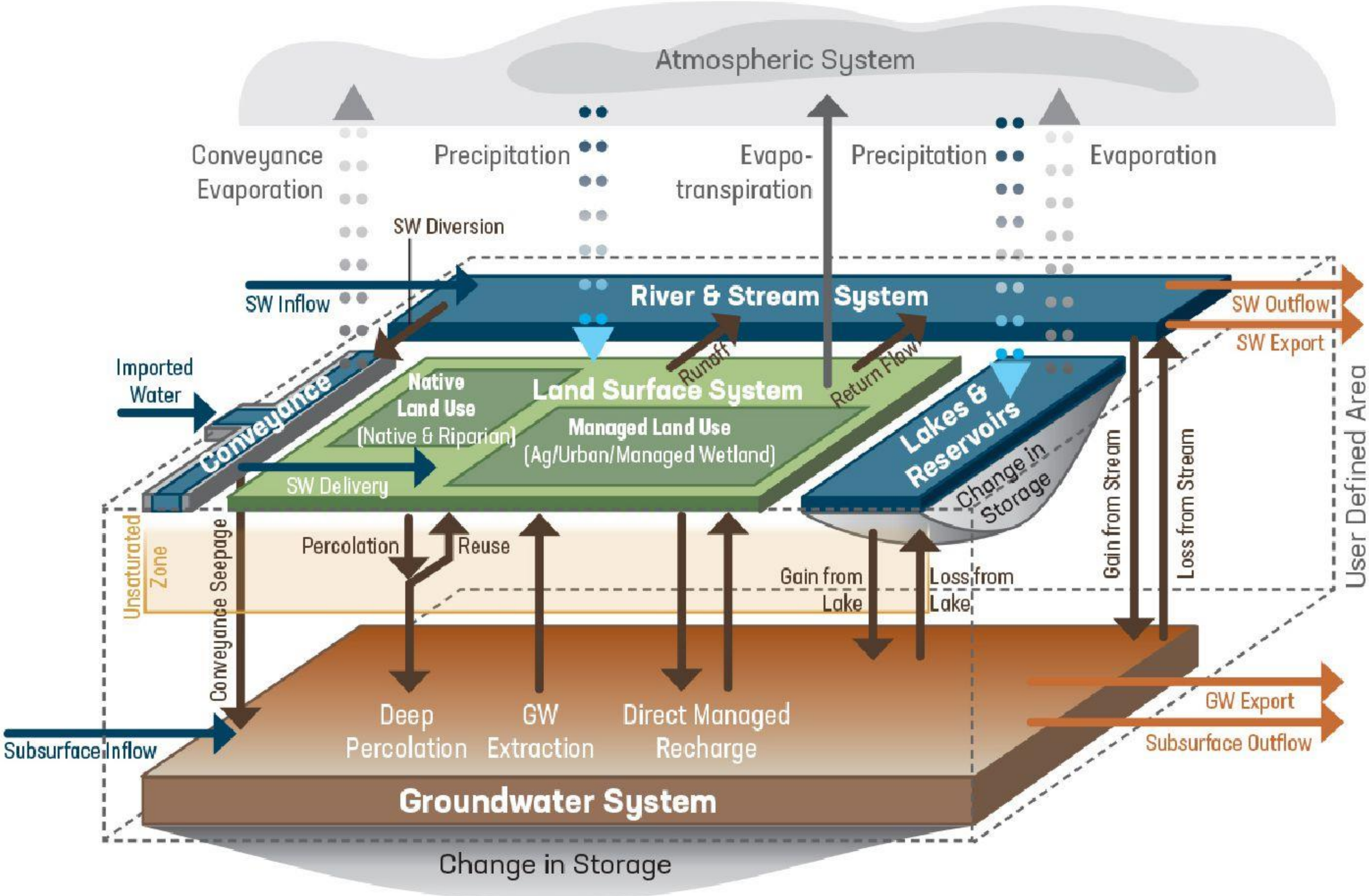
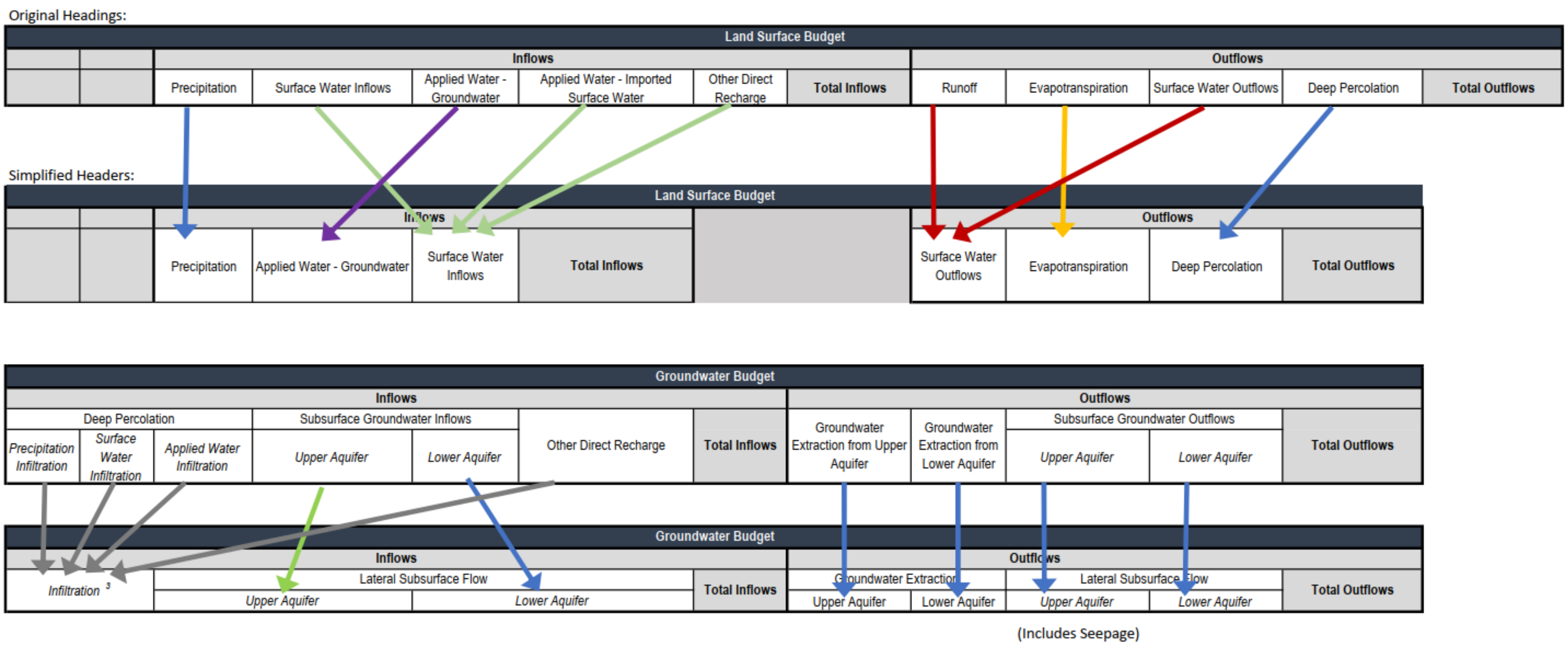


Figure 3-26: DWR Water Budget Graphic



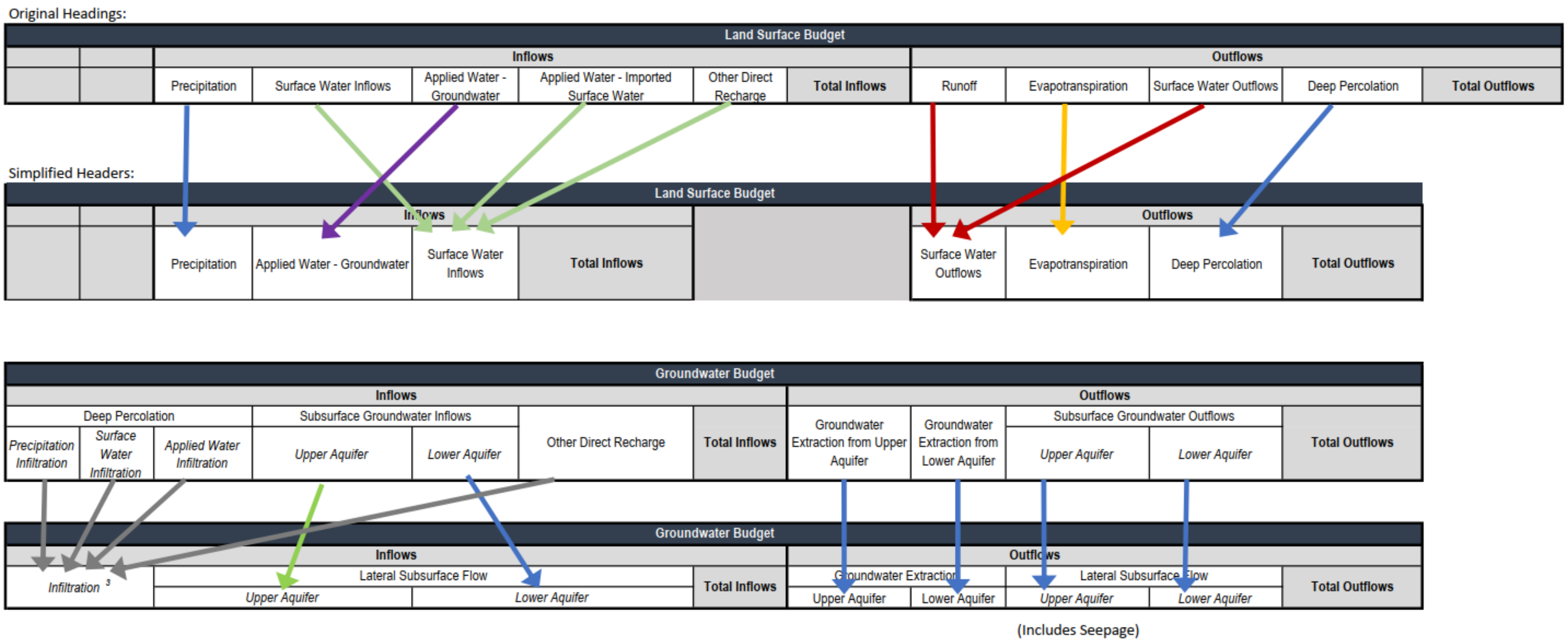
Notes:

1. Combined with the Surface Water Inflows category from original water budget in GSP. Surface Water Inflows represents unmetered, non-CVP inflows. Applied Water - Imported Surface Water quantifies federally contracted CVP water, 21 flood water, and *imported* groundwater.

2. Combined with the Surface Water Outflows category from original water budget in GSP. In the GSP, all metered surface water outflows that weren't runoff was considered Surface Water Outflows.

3. Quantifies Precipitation Infiltration, Surface Water Infiltration, Applied Water Infiltration, and Other Direct Recharge from the previously submitted water budget. Other Direct Recharge is defined as pond seepage in the GSP and for this simplified water budget it is considered infiltration.

Figure 3-27(a): Water Budget Crosswalk, Historic-Current (2003-2012)



Notes:

1. Combined with the Surface Water Inflows category from original water budget in GSP. Surface Water Inflows represents unmetered, non-CVP inflows. Applied Water - Imported Surface Water quantifies federally contracted CVP water, 21 flood water, and *imported* groundwater.

2. Combined with the Surface Water Outflows category from original water budget in GSP. In the GSP, all metered surface water outflows that weren't runoff was considered Surface Water Outflows.

3. Quantifies Precipitation Infiltration, Surface Water Infiltration, Applied Water Infiltration, and Other Direct Recharge from the previously submitted water budget. Other Direct Recharge is defined as pond seepage in the GSP and for this simplified water budget it is considered infiltration.

Figure 3-28(b): Water Budget Crosswalk, Projections Simplified

3.3.2.1 Land Surface System Inflows

Imported Surface Water

Both the GGSA and the MCDMGSA (Monitoring Zones 1 and 2, respectively, See **Figure 2-1**) have lands within their jurisdictions that receive federally contracted CVP surface water from USBR for private, state, and federal refuges. During wet water years, they also have the ability to receive Section 215 flood water from USBR. An additional source of surface water includes groundwater imported from outside of the GSA that is pumped into Monitoring Zone 2 and delivered to managed wetlands in Monitoring Zone 1 through the surface water delivery system (see Groundwater discussion below). Total values for delivered surface water for Monitoring Zone 1 can range from 125,000 AF during critically dry years to nearly 270,000 AF during wet years. In Monitoring Zone 2 surface water deliveries range from 31,000 AF during critically dry years to 52,000 AF during a wet year. This category was reorganized into the Surface Water Inflows category in the updated Water Budget table.

Surface Water Inflows

Non-CVP surface water inflows occur from surrounding agricultural districts and local waterways due to the low-lying elevation of the Plan Area. These inflows are accounted for in the surface water totals above. Typically, these inflows are unmetered but have been quantified using observed flow rates as they pass into the Plan Area, along with known watershed capacity characteristics. Surface water inflows have decreased over time with increased agricultural irrigation efficiencies. Non-CVP surface water inflows to Monitoring Zone 1 (GGSA area) are estimated at 30,600 AF under the current water budget and 33,800 AF under the average historic water budget. Some of these non-CVP surface water inflows may flow through into Monitoring Zone 2 (MCDMGSA area), but there are few independent sources of non-CVP surface water inflows to Monitoring Zone 2. Therefore, no additional value for non-CVP surface water inflows was assigned to Monitoring Zone 2 in the development of the Plan Area water budgets.

Precipitation

Monthly precipitation data was collected from the Los Banos CIMIS station for the surrogate water years. The same station was used to analyze data for the projected water budgets; however, data interpolated from the PRISM model was used in representative years prior to the installation of the CIMIS station (see **Section 3.3.4.3, Projected Water Budget**). The PRISM model calculates precipitation and evapotranspiration values in locations where monitoring stations do not exist and during years prior to the establishment of data collection. During the historically average period, rainfall ranged from slightly less than 4 inches in 2013 to 14 inches in 2005.

Precipitation either is utilized by plants as effective precipitation and evapo-transpired as an output from the surface water system, leaves the surface water system as precipitation runoff, or enters the groundwater system and becomes deep percolation as an input to the groundwater system and an output from the surface water system. These will be detailed further in their respective sections.

<u>Effective Precipitation</u>
Effective precipitation is the amount of rainfall that is beneficially used by vegetation. For managed wetlands, effective precipitation is considered to be any precipitation that has the potential to satisfy monthly evapotranspiration (ET) requirements. Precipitation that is in excess of ET requirements is considered runoff and contributes to surface water outflow.

For agricultural land, effective precipitation is calculated as 50% of total annual precipitation for the October-September water year. This 50% effective precipitation assumption is a commonly used method. Based on the Plan Area hydrology consultant's experience with calculating effective precipitation for other agricultural water balances, water transfers, and GSPs, the 50% assumption is known to produce results that are consistent with the more time-intensive Macgillivray method developed by DWR, which requires monthly time steps for precipitation data. The DWR method is based on the set of three equations seen below as **Equation 3-1** (1989 Macgillivray report for DWR).

Equation 3-1 Effective Precipitation

$$Nov - Feb = -0.54 + (0.94 * P)$$
$$Mar = -1.07 + (0.837 * P)$$
$$Oct = -0.06 + (0.635 * P)$$

Where P = Precipitation for the months listed in inches

Groundwater

Groundwater pumping is metered in the GGSA (Monitoring Zone 1 for Water Budget purposes) and much of the MCDMGSA (Monitoring Zone 2). Groundwater pumping for areas within Monitoring Zone 2 that are not metered was estimated using a consumptive use of applied water method (**Equation 3-2**). All consumptive use within the unmetered areas is assumed to be met with groundwater. Pumping was calculated as vegetation/crop demand with an irrigation efficiency factor of 80% applied to account for losses, primarily deep percolation into the aquifer. Groundwater pumping is an outflow to the groundwater system and an inflow to the land surface system.

Equation 3-2 Groundwater Pumping

$$GW = \left[\frac{(CD)}{IE}\right]$$

Where:
GW = Groundwater Pumped for Irrigation
CD = Crop Demand
IE = Irrigation Efficiency

Total groundwater extraction in Monitoring Zone 1 ranges from less than 3,000 AF during wet years to almost 20,000 AF during all other year types. Monitoring Zone 2 pumping ranges from nearly 30,000 AF in most year types to about 37,000 AF during critically dry years. Additional considerations were taken for groundwater pumped within Monitoring Zone 2 that is used within Monitoring Zone 1 for wetland habitat purposes. This groundwater pumping is metered and accounted for as groundwater outflow from Monitoring Zone 1 (labelled Groundwater Monitoring Zone 2 → Monitoring Zone 1).

Demand due to Irrigation Efficiency

Irrigation efficiencies were estimated for agricultural lands in the Plan Area. Efficiencies are estimated using the combination of actual irrigation practices and distribution system design. Irrigation methods were assigned to specific crop types based on known irrigation trends. Typical efficiencies of each irrigation method were used to estimate irrigation efficiency as it relates to irrigation practices, which was close to 80%. The irrigation efficiencies were used to estimate groundwater pumping for private agricultural lands in Monitoring Zone 2 as described in the groundwater description above.

Irrigation efficiencies are not a direct input or output from the surface water system. The volume of groundwater that is pumped to meet demands resulting from irrigation efficiency is assumed to percolate back into the groundwater system, essentially netting in no change to the water budget.

Water returning to the groundwater system as a result of irrigation efficiencies is described in further detail in the section below titled Deep Percolation of Irrigation Water.

3.3.2.2 Surface System Outflows

Runoff of Precipitation

Runoff of precipitation is estimated as the amount of precipitation that cannot be effectively used on the landscape. Only during wet years is runoff of precipitation considered to be a large contributing factor to the water budget. It is assumed that a majority of the precipitation is either consumptively used by vegetation, percolated back into the ground, or evaporated. This analysis was conducted where data was available within the Plan Area, with the exception of some portions of 2 (including the West Bear Creek and San Luis Units of the San Joaquin National Wildlife Refuge, and the China Island Unit of the North Grasslands State Wildlife Area), where runoff data is not available. The Plan Area participants will work with landowners and agencies in those areas to obtain this information in order to refine the water budget in future GSP updates. This category was reorganized into the Surface Water Outflows category in the updated Water Budget table.

Evapotranspiration

Evapotranspiration values for vegetation (ET_v) in the Plan Area were developed using vegetation coefficients Howes, Fox, and Hutton (2015) al. This paper developed evapotranspiration coefficients (K_v) for wetland and upland vegetation and also published K values for other rainfed vegetation. K_v values were used with reference ET (ET_o) to calculate ET_v.

Vegetation categories included open water, large stand seasonal wetlands, moist soil vegetation, rainfed vegetation, and crops (grassland, idle land). Developed land was also considered, but it was assumed that water on this land use type would be precipitation only and be attributed to runoff. The vegetation coefficients (Kv/Kc) and ETo values for the land use types are shown in **Table 3-1.**

Table 3-1: Vegetation Coefficients and ET for Natural Vegetation Types

Vegetation Coefficients and ET For Natural Vegetation Types				
	Kv/Kc (annual average, inches)	Wet Year ET_o 59.53 annual, inches	Normal/Dry Year Total ETo 59.39 annual, inches	Critical Year Total ET_o 57.75 annual, inches
		Wet Year $ET_{kc/kv}$ (annual average, inches)	Normal/Dry Year $ET_{kc/kv}$ (annual average, inches)	Critical Year $ET_{kc/kv}$ (annual average, inches)
Moist Soil Veg Vegetation	0.37	0.10	0.10	0.10
Large Stand Seasonal Wetlands	0.89	0.40	0.41	0.39
Open Water	0.87	0.39	0.39	0.38
Grassland	0.37	0.10	0.10	0.10
Idle Land	0.37	0.10	0.10	0.10

Using acreages of each land use type, total acre-feet of ET per month was calculated for each for each year type and is summarized in **Table 3-2** below.

Table 3-2: Evapotranspiration (AFY) by Monitoring Zone

Evapotranspiration (AFY)		
	Monitoring Zone 1 (GGSA)	Monitoring Zone 2 (MCDMGSA)
Wet	204,800	96,200
Normal/Dry	210,100	99,500
Critical	170,600	89,200

Evaporation of Channels and Ponds

Evaporation from water delivery channels and wetland ponds was calculated for all surfaces of waterbodies in the Plan Area during the evapotranspiration calculation, using vegetation coefficients from Howes' document that included ET estimates for open water. The surface area of each water body was determined using surveyed areas and aerial images. Total ET for the open water irrigation channels and ponds was included in **Table 3-2.**

3.3.2.3 Groundwater System Inflows

Inflows to groundwater are any sources of water that contribute to the groundwater aquifer as a result of natural or managed inflow. Inflows may come from surface water or adjacent boundary groundwater flow. Inflows from surface water include recharge from natural bodies of water, losses from irrigation and conveyance systems, and managed or intentional recharge.

Deep Percolation of Irrigation Water

Deep percolation of agricultural irrigation water is an inflow from the land surface to the groundwater. Deep percolation of irrigation water is calculated using the assumption that all applied water in excess of the evapotranspiration (due to irrigation inefficiencies) infiltrates past the root zone and makes it back into the groundwater system (**Equation 3-3**). Deep percolation of irrigation water was only calculated for agricultural lands in Monitoring Zone 2. Any deep percolation of water used for irrigation of managed wetlands was accounted for in the analysis of pond seepage and is not considered in this calculation. This category was combined with all of the other percolation inflow categories and reorganized into the Infiltration category.

Equation 3-3 Deep Percolation of Irrigation

$$Deep\ Percolation\ of\ Irrigation\ Water = \left[\frac{(ET)}{IE}\right] - (ET)$$

Where:
ET = Evapotranspiration
IE = Irrigation Efficiency

Deep Percolation of Precipitation

Deep percolation of precipitation is an inflow from the land surface system to the groundwater system. Deep percolation of precipitation is estimated to be 10% of total annual precipitation based on previously made assumptions and known hydrogeologic characteristic of the area. This category was combined with all of the other percolation inflow categories and reorganized into the Infiltration category.

Deep Percolation of Rivers, Streams, Channels, and Ponds

Deep percolation of water from surface water bodies, natural or managed, is often called seepage or infiltration. Seepage of water in surface water bodies is typically affected by soil permeability, channel width, and water depth. Other factors that can affect seepage include sedimentation of silts in channels, decaying vegetative matter, groundwater levels, and hydraulic gradients. Several sources and existing studies were examined to develop seepage estimates. The seepage analysis evaluated the following sources of data:

- The Grassland Water District Groundwater Management Plan
- Studies from the San Joaquin River Restoration Program (SJRRP)
- Saturated hydraulic conductivity maps developed using NRCS mapping layers (See **Section 3.1, HCM**)
- Soil texture and hydrologic grouping maps
- Irrigation delivery data

This category was combined with all of the other percolation inflow categories and reorganized into the Infiltration category.

Deep Percolation of Channels and Streams

Surface water delivery systems incidentally infiltrate water through the soil in unlined canals and storage and regulating reservoirs. According to the GWD Groundwater Management Plan, an estimated 18% of delivered water is lost due to seepage in the wetland water delivery canals. Therefore, 18% of total surface water deliveries was used to estimate seepage losses from channels within each Monitoring Zone for each water year type. Deep percolation from natural streams and channels that deliver spill water from neighbors or flood waters is also included in the estimated 18% of total surface water deliveries. This category was combined with all of the other percolation inflow categories and reorganized into the Infiltration category.

Local River Seepage

The portion of the San Joaquin River that runs along the eastern edge of the Plan Area is a gaining stream; therefore, there is no contribution from the river to the groundwater system. Streams that flow through the Plan Area are included in the estimates for deep percolation of channels. Losses to the SJR are accounted for in the Discharges & Consumptive Use/Lateral Flow of Groundwater in the Groundwater Outflow section below. This category was reorganized into the Infiltration category.

Pond Seepage

A mass balance method was used to calculate seepage from wetland habitat ponds. System gains and losses were quantified. Losses included evapotranspiration as described previously, surface water outflow from the Plan Area, and seepage of ponded water. Gains included effective precipitation and water deliveries. Seepage was quantified using **Equation 3-4** Total Seepage.

Equation 3-4 Total Seepage

$$Total\ Seepage = (ET + Outflow) - (EP + Water\ Deliveries)$$

Where:
ET = Evapotranspiration
EP = Effective Precipitation

Seepage rates for the flooded habitat were determined while ponded areas were full and receiving "maintenance" deliveries to compensate for losses. The volume of pond seepage was calculated using **Equation 3-4** Total Seepage for months where water deliveries for maintenance flow were provided. The monthly volume was converted to an average monthly loss rate over the ponded area. Using this method an average seepage rate of approximately 0.25 feet/month or 0.0082 feet/day was established. When a 0.25 foot/month loss rate was applied to the total acreage of open water for each month, total losses were approximately 67,000 AF. These losses also include losses from channels and streams, quantified as 18% of total surface water deliveries. By subtracting the seepage of the channels from the total seepage, it was determined that approximately 8.6% of the total applied surface water returns to the groundwater system. This category was reorganized into the Infiltration category.

Intentional Groundwater Recharge

There is no intentional groundwater recharge in the Plan Area; however, recharge from the ponded habitat results in gains to groundwater system, some of which is assumed to leave the groundwater system as described in **Section 3.3.2.4**.

Groundwater Inflow

Groundwater movement occurs due to hydraulic gradients. Calculations of groundwater movement use transmissivity values based on aquifer tests (see **Section 3.2.5**), groundwater level contours and cross- boundary flow directions (see **Section 3.2.2.2**). Transmissivity changes with depth due to variations in aquifer material. For the Plan Area, an average transmissivity value was used for each boundary line to estimate the thickness of the aquifer, based on available data. Therefore, the GGSA and MCDMGSA worked with the neighboring SJRECGSA, which had sufficient internal data to develop groundwater flow contours as groundwater contours were unavailable or inconsistent for some years in areas adjacent to and within the Plan Area. The SJRECGSA assisted KDSA in calculating the average-per-mile outflows from the SJRECGSA boundary adjacent to the Plan Area. These numbers were used to calculate Plan Area inflows. The Subsurface Groundwater Inflows to the upper and lower aquifers were recategorized to the Lateral Subsurface Flow to the upper and lower aquifers, respectively.

Other Recharge

There are no other known recharge components.

3.3.2.4 Groundwater System Outflows

Groundwater Pumping

Groundwater is pumped from both the upper and lower aquifers in the Plan Area. Pumping is not separated by aquifer for the purposes of this water budget and was explained in detail previously in the surface water discussion.

Subsurface Groundwater Outflow

Groundwater outflow was calculated the same way as inflow. Limited data was available for areas adjacent to and within the Plan Area. All groundwater outflow from the Grassland Plan Area leaves the Delta-Mendota Subbasin boundary and enters the Merced Subbasin. This category was reorganized from Subsurface Groundwater Outflows from the upper and lower aquifers to Lateral Subsurface Flows from the upper and lower aquifers, respectively.

Groundwater Pumped in Monitoring Zone 1 and Delivered in Monitoring Zone 2

Groundwater is pumped from portions of Monitoring Zone 2 and delivered to Monitoring Zone 1 through the surface water delivery system, where it is applied to habitat. This groundwater is accounted for in Monitoring Zone 2 as pumped groundwater (labelled “Groundwater Monitoring Zone

2 → Monitoring Zone 1) and is accounted for in Monitoring Zone 1 as surface water inflow. This category was reorganized into the Groundwater Extraction from the Upper Aquifer category under the Projected Groundwater Outflow Budget.

Discharges & Consumptive Use/Lateral Flow of Groundwater

Since the estimated inputs to the groundwater system are greater than the estimated outflows throughout most of the Plan Area, additional losses from the groundwater system were quantified as a "closing term" (in water accounting, where one part of a water budget is back-calculated using the other terms), to reflect other uses of groundwater as a result of the difference in physical change in storage. Additional losses from the groundwater system are assumed to be either passively discharged to surface water from the shallow groundwater table or consumptively used by GDE vegetation in the Plan Area, which may also be associated with localized lateral flow gradients. The total additional losses from this parameter range from 14,000 AFY to 58,000 AFY for the entire Plan Area. These outflows are included in the water budget under the category "Other Consumptive Use of Groundwater" and are labelled as "Discharge to Surface Water/Consumptive use by GDEs/Lateral Flow." Both of these categories were reorganized into the Lateral Subsurface Flow to the Upper Aquifer category under the Projected Groundwater Outflow Budget.

Discharges to Surface Water

Discharges to surface water occur when the groundwater table is at or above the elevation of adjacent surface water. Discharges from the groundwater system are known to enter the SJR adjacent to the Plan Area. Additional monitoring is needed to detect discharge locations and quantities. Discharges to some ditches, canals, and sloughs are also possible as groundwater elevation rises during the irrigation season and wet periods. Although discharges to surface water are not directly quantified, it has been determined based on water operator's experiences that during wet years, certain wetland units retain water in volumes that exceed precipitation, even without active surface or groundwater deliveries. In addition, water runoff from the Plan Area is sometimes greater than the volume of applied water and precipitation. In these wet years, it is estimated that passive discharges of shallow groundwater to surface water during wet years are greater than consumptive use of groundwater by vegetation. Pumping of groundwater is low in wet years due to wetland water needs being met by reliable deliveries of surface water and above average precipitation.

Consumptive Use/Lateral Flow of Shallow Groundwater

Consumptive use of groundwater is defined as the evapotranspiration of shallow groundwater by vegetation. During average/dry years and critically dry years, consumptive use is greater than applied water (both surface and groundwater), signifying that additional near-surface water sources are likely present for use in wetland habitats. This deficiency in available water for wetland consumptive use may also create a local gradient that allows groundwater to move laterally from ponded areas or areas with greater access to surface water to areas with less access to surface water. It should be noted that lateral flow may be induced in nearby areas where groundwater pumping is the main source of water.

3.3.3 Quantification of Overdraft and Sustainable Yield

Legal Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:

(4) The change in the annual volume of groundwater in storage between seasonal high conditions.

(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

(6) The water year type associated with the annual supply, demand, and change in groundwater stored.

(7) An estimate of sustainable yield for the basin.

3.3.3.1 Overdraft/Change in Groundwater Storage

Overdraft happens when more water is flowing out of the aquifer than is being replenished. Overdraft is synonymous with a negative change in groundwater storage. This is also the change in available water within an aquifer or the change in available storage space in an aquifer. Change in storage is typically based on annual seasonal high groundwater level measurements (Specific Yield Method), or a comparison of groundwater inflows and outflows (Inflow/Outflow Method). In the Specific Yield Method, seasonal high groundwater level measurement trends are plotted on water level hydrographs in order to observe long-term changes in water level for a single well. Seasonal high measurements are also used to create water level elevation contour maps. Hydrographs and contour maps are compared by location and from year to year, respectively, to calculate a change in groundwater storage. In the Inflow/Outflow Method, the change in storage is quantified by summing the groundwater inflows and outflows; however, calculations of subsurface groundwater flows are still dependent on seasonal high contour maps to determine subsurface inflow and outflow gradients.

There are two primary aquifers in the Plan Area, the upper unconfined aquifer and the lower confined aquifer. Upper aquifer change in storage is calculated using changes in the amount of water available for use from year to year, and can be calculated using the Inflow/Outflow Method (**Equation 3-6**) or the Specific Yield Method (**Equation 3-5**). The lower aquifer change in storage is the loss of the system's ability to store water due to compaction of fine-grained deposits observed as land subsidence and is calculated in the Subsidence Mapping Method for the lower aquifer.

For the upper unconfined aquifer, change in storage was calculated using both the Specific Yield Method and Inflow/Outflow Method for each year type. An annual change in storage for the hydraulic base period was calculated using the results of the Specific Yield Method for each year type in the annual water budget spreadsheet (**Table 3-3**), which averaged the change in storage over the 10-year period, based on year type. The results of the Specific Yield method were used to inform and calibrate the inflow and outflow components of the water budget (i.e., the Specific Yield method was used to check against the Inflow/Outflow Method).
Due to a current lack of water level data, lower aquifer change in storage is calculated by proxy as the loss of the system's ability to store water due to compaction of fine-grained deposits, observed as land subsidence and calculated using the Subsidence Mapping Method. See **Table 3-2** for a summary of changes in storage for the Plan Area.

Upper Aquifer Overdraft/Change in Storage

Specific Yield Method

Equation 3-5 was used to calculate annual change in groundwater storage based on average annual measured water level decline, developed using water level hydrographs and contour maps, and specific yield. As defined in the HCM, the average specific yield for the Plan Area is 0.12 feet, and average changes in water levels across the Plan Area for specific water year types range from +1.4 feet during wet years to -1.5 feet during critical years. When applied to the 10-year average hydrologic period there was an increase of approximately 0.2 feet per year. This Specific Yield Method for calculating annual change in groundwater storage is described in **Equation 3-5**:

Equation 3-5 Groundwater Storage Change (Specific Yield Method)

$$\Delta\, Storage = SY * \, \Delta WL * A$$

Where:
SY = Specific Yield (%)
ΔWL = Change in Water Level (feet/year)
A = Area of GSA (acres)

Inflow/Outflow Method

The Inflow/Outflow Method is based on the water budget difference between inflow to the area (supply sources) and outflow from the area (uses). **Equation 3-6** shows the method.

Equation 3-6 Groundwater Storage Change (Inflow/Outflow Method)

$$\Delta\, Storage = Inflows - Outflows$$

Where:
Inflows = Groundwater system inflows
Outflows = Groundwater system outflows

The water budgeting process generally used the Inflow/Outflow Method, and this method was used in the Coordinated Delta-Mendota Water Budget. The average change in storage calculated using the Specific Yield Method was used to help estimate some of the other water budget parameters, such as the closing term that includes consumptive use of groundwater by GDEs and groundwater discharges to the surface water system. This was achieved by setting the Inflow/Outflow parameter for change in groundwater storage as equal to the Specific Yield result for change in storage. Once values were developed for water budget parameters using the Inflow/Outflow method, individual water years during the hydrologic average base period were inserted as required for the Coordinated Delta-Mendota Water Budget.

Since some of the values for the Inflow/Outflow Method were calculated using the average period, values were unavailable for various year types. This created additional error when using the Inflow/Outflow Method to calculate change in storage for individual years.

Subsidence Mapping Method

Long-term change in storage in the lower aquifer can be directly correlated to subsidence. Due to a lack of water level and specific yield data for the lower aquifer, subsidence mapping was used to calculate a change in lower aquifer storage (as described in **Chapter 5**) using the following formula:

Equation 3-7: Groundwater Storage Change (Subsidence Mapping)

$$\Delta\, Storage = Average\ \Delta GS * A$$

Where:
Average ΔGS = Average Change in Ground Surface Elevation (feet)
A = Area of GSA (acres)

The average change in ground surface elevation was calculated over the available period of record from local surveys and USBR and SJRRP monitoring data from 2011-2017. An average annual rate of subsidence from that period amounted to a 0.075-foot loss. The subsidence mapping method is the preferred method for determining average change in storage in the lower aquifer per year. As a result of limited groundwater elevation in the lower aquifer and limited understanding of the lower aquifer in the Plan Area, change in lower aquifer groundwater storage using subsidence mapping was performed for the entire Plan Area, it was not done by any individual GSA.

Table 3-3: Average Annual Change in Storage Summary

	Plan Area	Equation Used
Upper Aquifer (based on rate of water level change)	0.19 feet/year	$\Delta\, Storage = SY * \Delta WL * A$ Where: SY = Specific Yield (%) ΔWL = Change in Water Level (feet/year) A = Area of GSA (acres)
Lower Aquifer (based on rate of land subsidence)	-0.075 feet/year	$\Delta\, Storage = Average\, \Delta GS * A$ Where: Average ΔGS = Average Change in Ground Surface Elevation (feet) A = Area of GSA (acres)

3.3.3.2 Sustainable Yield

The Plan Area does minimal pumping on a per-acre basis, and undesirable results have not been observed. It is unknown whether increases in pumping will affect the groundwater storage volume or cause undesirable results. Because of the lack of understanding regarding how pumping affects the aquifer, calculating sustainable yield can be complicated. The Plan Area experiences a positive change in groundwater storage on average, and therefore a calculation of sustainable yield for the Plan Area may be underestimated. It is also unknown how other factors, such as shallow groundwater discharges to surface water, or consumptive use of groundwater by GDEs, affect sustainability.

The Delta-Mendota Coordination Committee developed a basinwide sustainable yield estimation for the upper aquifer, as required by SGMA, using the change in storage from the historic water budget (WY2003-2012) – see **Section 4.3.4** of the Common Chapter. Improved sustainable yield estimates should be prepared as additional data are collected over the first five years. The basinwide analysis resulted in an Upper Aquifer Sustainable Yield estimate of 403,000 AF.

Based on observed extractions from the Lower Aquifer during WY2015 (see Section 4.3.4 of the Common Chapter), the basinwide estimates for the Lower Aquifer sustainable yield are approximately 101,000 AFY over the approximately 750,000-acre Subbasin. Sustainable yield is not uniform throughout the Subbasin, and it will be the responsibility of the GGSA and MCDMGSA to monitor groundwater conditions that may result from lower aquifer pumping. Additional information on the sustainable yield development for the upper and lower aquifer is available in **Appendix A – Common Chapter**.

3.3.4 Current, Historical, and Projected Water Budget

Legal Requirements:

§354.18 (c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

A detailed explanation of the revised coordinated water budget components is included in the Common Chapter**, Appendix A**, along with a discussion of the data and methodologies used. The reader is therefore referred to the amended Common Chapter for the SGMA-required historic, current, and projected water budget for the Delta-Mendota Subbasin. A track changes version of the Revised Common Chapter is presented in **Appendix G**.

The initial results of the historic, current, and projected water budget for the Grassland Plan Area were provided in subsequent sections of this chapter. However, because some components of the original Grassland water budget were reorganized for consistency with the other GSPs in the Subbasin, the initial water budget is now presented for reference purposes only, in **Appendix D**. A crosswalk of how certain components of the initial Grassland GSP water budget are categorized in the revised Subbasin-wide water budget is shown in **Figure 3-27**.

3.3.4.1 Current Water Budget

Legal Requirements:

§354.18 **(**c) (1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information. (d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget: (2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

The current water budget is just a snapshot, while the historic water budget more accurately portrays the cause and effect of different parameters in the Plan Area. The Delta-Mendota Subbasin chose 2013 as the current year. Since 2013 was also used as the surrogate year for the average/dry year water budget, data was readily available; however, annual data was not available for each individual parameter, so data was supplemented from other average/dry years to develop a value for some parameters. Data gaps include annual groundwater inflow and outflows and flow to the lower aquifer from the upper aquifer.

Table 3-4: 2013 - Current Water Budget (Combined Descriptions per Revised Common Chapter)

Description			Historic and Current Period (acre feet/year)
Inflows	Precipitation		30,400
	Applied Water – Groundwater		52,100
	Applied Water - Surface Water Inflows		270,000
	Total Inflows		**352,500**
Outflows	Runoff		27,100
	Evapotranspiration		309,600
	Deep Percolation		56,400
	Total Outflows		**393,100**
Inflows	Infiltration		76,500
	Lateral Subsurface Flow	*Upper Aquifer*	25,600
		Lower Aquifer	NA
	Total Inflows		**102,100**
Outflows	Groundwater Extraction from Upper Aquifer		52,100
	Groundwater Extraction from Lower Aquifer		0
	Lateral Subsurface Flow	*Upper Aquifer*	51,000
		Lower Aquifer	NA
	Total Outflows		**103,100**
Change in Storage	Estimated Annual Change in Groundwater Storage	Inflows	102,100
		Outflows	103,100
		Change in Storage - Upper Aquifer	-1,000
		Change in Storage - Lower Aquifer	See Table 3-2
		Change in Storage - Total	-1,000

3.3.4.2 Historical Budget

Legal Requirements:

§354.18
(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:
(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:
(A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.
(B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.
(C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.
(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

In accordance with GSP regulations, a base period must be selected so that the analysis of sustainable yield is performed for a representative period with minimal bias that might result from the selection of an overly wet or dry period while recognizing changes in other conditions including land use and water demands. The base period should be selected considering the following criteria: long-term mean annual water supply; inclusion of both wet and dry periods; antecedent soil conditions; adequate data availability; and inclusion of current hydrologic, cultural, and water management conditions in the basin.

As previously mentioned, the historical water budget was prepared using data from water years 2003-2012, which represents a typical hydrologic base period for the Subbasin based on flow in the San Joaquin River. In building the water budget, full natural flow of the SJR was evaluated for the duration of the historic record going back to 1901 in order to establish a long-term average flow rate. The period of WY 2003-2012 was chosen because it represents a recent average period that lies outside the most recent drought. The full natural flow (also known as unimpaired flow) was also compared to precipitation records in the area and the SJR water year index. The percent water year is based on DWR's water year index for the San Joaquin River. For simplification purposes, above normal and below normal years were grouped into "normal years," and dry and critically dry years were grouped into "dry years," with the exception of Shasta Critical water years in which surface water allocations are reduces to 75%. **Table 3-5** shows the full natural flow and percent water year of the SJR for the average historical period chosen.

Table 3-5: Average Historical Period – SJR Full Natural Flows

Water Year	Water Year Type	Runoff (AF)	Percent Water Year
2003	Normal	1,450,000	81%
2004	Dry	1,131,000	63%
2005	Wet	2,830,000	158%
2006	Wet	3,181,000	177%
2007	Dry	684,000	38%
2008	Dry	1,117,000	62%
2009	Dry	1,455,000	81%
2010	Normal	2,029,000	113%
2011	Wet	3,305,000	184%
2012	Dry	832,000	46%
Average Percent Water Year			100.3%

All other parameters for factoring inflow and outflow have been described in **Section 3.3.2** and are summarized in **Table 3-6**. Surface water system outflows are reported as greater than inflows, which is likely explained by the outflow of shallow groundwater to the surface water system or through consumptive use by GDEs. In addition, because managed wetlands within the Plan Area routinely receive less than the full Level 4 water supply needed for optimal wetland management, some wetlands may experience lower-than-estimated outflows through evapotranspiration.

The historical water budget was prepared for an average 10-year period where each parameter was analyzed independently and averaged both over a 10-year period, and on a year-by-year basis, as required by DWR. On an average annual basis, the water budget for the Plan Area shows a positive average change in storage of approximately 3,200 AFY in the upper unconfined aquifer (see **Table 3-6**). As discussed previously the Plan Area has significant amounts of surface water and is minimally dependent on groundwater. Groundwater is replenished and likely flows out of the Plan Area as a result of the heavy application of surface water to the area.

Table 3-6: Historical Water Budget Summary

Grassland GSP Historic Water Budget (Combined Descriptions per Amended Common Chapter)		
Period of Record: 2003 - 2013		
Land Surface Budget		Annual Average (acre-feet/year)
Description		
Inflows		
1)	Precipitation	34,300
2)	Applied Water - Groundwater	46,900
3)	Surface Water Inflows	283,900
	Total Inflows	***365,100***
Outflows		

1)	Surface Water Outflows	30,100
2)	Evapotranspiration	307,300
3)	Deep Percolation	62,400
	Total Outflows	***399,800***
Groundwater Budget	**Description**	**Annual Average (acre-feet/year)**
Inflows		
1)	Infiltration	*83,300*
2)	Subsurface Groundwater Inflows	
	Upper Aquifer	*25,600*
	Lower Aquifer (not enough data to calculate)	*0*
	Total Inflows	***108,900***
Outflows		
1)	Groundwater Extraction	
	Upper Aquifer	*46,900*
	Lower Aquifer	*N/A*
2)	Lateral Subsurface Flow	
	Upper Aquifer	*59,300*
	Lower Aquifer	*N/A*
	Total Outflows	***106,200***
Change in Storage		
	Estimated Annual Change in Groundwater Storage	
	Inflows	***108,900***
	Outflows	***106,200***
	Change in Storage	***2,700***

3.3.4.3 Projected Water Budget

Legal Requirements:

§354.18
(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:
(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:

(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.
(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.
(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.
(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
(3) Projected water budget information for population, population growth, climate change, and sea level rise.

The goal of a projected water budget is to estimate future baseline conditions in response to GSP implementation. The projected water budget must use 50 years of historical precipitation, evapotranspiration, and streamflow while using the most recent land use and water supply information as the baseline condition. In formulating future baseline conditions, the effects of climate change on water availability and use must be considered.

A yearly sequence was chosen to line up historical data to projected years from 2018 to 2070. A similar historic period to the recent drought was identified from 1975-1977. The following year 1978 was used as the first projected year and corresponded to 2017. The historical sequence of years from 1978 through 2017 was used in the projected water budget to represent future water years 2017 through 2056. For the years 2012-2017, which would correspond to projected years 2052-2056, climate change factors were not available, so surrogate years were chosen based upon water year type. **Table 3-7** shows the matching surrogate years for this period. For the years 2057-2070 the historical water years of 1965-1978 were used in sequence.

Table 3-7: Surrogate Projected Years

Surrogate Years for 2012-2017	
Historical Year	Surrogate Year
2012	2001
2013	1992
2014	1976
2015	1977
2016	2002
2017	2011

A simplified model was used to calculate the projected water budget for 2020-2070. Precipitation and ET components were calculated based upon historical measurements. For projected land use, cropping was maintained at 2017 acreages for all future years. No communities are within the GSAs, so population growth was not considered. Cross-boundary groundwater flows had the greatest uncertainty and were set during the calibration of the model. Other components were formulated by selecting and applying conditions based on four different water year types. Three types were identified based upon historical indices of the San Joaquin River: Dry, Normal, Wet. The fourth water year type, Shasta Critical, was identified as a critically dry year when reductions to surface water allocations may be experienced. Water year types were kept the same for projected years and were not recalculated based upon climate change. For each year type water budget components had specified volumes which were applied to the projected year from which the climate was derived. Wet years were represented with values from 2017, average/dry years from 2013, and Shasta Critical years from 2015.

Historical precipitation, evapotranspiration, and streamflow were not continuously recorded within the Plan Area for any 50-year period which necessitated using modeled climate data to project future conditions. Surface water allocations were kept the same and the effects of climate change on streamflow were not quantified due to the high-priority water right that the GSAs have for habitat use. Precipitation and minimum and maximum temperature measurements were obtained from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) historical datasets (http://www.prism.oregonstate.edu/, Daly et al.,1994). PRISM is a gridded monthly dataset that includes monthly temperature maximum and minimum and precipitation accumulation. All PRISM grid cells that are either fully or partially within the GSAs' boundaries were considered for the period of interest. The segmented maximum temperature, minimum temperature, and precipitation values were averaged for each parameter by month in the period.

Historical evapotranspiration measurements are not available for the GSAs before the mid-1980s implementation of the California Irrigation Management Information System (CIMIS). Thus, monthly evapotranspiration was calculated with PRISM temperature data using the Hargreaves-Samani equation (Hargreaves and Samani, 1982) from the DWR California Simulation of Evapotranspiration of Applied Water (Cal-SIMETAW) model (Orang et al., 2013). This equation (shown as **Equation 3-7)** provides a monthly reference ET estimate derived from mean temperature and long-term average radiation for a centroid of the Plan Area. This model was used to calculate monthly reference ET values.

Equation 3-7: Hargreaves-Samani Equation

$$ETo = 0.0023\,(T_{mean} + 17.8) * \sqrt{T_{max} - T_{min}} * R_a$$

where: *ETo* is reference monthly evapotranspiration
T is monthly temperature
Ra is the monthly average extraterrestrial radiation at the given latitude

Precipitation and derivation of ET from PRISM were used in the baseline calculations for the model. To consider the effects of climate change, DWR provided a dataset containing factors to apply to historical data. This method, known as climate period analysis, preserves the historical variability while dampening or amplifying the magnitude of events based upon projected changes in precipitation and temperature. The provided climate change factors for two future 30-year periods, centered on 2030 and 2070, were derived from statistical analysis of an ensemble of 20 global climate model projections.

Using the same method as was used with the PRISM grid, the monthly climate change factors provided by DWR were averaged over the spatial extent of the Plan Area. The monthly change factors were then applied to the PRISM-derived monthly precipitation and ET and then summed by water year. The 2030 climate change factors, which are applicable to the climate period of 2016-2045, were used for projected years through 2045. For the projected years of 2046-2070, the 2070 climate change factors were used.

In addition to the uncertainties of changes in climate, there were other factors that affected the projected change in storage calculations such as variability in subsurface flows and consumptive use of groundwater. The water budget was computed for each projected year individually, so inter-year trends and variability did not affect water budget components. The lack of inter-year variability may have led to compounding effects of wet or dry years. Since every dry year was 2015, a four-year drought would result in four consecutive projections of 2015 conditions. If this sequence of years were to occur, the years would be either slightly wetter or dryer, resulting in different availabilities of water and changes in management that would consume a different volume of water.

Projected changes in population were not made because there are no communities within the Plan Area, and the existing protected status of the majority of land in the Plan Area is not expected to support population growth. Effects of drought and water shortage beyond the conditions of the historical data were not considered. The most recently calculated vegetation coefficients were used to determine consumptive use, but it is unknown how the coefficients will change under future management and climate change. There are also limitations in the ability to predict future conditions for flows in the San Joaquin River. The SJRRP projects have increased flows from those that occurred during the 10-year average hydrologic period. These are not accounted for in the specific year types used to project current conditions due to uncertainty of implementation. In addition existing climate change projections expect increases in flood releases which will likely occur earlier in the year and at higher rates than they have historically resulting in more high-flow periods that would in turn increase seepage, associated groundwater flows, and availability of water in surface water systems. A summary of the projected water budget (with climate change) is summarized in **Table 3-8**, below, and the full projected water budget can be seen in **Appendix D**.

Table 3-8: Projected Water Budget Summary

Description (Combined Descriptions per Revised Common Chapter)			Projected Period Average 2014-2070 (acre-feet/year)
Inflows	Precipitation		94,256
	Applied Water - Groundwater		45,467
	Surface Water Inflows		275,095
	Total Inflows		**414,818**
Outflows	Surface Water Outflows		55,011
	Evapotranspiration		298,380
	Deep Percolation		72,135
	Total Outflows		**425,526**
Inflows	Infiltration		84,104
	Lateral Subsurface Flows	*Upper Aquifer*	26,389
		Lower Aquifer	NA
	Total Inflows		**110,493**
Outflows	Groundwater Extraction from Upper Aquifer		52,037
	Groundwater Extraction from Lower Aquifer		0
	Lateral Subsurface Flows	Upper Aquifer	57,007
		Lower Aquifer	0
	Total Outflows		**109,044**
Change in Storage	Estimated Annual Change in Groundwater Storage	Inflows	110,493
		Outflows	109,044
		Change in Storage - Upper Aquifer	1,450

3.4 Management Areas

Legal Requirements:

§354.20 (a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.
(b) A basin that includes one or more management areas shall describe the following in the Plan:

The GGSA and MCDMGSA will be managing the Plan Area as one unit.

4 Sustainable Management Criteria

Legal Requirements:

§354.22 This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of a GSP. Several requirements from GSP regulations have been grouped together under the heading of Sustainable Management Criteria (SMC), including a Sustainability Goal, Undesirable Results, Minimum Thresholds, and Measurable Objectives for various indicators of groundwater conditions. Development of these Sustainable Management Criteria was coordinated at the Subbasin level through the Coordination Committee and Technical Subcommittee.

Indicators for the sustainable management of groundwater were determined by SGMA based on factors that are important to the health and general well-being of the public. There are six indicators that must be monitored throughout the planning and implementation period of the GSP including groundwater levels, groundwater storage volume, land subsidence, water quality, interconnected surface water, and seawater intrusion. This chapter will describe the indicators and why they are significant and will define management thresholds for the Plan area.

The Sustainable Management Criteria described herein were prepared following the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 3 (§354.22 through §354.30).

4.1 Sustainability Goal

Legal Requirements:

§354.24 Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

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

The success of the GSP is reflected in the avoidance of undesirable results as described in section 4.3 Undesirable Results. This allows a significant amount of flexibility in defining and implementing Sustainable Management Criteria in the absence of undesirable results.

It is the intent of the Grassland Plan Area participants and the members of the Delta-Mendota Subbasin to work collaboratively to continue to better understand the basin characteristics by establishing a coordinated network of monitoring locations and reporting requirements. This will help to recognize existing hydrogeological patterns to better refine Sustainable Management Criteria in future GSP updates. It is the goal of the Grassland Plan Area and other Basin members to establish criteria and implement programs and projects to monitor and manage groundwater levels and storage, protect water quality, and reduce the effects of subsidence in a manner that is open to the public and stakeholders.

4.2 Sustainability Indicators

The Grassland GSP Area participants will monitor groundwater conditions that correspond to sustainability indicators established by DWR (**Figure 4-1**). These sustainability indicators are groundwater levels, change in storage, seawater intrusion, water quality, land subsidence, and depletions of interconnected surface water. SMCs (including measurable objectives and minimum thresholds) are developed for each applicable indicator by setting values in which undesirable results would be avoided and sustainability would be obtained. These values are intended to define the range in which groundwater is in a sustainable condition. For example, exceedance of a measurable objective would initiate additional investigations or monitoring to determine if significant and unreasonable effects are being experienced as a result of exceeding that SMC. Should an indicator exceed SMC values for any length of time without triggering significant and unreasonable effects, SMCs could be reconsidered and revised in future GSP updates. Conversely, should significant and unreasonable effects be experienced prior to a SMC exceedance, values may also be reconsidered and revised.

Figure 4-1: Sustainability Indicators

4.3 Undesirable Results

Undesirable results are defined by DWR. Definitions for specific sustainability indicators are provided in Section 10721 of the SGMA regulations:

<u>Groundwater Levels</u>

> *Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods*.

Groundwater Storage Volume

Significant and unreasonable reduction of groundwater storage.

Sea Water Intrusion

Significant and unreasonable seawater intrusion.

Water Quality

Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

Subsidence

Significant and unreasonable land subsidence that substantially interferes with surface land uses.

Interconnected Surface Water

Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

It is incumbent of agencies to define potential significant and unreasonable effects within each basin or plan area. This is the basis for establishing the SMC and allows flexibility for Plan implementation. Undesirable Results will be discussed in greater detail for each sustainability indicator in the following sections.

4.3.1 Undesirable Result Development

Legal Requirements:

§354.26 (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

Delta-Mendota Subbasin

Undesirable Results were defined by DWR as described above. It is the intent of SGMA to allow basins and GSAs to determine how groundwater conditions could cause significant and unreasonable effects and how significant and unreasonable effects could cause an Undesirable Result. The Delta-Mendota Subbasin Coordination Committee participants have defined Undesirable Results for the applicable sustainability indicators as:

Groundwater Levels

Chronic changes in groundwater levels that diminish access to groundwater, causing significant and unreasonable impacts to beneficial uses and users of groundwater.

Groundwater Storage Volume

A chronic decrease in groundwater storage that causes a significant and unreasonable impact to the beneficial uses and users of groundwater.

Sea Water Intrusion

Not defined – Inapplicable.

Water Quality

Degradation of groundwater quality as a result of groundwater management activities *that causes significant and unreasonable impacts to beneficial uses and users of groundwater.*

Subsidence

Changes in ground surface elevation that cause damage to critical infrastructure, including significant and unreasonable reductions of conveyance capacity, impacts to natural resource areas, or conditions that threaten public health and safety.

Interconnected Surface Water

Depletions of interconnected surface water as a direct result of groundwater pumping that cause significant and unreasonable impacts on natural resources or downstream beneficial uses and users.

Grassland Plan Area

The Grassland GSP Technical Working Group, comprised of the Grassland Water District General Manager, District Engineer, Water Master, Science Programs Manager, General Counsel, and technical consultants, coordinated during numerous meetings with the Coordination Committee to develop SMCs. The collaboration provided the opportunity to discuss at length the local understanding of undesirable results, beneficial users, and existing data from which to establish SMCs. Considerations were made regarding historic groundwater conditions, aquifer characteristics, groundwater quality, well construction, spatial distribution of groundwater production and monitoring wells, other existing infrastructure, adjacent agencies and basins, and previous experience.

The Grassland GSP Technical Working Group condensed their evaluation of potential impacts to the following topics:

- Impacts that could be experienced in the Grassland Plan Area and Subbasin-wide due to changing groundwater conditions
- Resiliency of the aquifer to changes in groundwater conditions
- Resiliency of beneficial users
- Financial and environmental tolerance to impacts

The purpose was to analyze potential impacts, determine at which point the impacts become significant and unreasonable, and develop SMCs based on the most vulnerable beneficial users.

The discussion at the plan level ultimately determined the most limiting beneficial user to all applicable sustainability indicators was habitat productivity. The SMC evaluation discussed in the initial Grassland GSP reflected the objective to maintain habitat productivity and avoid impacts from groundwater pumping on these systems. As a result, the less sensitive beneficial users, such as agriculture, were assumed to be protected under successful Plan implementation.

In its January 2022 determination letter for the six GSPs in the Subbasin, DWR concluded that the definitions of significant and unreasonable effects, and the Sustainable Management Criteria adopted by each GSP Group, were not adequately coordinated (defined as “Deficiency 2” and “Deficiency 3”). To address these deficiencies, the Subbasin’s Groundwater Sustainability

Agencies (GSAs) met frequently, through the Coordination Committee and Technical Committee, to develop consistent definitions of significant and unreasonable effects, and to establish consistent Sustainable Management Criteria. A detailed explanation of these changes is also included in the Common Chapter. A track changes version of the Revised Common Chapter is provided in **Appendix G**.

Significant and unreasonable undesirable results, as qualitatively defined by the Coordination Committee (see Common Chapter Tables CC-16 to CC-23) and applied to the Grassland Plan Area, are outlined below:

<u>Groundwater Levels</u>

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

<u>Groundwater Storage</u>

A significant and unreasonable impact to beneficial uses and users of groundwater is insufficient water storage to maintain beneficial uses and natural resource areas in the Subbasin, including the conjunctive use of groundwater.

<u>Sea Water Intrusion</u>
Not applicable. The Pacific Coast and San Francisco Bay are both greater than 55 miles from the border of the Grassland Plan Area and geologically separated by the Coastal Range.

<u>Water Quality</u>

Significant and unreasonable impacts to beneficial uses and users of groundwater as a result of groundwater management activities are the migration of contaminant plumes or elevated concentrations of constituents of concern that reduce groundwater availability, and the degradation of surface water quality as a result of groundwater migration that substantially impair an existing beneficial use. Significant and unreasonable is quantitatively defined as exceeding the MT at more than 50% of representative monitoring sites by aquifer in a GSP area where current groundwater quality (as established in the Subbasin's GSPs) does not exceed 1,000 mg/L TDS.

<u>Subsidence</u>

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

Interconnected Surface Water

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

4.3.2 Causes of Groundwater Conditions Leading to Undesirable Results

Legal Requirements:

§354.26 (b) The description of undesirable results shall include the following:
(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.

At present there are no conditions resulting in undesirable effects in the GSA. Going forward there are factors that have the potential to cause changes leading to undesirable effects such as the following:

1. **Climate Change**
   a. The State of California Department of Water Resources predicts that warmer conditions could lead to more intense rain events and less snowpack in the state. The Plan Area's surface water supply allocation is based on the Shasta Reservoir index and associated shortage provisions. The reliability of surface water supplies may be influenced by both the increased precipitation and the reduction in snowmelt to the reservoir.
   b. The same studies indicate that increased temperatures could result in higher evapotranspiration rates which would increase demand.
   c. Some studies suggest more variability in water year types with dry years becoming more dry and wet years becoming more wet, which could lead to more flooding in wet years and more severe droughts in dry years.

2. **Changing Crop Patterns**. Agriculture makes up only six percent of the Grassland Plan Area. Agricultural land use may change in the 20-year planning horizon, affecting the evapotranspiration demand of the system. Historically, the Grassland Plan Area has sustainably met the evapotranspiration demands of crops and wetlands through imported surface water supplies and a small amount of supplemental groundwater pumping. The underlying aquifer is replenished via deep percolation generated from precipitation, a network of unlined earthen water conveyance facilities, seasonal and permanent wetland water management within the Plan Area, and from irrigation practices on agricultural lands. The trend is projected to continue into the future due to the surface water supply reliability from the federal Central Valley Project, protected wildlife refuges owned and operated by the State and Federal agencies, and conservation easements established on the vast majority of the Plan Area. More information regarding the water demands and deep percolation are outlined in **Chapter 3, Section 3**.

3. **Access to Surface Supply**. Wetlands that make up the majority of the Grassland Plan Area have historically received reliable surface water deliveries under the Central Valley Project Improvement Act, which are anticipated to continue in the future as they are

mandated under law. The Level 2 wetland water supply allocation is based on the Shasta Reservoir Index, with reductions of no more than 25% in critically dry years.

4.3.3 Significant and Unreasonable Impacts & Threshold Exceedances Defining Undesirable Results

Legal Requirements:

§354.26 (b) The description of undesirable results shall include the following:
(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.

Upper Aquifer Groundwater Levels and Groundwater Storage

There are no significant and unreasonable effects of groundwater level declines or changes in groundwater storage in the Grassland Plan Area, and the initial projected water budget in **Chapter 3.3** indicated future sustainability in the Grassland Plan Area (see **Appendix D**). Recognizing that neighboring influences and the factors identified in **Section 4.3.2** may contribute to changes in the projected sustainability, the Grassland Plan Area participants worked with the Coordination Committee and developed groundwater level and groundwater storage thresholds that recognize the beneficial use most sensitive to significant and unreasonable lowering of groundwater levels, habitat productivity. See table CC-16 and Table CC-18 of the Common Chapter – **Appendix A**, incorporated here by reference.

The qualitative definitions stated above for significant and unreasonable undesirable results note that the lowering of groundwater levels or decreased groundwater storage would lead to substantially increased costs associated with higher total lift, lowering pumps, need to drill deeper wells or costs of securing alternative water sources. Such effects would be considered significant and unreasonable if they resulted from substantial lowering of groundwater levels that led to substantially increased costs.

The qualitative definitions above also note that impacts to habitat would require mitigation, including alternative water supplies and habitat restoration. The impacts of declining groundwater levels or decreased storage on habitat would take the form of drier ground conditions, unhealthy or less productive wetland plant populations that provide food and cover for wildlife, and the need to deliver increased amounts of surface water in lieu of near-surface groundwater. These are examples of the conditions for which mitigation would be required within the Plan Area.

Observed groundwater level lows were identified across the Grassland Plan Area from 2000 to present. No significant and unreasonable impacts to habitat productivity (or other beneficial users) associated with lowered groundwater levels or changes in groundwater storage in the Grassland Plan Area were experienced within this period. The undesirable result was conservatively quantified as a lowering of groundwater elevation from the representative groundwater level monitoring sites' recent historical (as of 2016) groundwater elevation low. In other words, an undesirable result would occur if the groundwater elevation at more than 50% of monitoring sites drops below the previously measured low. Compliance will be measured on a four-year rolling average. For most monitoring sites the recent historical low was measured during the severe drought years in 2014, 2015, or 2016. The minimum threshold is described in more detail in **Section 4.4.1**.

The representative water elevation monitoring sites provide meaningful spatial coverage of the Grassland Plan Area and will provide insight into whether changes in water elevation conditions are localized or regionwide. If meaningful changes occur in greater than fifty percent of wells (as detailed in Error! Reference source not found.) there is assumed to be a Plan Area-wide need f or mitigation. Additionally, the temporal consideration of a four-year rolling average allows for the natural fluctuations in hydrology and rebound potential of the habitat.

The GSAs in the Subbasin also recognize the need to develop acute, single-year thresholds at each representative monitoring site that will protect the most vulnerable beneficial users there. For the Grassland GSA, the most vulnerable beneficial users will likely be habitat. These single year thresholds will be developed during the initial stages of Plan implementation.

<u>Lower Aquifer Groundwater Levels and Groundwater Storage</u>
Lower aquifer representative monitoring wells have been identified for the monitoring network. However, little historic data exists, as lower aquifer pumping is not prevalent in the Plan Area. The Grassland Plan Area participants will monitor the identified sites and with the gathered data, and intend to establish numeric interim goals, measurable objectives, and minimum thresholds for lower aquifer groundwater levels in future GSP Updates. The sustainable management criteria for lower aquifer storage are based on inelastic land subsidence, which is the primary drive of change in storage in that aquifer. The criteria are described in Table CC-16 and Table CC-18 of the Common Chapter – **Appendix A**.

<u>Interconnected Surface Water</u>
The Grassland Plan Area Participants and other GSP Groups in the Subbasin defined significant and unreasonable undesirable results of interconnected surface water as “a reduction in available surface water supplies for natural resource areas, and reductions in downstream water availability as a result of increased streamflow depletions along the San Joaquin River when compared to similar historic water year types.” Essentially, any noticeable increase in the volume of surface water flows leaving the SJR and replenishing groundwater within the Plan Area could create an undesirable result, as it would signify an area-wide lowering of the historically high water table in the Plan Area. This would adversely affect not only the existing riparian corridors along the SJR but it might also impact the groundwater-dependent plant communities throughout the Plan Area. However, there is no indication that historical groundwater pumping in the Plan Area has not influenced surface water depletion and no management activities have depleted interconnected surface waters in the Plan Area within the historic period.

The San Joaquin River (SJR) is the only major natural surface waterbody in the Grassland Plan Area. **Chapter 3.3** identifies the groundwater inflows and outflows. It is assumed based on this analysis, groundwater contours, and hydrogeologist input that there is a net inflow from the Grassland Plan Area to the SJR, designating it as interconnected and a gaining stream in this section.

The presumed causations of this are related to: (1) the protected status of the majority of managed wetlands within the Plan Area, through both public lands protection as state wildlife areas and national wildlife refuges and permanent conservation easements held on private wetlands; (2) existing state and federal "No Net Loss" policies[2] regarding wetland preservation which caution that wetlands in the Grassland Plan Area should retain their spatial extent; and (3) the presence of shallow clay layers that hold groundwater close to the surface. Therefore, the Grassland Plan Area has historically maintained shallow depth to water in much of the area in order to retain wetland habitat. The protected status of managed wetlands in the Plan Area in conjunction with the "No Net Loss" policy and existing hydrogeologic conditions are indications that the Plan Area will continue to sustain shallow groundwater in the wetland areas and produce a net positive flow to the SJR. It is projected that sustainability will continue and there will be no significant and unreasonable depletion of interconnected surface water.

In the event that the groundwater levels in areas within or outside of the wetlands were to significantly decline, the steepened gradient of the applied water for wetland habitat conservation to the areas of lowered groundwater would likely result in impairment to those habitats or increased costs to irrigate and maintain the wetland systems. Both of these scenarios can be assumed to produce an undesirable result, as the groundwater gradient flowing towards the SJR may be impeded.
Therefore, the Grassland GSP Technical Working Group and Plan Area participants have decided to use water elevation SMCs as a proxy for interconnected surface water, on an interim basis until replacement thresholds based on a rate or volume of interconnected surface water losses can be established for the Subbasin (see **Section 5.3.2**). The minimum thresholds, measurable objectives and interim goals are set forth in Table CC-23 of the Common Chapter – **Appendix A**. A track changes version of the Revised Common Chapter is presented in **Appendix G.**

Sea Water Intrusion
Not defined – Inapplicable.

Upper Aquifer Water Quality
Although no degradation in groundwater quality has been observed historically, there is potential for water quality to experience degradation due to activities outside the Plan Area, which may compromise habitat health. The Grassland Water District monitors salt and additional constituents, such as boron and selenium, under the GWD Surface and Groundwater Monitoring Program.

There are several potential causes of groundwater quality degradation that could lead to undesirable results. These include, but are not limited to:

- Fertilizers: Although fertilizers are not used in managed wetlands, the accumulated effects of fertilizer nutrient application and other land management practices on lands outside of the managed wetland complex could lead to accumulation of constituents of concern in groundwater
- Salinity: The accumulated effects of salinity from repeated source water recycling, irrigation and pumping patterns outside the wetland complex

[2] *See* https://obamawhitehouse.archives.gov/the-press-office/2015/11/03/mitigating-impacts-natural-resources-development-and-encouraging-related, *and* https://www.waterboards.ca.gov/rwqcb5/board_decisions/tentative_orders/1504/2_5_wetlands/5_wet_policies_sum.pdf.

- Waste Discharge: The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, and food processors outside the wetland complex
- Contaminant Plumes: Groundwater pumping mobilizing groundwater contaminant plumes, although there are no known contaminant plumes affecting the Plan Area

The Grassland Plan Area will continue to monitor for declining groundwater levels that could cause pumped groundwater to have higher concentrations of some naturally occurring constituents that may cause habitat productivity and health concerns or aesthetic concerns.

The Grassland Plan Area regularly experiences variations in salinity tolerance, even within the same beneficial uses. Agricultural areas are more sensitive to higher salt and boron concentrations. The Central Valley Regional Water Quality Control Board's Water Quality Control Plan (Basin Plan) for the Central Valley notes that certain waterways within the planning area, such as Mud Slough and wetland water supply channels, are of limited use for irrigated agriculture because "elevated natural salt and boron concentrations may limit this use to irrigation of salt and boron tolerant crops" (CRWQCBCVR, 2018). For similar reasons those same waterways, as well as Salt Slough, are not designated for municipal and domestic water supply.

The Grassland Plan Area will continue to monitor for declining groundwater levels that can cause pumped groundwater to have higher concentrations of some naturally occurring constituents that may cause habitat productivity and health concerns or aesthetic concerns (see **Section 5.1.2**). Salinity is used as a key indicator for water quality because it affects all beneficial uses within the Plan Area and the Subbasin and is the primary constituent of concern under existing regulatory programs.

The sustainable management criteria adopted for the Subbasin are described in Table CC-19 of the Common Chapter – **Appendix A** – and are based on TDS levels that are acceptable for drinking water supplies. It must be emphasized that groundwater and surface water in the Grassland Plan Area is not a source of drinking water supply, and TDS levels routinely exceed drinking water standards. Representative monitoring sites that exceed the numeric sustainable management criteria will be referred to existing regulatory programs in the Subbasin, which are described in the Common Chapter. The Grassland Plan Area participants are longtime contributors and participants in these regulatory programs.

As with the representative groundwater level monitoring network, the representative quality monitoring network provides meaningful spatial coverage of the Grassland Plan Area and will provide insight into whether changes in water quality conditions are localized or regionwide. In accordance with GWD's longstanding groundwater quality policy, GWD does not accept groundwater for habitat use if the TDS concentration is 2,500 mg/L or above or causes an increase in surface water TDS concentration by more than 200 mg/L. These standards were set in the 1980s, have also been adopted by USBR for wetlands in the Plan Area, and have been successfully implemented to protect the health of wetlands and wildlife in the Plan Area for more than 30 years. Although the quality of water delivered within the Plan Area has a much lower TDS concentration than 2,500 mg/L due to blending with higher-quality CVP surface water supplies and the 200 mg/L maximum increase standard, the 2,500 TDS standard is a longstanding benchmark for significant and unreasonable results in the Plan Area.

Subsidence

The Grassland Plan Area has not experienced undesirable results related to subsidence, which is thought to be caused by the compaction of clays due to lower aquifer pumping. Lower aquifer pumping in the Plan Area has historically been negligible, rendering the Grassland Plan Area participant's contribution to subsidence-related impacts insignificant. However, subsidence caused by pumping outside of the Plan Area does pose a risk of creating undesirable results within the Plan Area. The sustainable management criteria adopted for subsidence in the Subbasin are described in Table CC-21 of the Common Chapter – **Appendix A**.

Future Assessment of Undesirable Results

After Plan implementation, if it is determined that there were no adverse effects to habitat health, the definition of significant and unreasonable effects leading to undesirable results may be reevaluated in future updates of the GSP. The Grassland Plan Area participants also recognize the opportunity to assess impacts to other beneficial users and revise the criteria in the event that currently unknown and unintended undesirable results were to occur.

4.3.4 Effects on Beneficial Users

Legal Requirements:

§354.26 (b) The description of undesirable results shall include the following: (3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

During the Grassland GSP Technical Working Group's SMC development process, there were several unanimously identified impacts that could become significant and unreasonable. These included impairments to habitat health, wells becoming unproductive, and water quality negatively impacted to the point of causing degradation of wetland habitat, crops, or productivity. However, the Grassland Plan Area is not currently experiencing undesirable impacts, nor has it experienced undesirable impacts in the past.

Negative effects to the SJRRP, domestic users, and adjacent agencies were also considered during the development of definitions of significant and unreasonable effects. There is no indication that other beneficial users have experienced any adverse effects due to current management practices in the Grassland Plan Area, which is unlikely to experience aquifer overdraft. There are actions in place to ensure the protection of conditions in, adjacent to, and downstream of the SJR in order to prevent impacts to beneficial users of both surface water and groundwater. These are discussed in greater detail in **Chapter 2 – Plan Area**.

There are a limited number of domestic wells within the Grassland Plan Area, most of which supply non-potable water to seasonal recreational properties that use bottled water or similar alternate supplies for drinking and cooking. Naturally occurring salinity in the upper water table has historically made these supplies unsuitable for potable use. The small number of private domestic wells qualify as "de minimis extractors" under SGMA and will be managed by landowners as necessary.

Adjacent agencies have been consulted, and it is agreed that groundwater conditions and practices in the Grassland Plan Area are unlikely to cause any significant and unreasonable impacts. However, neighboring agencies are experiencing undesirable results in their GSAs, the most significant being subsidence. Several agencies are experiencing loss of and damage to infrastructure as a result of subsidence. Therefore, significant and unreasonable effects were defined with consideration to subsidence as a limiting factor when possible. Grassland Plan Area participants will continue to work with neighboring agencies to monitor groundwater conditions and prevent undesirable results.

4.3.5 Evaluation of Multiple Minimum Thresholds

Legal Requirements:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

Although minimum thresholds for the sustainability indicators are consistent across the Grassland Plan Area, the GSAs recognize the value in applying the minimum thresholds to multiple monitoring sites in order to best reflect the conditions of the localized baseline and the meaning of future measurements. Based on the hydrologic conditions in the Plan Area and the defined undesirable results, a combination of minimum thresholds is not required to assess whether an undesirable result is occurring in the Grassland Plan Area and Delta-Mendota Subbasin. Sustainability indicators and quantification of undesirable results can be assessed independently or collectively.
The assessment for groundwater levels, groundwater storage, and interconnected surface water requires an evaluation of the ten representative monitoring sites in the upper aquifer (for all three indicators) and six representative sites in the lower aquifer (for groundwater levels and groundwater storage), as well as their unique water surface elevation values. The water quality assessment will evaluate three representative monitoring sites in the upper aquifer, three representative sites in the lower aquifer, and their respective TDS measurements. The site-specific method of assessment provides the opportunity to assess whether any impacts are localized or regionwide. See **Chapter 5** for greater detail on the monitoring network.

The Delta-Mendota Subbasin's **Common Chapter** (**Appendix A**) addresses the considerations of the basin-wide SMC analysis.

The Coordination Committee developed their sustainable management criteria consistent with the GSP Regulations, Article 5 Plan Contents, Subarticle 3 Sustainable Management Criteria (§ 354.2 through 354.30). DWR's Draft Best Management Practices for the Sustainable Management of Groundwater Sustainable Management Criteria BMP (2017) document was also used when and where applicable.

4.3.6 Sustainability Indicators Not Considered

Legal Requirements:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

Seawater Intrusion

The Grassland Plan Area is located 55 miles and several mountain ranges from the Pacific Ocean. Seawater intrusion is not applicable to the area.
More detail on decisions for omitting the development of this parameter can be found in **Chapter 2– Plan Area** and **Chapter 3 – Basin Setting**.

4.4 Minimum Thresholds

Legal Requirements:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.

Minimum Thresholds (MT) were developed for all sustainability indicators except for seawater intrusion. These MTs were developed to address the potential significant and unreasonable effects that could be caused by changes in groundwater conditions causing an Undesirable Result. Three of the upper aquifer and all of the lower aquifer representative monitoring wells identified for the representative monitoring networks have no historical data. The Grassland Plan Area participants will monitor these representative sites and use the gathered data to establish meaningful interim goals, measurable objectives, and minimum thresholds in future GSP Updates.

Undesirable results were defined specifically for the Grassland Plan Area in **Section 4.3** for all sustainability indicators. The Minimum Thresholds use known Basin/Plan Area characteristics and available data to quantify rates, elevations, and concentrations at which an undesirable result may be experienced.

4.4.1 Description of Minimum Thresholds

Legal Requirements:

§354.28 (b) The description of minimum thresholds shall include the following: (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

Table 4-1 identifies the MTs for each sustainability indicator and specific MT measurements for water levels at selected representative monitoring sites. Maps depicting the representative monitoring networks can be found in **Chapter 5**.

Sustainability Indicator	Threshold Description	Monitoring Site ID	DMS ID	Minimum Threshold	Threshold Units
Upper Aquifer Water Levels	The minimum threshold is set at a fixed elevation at each Monitoring Site, equivalent to the historic seasonal low prior to the end of Water Year 2016. To account for future year-to-year variations in hydrology, compliance with the fixed historic seasonal low threshold will be compared with a 4-year rolling average of annual groundwater level measurements.	2PU-3	19-003	90.5	WSE (feet)
		1PU-1	11-013	76.8	WSE (feet)
		08S09E34G001M	11-014	68.1	WSE (feet)
		08S10E30E001M	11-015	72.8	WSE (feet)
Lower Aquifer Water Levels	Lower aquifer representative monitoring wells have been identified for the monitoring network; however, no historical data exists. The Grassland Plan Area participants will continue monitor the sites and intend to use the gathered data to establish meaningful minimum thresholds for the Year 5 interim goal.	11S12E30H002M	11-017	90.2	WSE (feet)
		11S11E04N001M	11-016	83.1	WSE (feet)
		1MU-1	11-007	79.9	WSE (feet)
		1MU-2	11-008	82.3	WSE (feet)
		1MU-3	11-009	63.4	WSE (feet)
		3PU-2	11-019	27.0	WSE (feet)
		1ML-1	11-001	TBD	WSE (feet)
		1ML-2	11-002	TBD	WSE (feet)
		1ML-3	11-003	TBD	WSE (feet)
		1ML-4	11-004	TBD	WSE (feet)
		1ML-5	11-005	TBD	WSE (feet)
		1ML-6	11-006	TBD	WSE (feet)

Table 4-1: Minimum Thresholds

4.4.1.1 Upper Aquifer Groundwater Levels, Groundwater Storage, and Interconnected Surface Water Threshold Development

Legal Requirements:

§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
(B) Potential effects on other sustainability indicators.
(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.
(6) Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:
(A) The location, quantity, and timing of depletions of interconnected surface water.
(B) A description of the groundwater and surface model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.

Minimum thresholds for groundwater levels were developed for each RMS using common data and coordinated assumptions to consider hydrologic trends in the Basin. An equivalent process was used in both the Upper Aquifer and Lower Aquifer within the Subbasin.

Groundwater Levels

Chapter 5 describes the representative water level monitoring network in greater detail. The site selection was developed to provide enough spatial coverage to represent the variety of groundwater conditions that may occur across the Plan Area and sites were selected based on historical data available to establish SMCs.

The initial criteria for a representative monitoring network were based on wells that had at least three years' worth of data from 2000 to present. However, wells that did not meet the data requirements were also added to the monitoring network and will be used for contouring efforts as well as to supplement the understanding of the groundwater conditions associated with the five applicable sustainability indicators. There were multiple instances where representative monitoring sites were identified for the monitoring network even though no historical data existed for the site. The Grassland Plan Area participants will monitor the sites and intend to use the gathered data to further establish meaningful interim goals, measurable objectives, and minimum thresholds in future GSP Updates.

Interconnected Surface Water

It is understood that the Grassland Plan Area maintains wetland habitat in the Plan Area via a cycle of imported surface water deliveries rather than by groundwater pumping. The application of surface water results in a sustainable system as identified in **Chapter 3**. Historically, the SJR is interconnected to the stretch adjacent to the Grassland Plan Area for most of the year during most water years. The GSAs plan to establish an interconnected surface water monitoring network within the Subbasin to further establish a rate of volume of surface water depletions. Until a rate or volume of interconnected surface water depletions can be developed, the Grassland Plan Area's contribution to the interconnection can be quantitatively measured by the upper aquifer groundwater levels across the Plan Area, as the groundwater flow trends towards the SJR and contributes a net inflow to the river. Any disruptions to that contribution are best assessed on a regional basis rather than on a site-specific scale. The representative water level monitoring used for assessing upper aquifer groundwater levels will also serve as the interim monitoring and SMC evaluation method for interconnected surface water and will assess the location, quality, and timing of depletions of the SJR as a result of Grassland Plan Area management actions. Additionally, the Water Budget and ongoing upper aquifer groundwater level contouring effort described in **Chapter 3** and the **Appendix A – Common Chapter** will effectively serve as supplemental tools to assess the groundwater levels and flow direction in the Plan Area.

Groundwater Storage

Groundwater levels are directly related to upper aquifer storage and will be used as a proxy for groundwater storage volume changes (see **Section 3.2.6**). To calculate the volume of groundwater storage, the water levels gathered from the representative water level monitoring sites will be plotted and contours will be developed to understand groundwater levels in the Grassland Plan Area. A volume of groundwater storage can be assessed using the specific yield, water levels, and acreage.

Most of the upper aquifer representative monitoring wells have only three years' worth of groundwater levels and have conflicting temporal measurement periods. None of the lower aquifer representative monitoring wells have adequate historical data to develop a meaningful volumetric minimum threshold, as groundwater contours are dependent on spatial coverage of data measured under similar temporal conditions such as a seasonal high or seasonal low. Therefore, the minimum thresholds for groundwater storage in the upper aquifer are defined as the same thresholds set for water levels. The minimum thresholds for groundwater storage in the lower aquifer are based on inelastic land subsidence, as detailed in Table CC-21, given the relationship between observed inelastic subsidence caused by groundwater extraction and the loss in groundwater storage. The Grassland Plan Area participants plan to reassess the minimum thresholds in future GSP updates and expect improved data quality and quantity after implementation of the representative monitoring program.

Additionally, in the event that significant and undesirable results to beneficial uses or users are realized prior to reaching a minimum threshold, the Plan Area participants recognize the need to mitigate and reassess SMC development for future GSP updates. If a threshold has been exceeded, yet no undesirable results occur, the same opportunity to reassess SMC development may be exercised.

4.4.1.2 Subsidence Threshold Development

Legal Requirements:

> **§354.28** (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
> (5) Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:
> (A) Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including and explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.
> (B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

The Corcoran Clay that underlies the Plan Area is composed of inelastic clay minerals. Inelastic subsidence occurs when clay particles in the lower aquifer that are composed of certain minerals collapse when dewatered or subjected to rapid pressure reductions, resulting in the clay structure compacting and being unable to re-expand to its original thickness, despite replenishment causing rises in groundwater levels. Therefore, impacts related to subsidence in the Grassland Plan Area can be directly associated with pumping activities from wells perforated below the Corcoran Clay.

The Delta-Mendota Subbasin has experienced localized instances of severe subsidence and resulting infrastructural impacts. Although the Grassland Plan Area is within the Subbasin, it has not experienced the same rates of subsidence as the northern and southern areas of the Delta-Mendota Subbasin, and the Grassland Plan Area's influence on subsidence is insignificant considering that pumping from the lower aquifer is negligible in the Plan Area.

The Grassland Plan Area participants evaluated recent historical trends in subsidence in the Plan Area using USBR subsidence mapping and analysis from KSA as identified in **Chapter 3**. By using geographic information systems (GIS) to analyze the USBR ground surface file and incorporating the KSA calibration, the average subsidence rate was determined to be 0.075 ft/year during the period of 2011 to 2017.

Impacts to water available for habitat conservation serves as the limiting land use; however, impacts to agricultural irrigation were also considered when evaluating what the significant and unreasonable impacts would be in the Plan Area. The most likely impact is that subsidence would affect the critical infrastructure conveying water used for agricultural and habitat irrigation. Historically, the Plan Area has not experienced subsidence-induced disruptions to conveyance capacity. The current rate at which subsidence is occurring within the Grassland Plan Area is neither currently yielding nor projected to yield significant and unreasonable undesirable results. The minimum threshold for the Subbasin was set to not exceed two additional feet of subsidence by 2040, as measured by the historical annual average rate of subsidence from December 2011 to December 2018, defined at each of the three representative monitoring sites: 108, 137, and 152. The minimum threshold is described in Table CC-21 of the Common Chapter **– Appendix A**.

See **Figure 3-21** in **Chapter 3** for a map depicting the extent and rate of land subsidence. The Delta-Mendota Subbasin's Common Chapter **(Appendix A)** further explains the extent of subsidence on a basin-wide scale.

4.4.1.3 Water Quality Threshold Development

Legal Requirements:

§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows: (4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be used on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

As described in prior sections, there are several potential causes of groundwater quality degradation that could lead to undesirable results, such as fertilizer application on adjacent lands, salt accumulation, chemical spills, wastewater discharges, naturally occurring elements, and the mobilization of groundwater plumes.

GWD has developed and has been maintaining a Groundwater Monitoring Plan designed to monitor the key groundwater quality constituents based on the beneficial uses and wetland habitat tolerances of the area. The Groundwater Monitoring Plan uses state and federal water quality standards applicable to the beneficial uses to define the local standards.

GWD's Groundwater Monitoring Plan was considered in conjunction with the groundwater quality assessment developed by KSA in **Chapter 3**. The minimum threshold is more stringent than GWD's Groundwater Monitoring Plan threshold concentration of 2,500 mg/L TDS at each well head (**see Section 4.3.3**), because it was established at the Subbasin level and is focused on drinking water uses. The minimum threshold is described in Table CC-19 of the Common Chapter – **Appendix A**.

There are no known groundwater contaminant plumes in the Grassland Plan Area. As identified earlier in this chapter, the upper aquifer is the primary source aquifer in the Plan Area; however, water quality will be monitored, and SMCs will be analyzed in both the upper and lower aquifers. See **Chapter 5** for further details regarding the additional monitoring efforts that will be used to supplement the understanding of all five applicable sustainability indicators.

4.4.1.4 Relationship Between Thresholds

Legal Requirements:

§354.28 (b) The description of minimum thresholds shall include the following: (2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

Thresholds were developed considering:

1. Who are the beneficial users of groundwater?
2. How are/could they be impacted?
3. To what level does the impact become significant and unreasonable?

These questions were developed independently of groundwater conditions and historical trends in order to determine what problems existed or were likely to develop and at which point mitigation would become too expensive or logistically infeasible. Considering that the Grassland Plan Area has not and is not expected to experience significant and unreasonable effects as a result of current groundwater conditions, land use practices, projected trends, or groundwater uses, it made sense to reach out to neighboring agencies to see what impacts they were experiencing.

The Coordination Committee considered the Delta-Mendota Subbasin groundwater conditions in light of the five applicable sustainability indicators as the driving influence when developing the minimum thresholds. The Plan Area participants recognize influences from neighboring agencies as the greatest hindrance to achieving their sustainability goals and are committed to communication with neighboring agencies as pivotal to GSP success.

Water Levels, Groundwater Storage, and Interconnected Surface Water

The minimum thresholds for water levels, groundwater storage, and interconnected surface water are consistent, based on their direct relationship to water levels and the sustainability goal of avoiding undesirable results. Groundwater storage is traditionally measured by evaluating groundwater levels and the safe yield of a defined area. Therefore, the water level thresholds were also appropriate to use for groundwater storage thresholds for the upper aquifer, as the significant and unreasonable undesirable results of both are recognized and water levels and groundwater storage are both identified by the depth to water.

The Grassland Plan Area’s reliable imported surface water supply and management of wetland habitat has resulted in high groundwater levels and produces a net inflow to the SJR. On an interim basis before a rate or volume of interconnected surface water can be established, the water levels dispersed across the Plan Area will be measured as they are indicative of the groundwater level trends induced by applied irrigation for habitat conservation. The water level thresholds set for the representative monitoring network were deemed a conservative interim metric for assessing and maintaining interconnected surface water.

Subsidence

The recent historical rate of subsidence in the Plan Area is insignificant compared to other areas of the Subbasin, and there are no existing impacts or potential needs for infrastructure upgrades beyond the implementation horizon. Subsidence is unlikely to affect either water quality or water levels or groundwater storage in the upper aquifer. The upper aquifer serves as the primary source aquifer for the Plan Area. The minimum thresholds for subsidence are low and are intended to protect against the unreasonable lowering of groundwater levels or loss of groundwater storage in the lower aquifer.

Groundwater Quality

It is assumed that groundwater quality will remain appropriate for irrigation and wetland purposes with continued close monitoring and implementation of GWD’s established Groundwater Monitoring Plan. GWD’s efforts will continue into the GSP planning horizon. To comply with the requirements of SGMA, groundwater quality SMCs were set to address the potential for impairment to the most limiting beneficial use: drinking water, although drinking water users are not present in the Grassland GSP Area. The District does not predict that water quality will impact the Plan Area by necessitating the deepening of wells or requiring the use of the lower aquifer due to water quality issues in the upper aquifer. Groundwater quality is unlikely to affect groundwater levels or subsidence rates.

4.4.1.5 Groundwater Level Proxy

Legal Requirements:

§354.28 (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

Upper Aquifer Groundwater Storage
Water level elevations in the upper aquifer will be used as a proxy for groundwater volume in storage in the upper aquifer. The volume of groundwater storage will be quantified on an annual basis using a large network of hydrographs and contour maps as described in **Chapter 3.3 – Water Budget** using changes in groundwater elevation, specific yield of the aquifer, and acreage of the Plan Area. Attempting to quantify the volume of groundwater storage at a single representative well using water level elevation should be avoided; however, it can be a good indicator of sustainability without having to quantify all uses and extractions. A more robust data set using water level should be employed for quantifications of volume when it becomes available through increased monitoring. This method of calculation is a widely used and acceptable substitution for determining changes in groundwater storage and considers all sources of groundwater.

Interconnected Surface Water
The Grassland Plan Area has historically maintained a shallow depth to water in much of the area, which supports wetland habitat. The protected status of most wetlands in the Plan Area, the "No Net Loss" policy, and the existence of shallow clay layers identified in **Section 4.3** results in the Plan Area sustaining shallow groundwater in the wetland areas and producing a net positive flow to the SJR. The gradient of groundwater flows produced by the management activities in the Plan Area is currently understood as the primary influencer to the SJR connection adjacent to the Plan Area and is not expected to change.

The Coordination Committee made the decision to use groundwater level SMCs across the Subbasin, representing a variety of land uses to evaluate gradient influences, as an appropriate interim proxy for interconnected surface water.

4.4.1.6 Effects on Adjacent Basins

Legal Requirements:

§354.28 (b) The description of minimum thresholds shall include the following: (3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

The Grassland Plan Area participants have performed outreach internally with other members of the Delta-Mendota Groundwater Subbasin and have been supportive of inter-basin coordination efforts made by the Coordination Committee, such as a data sharing agreement with Westlands Water District in the Westlands Subbasin through the Northern and Central GSP group. After review of the Grassland Plan Area's historic and projected sustainable determinations regarding overdraft, and interbasin coordination performed by the Delta-Mendota Coordination Committee members with neighboring agencies, it is considered unlikely that implementation of the Plan and Minimum Thresholds will affect neighboring basins. Careful consideration was given to existing conditions outside the Plan Area and further coordination efforts will be ongoing. See the Delta-Mendota Subbasin **Common Chapter** (**Appendix A**) for more details on inter-basin coordination.

4.4.1.7 Affects to Beneficial Uses and Users

Legal Requirements:

§354.28 (b) The description of minimum thresholds shall include the following: (4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

Groundwater Levels, Groundwater Storage, and Interconnected Surface Water.
Implementation of these minimum thresholds is not likely to affect any beneficial uses and users of groundwater, except for potentially increasing costs to fund future projects and management actions. It is not the intention of the Grassland Plan Area participants to restrict access to groundwater unless undesirable results begin to occur, and substantial evidence indicates specific wells are causing impacts. Thresholds may establish conditions that would require mitigation to continue accessing groundwater at specific locations.

The minimum thresholds are intended to prevent the necessity of lowering pumps or deepening wells in order to continue to access groundwater, treating groundwater of decreasing quality, losing habitat or crop productivity, or adversely affecting riparian habitat health due to impacts to the positive groundwater gradient towards the SJR.

Subsidence
Maintaining a rate of subsidence that is minimal and does not exceed two additional feet by 2040 should avoid impacts to the conveyance capacity of critical water conveyance infrastructure. There is a potential for uneven ground surface movement to cause changes to the flow of gravity conveyance canals and damage to underground infrastructure that may require changes and updates to irrigation systems or other types of mitigation. In the event these types of impacts begin to occur prior to experiencing the minimum threshold, the Grassland Plan Area will reevaluate the SMCs' definitions.

Groundwater Quality
Adverse changes in groundwater quality may require additional sources of surface water to be imported into the Plan Area or relocation of wells to areas with better water quality. It is also possible that wells would require treatment of water prior to irrigation in order to prevent loss of habitat or crop production.

The Grassland Plan Area is anticipating continuing to operate consistent with the sustainability goals and GSP success will be measured by the avoidance of undesirable results. If minimum thresholds are exceeded yet undesirable results are not realized, the Grassland Plan Area participants may reevaluate SMC determinations and revise for the following GSP Update.

4.4.1.8 Relation to State or other Existing Standards

Legal Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

<u>Groundwater Levels, Groundwater Storage, and Interconnected Surface Water</u>
Groundwater levels have not been directly regulated federally, locally, or statewide prior to the adoption of SGMA and GSP implementation. However, wetlands that function based on shallow groundwater, including riparian wetlands along the SJR, are regulated under the federal Clean Water Act and recently adopted state wetland dredge and fill regulations and have been considered in the decision to establish conservative minimum thresholds and measurable objectives.

<u>Subsidence</u>
Subsidence has never been regulated under federal or state law or programs until SGMA.

<u>Water Quality</u>
State, federal, and local water quality regulations and programs applicable to the Grassland Plan Area are outlined in **Chapter 2**. All have been considered and have influenced the development of the water quality SMCs.

4.4.1.9 Threshold Measurement Methods

Legal Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

<u>Groundwater Levels, Groundwater Storage, Interconnected Surface Water</u>
Groundwater levels, and groundwater storage thresholds by proxy, will be measured biannually to correlate with seasonal high and low groundwater levels and the monitoring schedule set forward by the Delta-Mendota Subbasin Coordination Committee. Groundwater levels will be taken as depth to water measurements in feet and converted to water surface elevations.

<u>Subsidence</u>
Subsidence will be surveyed at discrete reference points biannually in the summer and winter to correlate with monitoring efforts currently underway by USBR. Subsidence will be reported as a relative ground surface elevation for both thresholds and contouring efforts. Additional monitoring information is outlined in the Delta-Mendota Subbasin **Common Chapter (Appendix A)** and **Chapter 5**.

<u>Groundwater Quality</u>
Groundwater quality will be measured in the summer. Water quality will be analyzed in a professional laboratory. Additional monitoring requirements and information are outlined in **Chapter 5,** Delta-Mendota Subbasin **Common Chapter** and **Common Monitoring Technical Memorandum**.

4.5 Measurable Objectives

Measurable objectives were developed to simulate a no-impact scenario based on historical trends or known levels at which impacts might occur. This is not to be confused with significant and unreasonable impacts, which for the purpose of this GSP show the level at which mitigation either becomes unaffordable or physically infeasible. For the purposes of this GSP, the term "measurable objective" serves as the quantitative point at which the sustainability goal has been realized at 2040 and the "interim goals" or "interim milestones" quantitatively reflect the sustainability goal being achieved within five-year increments corresponding with GSP Update submittal periods of 2025, 2030, and 2035.

Legal Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

4.5.1 Groundwater Levels, Groundwater Storage, & Interconnected Surface Water

Unlike most GSPs within critically overdrafted basins, the Grassland Plan Area is not projected to significantly deviate from the sustained groundwater levels it has historically experienced. Therefore, the interim goals and measurable objectives are reflective of a sustained system. The measurable objective is conservatively quantified as the representative groundwater level monitoring sites' recent historical high (preferably Water Year 2015 unless data is not available). In other words, an exceedance of the measurable objective would occur if the seasonal high groundwater elevation at a monitoring site drops below the previously measured high. Compliance will be measured on a four-year rolling average to account for year-to-year variability in water levels. For most monitoring sites the recent historical high was measured during the severe drought years in 2014, 2015, or 2016.

For the 2025 interim goal, the Grassland Plan Area participants will continue to gather data to complete the establishment of MOs and MTs at representative monitoring sites in the Lower Aquifer. In addition, the Subbasin will complete a monitoring network of interconnected surface water sites, including existing and additional sites, to estimate the influence of groundwater on gains and losses in the San Joaquin River. The Plan Area will also identify potential areas outside the Subbasin inducing chronic lowering of groundwater levels, while continuing to coordinate and develop shorter-term, acute groundwater elevation thresholds. The 2030 and 2035 interim goals are defined as a water surface elevation at or above the measurable objective. The upper aquifer groundwater level measurable objectives are listed below in **Table**

4-2. The rationale for groundwater levels being used as a proxy for groundwater storage (upper aquifer) and interconnected surface water (interim) SMC development is identified in **Section 4.4.1.5**

Table 4-2: Water Level SMCs

Sustainable Management Criteria						
Monitoring Site ID	DMS ID	2025 Interim Goal WSE (ft)	2030 Interim Goal WSE (ft)	2035 Interim Goal WSE (ft)	2040 Measurable Objective WSE (ft)	Minimum Threshold WSE (ft)
Upper Aquifer Groundwater Levels						
2PU-3	19-003	≥91.8	≥91.8	≥91.8	≥91.8	90.5
1PU-1	11-013	≥80.4	≥80.4	≥80.4	≥80.4	76.8
08S09E34G001M	11-014	≥80.7	≥80.7	≥80.7	≥80.7	68.1
08S10E30E001M	11-015	≥75.7	≥75.7	≥75.7	≥75.7	72.8
11S12E30H002M	11-017	≥116.6	≥116.6	≥116.6	≥116.6	90.2
11S11E04N001M	11-016	≥92.8	≥92.8	≥92.8	≥92.8	83.1
1MU-1	11-007	≥91.1	≥91.1	≥91.1	≥91.1	79.9
1MU-2	11-008	≥93.2	≥93.2	≥93.2	≥93.2	82.3
1MU-3	11-009	≥77.3	≥77.3	≥77.3	≥77.3	63.4
3PU-2	11-019	≥27.0	≥27.0	≥27.0	≥27.0	27.0
Lower Aquifer Groundwater Levels						
1ML-1	11-001	TBD Lower aquifer representative monitoring wells have been identified for the monitoring network; however, no historical data exists. The Grassland Plan Area participants will monitor the sites and intend to use the gathered data to establish meaningful interim goals, measurable objectives, and minimum thresholds in future GSP Updates.				
1ML-2	11-002					
1ML-3	11-003					
1ML-4	11-004					
1ML-5	11-005					
1ML-6	11-006					

The water level between the measurable objective and the minimum threshold is recognized as the operational flexibility, accounting for drought periods, land use changes, and allowance of opportunities to mitigate effects prior to experiencing water level data that exceeds the established minimum threshold on a four-year rolling average at more than 50% of representative monitoring sites. To achieve sustainability and Plan success, the Grassland Plan Area participants will continue to manage the various land uses within the operational flexibility identified in **Table 4-3.** The projected water budget in **Chapter 3.3** anticipates a sustainable system based on historical data.

Table 4-3: Water Level Operational Flexibility

Water Surface Elevation				
Monitoring Site ID	**DMS ID**	Measurable Objective (WSE, ft)	Operational Flexibility (ft)	Minimum Threshold (WSE, ft)
Upper Aquifer Groundwater Levels				
2PU-3	19-003	≥91.8	1.3	90.5
1PU-1	11-013	≥80.4	3.6	76.8
08S09E34G001M	11-014	≥80.7	12.6	68.1
08S10E30E001M	11-015	≥75.7	2.9	72.8
11S12E30H002M	11-017	≥116.6	26.4	90.2
11S11E04N001M	11-016	≥92.8	9.7	83.1
1MU-1	11-007	≥91.1	11.2	79.9
1MU-2	11-008	≥93.2	10.9	82.3
1MU-3	11-009	≥77.3	13.9	63.4
3PU-2	11-019	≥27.0	0	27.0

4.5.2 Subsidence

The measurable objective is reflective of coordination with neighbors regarding lower aquifer impacts to regional subsidence considering the negligible volume of lower aquifer pumping occurring in the Grassland Plan Area. The measurable objective and respective interim goals for inelastic subsidence are outlined in Table CC-19 of the Common Chapter – **Appendix A.** The measurable objective is to minimize inelastic land subsidence, with no additional subsidence after 2040. The Interim Goals are no more than one foot of additional inelastic subsidence in the first five years of GSP implementation, no more than one half foot of additional inelastic subsidence in the second five years of GSP implementation, and no more than 0.25 foot of additional inelastic subsidence in the third five years of GSP implementation, with no more than two feet of additional subsidence by 2040.

The pathway to achieving sustainability is strongly influenced by the Delta-Mendota Subbasin coordination, considering that the Grassland Plan Area's lower aquifer pumping is insignificant.

4.5.3 Water Quality

Water quality measurable objectives were established by the GSP groups within the Subbasin using the upper limit of 1,000 mg/L TDS for drinking water, defined by the California secondary maximum contaminant level standards for TDS in drinking water. Table CC-19 in the Common Chapter outlines the measurable objective and interim goals set at each representative water quality monitoring site.

As more information is obtained, interim goals may be refined to reflect the understanding of groundwater quality conditions in the Plan Area. It should be acknowledged that salinity standards are still being developed by water quality experts and regulatory agencies in the Central Valley, and thus may need to be revised in the future.

The plan to achieve water quality sustainability in the Grassland Plan Area lies in maintaining and managing the goals of other existing programs in the Plan Area. The understanding of groundwater quality is anticipated to improve with implementation of the representative water quality monitoring network.

4.5.4 Additional Measurable Objective Elements

Legal Requirements:

§354.30 (f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.

(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

No additional objective elements were set for this GSP.

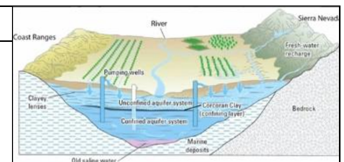
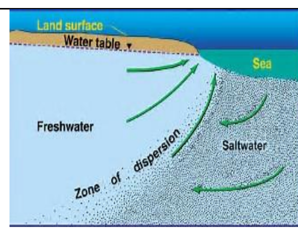
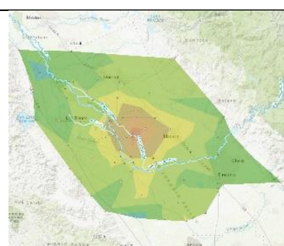
5 Monitoring Network

Legal Requirements:

> **§354.32** This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

A comprehensive monitoring network is a fundamental component of groundwater management and is needed to measure progress toward groundwater sustainability. Below, **Table 5-1** includes the indicators necessary to monitor in order to comply with SGMA monitoring and reporting requirements. Monitoring programs for the five applicable sustainability indicators are described in this chapter, including the history of the monitoring programs, proposed monitoring to comply with SGMA, and the adequacy and scientific rationale for each monitoring network.

Table 5-1: Monitoring Requirements

Groundwater Levels: Monitoring of static groundwater levels each spring and fall		Groundwater Storage: Monitoring the annual change in groundwater storage	
Seawater Intrusion: Intrusion of seawater into local aquifers *(This is not applicable to the GGSA or MCDMGSA.)*		Water Quality: Monitoring for water quality degradation that could impact available groundwater supplies	
Land Subsidence: Monitoring surface land subsidence caused by groundwater withdrawals		Depletion of Interconnected Surface Water: Monitoring loss of permanent connections between surface water and groundwater	

5.1 Description of Monitoring Network

Legal Requirements:

§354.34(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan Implementation.

This chapter describes the representative monitoring network and supplemental monitoring efforts currently being implemented by entities within the Plan Area, and the representative monitoring network that will be used by the GGSA and MCDMGSA for the Plan Area. The results and data from historical monitoring efforts can be found in **Chapter 3.2 – Current and Historical Groundwater Conditions**. These monitoring efforts will continue to collect data into the future to determine short-term, seasonal, and long-term trends in groundwater and related surface water conditions. Data from the internal representative monitoring network will be reported to the Delta-Mendota Subbasin for tracking existing conditions and threshold exceedances of any criteria or thresholds. This data will yield information necessary to support the implementation of this Plan, evaluation of the effectiveness of the Plan, and decision-making for the Plan Area.

Delta-Mendota Subbasin Representative Monitoring Networks

The Delta-Mendota Subbasin Common Chapter describes the coordination of each GSP's representative monitoring network:

As required by Subarticle 4. Monitoring Networks of the GSP regulations, the GSPs must include a monitoring network for each sustainability indicator, in addition to describing the monitoring protocols and data management to be followed in implementing the GSP monitoring program. Given the variability of conditions within the Delta-Mendota Subbasin, each GSP Group developed their individual monitoring networks, in coordination with their neighboring GSP Groups, such that the subbasin-wide monitoring programs is simply a compilation of those coordinated individual monitoring networks.

Grassland Plan Area Representative Monitoring Networks

The representative monitoring networks are sites specifically identified to monitor and evaluate sustainable management criteria (SMCs). These sites contribute to an understanding of hydrogeologic conditions and their relationship to groundwater pumping as well as the spatially dispersed data necessary to develop groundwater-level and subsidence contours and characterizations of changes in storage and water quality. Data obtained from these sites will be used for the evaluation and calculation of water budget updates, any future reconsideration of sustainable management criteria, and the refinement of groundwater level contours, water quality assessments, and subsidence analysis.

Supplemental Data

Data obtained via GWD's monitoring program (**Section 5.1.2, Density of Monitoring Sites and Frequency of Measurements**), state and federal monitoring, and additional publicly available monitoring programs will be used to supplement the representative monitoring network data. The Grassland Plan Area participants acknowledge the benefit of merging existing monitoring programs with GSP monitoring efforts.

Potential Future Monitoring Network

There are monitoring sites within or adjacent to the Grassland Plan Area that were not included in the representative monitoring network due to a lack of temporal data consistency. These sites will continue to be monitored under GWD's monitoring program and are included in the Grassland Plan Area's Potential Future Monitoring Network. The intention of this network is to recognize that the data obtained from additional monitoring efforts can be useful in the analyses required by SGMA and may be useful for inclusion in future GSP updates. These additional sites are considered supplemental to the Representative Monitoring Networks identified in **Section 5.4** and are not subject to SMC analyses unless otherwise decided upon by Plan participants in future GSP updates.

5.1.1 Monitoring Network Objectives

Legal Requirements:

§354.34(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the effects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

1. Demonstrate progress toward achieving measurable objectives described in the Plan.
2. Monitor impacts to the beneficial uses or users of groundwater
3. Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
4. Quantify annual changes in water budget components.

The objectives of the Grassland GSP monitoring network, consistent with the Delta-Mendota Subbasin Common Chapter, are as follows:

1. Establish a baseline for future monitoring.
2. Provide warning of potential future problems.
3. Generate information for water resources evaluation.
4. Quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.
6. Provide comparable data from various locales within the Plan Area.
7. Demonstrate progress toward achieving measurable objectives and interim goals in the Plan.
8. Monitor changes in groundwater conditions relative to minimum thresholds, measurable objectives, and sustainable management criteria.
9. Monitor impacts to the beneficial uses or users of groundwater.

5.1.2 Implementation of Monitoring Network

Existing Monitoring – Water Quality, Water Levels, and Interconnected Surface Water

GWD has maintained a groundwater level monitoring program (GWMP) that includes pre- and post-pumping season water level measurements and is approved by USBR for the acquisition of refuge water supplies under the federal Refuge Water Supply Program. For the past several years, DWR has also asked local agencies to collect and report groundwater level data under the California Statewide Groundwater Elevation Monitoring (CASGEM) program. Data from these wells was recorded in an electronic database and submitted to the San Luis Delta Mendota Water Authority (SLDMWA) for inclusion in the CASGEM program.

The GWD also identified similar objectives in its Groundwater Management Plan:

- Measure water level fluctuations within wells in the District and evaluate the data for change in storage conditions.
- Measure water quality in wells and evaluate for potential water quality degradation.
- Submit water level data to the California Statewide Groundwater Elevation Monitoring (CASGEM) program.

GWD's groundwater quality monitoring program includes the collection of analytical grab samples at each wellhead least twice a year: at the beginning of the pumping season and just prior to the end of the pumping season. These samples are analyzed for selenium, EC, TDS, and boron. During the pumping season, wells are also tested for EC on a weekly basis, along with surface water upstream and downstream of each well. Annual summaries of groundwater quality trends are reviewed by the District's Board of Directors and submitted to the USBR in annual reports. This monitoring effort extends to all wells that provide groundwater for wetland habitat within the GGSA, including wells located adjacent to the GGSA and within the MCDMGSA. The CDFW maintains a similar groundwater monitoring and reporting program for groundwater wells that produce water for wetland habitat on state wildlife areas within the MCDMGSA.

GWD's Real Time Water Quality Monitoring Network (RTWQMN) currently consists of approximately 30 real-time monitoring stations located at key inflow, delivery, confluence, and drainage points that continuously measure surface water flow, EC, temperature, and pH. Additionally, current groundwater monitoring plans require GWD to monitor for TDS, selenium, and boron in surface water channels monthly in order to ensure continued compliance with the water quality objectives of the Central Valley Regional Water Quality Control Board (CVRWQCB).

The constituent with the greatest potential for negative impact in the Plan Area is salinity. Chapter 4 identifies the potential concerns of salinity and details a plan to assess SMCs for TDS. Groundwater and surface water monitoring programs will continue and may expand as needed to comply with SGMA monitoring requirements. Monitoring for selenium and boron will continue independently of SGMA, compliant with the GWD's and CDFW's monitoring programs. In the event of a trend of groundwater or surface water quality deteriorating in such a way that would impact beneficial users of groundwater, the Plan Area participants recognize the necessity of updating the SMCs and water quality monitoring to reflect concern for potential impacts.

The San Joaquin River Improvement Project and Grassland Bypass Project improve water quality in the Plan Area's wildlife refuges and wetlands, sustain the productivity of 97,000 acres of farmland, and foster cooperation between area farmers and regulatory agencies in drainage management and the reduction of selenium and salt loading to surface water. The projects are located south of the Plan Area and are operated by the San Joaquin Valley Drainage Authority, the Grassland Basin Drainers group, USBR, and the SLDMWA. Under agricultural drainage improvements by the USBR, sub-surface agricultural drainage from a large portion of the 370,000-acre Grasslands Watershed west of the San Joaquin River in Merced County has been shifted from discharging into wetland areas to discharging to the San Luis Drain and Mud Slough, a tributary to the San Joaquin River. In 2019 the project will cease discharging agricultural drainage water and has been proposed to be managed as a storm water bypass project around the wetland complex going forward.

The San Joaquin Valley Drainage Authority has agreed to install 5 multi-completion monitoring wells along the common boundary between the GGSA and the San Joaquin River Improvement Project, also known as the drainage reuse area, to begin to monitor subsurface migration of salt. The results of this supplemental monitoring data will be considered during GSP updates.

Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to address pollutant discharges to surface water and groundwater from commercially irrigated lands. The primary purpose of the ILRP is to address key pollutants of concern, including salinity, nitrates, and pesticides introduced through runoff or infiltration of irrigation water and stormwater. The program is administered by the Central Valley Regional Water Quality Control Board (RWQCB or Regional Board). The Westside San Joaquin River Watershed Coalition serves as the third-party group for the landowners within the Western San Joaquin River Watershed. The Waste Discharge Requirements (WDRs) under General Order R5-2014-0002, which apply to landowners within the Western San Joaquin River Watershed, were adopted by the RWQCB on January 9, 2014.

To date, the Coalition has monitored surface water quality, and groundwater quality is being monitored under the recent groundwater trend monitoring program and groundwater quality management plan released in March 2017. Fourteen wells are monitored annually at representative locations in high monitoring priority areas for constituents including nitrate, EC, pH, dissolved oxygen, temperature, and turbidity. Nitrate is the primary constituent of concern for the Coalition. However, the Plan Area is in the lowest monitoring priority area and is not within a high vulnerability area for nitrate. Nitrate management plans are not required by the RWQCB because managed wetlands within the Plan Area help play a role in improving groundwater quality and do not apply nitrogen fertilizer.

Other Agencies

Several other agencies play important roles in the monitoring of groundwater quality. These include the RWQCB, U.S. Environmental Protection Agency (EPA), Department of Toxic Substances Control (DTSC), U.S. Geological Survey (USGS), USBR, and State Water Resources Control Board (SWRCB). The GSP participants make efforts to collect and review pertinent water quality data published by these agencies. GWD also provides annual groundwater and surface water quality monitoring reports to USBR, CDFW, USFWS, and RWQCB.

Existing Monitoring – Subsidence

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the state and federal governments. Measurement and monitoring for land subsidence are performed by a variety of agencies including USGS, USBR, U.S. Army Corps of Engineers (USACE), University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), and various private contractors. Interagency efforts between the USGS, USBR, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey), and DWR have resulted in an intensive series of investigations that have identified and characterized subsidence in the San Joaquin Valley. NASA also measures subsidence in the Central Valley and has maps on its website that show the subsidence for a defined period. Several subsidence monitoring sites are located within and adjacent to the Plan Area and are actively monitored as part of the San Joaquin River Restoration Program. These sites are included in the representative monitoring network.

The SLDMWA and Central California Irrigation District maintain land subsidence monitoring programs. The Grassland Plan Area participants will continue to follow the results of these established monitoring programs, collaborate with the agencies to mitigate problems associated with land subsidence, and participate in the development of both intra- and inter-basin solutions.

Grassland Plan Area - Representative Monitoring Networks

Additionally, new monitoring networks have been developed (**Figure 5-1, Figure** 5-2**,** and **Figure 5-3**) for the purposes of GSP compliance and improvement of the hydrogeologic understanding of the Grassland Plan Area. Existing networks will be enhanced when necessary using the Data Quality Objective (DQO) process, which follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objective Process* (EPA, 2006). The DQO Process is also outlined in the DWR's Best Management Practices for monitoring networks (DWR, 2016a) and monitoring protocols (DWR, 2016b).

The DQO process includes the following:

1. State the problem.
2. Identify the goal.
3. Identify the inputs.
4. Define the boundaries of the area/issue being studied.
5. Develop an analytical approach.
6. Specify the performance or acceptance criteria.
7. Develop a plan for obtaining data.

The DQO process helps ensure a repeatable and robust approach to collecting data with a specific goal in mind.

5.1.3 Description of Monitoring Network

Legal Requirements:

§354.34(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

The Grassland Plan Area's monitoring efforts address the five applicable sustainability indicators and are organized into three representative monitoring networks:

(1) Representative water quality monitoring network
(2) Representative water level monitoring network
(3) Representative subsidence monitoring network

The wells identified in the representative water level and groundwater quality monitoring networks include wells perforated in the upper aquifer and wells perforated in the lower aquifer. The two distinct aquifers are substantially separated by the Corcoran Clay and are the two principle aquifers in the Plan Area. The lack of historical data from the wells that perforate down to the lower aquifer has prevented establishment of meaningful sustainable management criteria in the 2020 Grassland GSP for all sustainability indicators excepting water quality (for which the criteria are the same for the upper and lower aquifer). Lower aquifer wells are identified as representative monitoring sites and will undergo monitoring associated with GSP implementation. The data collected will be used for groundwater contouring and will facilitate further SMC development in future GSP updates for the lower aquifer. Thus, at this time SMC for water levels have been developed only for the upper aquifer.

<u>Representative Groundwater Quality Monitoring Network</u>
The groundwater quality monitoring network (**Table 5-2** and **Figure 5-1**) includes three upper aquifer wells. To achieve representative spatial coverage and characterize the conditions of both aquifers underlying the Grassland Plan Area, three lower aquifer representative water quality monitoring wells are also included in the network. Existing data indicates that groundwater quality is relatively consistent across broad expanses of the Plan Area. The monitoring sites were selected at representative locations in the south, central, and northern portions of the Plan Area. Other GSP groups in the Delta-Mendota Subbasin have identified water quality monitoring sites that are close to but outside of the Plan Area which will provide additional relevant data (see **Common Chapter (Appendix A) Figures CC-74 and CC-75**).

Table 5-2: Representative Groundwater Quality Monitoring Network Sites

Representative Groundwater Quality Monitoring Network	
Upper Aquifer	
LT	Sufficient historical data available to establish SMCs.
2PU-1	
M3	
Lower Aquifer	
1PL-1	The Grassland Plan Area participants will continue to monitor this site and establish a meaningful measurable objective and minimum threshold with the gathered data in the Year 5 interim goal.
1PL-2	Sufficient historical data available to establish SMCs.
1PL-3	

Representative Water Level Monitoring Network

The groundwater level representative monitoring network (**Table 5-3** and **Figure 5-2**) is made up of nine upper aquifer wells, four of which have been and will continue to be monitored by DWR, and three of which are associated with two multicompletion well sites and do not have adequate historical data for SMC development. The lower aquifer representative water level monitoring network is comprised of six wells from three multicompletion well sites and also have limited historical data. After data is acquired during the implementation phase from the sites that do not have historical data, meaningful thresholds will be established and identified in GSP Updates. Existing data indicates that groundwater levels are relatively consistent across broad expanses of the Plan Area. The monitoring sites were selected at representative locations in the south, central, and northern portions of the Plan Area. Other GSP groups in the Delta-Mendota Subbasin have identified groundwater level monitoring sites that are close to but outside of the Plan Area, which will provide additional relevant data (see **Common Chapter (Appendix A) Figures CC-72 and CC-73**).

This network serves as the representative monitoring network for three of the sustainability indicators:

(1) Water levels
(2) Groundwater storage (upper aquifer)
(3) Interconnected surface water

Descriptions of their relationship to groundwater levels and spatial distribution are outlined in **Section 5.1.3.1**.

Table 5-3: Representative Water Level Monitoring Network Sites

Representative Water Level Monitoring Network	
Upper Aquifer	
2PU-3	Historical data available to establish SMCs.
1PU-1	
08S09E34G001M	
08S10E30E001M	
11S12E30H002M	
11S11E04N001M	
3PU-2	
2PU-3	
1MU-1	
1MU-2	
1MU-3	
Lower Aquifer	
1ML-1	Historical data available to establish SMCs.
1ML-2	
1ML-3	
1ML-4	
1ML-5	
1ML-6	

Representative Subsidence Monitoring Network

The representative subsidence monitoring network (**Table 5-4** and **Figure 5-3**) is comprised of three USBR-monitored subsidence survey benchmarks (108, 137, and 152) located within and near the Plan Area. Although these three sites will specifically be examined for SMC analysis (**Chapter 4**), the understanding of subsidence in the Delta-Mendota Subbasin and Plan Area may require the examination of supplemental subsidence monitoring data from all publicly available sources due to the limited spatial extent of the monitoring network.

Table 5-4: Representative Subsidence Monitoring Network

Representative Subsidence Monitoring Network	
USBR Monitoring Sites	
108	Historical data available to establish SMCs.
152	
137	

Monitoring Networks Not Considered

The Grassland Plan Area is geographically distanced from the Pacific Coast in such a way that prevents any impacts related to seawater intrusion in the Plan Area. Therefore, a seawater intrusion monitoring network is not feasible, necessary, or required.

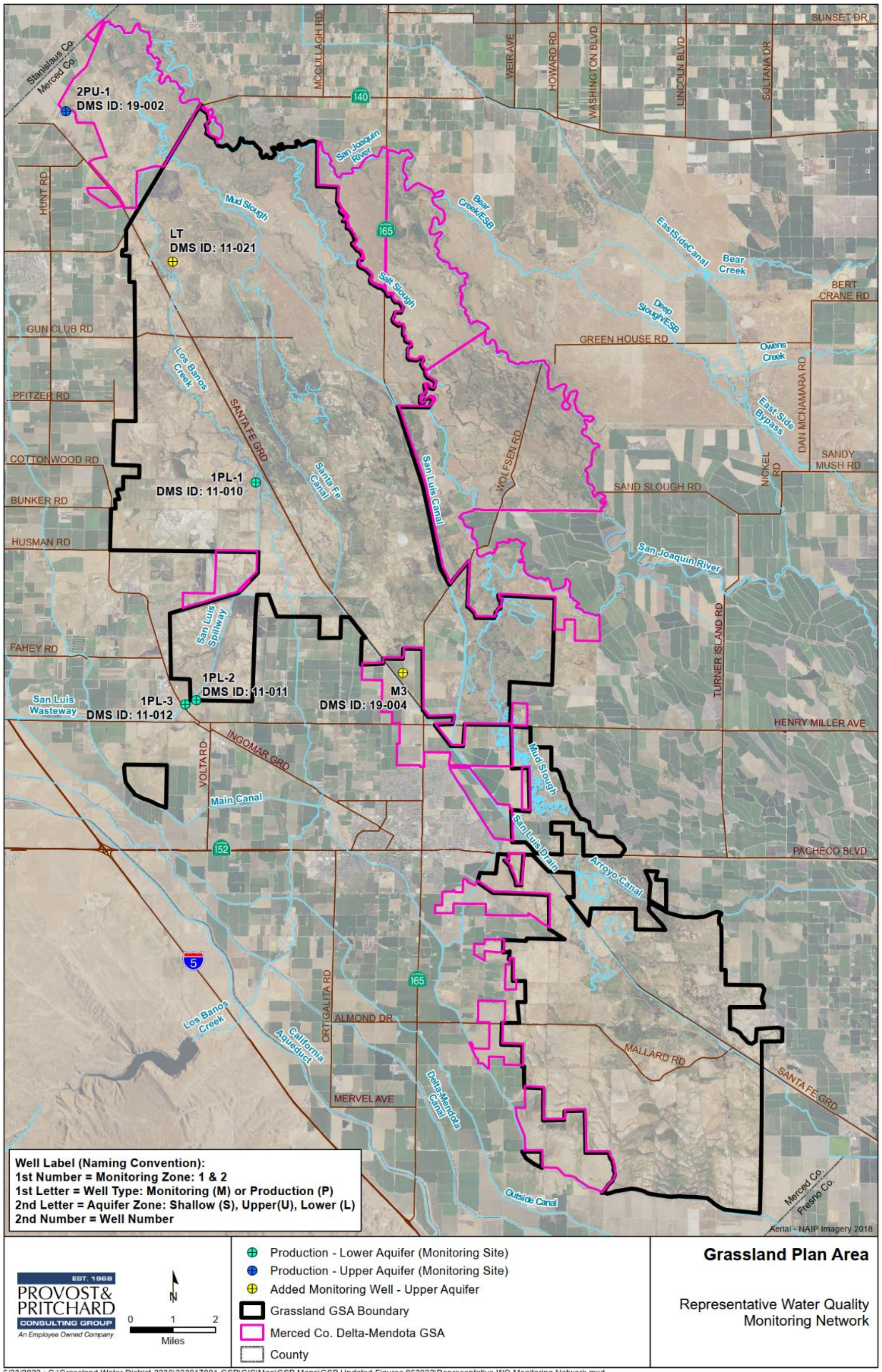


Figure 5-1: Representative Water Quality Monitoring Network

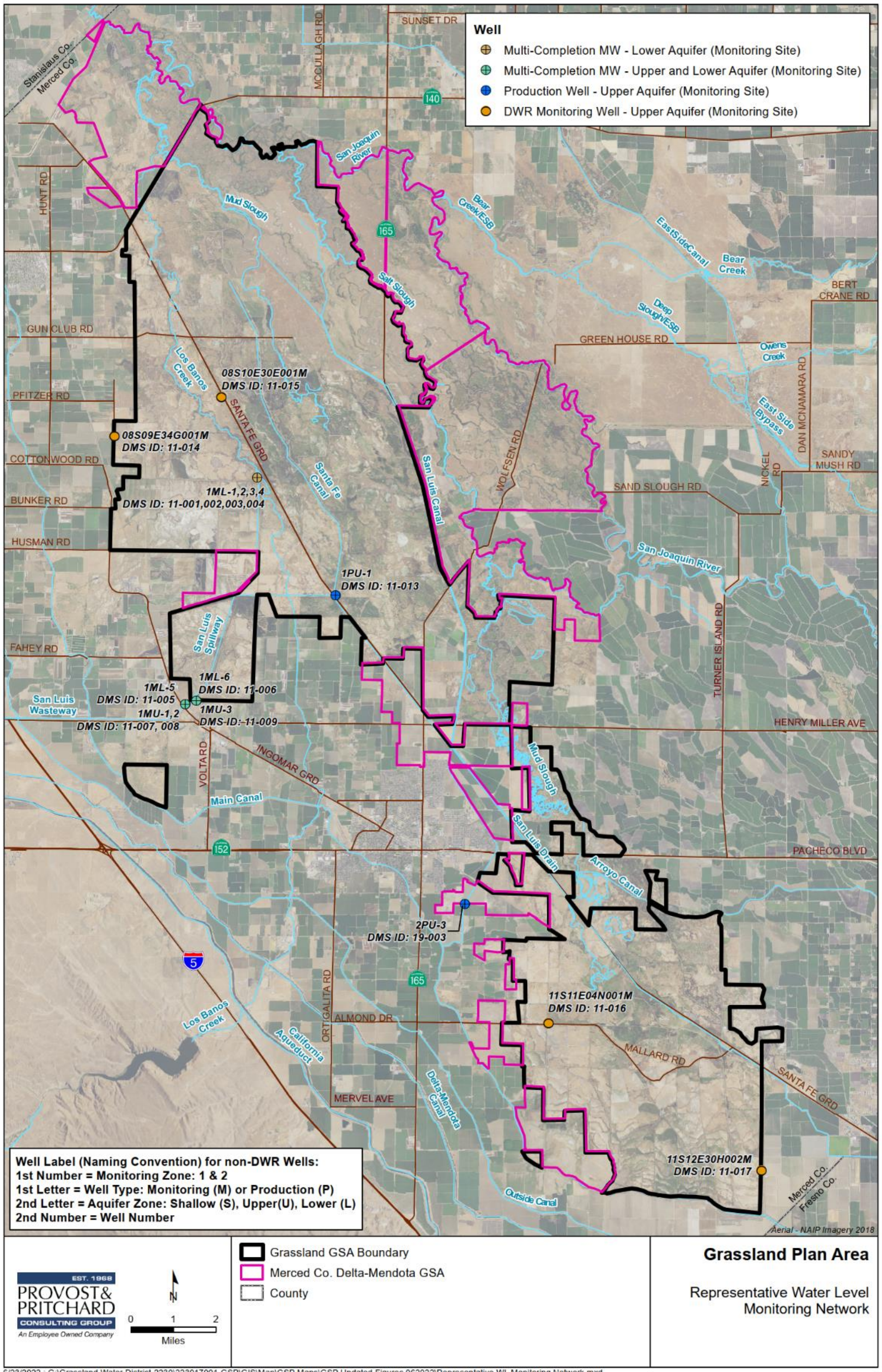


Figure 5-2: Representative Water Level Monitoring Network

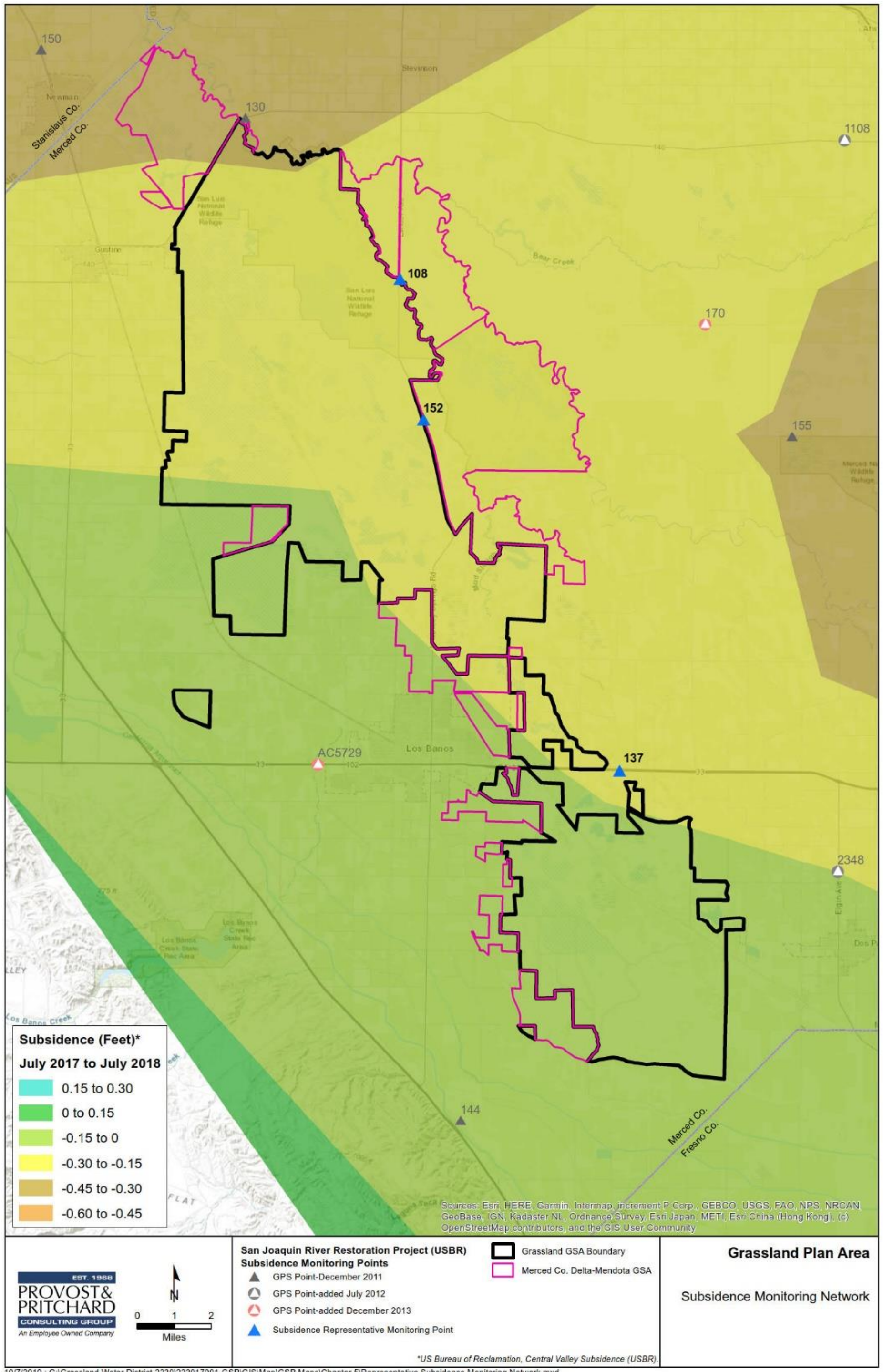


Figure 5-3: Representative Subsidence Monitoring Network

5.1.3.1 Groundwater Levels

Legal Requirements:

§354.34©(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
(A) A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

The representative water level monitoring network was developed by identifying wells with adequate spatial and temporal coverage to develop meaningful SMCs. The following questions were the focus of the Grassland Plan Area Technical Working Group during the process for developing the representative water level monitoring network.

Temporal:
- Of the wells within the Grassland Plan Area, which have measurements from at least three years within the period of 2000 to present?
- If a public agency monitors the well, is the responsible agency anticipated to continue to monitor this site?
- Is the well accessible for monitoring?
- Is the well perforated in the primary source aquifer to better monitor Grassland Plan Area participants' impacts on the hydrogeology through the implementation period?

Spatial:
- Does the proposed network provide sufficient spatial coverage across the Plan Area?
- Does the proposed network recognize both the upper aquifer and the lower aquifer?

Temporal Coverage
Certain wells that did not meet the temporal criteria were nonetheless included in the representative monitoring network. These wells will be monitored to increase the hydrologic understanding of the Plan Area, refine SMCs, and facilitate groundwater contours.

Spatial Coverage
Hopkins and Anderson (2016) provide recommendations for groundwater-level monitor well densities. The recommended densities range from one well per 150 square miles to one well per 25 square miles based on the quantity of groundwater pumped. A density of one well per 75 square miles is recommended for areas that use between 10,000 and 100,000 AF of groundwater per year and experience little water-level fluctuation or less than a 20-foot decrease in groundwater levels per decade. The Grassland Plan Area meets these criteria and is approximately 163 square miles. The density of water level monitoring sites is one well per 18 square miles for the upper aquifer and one well per 27 square miles for the lower aquifer; therefore, the representative water level monitoring network will exceed the minimum monitoring density suggested above (See **Figure 5-2**).

Monitoring Frequency

The groundwater levels will be monitored in January in order to be consistent with the Delta-Mendota Subbasin's spring measurement period as well as consistent with the seasonal high for the Plan Area. Groundwater levels will undergo their seasonal low measurement between September and October, consistent with the Delta-Mendota Subbasin coordinated effort. Spring measurements are typically designed to capture the recovery of the groundwater basin after demands have been met the previous year (seasonal high). Fall measurements typically capture a period prior to pond flood and after peak irrigation has ceased before any natural recovery has taken place (seasonal low). The two measurements together show the full effects of groundwater use in a given year. Due to the function of the managed wetlands, groundwater levels will be monitored at times that best reflect the seasonal high and low in the Plan Area.

5.1.3.2 Groundwater Storage

Legal Requirements:

§354.34(c)(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.

Upper Aquifer Groundwater Storage Calculations

Table 3-2 and **Section 3.3.3.1** Identify and outline the calculated change in storage of the Plan Area. Upper aquifer groundwater storage change will be estimated by utilizing the Specific Yield and Inflow/Outflow Methods. The Specific Yield Method estimates upper aquifer groundwater storage by multiplying local specific yield values by the overall change in groundwater elevation levels in the upper aquifer as determined using multiple hydrographs and contour maps prepared by the hydrogeological consultant. The Specific Yield Method is used as a check against the Inflow/Outflow Method. Specific yield values were identified in the hydrogeological conceptual model (**Chapter 3.1**).

Refer to **Chapter 3** for figures depicting the well coverage used for contour development. All available and relevant water level data from wells in the Plan Area will be used for the calculations associated with groundwater storage reporting requirements.

The process for calculating storage for the upper aquifer is detailed in **Section 3.3.3.1**.

Lower Aquifer Groundwater Storage Calculations

Due to insufficient historical water level data for wells that perforate below the Corcoran Clay and the complexity of calculating lower aquifer groundwater storage using water levels, subsidence was used as an initial proxy to quantify change in lower aquifer storage. Excessive lower aquifer pumping can induce inelastic compaction, which occurs when the structure of the overlying clay is compromised such that it is unable to expand to its original thickness even when groundwater levels rise to pre-pumping conditions. See **Section 5.1.3.5** for more information regarding the Grassland Plan Area's subsidence monitoring.

The method for calculating groundwater storage for the lower aquifer includes the following steps:

1. Develop subsidence contours or evaluate publicly available subsidence contours.
2. Using GIS, determine the change in land surface elevation.
3. Multiply land surface elevation by acreage to determine volumetric change.