Summary of Responses to the State Water Resources Control Board Staff Report on the Tulare Lake Subbasin Groundwater Sustainability Plan

Staff Report Identified Deficiency	Summary of Actions to Address the Deficiency in the 2024 GSP	Sections(s) and Page Number(s) in the 2024 GSP
Deficiency Groundwater Levels (GL)-1 – The 2022 GSP does not clearly describe the groundwater level conditions that would result in an undesirable result for the basin.	**Response to GL-1** – Defined the undesirable result for the chronic lowering of groundwater levels consistent with SGMA specific to the three aquifer zones: A, B and C.	**GL-1** - Section 4.3.2 (p.4-6) and Appendix I
Deficiency GL-2 – The GSAs did not consider all beneficial uses and users in setting SMC for groundwater levels in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users. MTs in the A-zone would allow for significant and unreasonable water level declines.	**Response to GL-2** – Set groundwater level sustainable management criteria to protect drinking water wells from dewatering at the minimum threshold elevations based on well construction information for the three aquifer zones. Described how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests relative to 2015 conditions.	**GL-2** - Section 4.3.3 (p. 4-10) and Appendix I
Deficiency GL-3 – The monitoring network does not provide sufficient coverage to monitor for impacts to beneficial uses and users in the three aquifers in the subbasin (due to data gaps in A-zone coverage and inconsistent sampling).	**Response to GL-3** – Filled data gaps in the groundwater level monitoring network. **Response to GL-3a** – Continued to use a consistent set of monitoring network wells. The 57 groundwater level monioring networks from the 2022 GSP used from year to year was incoporated into the 74 RMS wells for water levels to fill data gaps across all three aquifer zones. **Response to GL-3b** – Expanded the A-Zone to include the R-Zone and established twelve additional monitoring wells in the A-zone to monitor impacts to drinking water users and gathering data to better understand groundwater flow dynamics, especially during wet years.	**GL-3** - Section 5.2.5 (p. 5-11) and Figures 5.2.1-1 to 5.2.1-3 and Tables 4.3.1-1a,b,c; Table 5.1.0-2 **GL-3a** - Figures 5.2.1-1 to 5.2.1-3 and Tables 4.3.1-1a,b,c; Table 5.1.0-2 **GL-3b** - Section 5.2.2 (p. 5-7) and Figure 5.2.1-1 and Table 4.3.1-1a, Table 5.1.0-2 and Appendix I
Deficiency GL-4 – The 2022 GSP's discussion of well impact mitigation lacks important details and the GSP does not explain how well impact mitigation fits into the GSAs' approach for avoiding undesirable results.	**Response to GL-4** – Established accessible, comprehensive, and appropriately funded well impact mitigation programs that mitigate impacts to wells affected by lowering of groundwater levels and degradation of water quality. **Response to GL-4a** – Developed well mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources. (This action supports addressing both Deficiency GL-4 and Deficiency GWQ-5b.) **Response to GL-4b** – Evaluate how small farms wells will be impacted.	**GL-4** - Chapter 6 (p.6-1) and Appendix I **GL-4a** - Chapter 6 (p.6-1) **GL-4b** - Appendix I
Deficiency GL-5 – The 2022 GSP does not describe a feasible path for halting chronic lowering of groundwater levels.	**Response to GL-5** – Plan ahead for drought conditions and commit to managing demand. **Response to GL-5a** – Evaluate the feasibility of proposed supply augmentation projects. **Response to GL-5b** – Develop basin-wide allocations or utilize another demand management structure to help bring the subbasin into balance and meet basin sustainability goals. **Response to GL-5c** – Identify key indicator wells in each aquifer, with sufficient spatial coverage to represent beneficial uses and users in each aquifer and identify groundwater levels that will trigger specific demand management.	**GL-5** – Sections 3A.4 (p.3-8), 4.3 (p.4-5), Chapter 6 (p.6-1) **GL-5a** – Chapter 6 (p.6-1) **GL-5b** – Chapter 6 (p.6-1) **GL-5c** – Section 5.2.2 (p. 5-7) and Figures 5.2.1-1 to 5.2.1-3 and Tables 4.3.1-1a,b,c; Table 5.1.0-2 and Appendix I

Staff Report Identified Deficiency	Summary of Actions to Address the Deficiency in the 2024 GSP	Sections(s) and Page Number(s) in the 2024 GSP
Deficiency GL-6 – The GSAs do not consider the effects on other sustainability indicators, such as groundwater storage, subsidence, degradation of groundwater quality, and depletions of interconnected surface water.	**Response to GL-6** – Describe the relationship between MTs for each sustainability indicator. Revise groundwater level MTs as necessary to avoid undesirable results for other sustainability indicators.	**GL-6** – Chapter 4 (p. 4-1)
Deficiency Land Subsidence (LS)-1 - The 2022 GSP does not clearly describe the subsidence conditions that would result in an undesirable result for the basin.	**Response to LS-1** – Clearly define the subsidence conditions that would result in an undesirable result for the basin and provide enough detail that associated MTs can be determined (Cal. Code Regs., tit. 23 § 354.28).	**LS-1** – Appendix J
Deficiency LS-2 - The GSAs did not consider all beneficial uses and users in setting quantitative criteria for subsidence in the 2022 GSP or adequately describe the impacts of criteria on beneficial uses and users. - **Deficiency LS-2a** – MTs were not established based on avoiding undesirable results. - **Deficiency LS-2b** – Some MTs appear to exceed subsidence limits set in other pre-existing agreements. - **Deficiency LS-2c** – MOs and IMs were not established.	**Response to LS-2** – Develop quantitative criteria that avoid undesirable results and conform with other legal agreements. **Response to LS-2a** – Define and clearly list MTs based on the level of subsidence at each RMS that would cause the undesirable results conditions that the GSAs are trying to avoid. **Response to LS-2b** – Ensure MTs conform with current agreements with other agencies. **Response to LS-2c** – Establish MOs that avoid undesirable results and provide operational flexibility so that potential future droughts do not cause MT exceedances. Establish IMs that provide a reasonable path to achieving sustainable management.	**LS-2** – Section 3A.5 (p.3-12), Section 4.7 (p.4-22) and Appendix J **LS-2a** – Section 4.7.3 (p.4-24) and Appendix J **LS-2b** – Section 3A.5 (p.3-12), Section 4.7.3 (p.4-24) and Appendix J **LS-2c** – Section 3A.5 (p.3-12), Section 4.7 (p.4-22) and Appendix J

Staff Report Identified Deficiency	Summary of Actions to Address the Deficiency in the 2024 GSP	Sections(s) and Page Number(s) in the 2024 GSP
Deficiency LS-3 – The GSAs did not adequately consider the impacts of subsidence on flood protection infrastructure.	**Response to LS-3** – Consult with flood management agencies and expand the GSP's analysis of land subsidence impacts on flood infrastructure. **Response to LS-3a** – When establishing undesirable results and MTs, evaluate the impacts of reduced channel capacity, uncertainty around longitudinal differential subsidence, and increased inundation depths.	**LS-3** – Section 3A.5 (p.3-12), Section 4.7 (p.4-22) and Appendix J **LS-3a** – Section 3A.5 (p.3-12), Section 4.7 (p.4-22) and Appendix J
Deficiency LS-4 – The GSP does not provide adequate implementation details.	**Response to LS-4** – Plan ahead to avoid significant and unreasonable land subsidence. **Response to LS-4a** – Develop a plan to trigger management actions when subsidence exceeds defined thresholds, especially near critical infrastructure/facilities. **Response to LS-4b** – Update the Well Registration Program to meet subsidence goals in the subbasin; Do not allow new wells in areas where subsidence threatens critical infrastructure. **Response to LS-4c** – Develop infrastructure mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources.	**LS-4** – Section 3A.5 (p.3-12), Section 4.7 (p.4-22) and Appendix J **LS-4a** – Section 3A.5 (p.3-12), Section 4.7 (p.4-22) and Appendix J and Chapter 6 (p.6-1) **LS-4b** – Chapter 6 (p.6-1) **LS-4c** – Section 3A. (p. 3-12), Chapter 6 (p.6-1), Appendix J
Deficiency Groundwater Quality (GWQ)-1 – The 2022 GSP's definition of an undesirable result is not consistent with GSP Regulations. - **Deficiency GWQ-1a** – The 2022 GSP does not clearly describe the water quality conditions and impacts that would result in an undesirable result or the basin. - **Deficiency GWQ-1b** – The triggers for determining an undesirable result set by the 2022 GSP would result in delayed identification of an undesirable result and therefore delayed management of the basin. - **Deficiency GWQ-1c** – The GSP does not describe how it would determine whether significant and unreasonable degradation of water quality was associated with basin management.	**Response to GWQ-1** – Update the definition of an undesirable result to be consistent with GSP Regulations. **Response to GWQ-1a** – Clearly describe the water quality conditions and impacts that would result in an undesirable result or the basin. **Response to GWQ-1b** – Do not rely on trend detection or other methods that may delay identification of undesirable results. **Response to GWQ-1c** – Remove the "causal nexus" requirement and add information about the impacts of basin management on water quality.	**GWQ-1** – Section 4.5.2 (p.4-18) **GWQ-1a** – Section 4.5.2 (p. 4-18) **GWQ-1b** – Adddressed **GWQ-1c** – Addressed

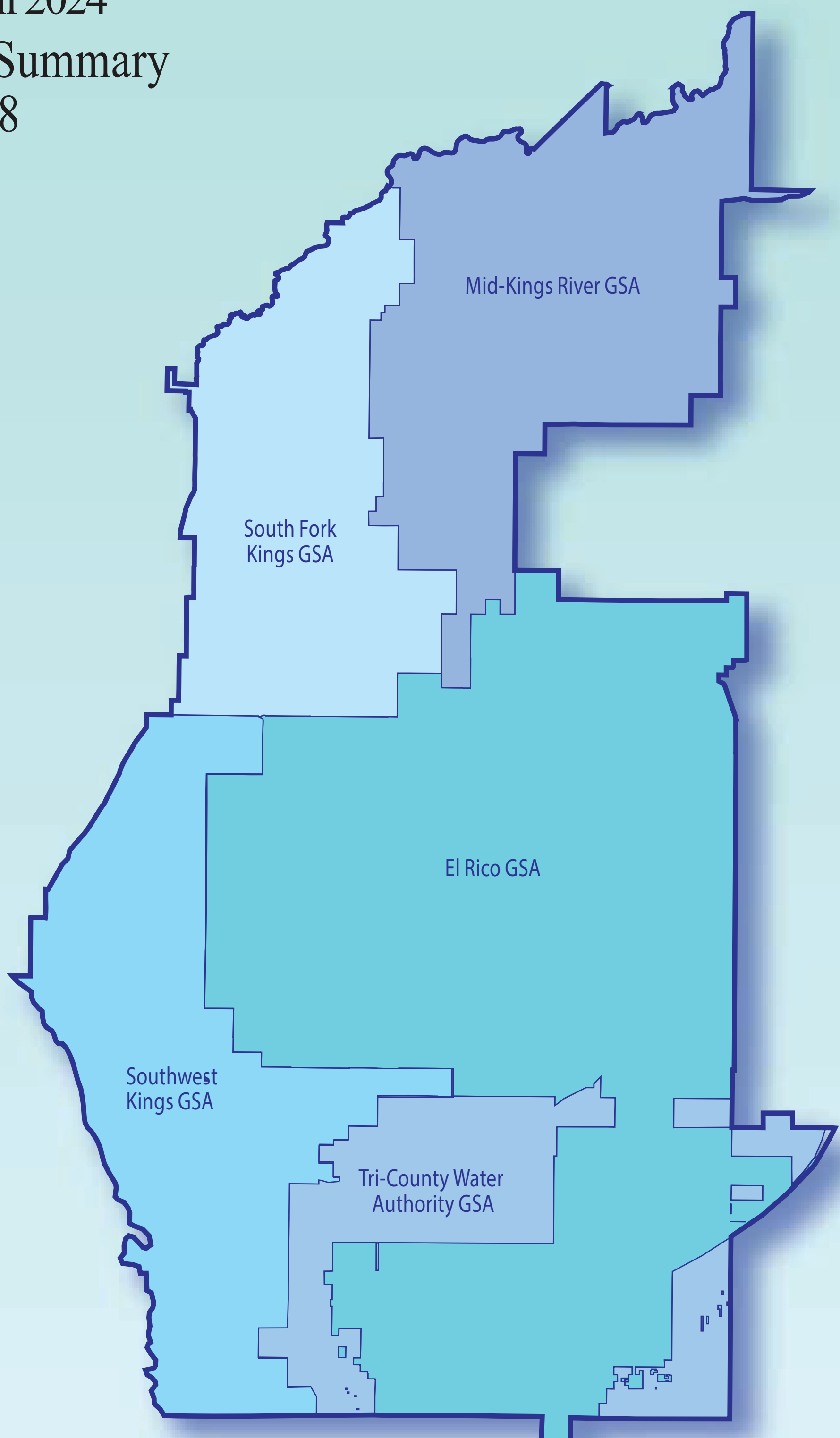
Staff Report Identified Deficiency	Summary of Actions to Address the Deficiency in the 2024 GSP	Sections(s) and Page Number(s) in the 2024 GSP
Deficiency GWQ-2 – Minimum thresholds set by the 2022 GSP are not consistent with GSP Regulations. - **Deficiency GWQ-2a** – The 2022 GSP establishes minimum thresholds that exceed regulatory water quality thresholds without explaining how that would not cause significant and unreasonable results or impacts to beneficial uses and users. - **Deficiency GWQ-2b** – Some MTs are inexplicably based on data that may represent undesirable results. - **Deficiency GWQ-2c** – The GSP does not explain how it quantifies "current conditions," yet uses current conditions to justify establishing MTs that exceed MCLs or SMCLs. - **Deficiency GWQ-2d** – MTs are sometimes set to the highest detected concentrations. - **Deficiency GWQ-2e** – MTs at some wells are based on data from wells nearby the RMS wells, rather than from the RMS wells themselves, without justification.	**Response to GWQ-2** – Update minimum thresholds to be consistent with GSP Regulations. **Response to GWQ-2a** – Establish minimum thresholds that do not inexplicably exceed regulatory water quality thresholds. **Response to GWQ-2b** – Don't base pre-2015 conditions and MTs on current conditions; use pre- 2015 conditions instead. **Response to GWQ-2c** – Fully explain how pre-2015 conditions are characterized. **Response to GWQ-2d** – Do not establish MTs that would allow for substantial degradation of water quality. **Response to GWQ-2e** – Do not use data from nearby wells when developing MTs without justification.	**GWQ-2** – Section 4.5.3 (p.4-20) **GWQ-2a** – Section 4.5.3 (p.4-20) **GWQ-2b** – Section 3A.2 (p. 3-1) and Section 4.5.3 (p.4-20) **GWQ-2c** – Section 3A.2 (p. 3-1) **GWQ-2d** – Section 4.5.3 (p.4-20) **GWQ-2e** – Section 4.5.3 (p.4-20)
Deficiency GWQ-3 – Measurable Objectives set by the 2022 GSP for groundwater quality are not consistent with GSP Regulations. - **Deficiency GWQ-3a** – The 2022 GSP allows MOs that exceed regulatory water quality thresholds (e.g., MCLs) without explaining how that would not cause significant and unreasonable results or impacts to beneficial uses and users. - **Deficiency GWQ-3b** – Some MOs are inexplicably based on data that may represent undesirable results. - **Deficiency GWQ-3c** – The GSP does not explain how it quantifies current conditions, yet the GSP uses current conditions to justify establishing MOs that exceed MCLs or SMCLs. - **Deficiency GWQ-3d** – MOs are sometimes effectively set to 95th percentile concentrations. - **Deficiency GWQ-3e** – MOs at some wells are based on data from wells nearby the RMS wells, rather than from the RMS wells themselves, without justification. - **Deficiency GWQ-3f** – The 2022 GSP establishes measurable objectives that may vary over time without explanation of how that would provide operational flexibility while avoiding significant and unreasonable results or impacts to beneficial uses and users.	**Response to GWQ-3** – Updated Measurable Objectives to be consistent with GSP Regulations. **Response to GWQ-3a** – Established Measurable Objectives that do not inexplicably exceed regulatory water quality thresholds. **Response to GWQ-3b** – The Pre-2015 groundwater quality conditions were utilized to establish Measurable Objectives. **Response to GWQ-3c** – Do not establish Measurable Objectives that would allow for substantial degradation of water quality. **Response to GWQ-3d** – Do not inexplicably use data from nearby wells when developing measurable objectives. **Response to GWQ-3e** – Do not use measurable objectives that may vary over time.	**GWQ-3** – Section 4.5.4 (p. 4-21) **GWQ-3a** – Section 4.5.4 (p. 4-21) **GWQ-3b** – Addressed **GWQ-3c** – Section 4.5.4 (p. 4-21) **GWQ-3d** – Section 4.5.4 (p. 4-21) **GWQ-3e** – Section 4.5.4 (p. 4-21)

Staff Report Identified Deficiency	Summary of Actions to Address the Deficiency in the 2024 GSP	Sections(s) and Page Number(s) in the 2024 GSP
Deficiency GWQ-4 – The water quality monitoring plan in the 2022 GSP is not consistent with GSP regulations. - **Deficiency GWQ-4a** – The GSP does not monitor or manage the aquifer below the de-designated zone. - **Deficiency GWQ-4b** – The proposed monitoring frequency is insufficient to detect short- term and seasonal trends. - **Deficiency GWQ-4c** – The proposed monitoring network does not adequately monitor key aquifers. - **Deficiency GWQ-4d** – The proposed sampling plan relies entirely on other agencies.	**Response to GWQ-4** – Updated the water quality monitoring plan to be consistent with GSP regulations. **Response to GWQ-4a** – Monitoring and management in the aquifer below the de- designated zone. **Response to GWQ- 4b** – Increased monitoring frequency and better described monitoring schedules provided in a Sampling Analysis Plan. **Response to GWQ-4c** – Adequately monitor all three aquifer zones. **Response to GWQ- 4d** – Added GSA monitoring capacity.	**GWQ-4** – Section 4.5 (pl 4-17) and Appendix H **GWQ-4a** – Section 5.5.1 (p. 5-14), Figure 5.2.2-3 **GWQ- 4b** – **GWQ-4d** – Section 5.5 (p. 5-14) and Table 5.1.0-2 and Figures 5.2.2-1 through 5.2.2-3
Deficiency GWQ-5 – Management actions should be responsive to water quality degradation. - **Deficiency GWQ-5a** – Additional sampling should be triggered when MTs are exceeded. - **Deficiency GWQ-5b** – Well mitigation plans need to address MT exceedances.	**Response to GWQ-5** – A basin-wide groundwater quality Sampling and Analysis Plan that outlines additional sampling when water quality is degraded has been added to the plan. **Response to GL-5a, 5b** – Developed well mitigation programs with clear triggers, eligibility requirements, metrics, and funding sources. (This action supports addressing both Deficiency GL-4 and Deficiency GWQ-5b.)	**GWQ-5** – Section 4.5 (pl 4-17), Section 5.5 (p. 5-14) and Table 5.1.0-2 and Figures 5.2.2-1 through 5.2.2-3 and Appendix H **GL-5a, 5b** – Chapter 6 (p. 6-1) and Appendix H

Tulare Lake Subbasin Groundwater Sustainability Plan

Revised April 2024

Executive Summary
Chapters 1-8
Figures
Tables



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ACRONYMS AND ABBREVIATIONS

%	percent
§	section
µm/sec	micrometers per second
µS/cm	microsiemens per centimeter
A-Clay	a perched unconfined aquifer exists above a locally extensive clay layer
AF	acre-feet
AF/Y	acre-feet per year
AGR	agricultural uses
AMSL	above mean sea level
ASR	Aquifer Storage and Recovery
bgs	below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practice
BPA	Basin Plan Amendment
Caltrans	California Department of Transportation
CASGEM	California Statewide Groundwater Elevation Monitoring
C-Clay	A semiconfined aquifer is present above a locally extensive clay layer
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGPS	Continuous Global Positioning System
CSD	Community Service(s) District
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV-SALTS	Central Valley Salinity Alternatives For Long-term Sustainability
CVSRN	Central Valley Spatial Reference Network
DAC	Disadvantaged Community
DDW	Division of Drinking Water
DMS	Data Management System

DOF	Department of Finance
DPR	Department of Pesticide Regulation
DQO	Data Quality Objective
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection Program
EC	electrical conductivity
E-Clay	(or Corcoran Clay) a fully confined aquifer exists below a regionally extensive clay layer
EPA	United States Environmental Protection Agency
ETc	Crop evapotranspiration
ft	foot/feet
ft/d	foot per day
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
HS	Health and Safety
ID	Irrigation District
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
ITRC	Cal Poly Irrigation Training and Research Center
KCWD	Kings County Water District
KDWCD	Kaweah Delta Water Conservation District
KRCD	Kings River Conservation District
KRFMP	Kings River Fisheries Management Program
KRWA	Kings River Water Association
KRWQC	Kings River Water Quality Coalition
K_{SAT}	saturated hydraulic conductivity
LiDAR	Light Detection and Ranging
LU	Land Use

MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MKR	Mid-Kings River
MO	measurable objective
MSL	mean sea level
MT	minimum threshold
MUN	municipal or domestic water supplies
NASA	National Aeronautics and Space Administration
NCCAG	Natural Communities Commonly Associated with Groundwater
PBO	Plate Boundary Observatory
pCi/L	picocuries per liter
PRISM	Parameter-elevation Regressions on Independent Slopes model
PUD	Public Utility District
PVC	polyvinyl chloride
RC	Resource Conservation
RD	Reclamation District
RMS	representative monitoring site
RWQCB	Regional Water Quality Control Board
SFK	South Fork Kings
SGMA	Sustainable Groundwater Management Act of 2014
SJRRP	San Joaquin River Restoration Program
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMARA	Surface Mining and Reclamation Act
SOPAC	Scripps Orbit and Permanent Array Center
SR	State Route
Subbasin	Tulare Lake Subbasin
SURF	Surface Water Database
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TCWA	Tri-County Water Authority
TDS	total dissolved solids
TLBWSD	Tulare Lake Basin Water Storage District

TNC	The Nature Conservancy
TV	television
U.S.	United States
UNAVCO	University Navigation Satellite Timing and Ranging Consortium
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VOC	volatile organic compound
WCR	Well Completion Report
WD	Water District
WHPA	Wellhead Protection Area
WWQC	Westside Water Quality Coalition

1. INTRODUCTION

This Groundwater Sustainability Plan (GSP) was prepared on behalf of the five Groundwater Sustainability Agencies (GSAs) for the Tulare Lake Subbasin (Subbasin) identified by the California Department of Water Resources (DWR) as Basin No. 5-022-12 (Bulletin 118). In compliance with the California Sustainable Groundwater Management Act (SGMA) of 2014, the GSAs adopted the GSP submitted to DWR on January 29, 2020 (2020 GSP). The five participating GSAs in the Subbasin are the Mid-Kings River, El Rico, South Fork Kings, Southwest Kings, and Tri-County Water Authority. The GSAs remain committed to coordinating and working together to implement the GSP and subsequent updates.

Key Features of SGMA

- **Senate Bill 1168 -** Requires the sustainable management of groundwater basins for long-term reliability and economic, social, and environmental benefits for future uses.
- **Senate Bill 1319 -** Authorizes State Water Resources Control Board intervention to remedy a mismanaged groundwater basin.
- **Assembly Bill 1739 -** Establishes criteria for sustainable management of groundwater and authorizes DWR to establish best management practices for groundwater management.

On January 28, 2022, the GSAs received a determination letter from DWR stating the 2020 GSP was considered “incomplete” (DWR, 2022). DWR stated that the GSP was considered incomplete as it “does not define undesirable results or set sustainable management criteria for groundwater levels, subsidence, and water quality in the manner consistent with SGMA and the GSP regulations.” Upon receiving the incomplete determination, the Subbasin had 180 days to address the identified deficiencies and submit a revised GSP by July 27, 2022. The GSAs submitted the 2022 GSP Addendum to address the three deficiencies outlined in the incomplete determination letter. The 2022 GSP Addendum was prepared to specifically address the incomplete determination letter from DWR and was considered a revision of the 2020 GSP.

On March 2, 2023, DWR issued an inadequate determination letter stating that the 2022 GSP Addendum did not take “sufficient actions to correct deficiencies previously identified by the Department.” The letter further stated that once DWR determines a GSP is inadequate, primary jurisdiction shifts to the State Water Resources Control Board (SWRCB). Subsequently, the SWRCB issued a Draft Tulare Lake Subbasin Probationary Hearing Staff Report in October 2023 (SWRCB, 2023).

In preparing this 2024 GSP, the GSA managers held numerous meetings with SWRCB staff to better understand the evaluation criteria utilized by DWR and SWRCB in reviewing the 2022 GSP Addendum. While meetings with SWRCB staff were generally helpful, the interaction was limited by the State determining the oversight process as it was occurring. However, the GSAs are committed to remaining compliant under SGMA and have prepared this updated GSP (2024 GSP) to both address the SWRCB concerns and to present a plan that will lead the Subbasin to sustainability by 2040.

This revised GSP incorporates details from the 2022 GSP addendum but has been updated to represent the GSAs achievements and actual implementation activities thus far. The Sustainable Management Criteria (Chapter 4) has been extensively revised and updated to specifically address DWR and SWRCB concerns. Regular updates to the GSP will continue as more data becomes available and will continue to evolve as changes occur to improve sustainability efforts.

1.1 SGMA

The legislative intent of SGMA is to sustainably manage California's groundwater basins. SGMA gives authority to local agencies to form GSAs and to manage groundwater basins to reach long-term groundwater sustainability through the preparation and implementation of GSPs (California Water Code, §10720-10737.8). The adoption of SGMA established California's first comprehensive framework for sustainable management of groundwater basins through local agency coordination. SGMA expands the role of DWR to enforce local implementation of sustainable groundwater management practices through the review and approval of GSPs and allows for SWRCB intervention if groundwater basins do not meet sustainability requirements.

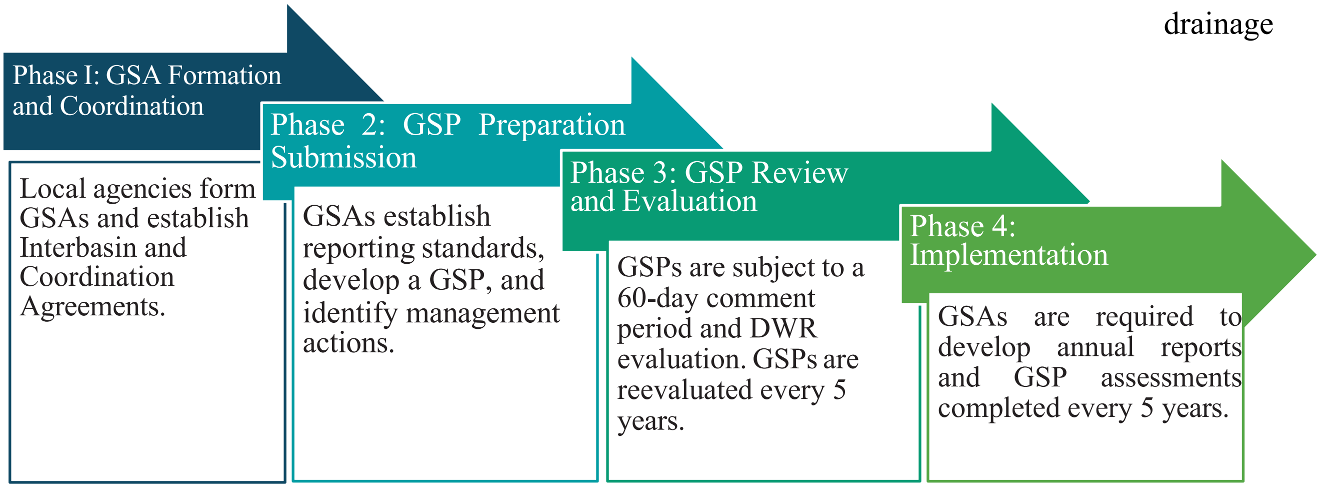
DWR Statewide Bulletin 118 Report describes regional groundwater occurrence, defines California groundwater basin boundaries, identifies basins that are subject to critical conditions of groundwater overdraft, and establishes basin priority (California Water Code, §12924). California's 515 groundwater basins are classified into four categories; high-, medium-, low, or very low-priority based on conditions identified in the California Water Code, §10933(b). Conditions include the population and irrigated acreage overlying the subbasin, the degree to which the population relies on groundwater as their primary source of water, and exceedance of sustainable yield (DWR 2019b). Basin prioritization also considers documented impacts on groundwater within the subbasin, including overdraft, subsidence, saline intrusion, water quality degradation, or other adverse impacts on local habitat and stream flows. A subbasin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts (DWR 2019b).

The Tulare Lake Subbasin is identified as high priority by DWR and is one of twenty– one basins considered to be in a critically-overdrafted condition (DWR 2019a). Five participating GSAs in the Subbasin have coordinated to develop this comprehensive GSP in compliance with SGMA: Mid-Kings River (MKR), El Rico (ER), South Fork Kings (SFK), Southwest Kings (SWK), and Tri-County Water Authority (TCWA). A copy of the Interim Operating Agreement between the GSAs is included in Appendix F. The GSAs are committed to continued coordination and compliance with annual and five-year reporting requirements during the implementation of their GSP.

Subbasins subject to critical conditions of overdraft are classified as medium-and high-priority basins under the above criteria and require the preparation and adoption of GSPs (California Water Code, §10720.7). Each GSP is required to set long-term sustainability goals as well as "interim milestones" in increments of 5 years that represent measurable groundwater conditions and target values. Data collection and annual reporting to DWR is also required to ensure conformance with SGMA following GSP adoption, to the maximum extent feasible (California Water Code, §10720.1). The GSPs therefore must be reevaluated and updated, at a minimum, every 5 years (2025, 2030, 2035, and 2040) to provide refinements to the GSPs and allow for revised management.

1.2 Subbasin Overview

The Subbasin (Basin No. 5-022.12) consists of 837 square miles (535,869 acres) in the southern region of San Joaquin Valley Groundwater Basin, within Kings County. The Kings, Kaweah, Tule, and Kern Rivers within the southern portion of the San Joaquin Valley flow into the Tulare drainage



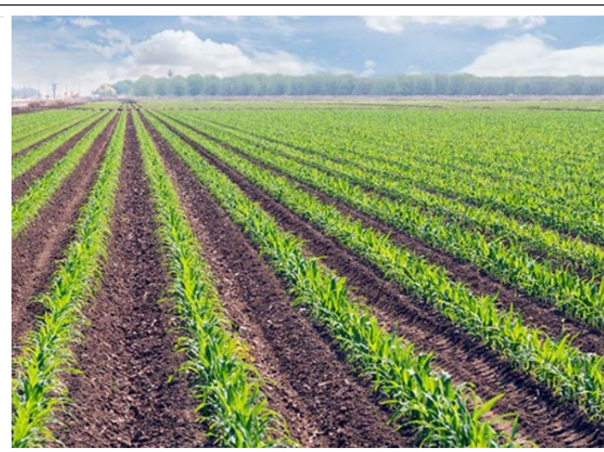
subbasin (DWR 2006). The Subbasin is bounded to the south by the Kern County Groundwater Subbasin (5-022.14), to the east by the Tule Groundwater Subbasin (5-022.13) and the Kaweah Groundwater Subbasin (5-022.11), to the north by the Kings Groundwater Subbasin (5-022.08), and the west by the Westside Groundwater Subbasin (5-022.09). The southern half of the Subbasin consists of lands In the historic Tulare Lakebed in Kings County (DWR 2016b).

The Subbasin has a population of 125,907 (2010) and population density of 150 persons per square mile (DWR 2019a; US Census Bureau 2018). Agriculture is one of the top three industries in Kings County, and a significant portion of the Subbasin population is involved in all facets of agricultural production (DWR 2019c). As one of the primary industries, agriculture is the largest source of employment in the County.

1.3 Purpose of the Groundwater Sustainability Plan

SGMA requires GSAs for high- and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge and expects subbasins to reach sustainability within 20 years of GSP implementation (DWR 2019c). GSAs establish minimum

The County of Kings is ranked the 10th largest agricultural production county in California. Top commodities include milk, cattle, cotton, almonds, pistachios, and tomatoes (Kings County Agricultural Commissioner 2017).



The Tulare Lake Subbasin contains approximately 251,994 irrigated acres of agricultural land. Approximately 50% of irrigation supplies are met by pumping groundwater (DWR 2019c).

sustainability thresholds, measurable objectives, and long-term planning strategies through GSP development to achieve SGMA requirements (California Water Code, §10720; 10727). GSPs must identify the existing physical setting of the groundwater basin and assess groundwater levels to inform management actions and measurable sustainability goals (California Water Code, §10727.2).

The purpose of this GSP is to develop a roadmap to groundwater sustainability that defines specific criteria to monitor and measure progress towards sustainable groundwater management as outlined in the SGMA. DWR defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (California Water Code, §10721 [v]). Undesirable results under SGMA are defined as:

Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply.

Significant and unreasonable reduction of groundwater storage

Significant and unreasonable sea water intrusion

Significant and unreasonable degraded water quality including migration of containment plumes that impair water supplies.

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

Surface water depletions that have significant and unreasonable adverse impacts on beneficial uses of surface water.

The DWR GSP Emergency Regulations establish the requirements of GSP preparation and implementation in medium-and high-priority designated basins (Table 1.3.0-1; DWR 2016a).

1.4 Sustainability Goals

23 CCR §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.*

1.4.1 Goal Description

The GSAs in the Tulare Lake Subbasin intend to manage groundwater resources to continue to provide an adequate water supply for existing beneficial uses and users in accordance with counties and cities general plans while meeting established measurable objectives to maintain a sustainable yield. This goal aims to continue to provide water supply for existing beneficial uses and users while ensuring the future, sustainable use of groundwater. Additionally, the GSAs will use this GSP as a tool for managing groundwater across the subbasin on a long-term basis for all beneficial uses and users in the basin. A more detailed description of the Sustainability Goal for the Subbasin, and Sustainable Management Criteria for the subbasin and this GSP, are included in Chapter 4.

GSAs in the Subbasin will work collectively to manage groundwater resources in the Subbasin, develop sustainability projects, and implement management actions, where appropriate. Section 3.2, Groundwater Conditions, provides insight to current and historical groundwater conditions, as well as a model for a 50-year forecast water budget to quantify groundwater level stability. Historic and hydrologic modeling estimates were used to develop a sustainable yield, which aims to stabilize forecasted groundwater levels. This goal was established in a manner that is transparent to the public and stakeholders to ensure the local population has a voice in the development of the programs. With the implementation of management actions and projects, as well as the continued interim monitoring and reassessment of activities, groundwater levels will be maintained at levels that will not create undesirable results.

1.4.2 Discussion of Measures

To achieve the goals outlined in the GSP, a combination of measures, including continued management practices and monitoring will be implemented through 2040 and continued thereafter. Additional surface water supply and infrastructure projects will be a crucial component of the supply system in diverting these waters to areas that provide the most benefit for offsetting the use of groundwater. Management actions will be implemented to help mitigate overdraft based on the demand from beneficial uses and users. Projects and management actions are discussed in further detail in Chapter 6, including a general timeline on when implementation will take place. When combined with consistent monitoring practices for each of the sustainability indicators, the GSAs will coordinate how individual GSAs pursue sustainability on a Subbasin level.

1.4.3 Explanation of How the Goal Will Be Achieved in 20 Years

The goal of this Subbasin will be achieved by 2040 by:

- Understanding the existing groundwater conditions and potential future conditions
- Analyzing and identifying the effects of management actions on the Subbasin
- Implementing this GSP and its associated measures including project and management actions to halt and avoid undesirable results.
- Collaborating between agencies to achieve goals and protect beneficial uses.

Assessing at each interim milestone implemented project and management action's success and challenges.

1.5 Groundwater Sustainability Agency Information

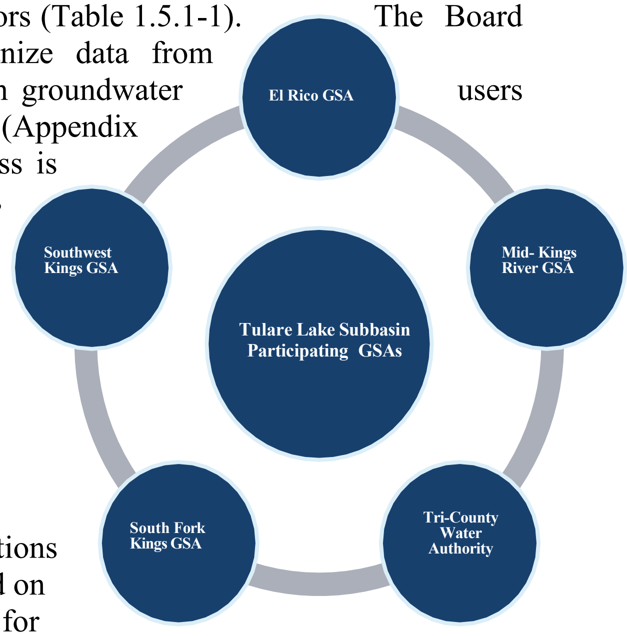
23 CCR § 354.6(a) *The name and mailing address of the Agency.*

Five GSAs form the Subbasin: Mid-Kings River, El Rico, South Fork Kings, Southwest Kings, and Tri-County Water Authority, as detailed in Table 1.5.0-1. These GSAs possess the authority and responsibility to manage the Subbasin sustainably under the SGMA (California Water Code, §10723). Contact information for each of the GSA plan managers is included in Appendix A.

1.5.1 Organization and Management Structure of the GSA(s)

23 CCR § 354.6(b) *The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.*

The five participating GSAs collaboratively developed this single GSP for Subbasin under an Interim Operating Agreement (Appendix F). Each GSA was formed by local member agencies that represent stakeholders on the GSA Board of Directors (Table 1.5.1-1). The Board of Directors and technical teams collect and organize data from experienced consultants as well as seek feedback from groundwater users within the GSA boundaries through each SGMA phase (Appendix B and Appendix C). The GSA decision-making process is divided into various organization's roles. Below includes a description of each organization's responsibilities:



Subbasin Management Team- Each GSA has a representative on the team who worked collaboratively to jointly develop this GSP and manage groundwater in the basin.

Board of Directors- Adopts policies regarding the development and implementation of the GSP.

Stakeholder/Advisory Committees- Makes recommendations to the Board of Directors and technical consultants based on feedback from stakeholders to ensure this GSP accounts for representative local interests of all beneficial users. The committees work to encourage active involvement of a diverse, social, cultural, and economic elements of each GSA's population. Not all participating GSAs elected to have stakeholder/advisory committees.

1.5.2 Legal Authority of the GSA(s)

23 CCR § 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.*

SGMA delegates the responsibility and authority to sustainably manage groundwater to local agencies through adoption and implementation of a GSP in medium-or high-priority basins (California Water Code, §10720). SGMA provides "*local [GSAs] with the authority and the technical and financial assistance necessary to sustainably manage groundwater*" (California Water Code, §10720.1). GSAs have regulatory authority including but not limited to adoption of regulations, conduction of investigations, and requirement of registered groundwater extraction facilities to sustainability manage groundwater within the basin (California Water Code, §10725). The five GSAs that overlay the Subbasin are collaborating to develop a single comprehensive GSP, as outlined in the California Water Code §10723(a). Each GSA covers a specific segment of the Subbasin, as delineated in DWR Bulletin 118, Basin No. 5-022.12. To facilitate coordinated development and implementation of the GSP, these GSAs have entered into an Interim Operating Agreement (Appendix F).

The Subbasin is designated as a high-priority basin and therefore requires preparation of a GSP that will achieve groundwater sustainability in the basin within 20 years of implementation (California Water Code, §10720.7; 10727.2[b]). GSAs are required to lead communication, outreach, and engagement efforts within the basin and develop and implement a GSP on a basin-wide scale to sustainable manage groundwater at the local level.

1.6 Interim Operating Agreement

Each of the five GSAs within the Subbasin operate under an Interim Operating Agreement (effective September 1, 2017) to facilitate coordination and management actions. SGMA expects local agencies to collaborate on a subbasin-wide scale and a combination of GSAs may be formed using a "joint powers agreement, a memorandum of agreement, or other legal agreement" (California Water Code, §10723 [b]). The Interim Operating Agreement is categorized as a legal agreement and ensures communication and coordination of the data and methodologies used by each GSA in developing the GSPs within the Subbasin for several factors, including groundwater elevation and extraction data, surface water supply, total water use, change in groundwater storage, water budget, total water use, and sustainable yield. Each GSA entered the Interim Operating Agreement to set forth their mutual intent to develop a single GSP for the Subbasin and authorize research and data collection required for the GSP according to a mutually agreeable timeline. Under this agreement, the GSAs agree to utilize their best efforts in preparing the GSP. A copy of the Interim Operating Agreement is included in Appendix F. Additionally, the SWK GSA and SFK GSA have a data sharing agreement with the neighboring Westside Subbasin.

1.7 Groundwater Sustainability Plan Organization

This GSP is organized as follows:

The Executive Summary provides a summary overview of this GSP and a description of groundwater conditions at the basin, including management strategies and implementation actions.

Responses to DWR and SWRCB Comments: A table presenting the comments by DWR in the Inadequate Determination letter and the SWRCB comments in the Draft Staff Report.

Chapter 1. Introduction: Includes the purpose of the GSP under SGMA to sustainably manage groundwater, the sustainability goals, the specifics of the participating GSAs, and the outline of the organization to this GSP.

Chapter 2. Plan Area: Specifies the geographic extent of the GSP including but not limited to jurisdictional boundaries, existing land uses and land use policies, identification of water sources, density of wells, and location of communities dependent on groundwater in the Subbasin.

Chapter 3. Basin Setting: Describes the physical setting and characteristics of the current Subbasin conditions relevant to the GSP, including a Hydrogeologic Conceptional Model of the basin conditions, current and historic groundwater conditions, management areas, and a water budget.

Chapter 4. Sustainable Management Criteria: Establishes criteria for sustainable groundwater management in the Subbasin, including how the GSAs will characterize undesirable results, and minimum thresholds and measurable objectives for the sustainability indictors.

Chapter 5. Monitoring Network: Describes the GSP's monitoring network to collect sufficient data on groundwater conditions and to assess the plan's implementation through monitoring protocols on data collection and an established management system.

Chapter 6. Projects and Management Actions: Outlines the project and management actions of the GSAs to meet the sustainability goal of the basin in a manner that can be maintained.

Chapter 7. Plan Implementation: Consists of estimated GSP implementation costs, funding sources, GSP implementation schedule, and a plan for annual reporting and evaluation.

Chapter 8. References: Includes a list of all references used to develop the GSP.

Appendices: Includes additional information including but not limited to GSA contact information, the Interim Operating Agreement, Communication and Engagement Plan, Hydrogeologic Models, and the GSP checklist.

2. PLAN AREA

23 CCR §354.8 *Each Plan shall include a description of the geographic areas covered, including the following information:*

- *One or more maps of the basin that depict the following, as applicable:*
- *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.*
- *Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.*
- *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.*
- *Existing land use designations and the identification of water use sector and water source type.*
- *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 the best available information.*

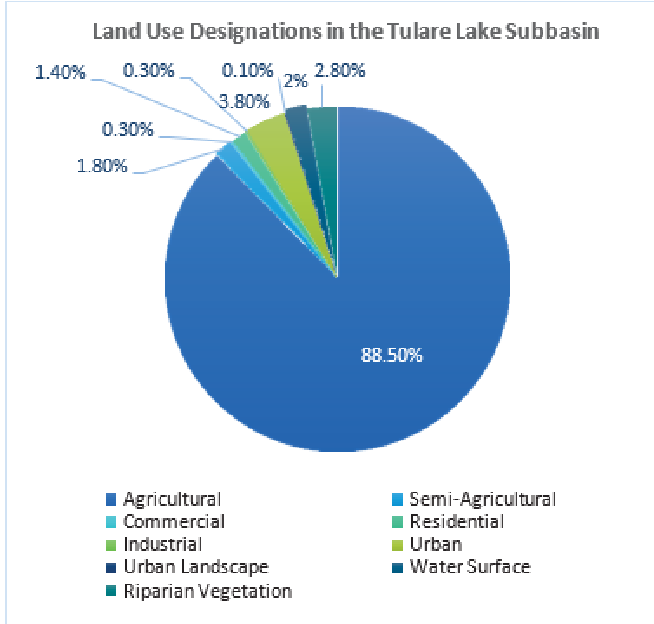
Tulare Lake Subbasin Prioritization Factors

- **Area:** ~837 square miles (535,869 acres)
- **Population (2010):** ~125,907
- **Projected Population Growth (2030):** ~176,446
- **Population Density:** ~150 persons/square mile
- **Public Supply Wells:** ~75
- **Total Wells:** ~9,380
- **Irrigated Acres:** ~251,994
- **Groundwater Supply:** ~50% of water supplies
- **Total Storage Capacity:** ~17.1 million acre-feet (AF)

Source: DWR 2019b.

The Tulare Lake Subbasin (Subbasin) is located within the southern portion of the San Joaquin Valley Basin in the Central Valley of California. The Subbasin is defined under DWR Bulletin 118 as a high-priority basin (Basin No. 5-22.012). The Subbasin covers approximately 837 square miles (535,869 acres) including portions of the Kings, Kern, and Tulare counties (DWR 2016b). The five GSAs located within the Subbasin are the Mid-Kings River (MKR), South Fork Kings (SFK), Southwest Kings (SWK), El Rico (ER), and Tri-County Water Authority (TCWA) (Figure 2.0.0-1). The GSAs do not overlap, and the groundwater basin contains no adjudicated areas.

There are a total of 28 water management entities in the Subbasin GSA Plan area (Plan area) that have signed on as members of GSAs (Figure 2.0.0-2 through Figure 2.0.0-6). Federal lands located within the Plan area include Bureau of Land Management (BLM) parcels and administrative offices, the Santa Rosa Rancheria lands owned by the Bureau of Indian Affairs, and portions of the California Aqueduct regulated by the United States Bureau of Reclamation (USBR) (BLM 2019). State lands include the California State Prison Corcoran, Avenal State Prison, California Judicial Council courthouses, California Department of Transportation (Caltrans) storage facilities, portions of the Coastal and California Aqueducts regulated by DWR, State Routes 41, 198, and 43 and Interstate 5 (DGS 2019). Future planned development of these thoroughfares includes expansion to allow for additional vehicle capacity. A portion of the proposed California High Speed Rail alignment traverses portions of the MKR and ER GSAs (Figure 2.0.0-1; Figure 2.0.0-2 and Figure 2.0.0-5) (High-Speed Rail Authority 2019). Tribal lands located within the Plan area include the Santa Rosa Indian Community of the Santa Rosa Rancheria (DWR 2017a).



Land uses within the Plan area were surveyed by DWR in 2014, with additional for Kings, Kern, and Tulare Counties in 2003, 2006, and 2007, respectively (Figure 2.0.0-7 through Figure 2.0.0-11). The Plan area is primarily comprised of agricultural and urban land use designations. Agriculture accounts for the largest percentage (over 88%) of land use in the Subbasin (Table 2.0.0-1). The primary land use designations for urban land are residential, commercial, and industrial, with groundwater being the primary source of potable water (Table 2.0.0-2; DWR 2017a).

The Subbasin is supplied by surface water from the California Aqueduct, and the Friant-Kern Canal, Kings River, the Tule River, the Kaweah St. John's Rivers, Kern River and unregulated streams including Deer Creek, Poso Creek, White River, Cottonwood Creek, and Arroyo Pasjero. In 1995, DWR estimated the total groundwater storage capacity of the basin to be 17.1 million acre-feet (AF) to a depth of 300 feet, and 82.5 million AF to the base of fresh groundwater (DWR 2016b).

Figure 2.0.0-12 presents a map showing the density of wells in the GSA area. Records dating back to the 1940s indicated that over 12,000 wells may have been installed. This figure is derived from various sources, including the DWR Online System of Well Completion Reports (DWR OSWCR), the United States Geological Survey update to the DWR OSWCR, the California Groundwater Ambient Monitoring and Assessment (GAMA) dataset, and the Kings County Well Permit Records database. As discussed further in Chapter 3, it is estimated that approximately 3,554 wells are currently active, serving beneficial purposes for domestic, agricultural, municipal, or industrial uses. Of these, approximately 1,797 wells are used for agricultural purposes, and 1,573 for domestic purposes. Additionally, there are about 89 wells for municipal supply, 54 for industrial use, 16 dedicated to water supply, and 30 wells categorized for undefined or miscellaneous purposes.

2.1 Summary of Jurisdictional Areas and Other Features

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

2.1.1 Groundwater Sustainability Plan (GSP) Area

The Plan area includes the jurisdictional boundaries of the MKR, SFK, SWK, TCWA, and ER GSAs (Figure 2.0.0-1). Most of the Plan area is located within Kings County, with small areas in Tulare and Kern Counties. The Kings Subbasin is the northern boundary of the Plan area, with the Westside and Kettleman Plains Subbasins on the western boundary, the Kaweah and Tule Subbasins to the East, and Kern County Subbasin to the south (DWR 2019d). The Plan area is comprised of five GSAs and 28 entities, which are described further below. Water use sector and water source type vary by agency (Table 2.0.0-2). Many private domestic and private community wells are used in rural and semi-rural areas throughout the Subbasin.

2.1.2 Mid-Kings River Groundwater Sustainability Agency

The MKR GSA covers approximately 152 square miles (±97,300 acres) and is located in the northeastern portion of the Subbasin (Figure 2.0.0-2) (DWR 2019d). The population within the MKR GSA is approximately 60,000 people, and the primary industry within the MKR GSA is agriculture. Other industries within the boundary include food processing, as well as warehousing and distribution, and commerce (e.g., automotive shops, supermarkets, etc.). There are numerous public and private entities that use or manage surface and groundwater within the MKR GSA as described below.

Kings County Water District

Formed in the 1950s, the Kings County WD area is approximately 223 square miles (~143,000 acres) in northeastern Kings County in the central portion of the San Joaquin Valley. Surface water is obtained from the Kings River and Kaweah and St. John's Rivers through ditch company stock ownership. Kings County WD owns ditch stock for Kings River supplies in Lemoore Canal and Irrigation Company, Peoples Ditch Company, Settlers Ditch Company, and the Last Chance Water Ditch Company and ditch stock for Kaweah River supplies from Lakeside Ditch Company. Kings County WD also purchases surplus water from the Friant Division of the Central Valley Project (CVP), when available. There are numerous intentional recharge basins located in the Kings County WD, including the Apex Ranch Conjunctive Use Project, which is a groundwater bank that uses 50 acres of dry Kings River channel as a recharge area (Kings CWD 2011). Kings County WD is also responsible for managing flood water deliveries to the Old Kings River channel – a former river channel which is delivered wet year supplies through Peoples Ditch.

County of Kings

Kings County, founded in 1893, is located on the western side of California's San Joaquin Valley. Kings County covers an area of approximately 1,391 square miles (~890,240 acres), 1,024 square miles (±655,132 acres) of which are dedicated to harvested crops and other agricultural uses (Kings County 2019). U.S. Census Bureau estimates Kings County has a population of 151,336 as of 2018 (U.S. Census Bureau 2018) and is the 10th largest agricultural production county in the state, grossing over two billion dollars in 2017. Top commodities produced in Kings County include cattle, milk, cotton, pistachios, almonds, tomatoes, and grapes.

City of Hanford

The City of Hanford, incorporated in 1891, is located 30 miles southeast of Fresno in northern Kings County. The City of Hanford encompasses approximately 25 square miles (~16,000 acres) and has a population of over 55,000. The sole source of water for the City of Hanford is groundwater, currently delivering 11,640 AF per year (AF/yr). The City of Hanford operates a wastewater treatment facility that discharges treated wastewater to percolation ponds or to farmlands for irrigation purposes (City of Hanford 2011).

Peoples Ditch Company

The Peoples Ditch Company, organized in 1873, is a pre-1914 water right holder on the Kings River that delivers water to the MKR and ER GSAs. Peoples Ditch Company's main canal system is located within the MKR GSA. The Peoples Ditch diversion off the Kings River is just upstream of Peoples Weir, south of Kingsburg. Peoples Ditch Company controls a portion of the storable volume behind Pine Flat Dam. The City of Hanford and Peoples Ditch Company have agreements regarding stormwater conveyance to Peoples Ditch and maintenance of facilities through the City of Hanford (City of Hanford 2017). Surface water diversions for Peoples Ditch Company average over 144,400 AF/yr over the last 100+ years of record (DWR 2012).

Last Chance Water Ditch Company

Last Chance Water Ditch Company, established in 1873, is a pre-1914 water right holder on the Kings River. The Last Chance Main Canal system and side ditches are located in the Hanford-Armona area in the central San Joaquin Valley. The Last Chance Main Canal diversion off the Kings River is just upstream of the Last Chance Weir, northeast of the 12th Avenue and Elder Avenue intersection. Last Chance Water Ditch Company controls a portion of the storable volume behind Pine Flat Dam, and surface water diversions for the company average over 62,200 AF/yr over the last 60+ years of record (KRCD 2009).

Santa Rosa Rancheria

The Santa Rosa Rancheria community is comprised of approximately 700 residents. The Rancheria encompasses 2.8 square miles (±1,800 acres) within Kings County. The Rancheria relies on groundwater pumping for the majority of its water consumption (DWR 2019b).

Grangeville

The Grangeville community, located 3.5 miles west-northwest of Hanford, is home to approximately 470 residents. Due to the lack of public water supply, the area is characterized by a high density of private domestic wells.

Armona Community Services District

Armona Community Services District (CSD) serves the unincorporated community of Armona in Kings County. Armona CSD operates two groundwater wells that supply the population of 3,200 residents with 600 AF/yr (Armona CSD 2015). Recent discussions with Armona CSD staff in November of 2019 suggest the population has increased to 4,150 (Armona CSD 2019).

Home Garden Community Services District

Home Garden CSD serves the unincorporated community of Home Garden in Kings County. Groundwater wells provide water for 1,700 residents of the community (Home Garden CSD 2015).

Settlers Ditch Company

Settlers Ditch Company stock is a derivative of Peoples Ditch Company stock. In contrast, the Settlers Ditch Company has a separate Board of Directors and the ditch system is not viewed as part of Peoples Ditch Main Canal. Settlers Ditch delivery system is east of Hanford and generally north of Highway 198 (Kings CWD 2011).

New Deal Ditch Company

The New Deal Ditch Company holds a dry ditch stock, which gives access to deliver other stock water supplies through the New Deal Ditch. The New Deal Ditch begins at the end of the Peoples Ditch near the basin southwest of the 12th Avenue and Houston Avenue intersection. The New Deal Ditch generally delivers surface water to Peoples Ditch Company within part of the Kings County WD service area (Kings CWD 2011).

Lakeside Irrigation Water District

Lakeside Irrigation WD was formed in 1962 and its 31,991 acre service area is almost entirely within Kings County WD. Lakeside Irrigation WD has roughly the northern third of its service area in the Subbasin and the MKR GSA, while the southern two-thirds is in the Kaweah Subbasin and the Greater Kaweah GSA. There are 56 miles of open ditch in the Lakeside system as well as 10 recharge/regulation basins.

Lakeside Ditch Company, established in 1874, is a pre-1914 water right holder on the Kaweah River. The Lakeside canal system is located in the area southeast of Hanford in the central San Joaquin Valley. The Lakeside diversion off the Kaweah River is northeast of the 5th Avenue and Grangeville Boulevard intersection, just east of the Lakeland Canal. Kings County WD is a Lakeside Ditch Company stock holder as is Lakeside Irrigation WD.

2.1.3 South Fork Kings Groundwater Sustainability Agency

The SFK GSA covers approximately 111 square miles (±71,313 acres) and is located in the northwestern part of the Subbasin (Figure 2.0.0-3) (DWR 2019d). The public and private agencies within the SFK GSA include the City of Lemoore, Kings County, Empire Westside Irrigation District (ID), Stratford ID, Stratford Public Utility District (PUD), Company, Lemoore Canal and Irrigation Company, John Heinlen Mutual Water Company, and Jacob Rancho Water Company. The primary industries within the SFK GSA are agriculture and food processing (Appendix B).

City of Lemoore
The City of Lemoore, incorporated in 1900, lies within the northern portion of Kings County. The City of Lemoore encompasses an area of 6.82 square miles (±4,371 acres) and includes over 25,000 residents. Water supplies are approximately 8,300 AF/yr, with groundwater acting as the sole source for the City of Lemoore. The majority of water deliveries are metered. The City of Lemoore operates a wastewater treatment plant where treated wastewater is delivered to local farms for agricultural use (City of Lemoore 2015).

Empire Westside Irrigation District
Empire Westside ID was formed in 1931 and is a Kings River member unit. Its service area of 6,400 acres stretches from northwest to southwest of Stratford in Kings County. Empire Westside ID has a storage share of the Kings River of 13,000 AF and is a State Water Project Contractor (KRCD 2009).

Stratford Irrigation District
Stratford ID was formed in 1916 and is a Kings River member unit. Its service area is near Stratford in Kings County and encompasses 9,800 acres. Stratford ID has a storage share of the Kings River of 11,000 AF (KRCD 2009).

Stratford Public Utility District
Stratford PUD serves a population of 1,300 in the unincorporated community of Stratford within Kings County. Stratford PUD operates three groundwater wells that serve 340 metered service connections (Kings County 2015).

Lemoore Canal and Irrigation Company
Lemoore Canal and Irrigation Company was established in 1870. As a mutual water company, it serves the stockholders of the Lemoore area. The Company encompasses 52,300 acres and has a storage share of the Kings River of 100,000 AF (KRCD 2009).

John Heinlen Mutual Water Company
The John Heinlen Mutual Water Company serves an area of 13,100 acres near Lemoore in Kings County. The Company has a storage share of 10,000 AF of the Kings River (KRCD 2009).

Jacob Rancho Water Company
Jacob Rancho Water Company is a private water company operating within the SFK GSA.

2.1.4 Southwest Kings Groundwater Sustainability Agency

The SWK GSA covers approximately 140.6 square miles (±90,000 acres) and is located in the western portion of the Subbasin (Figure 2.0.0-4). The public and private agencies within the SWK GSA are Dudley Ridge WD, Tulare Lake Reclamation District (RD) #761, Kettleman City CSD, and Tulare Lake Basin Water Storage District (TLBWSD). Due to the poor yield and poor quality of the groundwater within the SWK GSA, only a minimal quantity of groundwater is pumped within the GSA. The primary industries within the GSA are agriculture, oil production, and commercial usage specific to Kettleman City (Appendix B).

Tulare Lake Basin Water Storage District
The Tulare Lake Basin Water Storage District (TLBWSD), formed in 1926, is located in Kings and Tulare Counties and overlies several GSAs. TLBWSD has a service area of 296.88 square miles (±190,000 acres). TLBWSD obtains surface water from the Kings River, with supplemental deliveries from the Tule and Kaweah Rivers and the State Water Project (SWP). On average, TLBWSD delivers approximately 324,400 AF (Tulare Lake Basin Water Storage District 2015).

Dudley Ridge Water District
Dudley Ridge WD, organized in 1963, is located in Kings County south of Kettleman City. Dudley Ridge WD services agricultural lands and encompasses an area of 58.77 square miles (±37,615 acres). Dudley Ridge WD water supply consists of water from the SWP and local transfers. Dudley Ridge WD does not use local groundwater due to low yields and poor quality. Instead, landowners within Dudley Ridge WD import groundwater from the Angiola ID well field in Tulare County through canals across the Tulare Lake Bed. The annual water use for the Dudley Ridge WD is approximately 45,000 AF (Dudley Ridge WD 2012).

Tulare Lake Reclamation District #761
Tulare Lake RD #761 is located in the central San Joaquin Valley. Its boundaries primarily lie within the TLBWSD and encompass approximately 54.69 square miles (±35,000 acres). Tulare Lake RD #761 averages annual deliveries of approximately 24,500 AF from the Kings River (DWR 2012).

Kettleman City Community Service District
Kettleman City CSD serves a population of approximately 1,500 residents in the unincorporated community of Kettleman City. Historically, Kettleman City CSD has provided approximately 315 AF/yr from groundwater wells (Kettleman City CSD 2009). The CSD will now rely on surface water from their new Surface Water Treatment Facility. Their groundwater wells -are used as a back-up emergency supply.

2.1.5 El Rico Groundwater Sustainability Agency

The ER GSA covers approximately 357 square miles (±228,400 acres) and is located in the center of the Subbasin (Figure 2.0.0-5) (DWR 2019d). The public and private agencies within the El Rio GSA are the City of Corcoran, Kings County, Alpaugh ID, Melga WD, Lovelace RD, Salyer WD, Corcoran ID, Tulare Lake Drainage District, and the TLBWSD. The primary industry within the ER GSA is agriculture. Other industries within the boundary include food processing, as well as warehousing and distribution, and commerce industry that is standard in a community of approximately 10,000 people (e.g., automotive shops, supermarkets, etc.) (Appendix B).

City of Corcoran
The City of Corcoran, incorporated in 1914, lies on the eastern side of Kings County. The City of Corcoran has a population of approximately 22,215 and encompasses approximately 7.5 square miles (4,800 acres). The City of Corcoran relies on groundwater to supply its residents with approximately 5,000 AF/yr of domestic water supply (City of Corcoran 2014).

Tulare Lake Basin Water Storage District
TLBWSD, formed in 1926, is located in Kings and Tulare Counties and overlies several GSAs. TLBWSD has a service area of 296.88 square miles (±190,000 acres). TLBWSD obtains surface water from the Kings River, with supplemental deliveries from the Tule and Kaweah Rivers and the SWP. In a representative year, TLBWSD delivers approximately 324,400 AF (Tulare Lake Basin Water Storage District 2015).

Alpaugh Irrigation District
The Alpaugh ID was formed in 1915 and encompasses approximately 15.625 square miles (±10,000 acres). It is located on the southeastern edge of the Subbasin and is within the ER GSA. Alpaugh ID relies mostly on groundwater for its deliveries, operating 18 wells with the capability to deliver approximately 4,000 AF/yr. Alpaugh ID is a subcontractor with Tulare County for up to 100 AF/yr of CVP water. Alpaugh ID does not have other surface water contracts but utilizes small allotments of flood waters in the Homeland Canal (USBR 2018).

Corcoran Irrigation District
Corcoran ID was formed in 1919 to provide irrigation water to land within its boundaries. Corcoran ID encompasses approximately 34.38 square miles (±22,000 acres). Corcoran ID obtains most of its surface water from the Kings River, with supplemental deliveries from the Kaweah and St. John's Rivers and USBR Section 215 water (Irrigation Training and Research Center 2008).

Lovelace Reclamation District #739
Lovelace RD #739739 encompasses approximately 9.22 square miles (±5,900 acres) located north of TLBWSD. Lovelace RD's primary function is flood control (DWR 2012).

Salyer Water District
Salyer WD is located in and around the TLBWSD. Salyer WD encompasses approximately 16.25 square miles (±10,400 acres) (DWR 2012).

Tulare Lake Drainage District
Tulare Lake Drainage District is a California Drainage District located in Kings, Tulare, and Kern Counties.

Melga Water District
Melga WD was formed in 1953 and encompasses approximately 117.19 square miles (±75,000 acres) mostly within the TLBWSD. Surface water supplies are obtained from the SWP and Kings River with periodic availability from the Kaweah and Tule Rivers (DWR 2012).

2.1.6 Tri-County Water Authority Groundwater Sustainability Agency

The TCWA GSA is a collective group of local water agencies dedicated to monitoring and regulating groundwater in the Tulare Lake Hydrologic Region. The TCWA GSA covers approximately 170.0 square miles (±108,800 acres) in the Tulare Lake and Tule Subbasins (Figure 2.0.0-6) (DWR 2019d). Approximately 75.19 square miles (±48,120 acres) of the GSA's area is located within the southeastern portion of the Subbasin. The primary industry within the TCWA GSA is almost entirely agriculture (Appendix B).

County of Tulare
Tulare County, formed in 1852, encompasses approximately 4,839 square miles (±3,096,950 acres) and is located south of Fresno County. As of the 2010 census, the population was 442,179 (U.S. Census Bureau 2018; Tulare County 2019).

County of Kings
Kings County, founded in 1893, is located on the western side of California's San Joaquin Valley. Kings County covers an area of approximately 1,391 square miles (890,240 acres). U.S. Census Bureau estimates Kings County has a population of 151,336 as of 2018 (U.S. Census Bureau 2018). Federal lands located within the Plan area include BLM parcels and administrative offices, the Santa Rosa Rancheria lands owned by the Bureau of Indian Affairs, and portions of the California Aqueduct regulated by the USBR (BLM 2019)

Angiola Water District
Angiola WD, formed in 1957, is an agency within the TCWA GSA. Irrigation wells within the area are mostly owned by the Angiola WD. Groundwater pumping supplements the fluctuating surface water supplies sourced from SWP, CVP, Kings River, Tule River, Deer Creek, and floodwaters from Tulare Lake (DWR 2012).

Atwell Island Water District
Atwell Island WD encompasses approximately 11.1 square miles (±7,100 acres). Atwell Island WD delivers surface water supplies from subcontracts with the County of Tulare of up to 50 AF/yr. Atwell Island WD does not operate any groundwater wells or recharge facilities in the Tulare lake Subbasin (DWR 2012).

W.H. Wilbur Reclamation District #825
According to databasin website, W.H. Wilbur RD #825 is located within the TCWA GSA.

Deer Creek Storm Water District
According to Local Agency Formation Commission website for Tulare County, Deer Creek Storm WD is located within the TCWA GSA.

2.2 Water Resources Monitoring and Management Programs

> ***23 CCR §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.*

2.2.1 Monitoring and Management Programs

Groundwater Level Monitoring
Historically the California Statewide Groundwater Elevation Monitoring (CASGEM) Program tracked long-term groundwater elevation trends throughout California. The Kings River

Conservation District (KRCD) was the local agency that monitored groundwater levels within the Plan area. KRCD facilitates collaboration between local monitoring entities and DWR. The data was collected twice a year, in the spring and the fall (DWR 2012).

Kings County WD monitors groundwater levels on a regional scale and has monitored the groundwater since the 1950s. Kings County WD collects water level data from up to 280 wells in the spring and fall (Kings CWD 2011).

As of 2020, with the implementation of SGMA, the GSAs have taken over responsibility for groundwater elevation monitoring. The monitoring continues to be conducted twice a year with increased monitoring in select wells. Additional information is presented in Chapter 5, *Monitoring Network*.

Groundwater Extraction Monitoring

While there are wells with meters in the Subbasin, it is not known exactly how many private wells are metered. Agricultural groundwater pumping is currently monitored based on satellite imagery (which measures evapotranspiration), and total groundwater pumping is calculated based on surface water delivery (which is measured and reported). This methodology does not distinguish pumping amounts from shallow versus deep aquifers. The GSAs are committed to implementing a well registration program, as discussed in Chapter 6 (*Projects and Management Actions)*, which will improve the measurement of groundwater extraction. Potential future groundwater monitoring policies are discussed in Chapter 5, *Monitoring Network.*

Groundwater Quality Monitoring

Currently, groundwater quality monitoring in wells is limited, except for municipal systems. Chapter 4 (Sustainable Management Criteria), describes criteria for defining undesirable results based on existing information. Chapter 5 (Monitoring Network) describes the location and frequency of proposed future groundwater quality monitoring within the Subbasin.

Land Surface Subsidence Monitoring

Land subsidence has been measured for many years throughout the Central Valley. The Plan area contains various local monitoring networks, which can be utilized to survey existing benchmarks to measure subsidence. The United States Geological Survey (USGS), National Aeronautics and Space Administration (NASA), and KRCD also measure subsidence in the Central Valley. DWR commissioned NASA's Jet Propulsion Laboratory to utilize airborne and satellite radar data (InSAR) to measure ongoing land subsidence throughout California and produce maps showing how subsidence varies seasonally and regionally. USGS and NASA have published maps on their websites that show the subsidence monitoring results for a defined time-period (USGS 2019; NASA 2017). KRCD also has a 7-mile grid that monitors surface elevation benchmarks for land subsidence. Caltrans has a benchmark correction control network with historic elevation updates showing ground movement within the Subbasin at various locations. See Chapter 5, Monitoring Network, for further information regarding subsidence in the Plan area.

Surface Water Monitoring

The various irrigation entities in the Subbasin monitor the delivery of surface water, much of which originates from the Kings River. Kings River Water Association (KRWA) monitors surface water in the Kings River and the associated watershed conditions including seasonal snowpack, reservoir stage, reservoir inflow and outflow, Kings River flows, and Kings River diversions. The Friant Water Authority monitors San Joaquin River water deliveries through the Friant-Kern Canal. The

Kaweah and St. Johns Rivers Association monitors Kaweah River water flows and deliveries, and the St. John's River that reaches the subbasin via Cross Creek and Tule River. The Tule Rivers Association monitors Tule River water flows and deliveries. DWR, Dudley Ridge WD, Empire West Side WD, and TLBWSD monitor the SWP flows and deliveries that enter the Subbasin.

Surface Water Quality Monitoring

Surface water quality is monitored through the Irrigated Lands Regulatory Program (ILRP), which 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. Surface water quality has been monitored for several years, and in the future, groundwater quality will be monitored. The program is administered by the Central Valley Regional Water Quality Control Board (RWQCB).

Under the ILRP rules, agricultural crop growers may form "third party" coalitions to assist with required monitoring, reporting, and education requirements for irrigated agriculture. The Kings River Water Quality Coalition (KRWQC) was established in 2009 as a Joint Powers Agency to combine resources and regional efforts to comply with the regulatory requirements of the ILRP. The KRWQC area and supplemental areas cover most of the Plan area (KRWQC 2016). The Westside Water Quality Coalition (WWQC) was formed in 2013 as part of the ILRP. Dudley Ridge WD is within the boundaries of the WWQC (WWQC 2019). Regional information on surface and groundwater quality is available from the individual coalitions.

In 2020, agricultural representatives, dairies, and other permitted dischargers in the Kings and Tulare Lake Subbasins formed the Kings Water Alliance (KWA) to address nitrate impacts in groundwater. KWA offers free water quality tests to private well owners. Free bottled water is delivered to well owners with test results of elevated levels of nitrates.

GSP Monitoring and Management Plans

The individual water entities located within the Plan area will be responsible for continuing to collect data for any current monitoring or management plan. The monitoring program is described further in Chapter 5, Monitoring Network.

Operational Flexibility

> ***23 CCR §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.*

The operational flexibility available to water users (particularly agricultural water users) is affected by various factors that regulate the delivery of surface water into the Subbasin.

Regulatory Decisions and Agreements

Regulatory monitoring and management programs outside the boundaries of the Subbasin have limited the operational flexibility and management of the Subbasin, by reducing the CVP and SWP delivery amounts, which include the following:

1992 Central Valley Project Improvement Act (CVPIA): The CVPIA is a multipurpose federal water legislation providing for water resource management throughout the western United States (U.S.). Enactment of the CVPIA mandated changes in the CVP and reallocation of water supplies and reductions in pumping, particularly for the protection, restoration, and enhancement of fish and wildlife. Water supplies in the Plan area have been reduced as a result of the CVPIA. Supplies were impacted due to pumping restrictions within the Delta and development of refuge supplies from previously available contract supplies, which led to decreased allocations for Mid-Valley Canal and Cross Valley Canal contracts.

2007 Wanger Decision: A federal decision found that USBR did not consider evidence that fish, including salmon and delta smelt, would be harmed by increased water exports for the Sacramento-San Joaquin Delta. The result of this curtailed SWP and CVP pumping from the Delta, reducing overall supplies to the Subbasin.

Places of Use

Water users are limited in the place of use for which they irrigate depending on irrigation district that supplies the water. Application of irrigation water from Kings River, SWP, and CVP is restricted to the place of use defined by the water rights if each irrigation or water agency. This GSP will not alter these agreements.

Groundwater Contaminant Plumes

Contaminant plumes can create operational limitations if pumping either intercepts a plume of if pumping could change the extent or boundary of the plume. Contaminant plumes in the Subbains are not a major limiting factor affecting operational flexibility. Water quality for individual monitoring wells can be found from Geotracker (SWRCB 2019a) and Chapter 3, Basin Setting, contains more information on contaminant plumes in the Subbasin.

Kings River Fisheries Management Program

A partnership has been forged between KRCD, the KRWA, and the California Department of Fish and Wildlife (CDFW) to create the Kings River Fisheries Management Program (KRFMP). This program includes numerous measures that benefit the Kings River fisheries, including year-round flows, improved temperature control, and additional monitoring. However, this comes at the expense of some operational flexibility for Kings River water users. The Kings River provides the majority of the surface water used in the Subbasin area (KRFMP 1999).

Several requirements are placed on Pine Flat Reservoir and Kings River operations, as a part of the program. These include maintaining a minimum of 100,000 AF in Pine Flat Reservoir, temperature control pool (10 percent [%] of the reservoir's capacity), and October through March minimum fish flow releases below Pine Flat Dam (KRFMP 1999).

The local water entities have already adjusted agricultural operations to adapt to the KRFMP. In the future, additional recharge and banking facilities could help the program to further adapt by providing a place to store Kings River waters when supply exceeds irrigation demands.

2.2.2 Conjunctive Use Programs

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

> ***Conjunctive Use*** *is the deliberate combined use of groundwater and surface water, which involves actively managing the aquifer systems as an underground reservoir.*

Conjunctive use is the coordinated and planned management of surface and groundwater resources to maximize their efficient use. Conjunctive use can improve water supply reliability, maintain streamflows for environmental uses, and protect water quality. Conjunctive use has been occurring in the Tulare Lake Subbasin for many years, with many water users primarily relying on surface water when it is available and switching to groundwater when surface water supplies are less available seasonally or are limited throughout a season during droughts. Conjunctive use also using storage and recharge systems to recharge groundwater with excess surface water during wet years, allowing that recharge to be pumped as groundwater during dry periods.

Storage and recharge basins have existed in the Tulare Lake Subbasin for many years. Kings County WD operates numerous recharge basins within its district. Within Kings County WD, the Apex Ranch Conjunctive Use Project uses 50 acres of dry Kings River channel as a recharge area. Alpaugh ID has storage ponds that provide incidental recharge (Kings CWD 2011). Corcoran ID operates percolation basins with a 10,000 AF capacity capable of recharging 200 AF/day (DWR 2012). The City of Corcoran has an agreement with Corcoran ID to discharge stormwater into their ditch network for the purpose of recharge (City of Corcoran 2014). Additionally, the City of Hanford has a very similar agreement with Peoples Ditch Company.

2.3 Relation to General Plans

2.3.1 Summary of General Plan/Other Land Use Plans

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

Every county and city in California is required to develop and adopt a General Plan (California Government Code, §65350-65362). A General Plan is a comprehensive long-term plan for development of the county or city, which consists of a statement of development policies and identifies objectives, principles, standards, and proposals for the area. To an extent, a General Plan acts as a "blueprint" for development.

The Genera" Plan mus" contain seven state-mandated elements : Land Use, Circulation, Housing, Noise, Open Space, Conservation, and Safety. Additional elements can be included at the discretion of the land use entity. 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. Within the Plan area, all agencies with jurisdiction over land uses have adopted General Plans (Table 2.3.1-1).

As noted in Section 2.1.6.6, a relatively small portion of the ER GSA extends into Kern County. The extension consists of 640 acres (Figure 2.0.0-10), used as evaporation ponds and owned by the Tulare Lake Drainage District. It is considered unlikely that any Kern County General Plan policies have any practical relevance to the Plan area.

2.3.2 Land Use Plans and Water Demands

> ***23 CCR §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.*

All of the General Plans in the Plan area were adopted prior to SGMA and the establishment GSAs. The General Plans of Kings, Tulare, and Kern County, as well as the City of Hanford, Lemoore, and Corcoran make population and economic development assumptions to establish land use patterns for both rural and urban development. The Urban Water Management Plans (UWMPs) prepared for the City of Lemoore, Hanford, and Corcoran address assumed land use changes and growth rates. This GSP used the land use change assumptions identified in the General Plans as well as other information for forecasting the anticipated water budget, described later in this GSP. See Chapter 3, *Basin Setting,* for more information.

2.3.3 GSP Effects on Water Supply Assumptions for Land Use Plans

> ***23 CCR §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.*

There are six General Plans within the Plan area. The counties of Kings, Kern and Tulare and cities of Lemoore, Hanford, and Corcoran each possess a General Plan. The General Plan sections that cover the effect of the water supply are summarized below. Implementation of the GSP on planning assumptions will vary for each planning entity and the individual GSAs will recognize and coordinate with planning entity and consult with them prior to their five-year update milestones.

County of Kern General Plan

There are no anticipated impacts on Kern County lands within the Subbasin. The total Kern County land area within the Subbasin is approximately 640 acres (Kern County 2009).

County of Kings General Plan

Kings County ranks as the seventh fastest-growing county in population in California. The estimated 2018 population of Kings County was 151,366 (U.S. Census Bureau 2018). Future projections from the Department of Finance (DOF) expect the population to reach 181,218 by the year 2035 (DOF 2019). The Land Use (LU), Resource Conservation (RC), and Health and Safety (HS) sections of the Kings County General Plan discuss various topics including water supply. The primary water supply goal in this plan is for reliable and cost-effective infrastructure systems that permit the County to sustainably manage its diverse water resources and agricultural needs, secure additional water, and accommodate for future urban growth (Kings County 2010).

County of Tulare General Plan

Tulare County's General Plan 2030 Update developed goals and policies to encourage sustainable groundwater management, such as to develop additional water sources, implement water conservation, and encourage demand management measures for residential, commercial, and industrial indoor and outdoor water uses in all new urban development (Tulare County 2012).

City of Hanford General Plan

The Land Use, Transportation, Water Resources, and Public Facilities sections of the City of Hanford's General Plan discuss various topics including water supply. U.S. Census Bureau estimated the 2018 population to be 56,910 (U.S. Census Bureau 2018), City of Hanford staff suggest the population has increased to approximately 58,000 (City of Hanford 2019), which accounts for approximately 37% of the population of Kings County. The 2016 General Plan anticipates the population to increase to 90,000 by 2035. The annual gross water use in 2015 was 11,640 AF or 188 gallons per capita per day. The General Plan's 2020 urban water use targets 179 gallons per capita per day, which is intended to be maintained through the 2035 plan horizon. The anticipated gross annual water use by 2035 can be expected to be 18,045 AF (City of Hanford 2011). The primary water supply goal in the plan is to maintain reliable and cost- effective infrastructure systems that permit the City to sustainably manage its diverse water resources and needs.

City of Lemoore General Plan

The City of Lemoore General Plan policies are geared towards preserving environmental resources such as open space, prime farmland, wetlands, special species, water resources, air quality, and other elements of value to Lemoore residents. The estimated 2018 population of Lemoore was 26,474 (U.S. Census Bureau 2018). Sufficient land was allocated in the General Plan to accommodate for future population projections, which are expected to reach 48,250 by 2030. According to the 2005 City of Lemoore UWMP, the City of Lemoore's 2005 maximum day demand was approximately 12.8 million gallons per day, which is well within the current supply capacity of 19.2 million gallons per day. If the City grows at the anticipated rate, demand will exceed the supply available from existing wells. Since Lemoore is not located within an adjudicated water basin, there is no restriction on the number of wells the City of Lemoore may drill within City boundaries. Water quality maintenance is a more considerable challenge to meeting water demand for the City (City of Lemoore 2015).

City of Corcoran General Plan

The Land Use, Circulation, Safety, Conservation and Open Space, Air Quality, and Public Services and Facilities sections of the City of Corcoran's General Plan discuss various topics including water supply. U.S. Census Bureau estimated the 2018 total population of Corcoran to be 21,676 (U.S. Census Bureau 2018). By 2030, the population is expected to reach 26,888. The City of Corcoran's entire water supply is provided by local groundwater. The average daily demand in 2010 was 5.9 million gallons per day. Projected daily demand in 2030 is expected to increase to 5.5 million gallons per day, so projected water use targets a 20% use reduction. The General Plan's primary water supply goal is to protect natural resources including groundwater, soils, and air quality in an effort to meet the needs of present and future generations (City of Corcoran 2014).

2.3.4 Permitting Process for New or Replacement Wells

23 CCR §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.*

Kings County is the primary local jurisdiction with the authority to adopt a local well ordinance that meets or exceeds DWR Well Standards and provides regulatory authority over well construction, alteration, and destruction activities (DWR 2019a). California Water Code §10725 - §10726.9 describes the additional authoritative power of the GSAs to impose spacing requirements on new groundwater well construction, restrict operations for existing groundwater wells, and regulate groundwater extraction. The GSA may use the powers described in the above code to provide the maximum degree of local control and flexibility consistent with sustainability goals described in the GSP.

County of Kings

The Kings County General Plan Resource Conservation Policy A1.6.3 states the following regarding well installations:

Protect groundwater by enforcing the requirements for installation of wells in conformity with the California Water Code, the Kings County Well Ordinance, and other pertinent state and local requirements.

Kings County adheres to DWR Well Standards guidelines for the construction of groundwater wells that are intended to protect the groundwater quality and reduce the adverse effects caused by improper well construction (DWR 1981; DWR 1991). Kings County has the sole authority for establishing and enforcing the standards for construction and deconstruction of water wells. In accordance with the California Water Code §13801, Kings County Ordinance No. 587 has provisions that require permits for well construction, reconstruction and deepening, with oversight provided by the County's Health or Building Officials, and stipulates that no person shall dig, bore, drill, deepen, modify, repair, or destroy a well, cathodic protection well, observation well, monitoring well or any other excavation that may intersect groundwater without first applying for and receiving a permit unless exempted by law (Kings County 2000; 2001). The permittee is required to complete the work authorized by the permit within 180 days of the date of issuance of the permit.

Installation of domestic supply wells in Kings County must follow separate guidelines and regulations. Domestic wells installation requires completion of necessary permits, and site and well inspections. A well is not to discharge into the water distribution system until the above documents have been submitted to the Division Office and a field inspection of the well installation has been made by Kings County Environmental Health Services (Kings County Public Health Department 2009).

In 2022, the GSAs coordinated with Kings County to be included in the well permitting process. As well applications are submitted to the County, copies are routed to the appropriate GSA for review and approval. The GSA reviews the well application for details related to location, well depth, and proposed pumping rate. Once the GSA concurs that the well is not likely to cause impacts to surrounding wells, only then is the application approved.

County of Kern

There are no groundwater wells and no plans for any groundwater wells to be developed within Kern County within the boundaries of the Tulare Lake Subbasin

County of Tulare

Tulare County approved a water well ordinance in September 2017 (Tulare County Ordinance Code, Part IV. Health, Safety and Sanitation, Chapter 13. Construction of Wells) that addresses agricultural and domestic water wells. Well construction, destruction, and setback requirements have been altered under Tulare County Ordinance Code Part IV Chapter 13 (Tulare County 2017). This ordinance places restrictions on the drilling of new wells on previously non-irrigated land where the land has not had a well or has not had surface water in the past. Tulare County Environmental Health Services Division is responsible for the permitting and enforcement within the portion of the Subbasin in Tulare County. Tulare County Ordinance Code Part IV Chapter 13, Article 3 stipulates the following:

Except as otherwise provided in sections 4-13-1250 and 4-13-1255 of this Article, it shall be unlawful for any person to construct, deepen, reconstruct or destroy any well, or soil boring, or cause any of those acts to be done, unless a permit has first been issued to him or to the person on whose behalf the work is undertaken. The Tulare County Health Officer may prescribe *conditions if he determines that they are required to prevent contamination or pollution of underground waters. Permit conditions are appealable pursuant to section 4-13-1275 of this Article. A well permit shall be valid for six (6) months from the date of issuance.*

2.3.5 Land Use Plans Outside the Basin

23 CCR §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.*

In general, all future land use changes will need to consider potential impacts to neighboring basins from groundwater pumping, and updates to agency General Plans will need to consider GSPs along with other participating agencies. GSPs for neighboring basins will be evaluated by during the GSP review process. Coordination between subbasins is required as part of GSP implementation. A discussion of some potential management actions, including policy changes are described in Chapter 6, Projects and Management Actions.

Fresno County General Plan

The Public Facilities and Services section of the Fresno County General Plan discusses general public facilities and services; funding; water supply and delivery; wastewater collection, treatment, and disposal; storm drainage and flood control; and numerous other services (Fresno County 2000). The goal of the water supply and delivery section is to ensure the availability of an adequate and safe water supply for domestic and agricultural consumption. The relevant policies are listed below:

Policy PF-C.12 – The County shall approve new development only if an adequate sustainable water supply to serve such development is demonstrated.

Policy PF-C.13 – In those areas identified as having severe groundwater level declines or limited groundwater availability, the County shall limit development to uses that do not have high water usage or that can be served by a surface water supply.

Policy PF-C.23 – The County shall regulate the transfer of groundwater for use outside of Fresno County. The regulation shall extend to the substitution of groundwater for transferred surface water.

Policy PF-C.26 – The County shall encourage the use of reclaimed water where economically, environmentally, and technically feasible.

2.4 Additional GSP Elements

23 CCR §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.*

2.4.1 Saline Water Intrusion

Saline (or brackish) water intrusion is the induced migration of saline water into a freshwater aquifer system. Saline water intrusion is typically observed in coastal aquifers where over-pumping of the freshwater aquifer causes salt water from the ocean to encroach inland, contaminating the fresh water aquifer. The Subbasin is approximately 70 miles from the Pacific Ocean, and the potential for adverse impacts of saline intrusion in the Subbasin are considered low.

2.4.2 Wellhead Protection

A Wellhead Protection Area (WHPA) is defined by the Safe Drinking Water Act Amendment 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" (100 U.S. Code. 764). The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that 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.

According to the EPA website, 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.

According to the Safe Drinking Water Act, states may be delegated primary implementation and enforcement authority for the drinking water program. To date, California has no State-mandated program and relies on local agencies to plan and implement programs. 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.

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. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Essential to any wellhead protection program is proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface 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 not generally required, but is still recommended, for agricultural wells.

Municipal and agricultural wells constructed by the GSA member agencies are designed and constructed in accordance with DWR Bulletins 74-81 and 74-90. A permit is required from the applicable county prior to construction of a new well within the GSA's area. In addition, the GSA member agencies encourage landowners to follow the same standard for privately owned wells. Specifications pertaining to wellhead protection include (DWR 1981; DWR 1991):

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; and

Site grading to assure drainage is away from the wellhead.

2.4.3 Migration of Contaminated Groundwater

Groundwater contamination can be human-induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairy production, pesticide applications, septic tanks, industrial sources, stormwater runoff, and disposal sites. Contamination can also spread through improperly constructed wells that provide a connection between two aquifers or improperly abandoned/destroyed wells that provide a direct conduit of contaminants to aquifers.

The following 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.

State Water Resources Control Board
The State Water Resources Control Board (SWRCB) maintains an online database that identifies known contamination cleanup sites, known leaking underground storage tanks, and permitted underground storage tanks. The online database contains records of investigation and actions related to site cleanup activities (SWRCB 2019a).

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, 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 (DTSC 2019).

California Department of Pesticide Regulation
The California Department of Pesticide Regulation (DPR) maintains a Surface Water Database (SURF) containing data from a wide variety of environmental monitoring studies designed to test for the presence or absence of pesticides in California surface waters. As part of DPR's effort to provide public access to pesticide information, this database provides access to data from DPR's SURF (DPR 2019).

Groundwater Ambient Monitoring and Assessment Program
The SWRCB Groundwater Ambient Monitoring and Assessment (GAMA) program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all of the data into a publicly accessible online database (SWRCB 2019b).

DWR's Bulletin 74–90 establishes California Well Standards, which states:

A monitoring well or exploration hole subject to these requirements that is no longer useful, permanently inactive or "abandoned" must be properly destroyed to:

- Ensure the quality of groundwater is protected, and;
- Eliminate a possible physical hazard to humans and animals.

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well that has not been used in over a year. Well destruction includes completely filling in a well in accordance with standard procedures listed in Section 23 of DWR Bulletin 74-81 (DWR 1981). DWR Bulletin 74-90 includes a revision in Section 23, for

Subsection A and B, from Bulletin 74-81 (DWR 1991). The following revision is stated for Subsection A, Item 1:

Obstructions. The well shall be cleaned, as needed, so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction are removed for disposal. The enforcing agency shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed.

The following revision from DWR Bulletin 74-90 states for Subsection B:

Wells situated in unconsolidated material in an unconfined groundwater zone. In all cases the upper 20 feet of the well shall be sealed with suitable sealing material and the remainder of the well shall be filled with suitable fill or sealing material from Bulletin 74-81.

The remainder of Section 23 from DWR Bulletin 74-81 is unchanged.

Proper well destruction and abandonment 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, undesired mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

The administration of a well construction, abandonment, and destruction program has been delegated to the counties by the California State legislature. Kings County requires that wells be abandoned according to State standards documented in DWR Bulletins 74-81 and 74-90. Due to staff and funding limitations, enforcement of the well abandonment policies is limited.

Primary groundwater replenishment sources in the Plan area:

- Kings River
- Kaweah River
- Tule River
- Deer Creek
- Poso Creek
- Precipitation
- Various smaller streams

2.4.5 Replenishment of Groundwater Extractions

Replenishment of groundwater is an important technique in management of a groundwater supply to mitigate groundwater overdraft. Groundwater replenishment occurs naturally through rainfall, rainfall runoff, and stream/river seepage and through intentional means, including deep percolation of crop and landscape irrigation, wastewater effluent percolation, and intentional recharge. The primary local water sources for groundwater replenishment in the Plan area include precipitation, Kings River, Kaweah River, Tule River, Deer Creek, Poso Creek, and various smaller local streams. For more information, refer to Section 2.2.3, *Conjunctive Use Programs*, of the GSP.

2.4.6 Well Construction Policies

Proper well construction is necessary to ensure reliability, longevity, and protection of groundwater resources from contamination. All of the GSA member agencies follow state standards when constructing municipal and agricultural wells (DWR 1991). Kings County has adopted a well construction permitting program consistent with state well standards to help assure proper construction of private wells. Kings County maintains records of all wells drilled in the Plan area.

State well standards address annular seals, surface features, well development, water quality testing and various other topics (DWR 1991). Well construction policies intended to ensure proper wellhead protection are discussed in Section 2.4.2, *Wellhead Protection.*

2.4.7 Groundwater Projects

The GSA member agencies in general developed their own projects to help meet their water demands and will develop additional future projects to meet sustainability. Developing groundwater recharge and banking projects is considered key to stabilizing groundwater levels. Chapter 6, Project and Management Actions to Achieve Sustainability, provides descriptions, estimated costs, and estimated yield for numerous proposed projects.

The GSA will also support measures to identify funding and 2-20anagement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of local areas conducive to recharge and areas where recharge provides the most benefit to the GSA. This can reduce the burden for certain agencies from having to recharge within their boundaries if they do not have suitable land or soils.

2.4.8 Efficient Water Management Practices

Water conservation has been and will continue to be an important tool in local water management, as well as a key strategy in achieving sustainable groundwater management. Municipal water purveyors have water conservation programs that can be found in various documents, such as individual UWMPs (City of Corcoran 2017; City of Lemoore 2015; City of Hanford 2011). Some purveyors are exploring innovative water management practices such as recycled water use.

The GSA's currently support various forms of water conservation through implementation of groundwater pumping restrictions, well metering, education, and tiered pumping fee structures. Irrigation efficiency is an area where the GSA's will support additional measures that reduce the overall irrigation demand for groundwater. GSAs can help identify funding and that improves on-farm delivery, canal delivery efficiency, and pumping efficiency for groundwater systems.

2.4.9 Relationships with State and Federal Agencies

From a regulatory standpoint, the GSAs have numerous relationships with state and federal agencies related to water supply, water quality, and water management. Relationships that are common to all water agencies, such as regulation of municipal water by the California Division of Drinking Water (DDW), are not discussed here. Many of the GSA member agencies receive grants from various agencies for water-related projects. Grants are obtained from agencies including but not limited to DWR, SWRCB, and USBR. The GSA member agencies work closely with these state and federal agencies to track grant programs and administer and implement grant contracts. Relationships unique to the region are summarized below.

Kings River Water

The Kings River provides the majority of surface water used in the area. Kings River water is impounded by Pine Flat Dam, which is owned and operated by the United States Army Corps of

Engineers (USACE) (Kings County 2002). The water rights permits were obtained from the SWRCB; however, allocation and management of water is largely controlled by the KRWA. The GSA member agencies work with the USACE and SWRCB to oversee and manage their Kings River water as needed. The local agencies also developed and continue to implement the KRFMP in partnership with the CDFW.

2.4.10 Land Use Planning

Land use policies are documented in various reports, such as General Plans, specific land use plans, and plans for proposed developments. Updating some of these plans is a multi-year process and not all plan updates can be fully completed concurrently with the GSP development. These land use plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP. Some smaller communities rely on county policies and have no formal land use. Land use is shown in Figures 2.0.0-7 through 2.0.0-11.

Each of the local member agencies and water entities of the Subbasin's GSAs have an interest in land use planning policies and how they will impact their continued development and water supplies.

The following GSA member agencies have direct land use planning authority:

County of Kings

County of Kern

County of Tulare

City of Corcoran

City of Hanford

City of Lemoore

2.4.11 Impacts on Groundwater Dependent Ecosystems

The Nature Conservancy (TNC) worked with DWR to identify Groundwater Dependent Ecosystems (GDE) throughout the state. TNC primarily used vegetative indicators and applied them to historical aerial imagery. Imagery was cross-referenced with CASGEM well levels to identify possible GDEs. The data used in GDE identification pre-dates the baseline year of 2015, so all land use changes in the interim period may not be included. Given the depth to groundwater throughout the Subbasin, it is believed that no GDEs exist.

2.5 Notice and Communication

Stakeholders gathered monthly to develop the recommended GSA formation governance structure for the Subbasin. Representatives from cities, counties, WDs, IDs, CSDs, and private water companies participated in the formation of the GSAs. Additionally, landowners, Disadvantaged Community (DAC) representatives, and industry representatives were present at GSA formation meetings. Documentation of Stakeholder communications and consultation is provided in Appendix B.

2.5.1 Implementation of the GSP

SGMA implementation at the GSA level began with the submittal of the 2020 GSP . During the implementation phase, communication and engagement efforts focus on educational and informational awareness of the requirements and processes for reaching groundwater sustainability as set forth in the submitted GSP. Active involvement of all stakeholders is encouraged during implementation, and public notices are required for any public meetings, as well as prior to imposing or increasing any fees. Public outreach is also completed by the individual GSAs with collaborative efforts subbasin-wide when target audiences span more than one GSA boundary.

2.5.2 GSA Decision-Making Process

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

Each of the five GSAs within the Subbasin operate under an Interim Operating Agreement (effective September 1, 2017) to facilitate coordination and management actions (Appendix F). The Interim Operating Agreement is categorized as a legal agreement and ensures communication and coordination of the data and methodologies used by each GSA in developing the GSPs within the Subbasin for several factors, including groundwater elevation and extraction data, surface water supply, total water use, change in groundwater storage, water budget, total water use, and sustainable yield. The governing body of the GSP consists of a single authorized representative from each of the five member GSAs. Significant decisions require a unanimous vote of the representatives, while less significant decisions only require a four-fifths vote.

The Subbasin GSAs' decision-making process is broken down by the roles of the Subbasin management team, their respective Board of Directors, and any Stakeholder/Advisory Committees. The roles of the boards and GSA entities are outlined below.

Subbasin Management Team – Comprised of a representative from each of the five GSAs working collaboratively to jointly manage groundwater within the Subbasin and to develop a GSP. These individuals met on a monthly and then bi-weekly basis throughout the GSP development and public review phases.

Boards of Directors – Adopts general policies regarding development and implementation of the individual GSAs and the GSP.

Stakeholder/Advisory Committees – Represents all beneficial uses and users of groundwater within the individual GSA boundaries and makes recommendations to the Boards of Directors and technical consultants regarding feedback from stakeholders to account for local interests. Not all GSAs have Stakeholder/Advisory Committees, and while allowed within SGMA, these committees are not required.

2.5.3 Beneficial Uses and Users

> ***23 CCR §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 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.*
> - *A list of public meetings at which the Plan was discussed or considered by the Agency.*
> - *Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.*

The GSAs shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing a GSP (California Water Code, §10723.2). The interests of all beneficial uses and users of groundwater within the Subbasin by GSA are identified in Table 2.5.3-1. Engagement with groundwater users occurred in the following phases of the development and implementation of the GSP:

2.5.4 Opportunities for Public Engagement

> ***23 CCR §354.10 (d)(2)*** *Identification of opportunities for public engagement and a discussion of how public input and response will be used.*

The GSAs within the Subbasin developed a joint Communication and Engagement Plan to address how stakeholders within the individual GSA boundaries were engaged through stakeholder education, opportunities for input, and public review during GSP development and implementation (Appendix B). Stakeholders were invited to public meetings through distribution of meeting notices to the Subbasin GSAs' district and member agency distribution lists, community organizations' contact lists, and press releases and public service announcements. Press releases were distributed to local media outlets announcing the meeting dates, times and locations. Local community organizations, such as the Kings County Farm Bureau, were asked to distribute meeting notices via email to their membership/contact lists. Public meetings held during the preparation and submission phase of the GSP were geared towards an overview of the SGMA, the GSP development process,

Stakeholder Key Interests related to groundwater include:

- Drinking water
- Domestic, everyday usage
- Agriculture—farming, dairy, and livestock
- Industrial (food processing)
- Recreational

stakeholders' expectations of public review and implementation, distribution of stakeholder surveys and solicitation of stakeholder input, and question/answer sessions. This segment of public meetings gave stakeholders an opportunity to be involved in GSP development and share their thoughts and concerns.

Communication & Outreach Methods

There were a variety of opportunities, venues, and methods for the Subbasin's GSAs to connect with and engage stakeholders throughout GSA formation, GSP development, GSP review, which will continue to be utilized through the GSP implementation phases.

Printed Communication

Printed materials incorporated the visual imagery established through individual GSA branding efforts and was tailored for specific means of communication throughout the phases of GSP development, public review, and implementation. Printed materials were also translated into Spanish, when necessary for diverse stakeholder education.

Fliers: Fliers designed and tailored for stakeholder audiences, encompassed infographics and text with key messages that were pertinent for the appropriate phase of GSP development. Distribution was via GSA-website posting, direct mail, email, and direct distribution as handouts throughout communities, GSA, and Subbasin-wide outreach meetings. For outreach to DACs/Severely Disadvantaged Communities, fliers were available in both English and Spanish languages.

Letter Correspondence: When letter correspondence was necessary, particularly during the public review and implementation phases, letters were distributed via email and/or direct mail. Letters included pertinent facts and explanations communicated to specific stakeholder groups.

Presentation Materials: PowerPoint presentations were utilized at educational/outreach public meetings. For a consistent Subbasin-wide message, a draft presentation was developed for the GSP development and public review phases, with placeholder slides for GSAs to update with GSA-specific information. Handouts of presentations were distributed to stakeholders in attendance, emailed to the Interested Parties list, and/or posted on individual GSAs' websites for stakeholders to access, particularly if they were unable to attend.

Digital Communication

Digital communication outlets were also designed to incorporate the Subbasin GSAs' branding and was a significant means of communication through the GSP development and public review phases and will continue during the implementation phase.

Websites: Public meeting notices, agendas, and minutes of the Board of Directors and Stakeholder/Advisory Committee meetings were posted on the individual GSAs' websites. These websites serve as integral resources for stakeholders within the Subbasin boundary. Electronic files of printed materials, presentations and other educational resources, and direct links to stakeholder surveys (English and Spanish versions) were also accessible via the websites. Websites will be maintained throughout the implementation phase of this GSP. This serves as a way for stakeholders to easily educate themselves on the GSP process and phases.

Interested Parties List: As required by SGMA §10723.4 "Maintenance of Interested Persons List," the Subbasin's GSAs maintain contact lists and regularly distribute emails to those who have expressed interest in the GSAs' progress. These emails consist of meeting notices and other documents that are pertinent to the Subbasin GSAs and their communication efforts. This process will continue through the GSP implementation phase.

Email Blasts: Email blasts for meeting notices, stakeholder surveys, public review notices, and other crucial information were coordinated with community organizations and stakeholder groups by utilizing their distribution lists. Examples of these organizations are Kings County Farm Bureau and water/irrigation districts within the individual GSAs' boundaries.

Media Coverage

Press releases were written and distributed to the media list of local newspaper publications. These press releases focused on notification of public engagement opportunities, such as targeted stakeholder meetings, public review/comment processes and opportunities. Press releases will continue during GSP implementation for meetings and notifications.

Stakeholder Surveys

Stakeholder surveys were used for the deliberate polling of stakeholders to give them a direct voice in the GSP development phase. The SFK and SWK GSAs circulated physical surveys, while the remaining three GSAs conducted verbal surveys through one-on-one discussions with stakeholders within their GSA boundaries. For the GSAs who administered physical stakeholder surveys, they developed both online and printed versions of their surveys. Survey links were posted as Google Forms on the individual GSAs' websites and were utilized in email blasts to the Interested Parties Lists. Hardcopies were also available for distribution throughout the respective GSA. Feedback received from the surveys was taken into consideration during the development of the GSP.

2.5.5 Encouraging Active Involvement

> ***23 CCR §354.10(d)*** *A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.*
>
> - *The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.*

Through Stakeholder Committees and, in some instances an Advisory Committee, GSAs are able to encourage the active involvement of diverse social, cultural, and economic elements of the population within the Subbasin prior to and during the development and implementation of this GSP. Printed materials are tailored for specific means of communication throughout the phases of the GSP development, public review, and implementation. As stated above, printed materials are translated into Spanish. Fliers, fact sheets, letter correspondence, presentation materials stakeholder surveys, and newsletters are the forms of printed communication between the public and GSAs. Digital communication and media coverage serve as an additional means of communication between the public and GSAs. During this GSP's implementation, specific stakeholders are informed of upcoming compliance requirements. Addresses of the area's property owners within the GSAs' boundaries can be obtained through Kings County. Meetings were held in a range of areas within the Subbasin to encourage attendance.

Subbasin Public Meetings

Public meetings to ensure equitable community access occurred within each GSA throughout the GSP's phases. Each GSA provided a list of previous and ongoing public meetings to track the effectiveness of outreach efforts (Appendix C).

2.5.6 Interbasin Communications

Subbasin GSAs and technical consultants met with surrounding subbasins throughout the development of the GSP to discuss how to achieve sustainability on a regional level. This included development of inter-basin agreements, and data sharing agreements. Inter-basin communications are included in Appendix C.

3. BASIN SETTING

23 CCR §354.12 *This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.*

The Tulare Lake Subbasin (Subbasin) is located primarily in Kings County in the Tulare Lake Hydrologic Region of the San Joaquin Valley. The San Joaquin Valley is relatively flat and elongates to the northwest and is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada Mountain Range. The Subbasin is located in the south-central portion of the greater San Joaquin Valley. Topography in the Subbasin slopes inward towards the center of the valley. The former Tulare Lake occupies this portion of the Subbasin. Land use in the Subbasin and surrounding areas is predominately agricultural with localized urban areas of Hanford, Lemoore, and Corcoran. This chapter discusses the hydrogeologic conceptual model (HCM), groundwater conditions, the water budget, and management areas for the Subbasin.

Key Features of the Tulare Lake Subbasin

- **Area:** ~837 square miles (535,869 acres)
- **Population (2010):** ~125,907
- **Projected Population Growth (2030)**: ~176,446
- **Population Density:** ~150 persons/square mile
- **Public Supply Wells:** ~75
- **Total Wells:** ~9,380
- **Irrigated Acres:** ~251,994
- **Groundwater Supply:** ~50% of water supplies
- **Total Storage Capacity:** ~17.1 million acre-feet

Source: DWR 2019b

The HCM, discussed in Section 3.1, acts as a sustainable groundwater management tool for the Subbasin's Groundwater Sustainability Agencies (GSAs) and provides a basis for the numerical groundwater flow model developed for the Subbasin (Appendix D). The HCM includes a description of the geographic, geologic and hydrogeologic setting, and a discussion of data gaps and uncertainties associated with the HCM.

Groundwater conditions, provided in Section 3.2, include current and historical groundwater conditions in support of the Groundwater Sustainability Plan (GSP) to ensure historical and present challenges are adequately described. The groundwater conditions section includes a description of current and historical groundwater conditions, current and potential subsidence in the Subbasin, a summary of groundwater quality, interconnected surface and groundwater systems, and groundwater dependent ecosystems.

The water budget, discussed in Section 3.3, provides a quantitative description of the historical, current, and 50-year projected inflows and outflows of the Subbasin. Additionally, the water budget will be used to develop an estimate of existing overdraft in the Subbasin and establish baseline conditions for the purpose of understanding future water supply reliability and for development of sustainable management actions and projects within the Subbasin. The historical water budget was used to develop and calibrate a numerical groundwater model of the Subbasin (Appendix D) and develop a 50-year forecast of future conditions, assuming normal hydrologic conditions adjusted for estimated climate change. The forecast model will be used as a planning tool to evaluate overdraft, develop sustainable management projects, and to evaluate management practices and projects' abilities to meet measurable objectives to avoid undesirable results.

Additionally, management areas, discussed in Section 3.4, have been delineated to facilitate data management and GSP implementation.

3.1 Hydrogeologic Conceptual Model

> **23 CCR §354.14(a)** *Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterize the physical components and interaction of the surface water and groundwater systems in the basin.*

The HCM provides a general understanding of the physical setting, characteristics, and processes that govern groundwater occurrence and movement within the Subbasin (DWR 2016c). It comprises a compilation of available information to portray the geographic setting, regional geology, basin geometry, water quality, and consumptive water uses (municipal, agricultural, and industrial) in the Subbasin. The HCM looks at the groundwater and surface water interactions and assesses the inflows and outflows to and from the Subbasin. Subbasin boundaries are often a combination of physical and political boundaries, so subbasin boundaries often do not reflect the actual physical hydrologic boundaries of an area. Thus, the area of study in an HCM is often larger than the designated subbasin boundaries. The HCM also provides the foundation for the numerical groundwater model, delineating the boundary conditions, the hydrogeologic layers, and the model domain needed to provide an accurate representation of the groundwater flow system.

3.1.1 Geographic Setting

The Subbasin is located primarily in Kings County in the Tulare Lake Hydrologic Region of the San Joaquin Valley, California (Figure 3.1.1-1). The Subbasin covers an area of approximately 535,869 acres or about 837 square miles (DWR 2016b). The Subbasin contains five GSAs: El Rico (ER), Mid-Kings River (MKR), Southwest Kings (SWK), South Fork Kings (SFK), and Tri-County Water Authority(TCWA) (Figure 3.1.1-2). It is bounded by the Kings Subbasin to the north, the Kaweah Subbasin to the northeast, the Tule Subbasin to the southeast, the Kern County Subbasin to the south, the Kettleman Plain Subbasin to the southwest, and the Westside Subbasin to the northwest (Figure 3.1.1-3).

The San joaquin Valley is relatively flat and is oriented in a northwest-southeast direction and is bounded on the west by the Coast Ranges and on the east by the Sierra Nevada Mountains (Figure 3.1.1-4).

Flow from the rivers and streams of the Sierra Nevada Mountains are largely regulated by a series of dams and reservoirs, which capture runoff from winter precipitation. Most of the runoff falls as snow in the adjoining highlands. The flow from the reservoirs is fed into man-made canals and modified streambeds that carry surface water primarily to agricultural users (Figure 3.1.1-5).

Climate

The climate in the Subbasin is semi-arid, characterized by hot, dry summers and cool moist winters and is classified as a semi-arid climate (BSk to BSh under the Köppen climate classification), usually found within continental interiors some distance from large bodies of water. The wet season occurs from November through March with 80 percent (%) of precipitation falling during this season. The valley floor often receives little to no rainfall in the summer months. Precipitation typically occurs from storms that move in from the northwest off the Pacific Ocean. Occasionally storms from the southwest, which contain warm sub-tropical moisture, can produce heavy rains.

Historical annual precipitation records over a span of 118 years have been recorded by the Hanford weather station. The Hanford weather station is located in the northern portion of the Subbasin where precipitation averages 8.28 inches per year. From 1899 to 2017, rainfall has ranged from a minimum of 3.37 inches in 1947 to a maximum of 15.57 inches in 1983 (NOAA 2019) (Table 3.1.1-1). Monthly precipitation in the area ranges between 0.00 and 6.69 inches per month. Typically, precipitation decreases from northeast to southwest across the Subbasin due to the rain shadow of the Coast Ranges. Figure 3.1.1-6 provides a map of the 30-year average annual precipitation across the Subbasin from January 1989 through December 2010 using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) database, maintained by the Oregon State University (PRISM 2018).

Topography

The topography of the Subbasin is generally low sloping inward from all directions toward the center of Tulare Lake (Figure 3.1.1-7). From the northeast edge to the center of Tulare Lake, ground surface elevations range from about 292 to 188 feet above mean sea level (AMSL). The highest elevations within the Subbasin of approximately 405 feet AMSL occur along the northeast flank of Kettleman Hills. Drainage within the Subbasin is internal flowing toward Tulare Lake.

Land Use

Land use in the Subbasin and surrounding areas is predominately agricultural with three primary urban areas of the cities of Hanford, Lemoore, and Corcoran. Land use was evaluated using California Department of Water Resources (DWR) land use maps for 1990 through 2006 and annual United States Department of Agriculture (USDA) CropScape maps from 2006 through 2016 (DWR 2016d; USDA 2016). These maps were provided in Geographic Information System (GIS) formats, allowing for aggregation of similar land uses to simplify analysis. A total of 24 land uses were identified and evaluated (Table 3.1.1-2). Land use maps for eight different time periods between 1990 and 2016 are presented in Figures 3.1.1-8a to 3.1.1-8d.

Between 1990 and 2016, the 535,869-acre Subbasin had an average of approximately 61% of its surface area or 342,400 acres of crops, 7,490 acres of riparian land or land covered by water, 140,540 acres of fallow or undeveloped forest land, 9 acres of industrial parks, and about 22,860 acres of urban areas (Figures 3.1.1-8a to 3.1.1-8d; Table 3.1.1-2) (Wood 2018). The mix of crops grown, and the areas of fallow lands has changed over time as agricultural practices changed in response to agricultural markets and water conditions. During the 2010-2015 drought, fallowed acreage increased while riparian, cotton, and pasture acreage all decreased (Figures 3.1.1-8a to 3.1.1-8d; Table 3.1.1-2) (Wood 2018). Cotton showed the most change with a decrease of more than 100,000 acres (approximately 46%) between 1996 and 2015. The data also show an overall increase in permanent crops over time, with substantial increases (about 52,260 acres or 250%) in almonds, stone fruit, and pistachios from 1995 to 2016.

Soils

Many soil surveys have been conducted across the Subbasin by the USDA Natural Resources Conservation Service (NRCS 2018). The surveyed areas may have been mapped at different times, at different scales, and with varying levels of detail, occasionally resulting in abrupt soil survey area boundaries and incomplete data sets.

Soil texture is interrelated with groundwater flows as it affects water holding capacity and vertical water movement through the soil profile. Soil textural classifications vary across the Subbasin.

Clayey soils are dominant in the interior of the Subbasin, corresponding with Tulare Lake (Figure 3.1.1-9) (Soil Survey Staff 2018).

Clayey soils dominate in the Tulare Lake area. Loam and sandy loam soils border the clayey soils and are the predominant soils to the east of the lake, including areas of the Tule and Kaweah rivers watersheds; to the west, along the eastern flanks of Kettleman Hills and the Coast Ranges; and to the north and northeast, including along the Kings River watershed.

Salts in soil are commonly sourced from parent rock and can be a result of evapotranspiration concentrating salt within irrigation water. The saturated hydraulic conductivity (Ksat) of a soil affects a saturated soil's ability to move water through soil pore spaces under a hydraulic gradient. Ksat is very low in the lake of the Subbasin (Figure 3.1.1-10), ranging only from 0.0-10.0 micrometers per second (µm/sec) (NRCS 2018). These clay soils tend substantially limit percolation and basin recharge in this area. As the soil textures become coarser (sandier), the conductivity tends to improve. The Ksat increases north of the lake, in the Kings River watershed, to 10.0-40.0 µm/sec. Similar conductivities are also present in alluvial fan channels emanating from the Kettleman Hills and Sierra Nevada Mountain ranges.

Some soil profiles in the area contain natural levels of salts.

Rivers, Streams, and Tulare Lake

Stream flow in rivers, streams, and surface water conveyances (canals) is a significant source of groundwater recharge throughout the Subbasin by direct infiltration to the subsurface and from deep percolation where surface water is applied for agricultural irrigation. The modern-day surface water conveyances that supply the Subbasin are primarily described as follows (Figure 3.1.1-5):

Kings River

The Kings River is the one of the largest sources of surface water supply to the Subbasin, contributing most of the surface runoff in the Subbasin. The Kings River is a 133-mile long river with a watershed of approximately 1,500 square miles above Pine Flat Dam (USBR 2003). It is the largest river draining the southern Sierra Nevada Mountains with headwaters in and around Kings Canyon National Park. The Kings River has three main tributaries, the North Fork, Middle Fork and South Fork. The flow of the North Fork is regulated by several dams, Courtright and Wishon Reservoirs, used to generate hydroelectric power. Pine Flat Dam at a maximum elevation of approximately 952 feet in the foothills of the Sierra Nevada Mountains captures the controlled flow from the North Fork as well as well as the combined unregulated flow from the South and Middle Forks and the controlled flow from the North Fork of the Kings River (USBR 2003). The dam is owned by the United States Army Corps of Engineers (USACE) and has a maximum capacity of about 1,000,000 acre-feet (AF) of water (KRCD and KRWA 2009). The primary purpose of the dam is flood control and secondary purposes include irrigation, hydroelectric power generation, and recreation. The flow in the Kings River below Pine the Flat Dam is controlled by the dam and distributed into various canals and distributary channels by diversion structures described in Section 3.1.1.6.

Kaweah River

The Kaweah River is located in Tulare County and drains the high Sierra Nevada Mountains, with headwaters in Sequoia National Park. Above Lake Kaweah, the main stem of the Kaweah River is about 33 miles long with a drainage area of about 561 square miles (SCE 2016). Prior to stream regulation, the main trunk of the Kaweah River historically flowed southwestward entering the

San Joaquin Valley near Lemon Cove. The river separated into several distributary channels forming the alluvial plain known as the Kaweah Delta, upon reaching the edge of the valley. During periods of high flow, these channels historically carried sufficient water to reach Tulare Lake.

In the 1920s, weirs were built at McKay's Point to partition water into the St. Johns and Kaweah rivers (KDWCD 2018). In 1962, the USACE constructed Terminus Dam to provide flood control for the cities and lands below the dam. In 2004, six fuse gates were installed on the dam to raise the lake level by 21 feet and increase the capacity of Kaweah Lake to about 185,000 AF (IWP and DC 2004). In addition to flood control, the dam and reservoir also provide irrigation water for agriculture on the Kaweah Delta (KDWCD 2018). Below the dam, most of the flow is controlled by a network of diversions, canals, and improved distributary channels. During below average rainfall years, minimal, if any, water reaches the Tulare Lake; however, during years with average to above average runoff, water from the Kaweah River system has reached the Tulare Lake and is stored or used for irrigation in ER GSA. The primary purpose of the dam is flood control and secondary purposes include irrigation, hydroelectric power generation, and recreation.

Tule River

The Tule River is located in Tulare County and drains highlands in the southern Sierra Nevada Mountains. The Tule River has three main tributaries, the North Fork, Middle Fork, and South Fork, with a maximum length of about 28 miles at the North Fork and below the confluence of Middle Fork, as well as a drainage area of about 390 square miles above Lake Success (USACE 2017). The Tule River below Porterville splits into two main channels. Eventually, these channels merge again downstream and flow into the Tulare Lake, south of Corcoran. By the early 1900s many diversions were constructed to move water into irrigation ditches that spread across the Tule River fan. Lake Success was constructed primarily for flood control purposes and has a capacity of about 82,000 AF (https://www.spk.usace.army.mil/Locations/Sacramento-District-Parks/Success-Lake). Since the lake's construction, the Tule River flows to the Tulare Lake on average and above average rainfall years, and Tule River water is stored or used for irrigation. The primary purpose of the dam is flood control and secondary purposes include irrigation, hydroelectric power generation, and recreation.

Kern River

The Kern River is located in Kern County and drains the southern slopes of the Sierra Nevada Mountains. The Kern River was dammed by Isabella Dam in 1953. Occasionally, during times of very high runoff, the Kern River could flow into the Tulare Lake and the water is stored or used for irrigation in Tulare Lake Basin Water Storage District. The primary purpose of the dam is flood control and secondary purposes include irrigation and recreation.

Streams of the Tulare Lake Subbasin

Streams emanating from the southern Sierra Nevada Mountains, south of the Tule River, drain lower elevations and more arid areas of the Sierra Nevada Mountains. These streams, White River, Deer, Mill, Cottonwood, Dry, and Poso Creeks, typically lose their discharge to percolation into the alluvial fans before entering the Tulare Lake. Currently, most of these streams have diversions on them, which channel their flows to delivery systems for irrigation. Cottonwood and Dry Creeks contribute to the Kaweah River system and add supplies to the Subbasin in wet years. Dry Creek's runoff is accounted for in the Kaweah River system. Poso Creek has few diversions for irrigation and remains important in and near Tulare Lake. These streams account for a small percentage of the runoff delivered into the Subbasin.

Streams emanating from the Coast Ranges are typically ephemeral and do not reach any major water course or surface impoundment in the Subbasin.

Tulare Lake

Currently, a system of open canals and pumping systems allow for the efficient distribution of irrigation water throughout the area.

Water Supply Delivery System

Extensive water supply delivery systems have been developed over the past 160 years within the Subbasin to move surface water supplies for irrigation, flood control, and land reclamation. Currently, at least 34 conveyance systems (rivers, streams, canals, and diversions) are available to deliver surface water to the Subbasin (Figure 3.1.1-5). The only water generated within the Subbasin is from pumped groundwater. Pumped groundwater may be used for direct irrigation on nearby agricultural lands or piped into municipal or agricultural water delivery systems. Much of the land within the Subbasin has associated water rights to the Kings, Kaweah, and Tule rivers, as well as some of the minor streams of the Subbasin. These water allocations are supplied by the many irrigation and water districts within the Subbasin.

Water is imported into the Subbasin using facilities of the State Water Project (SWP) located to the west and the Central Valley Project (CVP). The California Aqueduct is operated and maintained by DWR. The California Aqueduct originates in the southwestern corner of the Sacramento-San Joaquin Delta and runs down the west side of the San Joaquin Valley and over the Tehachapi Mountains into southern California. Water from the California Aqueduct can be turned out at Lateral A, which delivers water to the Subbasin at or above the Empire Weir No. 2. This water can be distributed to the Subbasin through the series of canals below the Empire Weir No. 2.

The Friant-Kern Canal is operated and maintained by the Friant Water Authority and is used to convey water from the San Joaquin River to Kern County. The canal originates at Friant Dam, which is operated by the United States Bureau of Reclamation. The Friant-Kern Canal flows southeasterly along the western flank of the Sierra Nevada foothills through Fresno, Tulare, and Kern counties. The Friant-Kern Canal crosses the Kings River about 10 miles west of Pine Flat Dam, where water can be released into the river. This water can be delivered to the Subbasin through a series of canals along the Kings River and its distributaries.

3.1.2 Geologic Setting

The Subbasin is located in the south-central portion of the greater San Joaquin Valley. The major geologic features of this portion of the San Joaquin Valley are the San Andreas Fault, the Garlock Fault, and the three bounding mountain ranges: the Coast Ranges to the west, the Sierra Nevada Mountains to the east, and the Tehachapi and San Emigdio Mountains to the south (Figure 3.1.2-1). The San Joaquin Valley elongates to the northwest and stretches approximately 250 miles from the Sacramento-San Joaquin delta on the north to the Tehachapi and San Emigdio Mountains on the south. The valley is filled with marine and continental sedimentary rocks that are more than 30,000 feet in total thickness.

3.1.3 Geologic Structure

The geologic structure of the San Joaquin Valley is complex and has evolved considerably through geologic time. The San Joaquin Valley was formed generally as a structural trough subsiding between two uplifts: the tectonically-driven tilted block of the Sierra Nevada Mountains and the folded and faulted mountains of the Coast Ranges. The axis of the trough is asymmetrical, with the deepest portion of the trough closer to the Coast Ranges. The southern Sierra block forms the eastern limb of the valley syncline or trough (Bartow 1991). It is a southwest-plunging ridge of basement rock, primarily Mesozoic plutonics, upon which has accumulated more than 10,000 feet of Tertiary sediments in the vicinity of the Subbasin.

The west-side fold belt runs along the western portion of the Subbasin and comprises the low-lying portion of the eastern Coast Ranges (Figure 3.1.3-1). The fold belt is characterized by Cenozoic sedimentary rocks that have been deformed by thrust faults. The fold belt formed adjacent and subparallel to the San Andreas Fault, a major strike-slip transform fault between the North American and Pacific plates. These sedimentary rocks dip steeply beneath the San Joaquin Valley to the east and are found at depths of more than 3,000 feet below the Valley floor. The Kettleman Hills on the west side of the Subbasin are part of the west-side fold belt.

3.1.4 Basin Development

During late Mesozoic and early Cenozoic time, much of the current San Joaquin Valley was part of a forearc basin that was open to the Pacific Ocean allowing deep marine sediment deposition into the San Joaquin basin (Bartow 1991). As plate boundaries shifted and movement along the San Andreas Fault began in the late Miocene, the San Joaquin Basin west of the fault was beginning to close off creating an extensive inland sea. During the Pliocene, marine sediments of the Etchegoin Formation and the primarily marine San Joaquin Formation were deposited in the shallowing sea bottom of the basin.

During the late-Pliocene and early-Pleistocene, the terrestrial Tulare Formation was deposited as sediments, which were eroded and shed from the rising mountains into the subsiding San Joaquin Valley. As the San Joaquin Valley evolved during the Pleistocene, the tilting of the Sierran block and the push from the thrust belts on the west side aided in the subsidence of the Valley trough. Throughout much of the valley, Tertiary-Quaternary sediments filled the basin with a mixture of sands, silts, and clays, which were deposited on alluvial fans and along the San Joaquin Basin axis by the rivers and streams emanating from the adjoining mountains.

The periodic glacial and wet Pleistocene climate produced times when the sediment loads from the mountains exceeded the subsidence rate in the Valley creating aggrading alluvial fans that cut off the flow of the San Joaquin Valley rivers to the sea (Atwater et al. 1986). Large-scale lacustrine deposits accumulated in the shallow lakes that developed as a result of the internal drainage. Corcoran Lake appears to have covered most of the Valley during the mid-Pleistocene (Bartow 1991) from about present-day Stockton to Bakersfield and roughly from Interstate 5 to State Route (SR) 99 (Figure 3.1.3-1). During this time, the lacustrine Corcoran Clay (E-Clay of Croft 1972) accumulated to thicknesses of as much as 300 feet (Figure 3.1.4-1a through 3.1.4-1c). Additionally, thick deposits of lacustrine sediments have accumulated in Tulare Lake. Due to the anomalously rapid tectonic subsidence in the Tulare Lake area and the internal drainage from the Kings, Kaweah, and Tule rivers, as well as early-on the Kern River into the lake, thick lacustrine deposits in addition to the Corcoran Clay have accumulated beneath the Tulare Lake. The total thickness of the Tulare Lake clays, including the Corcoran Clay, is more than 3,000 feet as labeled on Figures 3.1.4-1a through 3.1.4-1c.

3.1.5 Stratigraphy

Table 3.1.5-1 is a generalized stratigraphic column for the Subbasin. It represents a synthesis of stratigraphic descriptions from published reports for the area (Davis et al. 1959; Hilton et al. 1963; Croft and Gordon 1968; Loomis 1990; and Wood 2018). Stratigraphic units and their importance to groundwater occurrence and movement are described below.

Basement Complex

The basement complex beneath the Subbasin comprises primarily Sierran plutonic and metamorphic rocks, while the western margin of the basin is underlain primarily by Coast Ranges ophiolite (Scheirer 2007). The depth to the basement complex ranges from about 6,000 feet on the eastern margin of the Valley to about 30,000 feet below ground surface (bgs) on the western margin (Scheirer 2007). The depth to basement complex is such that the basement rocks do not affect the usable groundwater beneath the Subbasin.

Miocene and Pre-Miocene Sedimentary Deposits

The Miocene and pre-Miocene sedimentary deposits are found deep below the Subbasin and have been encountered in deep exploration borings drilled for oil and gas deposits. The water contained in these deposits is saline or the depth to these deposits are such that that they do not affect the usable groundwater beneath the Subbasin with the exception of the Santa Margarita Formation to the east.

The Santa Margarita Formation is a gray sandstone of upper Miocene age that is present at a depth of about 1,100 feet bgs beneath Terra Bella (Hilton et al. 1963). The formation dips steeply to the west and is about 4,300 feet deep near SR 99 at Earlimart. The Santa Margarita Formation has been tapped as an aquifer in the area from Terra Bella to Richgrove, about 25 miles east of the eastern Subbasin boundary. The Santa Margarita Formation is separated from the usable groundwater in the Plio-Pleistocene Tulare Formation by about 2,000 to 3,000 feet of mostly fine-grained marine deposits of the Pliocene San Joaquin and Etchegoin Formations. Groundwater in the Santa Margarita Formation increases in salinity content to the west and the approximate position of the saline to freshwater interface is about 20 miles east of the Subbasin. Thus, the Santa Margarita is likely too deep and too saline to yield usable groundwater beneath the Subbasin for usage.

Upper Miocene to Pliocene Etchegoin

The Etchegoin Formation is a shallow water marine formation of upper Miocene and early Pliocene age that crops out in the Kettleman Hills west of the Subbasin. The Etchegoin Formation comprises silty and clayey sands, sandy silt, silty clay, blue sandstone, and conglomeratic sandstone (Woodring et al. 1940). The Etchegoin dips steeply to the east from the Kettleman Hills. Deep exploratory borings for oil and gas have encountered the Etchegoin beneath the Subbasin at depths of 3,500 to 4,000 feet bgs. Geophysical logs indicate that water in the Etchegoin Formation is saline and its groundwater is unusable beneath the Subbasin.

Pliocene San Joaquin Formation

The San Joaquin Formation is a shallow marine formation of mid-to-upper Pliocene age that also contains some near-shore continental deposits. It comprises a basal conglomerate member and overlying thin beds of poorly-sorted, fine-grained sandstone amongst thick beds of siltstone and claystone (Loomis 1990; Woodring et al. 1940). The formation crops out in the Kettleman Hills and dips steeply to the east beneath the Subbasin.

In the Kettleman Hills area, the top of the San Joaquin Formation is conformable with the overlying Tulare Formation and is marked by the uppermost Mya zone, which is described as a transition from marine deposits (Mya fossils) to continental deposits (Tulare Formation) of lake, swamp, and stream origin (Woodring et al. 1940). In the Kettleman Hills area, monitoring wells indicate the sandstones within the San Joaquin Formation contain saline water and do not yield sufficient water to be classified as an aquifer (Wood 2018). The formation is in contact with the base of the Tulare Formation beneath the Subbasin, with the contact typically about 3,000 feet bgs (Page 1983). The San Joaquin Formation is considered too deep and too saline to yield usable groundwater beneath the Subbasin.

Pliocene-Pleistocene Tulare Formation – Continental Deposits

The Tulare Formation is generally regarded as the most important water-bearing formation in the southern San Joaquin Valley. The Tulare Formation is a continental deposit that overlies the San Joaquin Formation and has been assigned to the upper Pliocene and Pleistocene epochs. It has been described mostly by investigators on the west side of the valley, where it crops out in the west-side fold belt anticlines. The type section is generally taken to be the Kettleman Hills, where 1,700 to 3,500 feet of the Tulare Formation have been described on the east and west flanks of North Dome, respectively (Woodring et al. 1940). Other investigators, particularly on the east side of the valley, have described continental deposits, primarily of Sierran origin, that are time-correlative with the Tulare Formation such as the Kern River, Laguna, Turlock Lake, Riverbank, and Modesto formations (Lettis and Unruh 1991).

The Tulare Formation is defined as the uppermost continental deposits deformed by the west- side fold belts (Woodring et al. 1940). This was relatively clear in the Kettleman Hills area; however, in other west-side folds (e.g., Lost Hills), the quaternary alluvium has also been deformed as uplift continues into the Holocene. In the Tulare Lake area, the east side Plio- Pleistocene deposits that overlie the San Joaquin Formation with the Tulare Formation are mapped (Page 1983). In the subsurface, because of textural and depositional similarities, it is difficult to separate recent alluvial deposits from sediments of the Tulare Formation (Davis et al. 1959). Based on existing research in the Tulare Lake area, the Tulare Formation in this report is considered an ongoing sequence of Plio-Pleistocene continental deposits above the San Joaquin Formation that continue to be deposited today in the Holocene period. These deposits can be subdivided into Sierra and Coast Range origins. Each source area contributes different grain sizes and mineralogy that will affect potential well yields and groundwater quality. They also can be subdivided by lacustrine units, older alluvium, and younger alluvium. The different units has a bearing on groundwater occurrence and movement.

The Tulare Formation comprises unconsolidated clay, silt, sand, and gravel, as well as poorly consolidated sandstones and conglomerates. These sediments have been deposited by streams and rivers emanating primarily from the Sierra Nevada and Coast Ranges. The Coast Ranges are composed of gypsiferous marine shales, sandstones and volcanic rocks, sediments sourced from the Coast Ranges, which are generally gypsiferous, typically finer-grained, and contain more angular lithic fragments than Sierran sediments (Page 1983). The granitic source rocks of the Sierra yield sediments with abundant quartz, feldspars, and micas, and are typically coarser- grained and more rounded than the Coast Ranges sediments. Thus, areas of the Subbasin comprised of Sierran sediments tend to have greater water storage capacity due to higher levels of porosity than areas comprised of sediments from the Coast Ranges.

Sedimentary facies of the Tulare formation range from mid-to-distal alluvial fan deposits, marsh deposits, lacustrine deposits, overbank and flood deposits, and fluvial deltaic deposits entering Tulare Lake, and terrestrial shoreline deposits. In terms of depositional environments for the Tulare Formation, the Subbasin is dominated by the lacustrine environment of Tulare Lake in the southern portion of the Subbasin (Figures 3.1.4-1a through 3.1.4-1c). In the northern portion, the depositional environment is dominated by mid-to-distal alluvial fan deposits of the Kings River. The northwestern corner of the Subbasin contains a strip of basin deposits along the South Kings River, west of Lemoore and Stratford. To the east of the Subbasin, the depositional environment comprises mid-to-distal alluvial fan deposits of the Kaweah and Tule rivers.

3.1.6 Lateral Basin Boundaries and Geologic Features Affecting Groundwater Flow

Groundwater flow in the Subbasin has historically been influenced by five significant bounding conditions, including: Kettleman Hills on the southwest, Kings River alluvial fan on the northeast, Arroyo Pasajero fan on the northwest, Tulare Lake clay beds in the central portion of the Subbasin, and the Kaweah and Tule River alluvial fans on the east (Figure 3.1.6-1).

Kettleman Hills Anticline

The Kettleman Hills anticlinal structure is located on the southwest edge of the Subbasin (Figure 3.1.6-1). The Kettleman Hills anticline exposes the late Miocene-Pliocene Etchegoin Formation along its axis, with the younger San Joaquin and Tulare Formations exposed along its flanks. To the west, these formations dip steeply beneath the Kettleman Plain, where the Tulare Formation reaches an estimated thickness of 4,000 feet (Stewart 1946). Groundwater recharge to the Subbasin from direct infiltration on the Kettleman Hills is almost non-existent due to low precipitation, low relief of the Hills, and minimal eastern exposure of the Tulare Formation. The lack of groundwater recharge is evident due to the lack of development of significant alluvial fans on the east side of the Hills. Inter-basin movement of groundwater from the Kettleman Plain to the Subbasin is blocked by the synclinal structure of the Kettleman Plain and the anticlinal structure of the Kettleman Hills, which places thousands of feet of steeply dipping marine claystones and siltstones between the Tulare Formation beneath the Kettleman Plain and the Tulare Formation beneath the San Joaquin Valley. Additionally, the Tulare Formation has been eroded off the tops of each of the Kettleman domes and the San Joaquin Formation exposed in the gaps between the domes, essentially leaving no connection between the Tulare Formation on either side of the Kettleman Hills. Hence there is little or no groundwater flow between the Kettleman Hills and the Subbasin.

Kings River Fan

The Kings River alluvial fan extends northward from the Tulare Lake to beyond the northeastern boundary of the Subbasin (Figure 3.1.6-1). The fan deposits comprise a series of sand beds and intervening silty to clayey layers with paleosol interludes. Coarser deposits are present higher on the fan north and east of the Subbasin and finer deposits are more prevalent toward the distal end of the fan, within the Subbasin near the center of the valley. Where the historical Kings River entered Tulare Lake, the depositional environment changed from fluvial and alluvial to deltaic, with the sandier beds interfingering with finer lacustrine deposits within the lake. The Kings River, which forms the northern boundary of the Subbasin, appears to provide persistent recharge to the fan deposits along its course. Because of the size of the Kings River drainage area and the magnitude of its flows, the Kings River fan typically contains thicker and coarser sediments than the fans of the lesser Kaweah and Tule Rivers. The fan below the Subbasin is divided into upper and lower aquifers by the Corcoran Clay, which stretches east to west across the fan beneath the Subbasin, extending up fan to about SR 99 (Figures 3.1.4-1a and 3.1.4-1b). The Corcoran Clay layer often has very limited transmissivity and can confine lower aquifers beneath this layer while also preventing or limiting percolation of water from upper aquifers into lower aquifers. The Kings River alluvial fan is a significant source of groundwater inflow and outflow to/from the northern portion of the Subbasin.

Los Gatos Creek and Arroyo Pasajero Fan

Los Gatos Creek emanates from the Diablo Range, which is a part of the Coast Ranges, west of Coalinga and grades eastward toward the valley floor. Although the Los Gatos Creek fan is not within the Subbasin, it borders the Subbasin to the northwest (Figure 3.1.6-1). The creek is ephemeral and creek flows only reach the valley floor and areas near the Subbasin during periods of extremely high precipitation. As such, there is little or no groundwater flow between the Los Gatos Creek and the Subbasin.

The Los Gatos Creek fan has prograded eastward during the wetter climates of the Pleistocene. Coast Range sediments extend perhaps 15 to 18 miles into the Valley and to a depth of several hundred feet above the Corcoran Clay (Croft 1972; Miller et al. 1971). Another lobe of the Coast Range sediments lies beneath the Corcoran Clay and also extends approximately 15 to 18 miles into the Valley. These sediments comprise sands, silts, and clays of relatively fine-grained textures (Meade 1967). Additionally, sands from the Diablo Range consist of darker minerals and contain more lithic fragments. Grains are subounded to subangular andesite, serpentinite, and chert with some weathered mica flakes. Below the Coast Range sediments are described as floodplain and deltaic/lacustrine deposits of Sierran origin (Miller et al. 1971). The Sierran deposits are described as lighter in color and micaceous, primarily biotite with more than 25% feldspars (Meade 1967). These Sierran deposits extend down to the top of the San Joaquin Formation marking the base of the Tulare Formation.

Groundwater in the Coast Range sediments show a distinct sulfate type of water derived from the marine formations from which the sediments originated (Davis and Coplen 1989). This contrasts with the bicarbonate-type water typical of the Sierran sediments. The total dissolved solids (TDS) of the Coast Range sediments are also typically higher than the Sierran sediments. Wells on the Los Gatos Creek fan typically tap the Sierran deposits below the Corcoran Clay.

Tulare Lake Lacustrine Deposits (Clay Plug)

The lacustrine deposits of the ancestral and former Tulare Lake are potentially the most significant controlling factor for groundwater movement in the central portion of the Subbasin. The center of the Tulare Lake depositional system is elongate from northwest to southeast with continuous lacustrine deposits extending like down through the interior portions of the lake to the top of the San Joaquin Formation, which beneath the Subbasin is 2,600 to 3,000 feet bgs (Figures 3.1.4-1a through 3.1.4-1c). The area with continuous lacustrine sediments from the surface to the underlying San Joaquin Formation is roughly 23 miles long by 12 miles wide (Figure 3.1.6-1). The horizontal and vertical extent of these continuous fine-grained lacustrine deposits is called the "clay plug." The lacustrine deposits are primarily silts and clays with occasional interbedded fine sands. The deposits are under reduced conditions in nearly all locations where coring has occurred, which indicates little, if any, subaerial contact or oxygenated water since the sediments were emplaced (Miller et al. 1971). Although some of the clays and sand stringers are saturated, they do not produce enough water to have been developed for groundwater extraction. Near the northern, southern, and eastern peripheries of the lacustrine plug, coarser deposits interfinger with the fine-grained sediments. Coarser and more transgressive sediments are present on the eastern, Sierran periphery compared to the western, Coast Range periphery. Where present, the clay plug acts as a barrier to groundwater flow beneath the Subbasin.

Kaweah and Tule River Fans
The Kaweah and Tule River fan sediments to the east of the Subbasin have similar deposition to the sediments beneath the Kings River fan; however, they are not as laterally extensive and appear to be thinner and more interbedded than the Kings River deposits (Figure 3.1.6-1). Near the toe of the Kaweah and Tule River fans, deposits become more deltaic and interbed with the lacustrine deposits of the Tulare Lake. Similarly, to the Kings River fan deposits, the Kaweah and Tule River fans below the Subbasin are divided into upper and lower aquifers by the Corcoran Clay, which stretches east to west across the fan beneath the Subbasin, extending up fan to the area of SR 99 (Figure 3.1.4-3). The Kaweah and Tule River fan deposits comprise well graded course Sierran sediments with ample water storage capacity and have been extensively developed for groundwater extraction east of Tulare Lake and the Subbasin. The Kaweah and Tule River fans are a significant source of groundwater inflow and outflow to/from the eastern portion of the Subbasin.

3.1.7 Definable Bottom of the Basin

The DWR published Best Management Practices (BMPs) for HCMs for the sustainable management of groundwater (DWR 2016c). Identifying a definable bottom of the Subbasin is one key step in addressing the issue of total basin water storage, as well as the depth to which water can feasibly be extracted. In their section on "Definable Bottom of the Basin," DWR noted "several different techniques or types of existing information can be used in the evaluation of the definable bottom of the basin and extent of fresh water." One method would be to define the base of the water-bearing formations below which no significant groundwater movement occurs, such as the depth to bedrock or some other low permeability formation. A second method would be to evaluate the chemistry of the groundwater beneath the basin vertically and then map the elevation at which the groundwater exceeded a pre-determined criterion for fresh water.

The criteria for fresh water, however, is inconsistent in that it has been defined as a TDS content at approximately 2,000 milligrams per liter (mg/L), 3,000 mg/L, and 10,000 mg/L by various sources (Page 1973; RWQCB 2015; and 49 Code of Federal Regulations 146.4) Additionally, in their BMPs (DWR 2016c), DWR noted they will be constructing a freshwater map for the Central Valley that assumes the base of fresh water is defined by California's secondary maximum contaminant level recommendation of 1,000 mg/L. Because of these inconsistencies, the definable bottom of the basin will be discussed below using two different methods.

Geologic Method
A case can be made, on a geologic basis, to define the bottom of the Subbasin at the base of the Tulare Formation, above the underlying San Joaquin Formation. The Tulare Formation is a continental deposit that includes sediments deposited in the San Joaquin Basin from the Pliocene to the present. The Tulare Formation is the primary groundwater aquifer for the southern San Joaquin Valley, including the Subbasin. The Tulare Formation overlies the San Joaquin Formation, a predominantly marine formation comprising significant thicknesses of claystone and siltstone along with minor beds of fine-grained sandstone, which contain brackish water (Wood 2018).

Sandstone beds are of low permeability and do not yield sufficient water to be considered an aquifer or a suitable source for agricultural or municipal uses. Even if some sandstone beds contained water that might meet water quality criteria, they are of low permeability and do not yield sufficient water to be considered an aquifer (Wood 2018). Thus, the contact between the Tulare Formation and the underlying San Joaquin Formation would fit the definition for a geologic barrier to groundwater flow under DWR criteria.

The contact between the Tulare Formation and the San Joaquin Formation was previously mapped as the top of the upper Mya zone near the central and southern portions of the Subbasin (Figure 3.1.7-1) (Page 1981; Page 1983). Sources included identifications of the upper Mya zone in well logs from 292 oil and gas exploratory borings as well as structure contour maps and geologic sections done for oil and gas fields in the area. These data show that the approximately water bearing depth of the Tulare Formation ranges from about 4,000 feet bgs near the axis of the San Joaquin syncline, which lies to the east of the Kettleman Hills to approximately 2,500 feet bgs near the southeastern corner of Kings County. The study's map did not extend into the northern portion of the Subbasin, so the contact between the Tulare and San Joaquin Formations has been estimated from oil and gas exploration wells in the area (Wood 2018). The depth to the base of the Tulare Formation in the northern portion of the Subbasin ranges from 2,700 to 2,200 feet bgs, rising to the north (Figure 3.1.7-1). Near the City of Corcoran, the depth of the Tulare Formation is greater at approximately 3,400 feet bgs.

Studies have shown that portions of the Tulare Formation do not yield groundwater that meets water quality criteria for beneficial uses, particularly in and surrounding the Tulare Lake. These criteria are examined in detail in the following section.

Water Quality Method

Several potential criteria exist for determining the extent of fresh water in a groundwater basin; however, the criteria adopted by the California Regional Water Quality Control Board (RWQCB), Central Valley Region, appears to be the most appropriate for the Subbasin. The RWQCB is the state agency that has been charged with adopting and enforcing water quality control plans, or basin plans, to protect state waters. The Subbasin is within the boundaries of the Tulare Lake Hydrologic Region (Figure 3.1.1-1) as defined by the RWQCB and therefore subject to the Tulare Lake Basin Plan (Basin Plan).

The Basin Plan describes designated beneficial uses of groundwater to be protected, water quality objectives to protect those uses, and a program for implementation to achieve the objectives (RWQCB 2015). Beneficial uses of groundwater in the Tulare Lake Hydrologic Region include municipal, agricultural, and industrial. The Basin Plan incorporates the Sources of Drinking Water Policy Resolution No. 88-63, adopted by the State Water Resources Control Board (SWRCB), which states all surface and ground waters of the State are considered to be suitable, or potentially suitable for municipal or domestic water supplies (MUN) with the exception of water that has a TDS exceeding 3,000 mg/L and is additionally not reasonably expected by the RWQCB to supply a public water system (SWRCB 2006). Regarding agricultural uses (AGR), the basin Plan Is not explicit to the numerical criteria for determining beneficial use; however, the Basin Plan contains a narrative regarding an exception to the AGR designation if pollution by natural processes or human activity is documented that cannot be reasonably treated by BMPs or economically achievable treatment practices to achieve water quality suitable for agricultural uses.

In 2014, the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), a stakeholder group that was created to develop a comprehensive Salt and Nitrate Management Plan for the Central Valley, identified a need to define the salinity-related requirements for the protection of both the MUN and AGR beneficial uses. This evolved into the development of a technical information and environmental and economic analysis in support of a MUN and AGR beneficial use evaluation project for a portion of the historical Tulare Lake (RWQCB 2017). A beneficial use evaluation report was submitted on behalf of CV-SALTS proposing portions of the groundwater body beneath the historical Tulare Lake be de-designated for MUN and AGR beneficial uses (KDSA et al. 2015). The evaluation report affirmed the criteria for exemption from MUN to be a TDS of 3,000 mg/L. CV-SALTS has also provided a literature review, which affirmed guidelines that stated only the most salt-tolerant crops may be sustainably irrigated with water exceeding 3,000 microsiemens per centimeter (µS/cm) or less (a TDS of about 2,000 mg/L) (CV-SALTS 2013; Ayers and Westcot 1985). As part of the literature review, CV-SALTS also identified acceptable salt levels for livestock watering to be water with an electrical conductivity (EC) of 5,000 µS/cm or less (a TDS of about 3,000 mg/L).

The RWQCB adopted the preferred alternative for MUN beneficial use de-designation to be the application of the Sources of Drinking Water Policy exception 1a, where water quality exceeds an EC of 5,000 µS/cm (RWQCB 2017). The report further proposed the preferred alternative for AGR beneficial use de-designation be based on a 5,000 µS/cm EC threshold value (3,000 mg/L) taken from the Canadian Council of Ministers for the Environment for all classes of livestock (CCME 2007). These criteria were accepted by the RWQCB (Resolution R5-2017-0032) on April 6, 2017, and adopted by the SWRCB (Resolution No. 2017-0048) on September 6, 2017.

Based on the body of work by CV-SALTS and the regulatory acceptance of the criteria for de-designation of MUN and AGR of an EC of 5,000 µS/cm (approximately 3,000 mg/L TDS), the criteria for determining the extent of fresh groundwater in the Subbasin was set at 3,000 mg/L TDS. Within the Subbasin, water quality of 3,000 mg/L TDS, typically found at depths greater than 3,000 feet bgs, could define the bottom of the Subbasin using this methodology for this GSP.

3.1.8 Hydrogeologic Setting: Principal Groundwater Aquifers and Aquitards

The current hydrogeology of the Subbasin is complex in that the only physical boundaries are the Kettleman Hills on the southwestern edge and the Kings River on the northeastern edge of the Subbasin. The remaining edges of the Subbasin are based on political boundaries and water management areas, and the actual physical water-bearing formations of the Subbasin extend into these adjacent areas. Groundwater beneath the Subbasin occurs primarily in the coarser- grained Sierran sediment deposits of the alluvial fans of the Kings, Kaweah, and Tule rivers, as well as the fans of the lesser streams that drain from the Sierra Nevada Mountains into the southeastern portion of the Subbasin. A study conducted in the 1960s subdivided the coarser- grained deposits into three units, older and younger alluvium and undifferentiated continental deposits (Croft and Gordon 1968). These deposits are primarily Sierran in origin and were deposited during the Quaternary period by the major stream channels emanating from the Sierra Nevada Mountains. On the west side of the Subbasin, some sediments may have Coast Ranges origin, but the axis of Tulare Lake is close to the Kettleman Hills and its finer-grained sediments, which leaves little room for potentially coarser-grained Coast Ranges sediment deposition on the west side. The Corcoran Clay underlies most of the Subbasin, which essentially subdivides the Subbasin into two aquifer systems, an unconfined to semi-confined aquifer system above the Corcoran Clay and a confined aquifer system below the Corcoran Clay.

The younger alluvium is generally thinner than the older alluvium and is present in current stream channels and as a veneer over the older alluvium as the deposits stretch to the west. The younger alluvium is primarily arkosic and is considered of Holocene age. It occurs entirely above the Corcoran Clay and is unconfined. In places, it may contain groundwater perched above any one of a number of relatively continuous clay layers.

The older alluvium is widespread throughout the San Joaquin Valley and represents deposition from both the Coast Ranges on the west side of the Valley and the Sierra Nevada Mountains on the east. The older alluvium is generally identified by its stratigraphic position on terraces of the major rivers, though as mentioned earlier, there is no current method to differentiate it in the subsurface from the Tulare Formation. The older alluvium is considered Pleistocene to Holocene in age and it is typically bifurcated by the Corcoran Clay such that groundwater contained in the older alluvium may be either confined or unconfined.

Beneath the older alluvium are the undifferentiated continental deposits, which beneath the Subbasin are Sierran in origin. The deposits are beneath the Corcoran Clay, and as such, groundwater contained in the undifferentiated Tulare Formation is all confined.

Lacustrine deposits have been identified in the Subbasin principally beneath the Tulare Lake. Geologic cross sections illustrate the thick and continuous nature of these clay deposits beneath the lake (Croft 1972; Croft and Gordon 1968; Davis et al. 1959). Additionally, six individual lacustrine clays were identified in the subsurface and had sufficient lateral extent to be considered important in affecting groundwater movement (Croft 1972). These clays were identified in geophysical logs and named the A- through F-Clays, with the E-Clay being equivalent to the Corcoran Clay. Though the A- through D-Clays may be important locally in restricting downward movement of groundwater, Corcoran Clay or E-clay is the most significant (KDSA et al. 2015). The Corcoran Clay has been identified beneath tulare Lake and extends beyond the Subbasin in all directions except for a small area in the northeast corner of the Subbasin (Croft 1972).

Marsh and flood basin deposits are found typically near the modern axis of the San Joaquin Valley, along the distal reaches of the streams in the southern Valley. These deposits comprise silts and clays that can be relatively thick in some locations creating local areas of perched groundwater.

For purposes of monitoring, as described in Chapter 5, the aquifers are divided into three aquifer zones:

The A zone is the shallow portion of the aquifer above the A-Clay and in areas where shallow groundwater is present outside of the A-Clay,

The B zone is the unconfined portion of the aquifer above the E-Clay or Corcoran Clay and below the A-Clay where the A-Clay is present, and

The C zone is the confined portion of the aquifer below the E-Clay.

The main aquifers and aquitards are described in greater detail in the following sections.

Unconfined Aquifer

The unconfined and semi-confined upper portions of the regional freshwater aquifer are found above the Corcoran Clay. This upper portion of the regional freshwater aquifer is generally comprised of coarse- to medium-grained sediments (i.e., sand and gravel) with silt and clay interbeds. The depth to first groundwater beneath a large portion of the Subbasin is less than 15 feet bgs in a zone situated above the A-Clay (Figure 3.1.8-1).

Groundwater within the rest of the Subbasin and surrounding areas are typically found between depths of 30 and 250 feet bgs, depending on location and the season or year when the water levels are measured. The shallow groundwater areas typically have poor water quality, and the shallow soils require drainage to grow crops (KDSA et al. 2015) (Figure 3.1.8-1). In areas where groundwater is below 15 feet, the shallow unconfined aquifer is subject to large swings in water levels due to groundwater recharge, which occurs primarily along stream channels, unlined surface water conveyances, and artificial recharge basins. In thicker sections of the unconfined aquifer, pumping for agricultural uses may create significant drawdown of the water table during the irrigation season and under prolonged drought conditions. Nearer the Tulare Lake, where the upper aquifer is substantially interbedded with lacustrine deposits, the groundwater producing zones are thinner and become increasingly finer-grained limiting groundwater withdrawals to primarily relatively low demand domestic uses.

Confined Aquifer

The sediments below the Corcoran Clay comprise the lower confined portion of the regional freshwater aquifer. This lower portion of the regional freshwater aquifer is generally comprised of clay, silt, sand, and gravel (Page 1983).

Few maps are available showing groundwater elevations in the confined aquifer beneath the Subbasin and surrounding areas (Harder and Van de Water 2017). In fall 1998 and 1999, groundwater was at an elevation of about 100 feet below mean sea level (MSL) at a depth of about 300 feet bgs near Corcoran, decreasing in elevation to the south towards an apparent pumping center near Alpaugh. The coarser and thicker sections of sediments below the Corcoran Clay lend themselves to development of higher capacity wells that withdraw groundwater for municipal and agricultural uses. However, the limited extent of highly productive fresh groundwater aquifers within the boundary of the Subbasin, generally along the coarse-grained sediments within the alluvial fans (e.g., Kings River fan), concentrates these wells in the eastern portion of the Subbasin and in adjoining subbasins to the east, beyond the finer-grained deltaic and lacustrine deposits grading into the Tulare Lake. Because of the effectiveness of the Corcoran Clay as an aquitard, recharge to the confined aquifer likely occurs primarily in the upper portions of the alluvial fans beyond the Corcoran Clay's eastern extent.

The sediments within the southern portion of the Tulare Lake consist of a thick, continuous sequence of clays, forming a clay plug. There are no significant production wells within the clay plug due to the fine-grained nature of the sediments; however, there may be a few stock watering wells in this area.

Aquitards

Fine-grained lacustrine, marsh and flood deposits underlie the Valley trough and floor and were deposited in lacustrine or marsh environments (Croft 1972). These fine-grained units are critically important in the hydrology of the basin in that they restrict the downward movement of water and act as aquitards. These nearly impermeable gypsiferous fine sand, silt and organic clay deposits are more than 3,000 feet thick beneath parts of Tulare Lake and spread out laterally and interfinger with the coarser sediments found along the basin margins (Croft 1972; Page 1983). The clayey or silty clay units interbedded within the Tulare Formation are designated by letters A through F (Croft 1972). The A-, C- and E-Clay units are the primary fine-grained units underlying significant portions of the Subbasin and can isolate different waters and bounds the freshwater aquifers. However, beneath Tulare Lake, these individual clay units are not distinguishable from the other clay deposits that form the massive clay plug beneath the center of the lake (KDSA et al. 2015).

A-Clay

The A-Clay is a dark greenish gray or blue, organic clay found approximately 60 feet bgs in the Tulare Lake area (KDSA et al. 2015). A-Clay is approximately 10 to 60 feet in thickness and in some places a sand lens separates the A-Clay into an upper and lower unit (Croft 1972). However, due to similarities in the sedimentary deposits beneath Tulare Lake, A-Clay was not able to be positively identified in all areas (Page 1983). Outside of Tulare Lake area and near rivers and streams, groundwater above the A-Clay can be an important source of shallow groundwater for domestic and limited AGR uses. In Tulare Lake area, groundwater above the A-Clay is typically too saline for MUN or AGR usage and has been exempted from MUN and AGR beneficial use (RWQCB 2017). The delineated lateral extent of the A-Clay is shown in Figure 3.1.8-1 delineated by Croft (1972) and Page (1983) is shown on Figures 3.1.4-2 through 3.1.4-4 and Figure 3.1.8-1 (Croft 1972; Page 1983).

C-Clay

The C-Clay consists of yellowish-brown to bluish-gray silty-clay and is found approximately 230 feet bgs in the Tulare Lake area (KDSA et al. 2015). The C-Clay is about 10 feet thick and is structurally warped and folded (Croft 1972). C-Clay could not be positively identified beneath Tulare Lake in previous studies (Page 1983). Outside of the Tulare Lake area, most of the groundwater production from public supply wells is from wells that tap water below the C-Clay (KDSA et al. 2015). In the Tulare Lake area, groundwater above the C-Clay is typically too saline for MUN or AGR usage (RWQCB 2017) and has been exempted from MUN and AGR beneficial use. The delineated lateral extent of the C-Clay is shown on Figure 3.1.8-2 and in cross sections A to A', B to B', and C to C' (Figures 3.1.4-2 through 3.1.4-4) (Croft 1972; Page 1983).

Corcoran Clay (E-Clay)

The Corcoran Clay is the most extensive aquitard in the San Joaquin Valley. The Corcoran Clay is composed of dark-greenish gray, mainly diatomaceous, silt, clay, silty clay, clayey silt and sand that was deposited in a lake that occupied the San Joaquin Valley (Croft 1972). The lateral extent and depth of the Corcoran Clay is shown on Figure 3.1.8-3 and its thickness on Figure 3.1.8-4. The Corcoran Clay is warped into a major, asymmetric, northwest trending syncline that has been additionally deformed with smaller, subordinate folds.

Recently, a detailed evaluation of the presence of the Corcoran Clay beneath Tulare Lake area was undertaken in support of a de-designation of beneficial uses for groundwater beneath this lake area (KDSA et al. 2015). This study identified the Corcoran Clay as being present at depths of about 400 to more than 800 feet bgs throughout the Subbasin. Within the clay plug itself, due to the continuous fine-grained lacustrine nature of the sediments, similar to that of the Corcoran Clay, the Corcoran Clay cannot be delineated. The low permeability of the Corcoran Clay makes it an effective aquitard. It has sharp vertical boundaries and shows up well on borehole geophysical electric logs. The Corcoran Clay appears to extend out to the east of the Subbasin near SR 99. On the west, it rises sharply with the Tulare and underlying San Joaquin Formations. E-clay is more difficult to recognize as it approaches the west-side fold belts. Geophysical well logs indicate that the Corcoran Clay, although the largest single confining bed in the Subbasin, constitutes only a small percentage of the total cumulative thickness of clay layers in the unconsolidated sediments beneath the Tulare Lake clay plug.

3.1.9 Hydraulic Parameters

Two significant hydraulic parameters for groundwater resources are hydraulic conductivity and storage coefficient. The hydraulic conductivity is directly proportional to the rate at which groundwater will move under a unit hydraulic gradient. The storage coefficient is the amount of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit head change. When referring to an unconfined aquifer, the storage coefficient is called the specific yield and is related to the amount of water drained from the pore spaces in the aquifer and given as a percent of the total volume of the aquifer material. For a confined aquifer, the amount of water released is derived from limited compressibility of the water and primarily by the compression of the aquifer. No drainage of the water pores is involved.

A method referred to as "yield factor" was utilized to approximate relative permeability, also known as hydraulic conductivity (Croft and Gordon 1968). The yield factor is equal to 100 times the specific capacity of a pumping well divided by the thickness of saturated material penetrated by the well (Croft and Gordon 1968). Specific capacity is calculated by dividing the discharge from the well by the amount of drawdown created by pumping. The study used pump-efficiency tests supplied by Pacific Gas and Electric Company and Southern California Edison Company to calculate the specific capacities of numerous wells in the Tulare Lake area. These data were compiled and indicated increasing yield factor or permeability moving away from Tulare Lake, largely related to the increasing coarseness of sediments further removed from the lacustrine fine-grained sediments within the lake (Figure 3.1.9-1).

Specific yields have been estimated for various areas of the San Joaquin Valley based on average grain size in the unconfined aquifers (Davis et al. 1964). On the Kings River alluvial fan, the specific yield was estimated to be 14.1%. On the Kaweah and Tule River fans, specific yield was estimated to be 9.5%. The storage coefficient for the confined aquifer has not been estimated specifically for the area within the Subbasin; however, a method is provided for estimating storage coefficient by multiplying the thickness of the confined aquifer in feet by a factor of 1x10-4 (Lohman 1972).

In support of the Central Valley Hydrologic Model (CVHM), scientists from the United States Geological Survey (USGS) developed a geologic texture model to describe the coarseness or fineness of basin-fill materials that make up the hydrogeologic system and used this model to estimate hydraulic properties including hydraulic conductivity and storage properties for every cell in the CVHM model grid (Faunt, ed. 2009) (Figure 3.1.9-2). Hydraulic conductivities derived from these texture models would range from approximately 1 foot per day (ft/d) to about 70 ft/d. Specific yields estimated for the CVHM ranged from 9% to 40% and varied based on the percentage of coarse-grained deposits with higher specific yields from coarser-grained deposits. The specific storage (storage coefficients divided by the thickness of the unit) ranged from

1.4 x 10-4 per foot (ft) for inelastic aquifers, 1.0 x 10-6 per ft for coarse-grained elastic aquifers, and 4.5 x 10-6 per ft for fine-grained elastic aquifers. The compressibility of water is estimated to be 1.4 x 10-6 per ft and must be added to the specific storage of the matrix to determine the confined specific storage.

3.1.10 Groundwater Recharge and Discharge

Groundwater recharge in the Subbasin occurs primarily by two methods: (1) infiltration of surface water from the Kings River and unlined conveyances, and (2) infiltration of applied water for irrigation of crops. Recharge from infiltration of direct precipitation is minor owing to the low annual rainfall and the predominance of fine-grained surface soils. Some recharge enters the Subbasin by subsurface flow from adjoining subbasins; however, this is a minor component as most pumping for irrigation lie to the north and east of the Subbasin due to the more favorable hydraulic properties of the sediments outside of the Subbasin. Intentional recharge also occurs within the Subbasin by percolating surface water through storage ponds and old river channels, though the magnitude of this component is small compared to the groundwater demand in the Subbasin. Most surface water entering the Subbasin is consumptively used or retained due to the internal drainage within the Subbasin.

Groundwater discharge in the Subbasin is predominantly by groundwater extraction along the eastern and northern portions of the Subbasin where water quality and well yields are higher than near Tulare Lake. Some discharge is impacted by direct soil evaporation and evapotranspiration, particularly in areas where groundwater is less than 10 feet bgs. Additionally, some discharge occurs by tile drains in agricultural areas that have high groundwater levels to lower the groundwater table to below the root zone to sustain agriculture. Groundwater discharge also occurs by subsurface movement of groundwater from the Subbasin toward adjoining subbasins. Potential groundwater recharge based on soil classification and potential groundwater extraction based on subsurface sediment texture varies (Figure 3.1.10-1).

3.1.11 Primary Uses of Each Aquifer

The upper unconfined and semiconfined aquifer and the lower confined aquifer are sometimes used for different purposes based on economics and water quality. Primary groundwater uses within the Subbasin include domestic, municipal, agricultural, and industrial.

Domestic Pumping
Domestic pumping is primarily from the upper unconfined and semiconfined aquifer because it is easier to access and typically has sufficient yield for domestic purposes.

Municipal Pumping
Municipal pumping of groundwater occurs in the Subbasin by the cities of Hanford, Lemoore, Stratford, and Corcoran (Table 3.1.11-1). Wells for municipal purposes are typically in the deeper portions of the unconfined and semiconfined aquifer and sometimes reach into the confined aquifer. Municipal uses require larger sustained yields than domestic uses; therefore, municipal pumping looks to deeper zones with longer well screens than domestic wells. The municipal pumping demand varies seasonally, peaking in the summer months.

Agricultural Pumping
Agricultural pumping requires large quantities of water and water quality not impacted by elevated TDS, chloride, and boron concentrations. The requisite quantity and quality can be achieved by drilling into the deeper portions of the upper aquifer and below the Corcoran Clay into the lower

confined aquifer. Thus, most of the agricultural pumping in the Subbasin and in adjoining subbasins is from deep wells.

Industrial Water Pumping
Industrial use depends on application. Groundwater used to provide steam for power generation or heating needs to contain low TDS and may require treatment. Some industrial use such as dust control may not be dependent on water quality.

3.1.12 Uncertainty and Data Gaps

The HCM is being used to characterize groundwater conditions in the Subbasin and to provide the basis and assumptions used to construct and run the groundwater model. The groundwater model is being used to estimate changes over time in groundwater levels, flow directions, and storage given a set of inflows (precipitation, surface water, underflow in, etc.) and outflows (evapotranspiration, pumping, underflow out, etc.). Prior to SGMA, there were no requirements to manage or report groundwater usage. As a result, most water supply entities do not know the location, construction, and pumping history of many pumping wells within their jurisdiction. Although depth to groundwater measurements are collected periodically from many wells, the lack of well construction data makes it difficult to interpret the data. Furthermore, most of these entities often do not have a good historical accounting of which parcels have received surface waters and at what rates. Hence, these inputs and outputs need to be approximated by other means than direct measurement.

The data utilized for the HCM and subsequently the construction and calibration of the groundwater model were provided by various private parties, public agencies, and data extracted from existing numerical models of the area.

Much of the hydrologic data used in the HCM and to construct and calibrate the groundwater model are based on estimates or inferred from multiple data sources. As noted above, most water suppliers do not know the historical delivery of surface water to various parcels within their jurisdiction. Hence, it was necessary to assume that all irrigated parcels received some surface water allotment. Likewise, the location, construction, and pumping history of most of the irrigation wells in the Subbasin are not known. Hypothetical irrigation well locations were assumed to be distributed with relatively uniform spacing across the model domain. The hypothetical irrigation wells were also assumed to have completion intervals and frequency similar to that of a small subset of wells with known constructions. Hypothetical irrigation well pumping was estimated based on a water balance method using estimated agricultural demand based on reported crop type minus the assumed distribution of surface water supplies. While these simplifying assumptions and estimates are reasonable given the sparseness of measurements, they add uncertainty to the HCM and the groundwater model.

Overtime, under SGMA, more accurate data regarding well construction, water level measurement, spatial and temporal groundwater pumping, and surface water deliveries should be collected and utilized to update the HCM and the groundwater models of the Subbasin. As the HCM and the groundwater model are updated with actual measurement instead of estimates, the HCM and the groundwater model will become more useful tools for managing groundwater in the Subbasin.

3.2 Groundwater Conditions

> **23 CCR §354.16** *Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions based on the best available information…*

This section contains information related to historical and current groundwater conditions necessary to understand the characteristics of groundwater flow within the Subbasin, groundwater quality, and the water budget. Subsidence and its overall effect on groundwater storage, surface and groundwater interactions, and groundwater dependent ecosystems is also discussed.

3.2.1 Historical Changes in Groundwater Flow

Historically, groundwater movement in the Subbasin was dominated by recharge of surface water on the alluvial fans of the rivers and streams emanating from the Sierra Nevada Mountains and by the discharge sinks created by evaporation from Tulare Lake and evapotranspiration created by the swamps and marshes along the periphery of the Lake. Maps of unconfined groundwater conditions in the San Joaquin Valley between 1905 to 1907 (Figure 3.2.1-1) showed groundwater flow converging on the Tulare Lake bottom and confined flowing wells (artesian) in the Subbasin along the center of the valley and as far east as Goshen, Tulare, and Pixley (Mendenhall et al. 1916). Water levels indicated groundwater recharge on the Kings, Kaweah, and Tule River fans.

By 1952, groundwater development had altered the potentiometric surface such that distinct pumping cones of depression had developed in the unconfined upper aquifer east of the Subbasin beneath the Kaweah and Tule River fans and within the Subbasin on the Kings River fan near Hanford (Figure 3.2.1-2) (Davis et al. 1959). These groundwater depressions interrupted the through flow of groundwater from the alluvial fans west of the Sierra Nevada Mountains to the Tulare Lake area.

In 2016, groundwater cones of depression in the unconfined upper aquifer were apparent east of the Subbasin with groundwater elevations having declined 100 to more than 200 feet from the 1952 data (Figure 3.2.1-3). Based on available groundwater elevation data, the groundwater cones of depression peripheral to the Subbasin changed the natural prevailing direction of groundwater flow from west-southwest toward Tulare Lake, to east, northeast, and southeast away from Tulare Lake.

There were insufficient data available for confined aquifer only wells to prepare potentiometric surface maps for the confined aquifer system.

3.2.2 Recent Groundwater Elevation Data and Flow

In 1990, the DWR mapped groundwater levels in the unconfined aquifer at an elevation of about 260 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom (Figure 3.2.2-1). Groundwater elevations beneath Hanford were about 170 feet AMSL and about 140 feet AMSL near Corcoran. There were several groundwater cones of depression in the water table near Hanford, north and south of Corcoran, and around Alpaugh. The Kings River appears to be a natural groundwater divide, a losing stream that provides a significant source of groundwater recharge to the unconfined aquifer. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin to the west-northwest (Figure 3.2.2-1).

In 1995, groundwater in the unconfined aquifer was at an elevation of about 260 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom (Figure 3.2.2-1). Groundwater elevations beneath Hanford were about 150 feet AMSL and about 110 feet AMSL near Corcoran. By 1995, the cones of depression in the water table between Hanford and Corcoran had merged into a single large depression. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin.

In 2000, groundwater in the unconfined aquifer was at an elevation of about 250 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom (Figure 3.2.2-1). Groundwater elevations beneath Hanford were about 150 feet AMSL and less than 100 feet AMSL near Corcoran. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings and Kaweah subbasins and out of the Subbasin to Tule and Westside subbasins.

In 2005, groundwater in the unconfined aquifer was at an elevation of about 260 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom. Groundwater elevations beneath Hanford were about 140 feet AMSL, about 10 feet lower than in 2000. No data were collected in the Corcoran area (Figure 3.2.2-2). Throughout the Subbasin, groundwater levels had declined about 10 feet or greater than in 2000, during a period of average rainfall. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin.

In 2010, groundwater in the unconfined aquifer was at an elevation of about 250 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom. Groundwater elevations beneath Hanford were about 130 feet AMSL, and less than 10 feet AMSL near Corcoran (Figure 3.2.2-2). Throughout the Subbasin, groundwater levels had further declined about 10 feet or more feet since 2005. The Kings River continued to be a natural groundwater divide. In general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin.

In 2016, after roughly five years of severe drought, groundwater in the unconfined aquifer was at an elevation of about 230 feet AMSL near Kingsburg, decreasing toward the Tulare Lake bottom. In the Hanford area, groundwater levels were about 110 feet AMSL, about 20 feet lower than in 2010 (Figure 3.2.2-2). Cones of depression in the water table west, north, and southeast of Corcoran had deepened to -40 feet AMSL. In general, groundwater flowed into the Subbasin from the Kings and Kaweah subbasins and out of the Subbasin to the Tule and Westside subbasins.

Wells with groundwater monitoring records are shown in Figure 3.2.2-3a. The hydrographs for these wells were evaluated to look at seasonal trends. Hydrographs for representative wells with unknown construction, wells completed in the unconfined aquifer, and wells completed in the confined aquifer are shown on Figures 3.2.2-3b through 3.2.2-3d.

3.2.3 Vertical Groundwater Gradients

Vertical groundwater gradients between the upper unconfined aquifer and the confined aquifer separated by the Corcoran Clay are spatially and temporally variable. Prior to widespread groundwater development, there was an upward gradient from the confined aquifer to the unconfined aquifer (including artesian conditions) beneath much of the Subbasin (Figure 3.2.1-1). As agriculture was developed, pumping from below the Corcoran Clay eventually resulted in a downward gradient beneath much of the Subbasin. Pumping from a confined aquifer (which is a function of the storage coefficient) will often result in a larger change in head compared to pumping from an unconfined aquifer (which is a function of the specific yield) for the same volume of pumping. This is because the specific yield is typically several times larger than storage coefficient. Due to the different yield factors and the seasonal nature of agricultural pumping, groundwater levels in the confined aquifer tend to decrease much more than in the unconfined aquifer during the summer months, increasing the vertical gradients. As a result, vertical gradients tend to show a large range seasonally. As of December 2016, vertical gradients range between approximately 0.0 to 0.504 ft/ft (0.0 to 50 ft/100 ft) downward.

3.2.4 Groundwater Storage Estimates

Groundwater storage is the capacity of an aquifer system to yield groundwater. The amount of groundwater in storage (i.e., groundwater volume) is a function of the saturated thickness of the aquifer, the area of the aquifer, and the storage coefficients of an aquifer, which is the specific yield for unconfined aquifers and specific storage for confined aquifers. The specific yield of the Subbasin's aquifer system above the E-Clay (Corcoran Clay) ranges from 0.01 to 0.3 (unconfined), while the specific storage ranges between 1x10-5/ft and 4.5x10-2/ft for semi-confined intervals above the E-Clay (Wood 2018). The specific storage of confined sediments below the Corcoran Clay ranges between 2.5x10-7/ft and 1.25x10-3/ft (Wood 2018).

The Subbasin groundwater model and DWR estimates were used to calculate groundwater in storage for the principal aquifers (unconfined above the E-Clay and confined below the E-Clay) within the Subbasin boundaries based on 2016 conditions. The unconfined aquifer has an average specific yield of 8.5% (DWR, 2006) and an average saturated thickness of 451 feet over the 535,869 acres of the Subbasin. This yields an estimated at 20.5 million AF of groundwater in storage in the unconfined aquifer zone. The confined aquifer has an estimated average specific yield of 4.91% and an average saturated thickness of 2,294 feet over the 535,869 acres of the Subbasin. This yields an estimated 60.4 million AF of groundwater in storage in the confined aquifer zone. Total estimated groundwater in storage as of 2016 is approximately 80.9 million AF, slightly less than the DWR estimate of 82.5 million AF as of 1995 (DWR, 2006).

The groundwater model was also used to estimate the overall change in groundwater storage over the model calibration period of 1990 to 2016 for the unconfined and confined aquifers. Change in groundwater storage over time is a function of the change in hydraulic head of the aquifer, the aquifer area, and the storage coefficients. Groundwater storage can be negatively impacted by decreasing groundwater head and an overall reduction of the aquifers area resulting from declining groundwater.

Annual changes occurred in groundwater storage from 1990 through 2016 in the upper and lower aquifer zones for each GSA area (Figures 3.2.4-1a and 3.2.4-1b). Overall there has been a loss of storage of about 3.84 million AF from the unconfined aquifer, a storage gain of about 1.53 million AF in the confined aquifer, and a total loss of about 2.31 million AF between 1990 and 2016.

Permanent loss of groundwater storage capacity occurs when dewatering of an aquifer results in compression of sediments also known as subsidence due to loss of hydrostatic pore pressure that formerly offset compressional loading of the sediment overburden. Compaction of sediments permanently reduces effective porosity of an aquifer thus reducing overall aquifer storability. Between 1990 and 2016, the average subsidence across the Subbasin was approximately 1.42 feet with most of the compaction probably occurring in the fine-grained sediments within the confined aquifer. Assuming that the reduction in effective porosity of the fine-grained sediments is about

4.91%, then an average of 1.42 feet of subsidence (compaction) over the 535,869 acres of the Subbasin would result in a permanent loss of groundwater storage capacity beneath the Subbasin on the order of 37,360 AF, or approximately 0.05% of the total groundwater in storage in 2016.

3.2.5 Groundwater Quality

Water quality geochemistry varies in groundwater beneath the San Joaquin Valley (Mendenhall et al. 1916). On the west side of the valley, groundwater was always high in sulfate compared to groundwater on the east side of the valley. Near the center of the valley, groundwater had a mixed character, also being high in alkalis. Most of the water sampled represented essentially pre-development conditions. The difference in chemical characteristics of the groundwater was attributed to the source area for the sediments in which the groundwater was contained (Mendenhall et al. 1916). On the west side, deposits were derived from marine sedimentary rocks with high proportions of sulfur-rich minerals (such as gypsum), whereas on the east side, deposits were derived from granitic rocks with high proportions of silicates. Near the center of the Valley and around the historical Tulare Lake, groundwater contained higher proportions of chloride. It was also noted that TDS measurements in groundwater were greater on the west side than the east.

These findings were confirmed by an additional study in 1956, which concluded groundwater quality is markedly different vertically than horizontally (Davis et al. 1959). The increase in groundwater development between the initial and secondary reports resulted in the latter study subdividing groundwater into unconfined and semiconfined waters that have generally free communication with land surface, the fresh water confined beneath the Corcoran Clay, and brackish and saline marine connate waters that occur at depth beneath the useful aquifers throughout most of the Valley. These studies reported the confined fresh groundwater had lower TDS and a higher percentage of sodium than the unconfined or semi-confined aquifer. The differences between groundwater (carbonate) and west groundwater (sulfate) continued into the 1950s. The groundwater beneath the axial trough was highly variable because of evaporative concentration, variable mixing of east and west groundwater, and recharge of surface water along stream courses of Sierran rivers.

In 2018, a study undertook a comparison of historical groundwater quality data from the historical report of 1916 and modern samples from 1993–2015 to quantify anthropogenic contributions to salinity changes in groundwater quality (Hansen et al. 2018). Findings indicate TDS had increased in most groundwater in the San Joaquin Valley over the past 100 years. However, the spatial distribution of the TDS and individual cation-anion makeup of the groundwater still reflect the geologic provenance of the containing sediments as well as the chemical characteristics of the recharge water. The greatest TDS increases in the Tulare Lake area and eastward were in the shallow portions (i.e., unconfined to semiconfined) of the aquifer.

Excluding water above the A-Clay, the historical data did not indicate any substantial differences in TDS between shallow and deep groundwater. Modern increases in TDS in the shallower groundwater were hypothesized to be due to land usage, which is primarily agricultural in this area (Hansen et al. 2018). The changes to individual cations and anions suggest dissolution of silicate minerals possibly caused by increases in carbonic acid in the soil zone due to agricultural practices. An increase in bicarbonate concentrations were the highest contributor to increases in TDS over the past 100 years. Migration of higher TDS water to deeper portions of the unconfined/semiconfined aquifer was postulated to be the result of high rates of agricultural pumping, along with more limited municipal pumping creating downward vertical movement from upper to lower portions of the upper aquifer. Only limited changes to the TDS and chemical makeup of the lower, confined aquifer were apparent, assuming that the historical chemistry reflected both native conditions for both the upper and lower aquifers (Hansen et al. 2018).

Deep groundwater near the boundary of the continental deposits and the Tertiary marine deposits (San Joaquin Formation) has been estimated to exhibit TDS upwards of 2,000 mg/L based on limited groundwater samples and interpretation of geophysical logs of deep borings. This water represents saline connate water contained or adjacent to the marine deposits.

The SWRCB maintains a database of water quality data (GeoTracker) collected from various state regulatory programs, the USGS, and the University of California Davis Nitrate Study. These datasets were obtained for the Subbasin to gain a general overview of water quality. In general, chemicals of concern that generally affect water quality in the San Joaquin Valley were screened including naturally occurring and anthropomorphic. These included salinity (TDS), arsenic, nitrate, and volatile organic chemicals (VOCs). Figure 3.2.5-1 shows the area-wide distribution of TDS in groundwater. Figure 3.2.5-2 shows the distribution of arsenic in groundwater. Figure 3.2.5-3 shows the distribution of nitrate in groundwater, and Figure 3.2.5-4 shows the distribution of VOCs in groundwater.

South of Stratford and Corcoran, groundwater quality diminishes, and portions of the Tulare Lakebed have been de-designated as not suitable for municipal, domestic, agricultural irrigation, and stock watering supply (RWQCB 2017). The primary constituents of concern for the de-designated areas included boron, chloride, sodium, salinity (EC), and TDS (RWQCB 2017). Prior to amendment of the Water Quality Control Plan for the de-designation of MUN and AGR use of groundwater in areas of poor water quality in the Subbasin, characterization studies were conducted to evaluate the potential for the migration of poor water quality from the de- designated areas or the capture of poor quality water by wells near the de-designated area (KDSA et. Al. 2015). The results of these characterization studies are summarized in RWQCB Resolution R5-2017-0032 as follows: basin-wide groundwater flows to the center of the Tulare Lakebed, poor water quality is present in a shallow saline aquifer above the Corcoran Clay, and better water quality is present in the aquifer located below the Corcoran Clay.

Data Gap: The available data from GeoTracker and other public sources generally do not distinguish groundwater quality by aquifer zone. Therefore, the depth intervals for water quality data presented in Figures discussed above are unknown and represent a data gap. Well completion data should be reviewed to potentially identify completion intervals for the reported wells, and subsequent water quality samples should only be collected from wells with known construction.

3.2.6 Land Subsidence

Alluvial aquifer systems including those found in the San Joaquin Valley typically consist of a granular mineral skeleton of sand, silt, and clay, and pore-spaces filled with water (LSCE 2014). When water is withdrawn (i.e., pumped) from an aquifer, the fluid pressure in the pore space, also known as pore pressure, is reduced and the weight of the overlying materials must be increasingly supported by the granular mineral skeleton of the aquifer system. As the pressure on the granular skeleton including effective stress increases, some compression of the aquifer system skeleton may occur causing elastic deformation. When the effective stress exceeds the previous maximum effect stress on the aquifer skeleton (pre-consolidation stress) then some rearrangement of the mineral grains, typically clays, may occur and result in permanent compaction resulting in inelastic deformation. For individual thin clay lenses, the amount of compaction is relatively small.

However, the combined compaction of many clay lenses within an aquifer system can result in significant subsidence at the ground surface.

Land subsidence due to groundwater withdrawals and associated drawdown has been well documented and has affected significant areas of the San Joaquin Valley since the 1920s, including the Subbasin (Wood 2017). Between 1926 and 1970, there was approximately 4 feet of cumulative subsidence near Corcoran, 4 to 6 feet of subsidence near Hanford, and as much as 12 feet of subsidence near Pixley (Figure 3.2.6-1). Following the completion of the SWP and CVP, surface water became more readily available in the San Joaquin Valley and groundwater extraction was reduced and groundwater levels recovered. As a result, subsidence due to groundwater withdrawal was temporarily slowed or stopped.

Groundwater pumping has since increased in the San Joaquin Valley in the past 10 to 25 years due to several factors including the planting of permanent crops and a reduction of available imported surface water. At the same time, some existing wells were deepened or the pumps were lowered, and new wells were installed into deep, previously un-pumped and unconsolidated portions of the confined aquifer beneath the Corcoran Clay. Pumping from the confined aquifer eventually exceeded the pre-consolidation stress of the aquifer system, resulting in the resumption and acceleration of compaction of the fine-grained sediments in the confine aquifer system and associated subsidence at the land surface.

Subsidence in the San Joaquin Valley was exacerbated during a moderate to severe drought from 2007 through 2009 and a severe to exceptional drought from 2012 through 2016. A Jet Propulsion Laboratory study of subsidence between June 2007 and December 2010 indicated subsidence rates were as high as 8.5 inches per year near Corcoran (Farr et al. 2015) (Figure 3.2.6-2a). A more recent study by Jet Propulsion Laboratory indicted subsidence rates accelerated in some areas during the recent drought, with annual subsidence rates of 1 to 1.5 feet near Corcoran in 2015-2016 (Farr et al. 2017) (Figure 3.2.6-2b).

Groundwater pumping and drawdown and consequent subsidence are anticipated to continue until withdrawals from the deep confined aquifer can be managed so that sustainable groundwater pumping is achieved. Most of the aquifer compaction is inelastic, so subsidence is mostly irreversible even if groundwater pumping decreases and groundwater level recover.

3.2.7 Surface Water Systems

The established surface water system is described in detail in Section 3.1.1.5. The historical conditions of surface water flow have been significantly altered by irrigation demand and flood control/reclamation projects since the turn of the 20th century. In pre-development in the 1800s, runoff from the southern Sierra Nevada Mountains south of the San Joaquin River south to Kern River collected in three terminal lakes: Tulare Lake, Kern Lake, and Buena Vista Lake. This internal drainage configuration created vast regions of adjoining Tule marshes and riparian woodland wetlands. Tulare Lake in the 1870s was reported to have an area of approximately 446,000 acres or 697 square miles and an elevation of about 200 feet AMSL (BCI 1874). The surface area of Tulare Lake was about 505,000 acres or 790 square miles at its highest overflow level of 216 feet AMSL. The lake level and its aerial extent fluctuated during wet and dry periods.

Prior to development, Tulare Lake received runoff from the major and minor streams of the Southern Sierra Nevada described in Section 3.1.1.5. Tulare Lake also received overflow from Buena Vista Lake which in turn received overflow from Kern Lake (Figure 3.2.7-1). The major rivers formed broad deltaic and alluvial fans as they flowed from the Sierra Nevada foothills into the San Joaquin Valley, creating multiple distributary channels and sloughs that shifted periodically, especially during flooding events.

Natural hydrology of the Subbasin has been altered over the last century for flood control, irrigation, land reclamation, and water conservation priorities. Concerns about flood control and water supplies resulted in the construction of Pine Flat Dam on the Kings River, Terminus Dam on the Kaweah River, Success Dam on the Tule River, and Isabella Dam on the Kern River. The modern-day surface water conveyances that supply the Subbasin are primarily man-made canals and streambeds.

3.2.8 Interconnected Surface Water and Groundwater Systems

Prior to development in the late 1800s and early 1900s, groundwater and surface waters were interconnected around the Subbasin, resulting in extensive wetlands, a nearly persistent Tulare Lake, and notable artesian aquifers indicating strong upward groundwater gradients (Figure 3.2.1-1 and 3.2.7). Groundwater levels were near the ground surface beneath much of the Subbasin, and as streams and rivers flowed from the Sierra Nevada foothills and Coast Ranges towards Tulare Lake, they geographically transitioned from losing streams which recharged underlying groundwater to into gaining streams which benefit from groundwater discharge (Figure 3.2.8-1).

During development, the four major rivers draining into Tulare Lake were dammed, and Tulare Lake itself was able to be reclaimed due to upstream irrigation demands. As a result, most streams and rivers draining into Tulare Lake became disconnected from the regional unconfined aquifer system. The 1952 potentiometric surface maps show the Kings River was a losing stream from the Sierra Nevada foothills to where it crossed SR 198 (Figure 3.2.1-2). South of SR 198 and north of Tulare Lake, groundwater contours converge indicating the lower reach of the Kings River may have gained water due to groundwater discharge. The Tule and Kaweah rivers were losing streams in 1952. Potentiometric surface maps from 1990 show that the Kings, Kaweah, and Tule rivers are all losing streams (Figure 3.2.2-1).

In the past 160 years, the expanded use of surface water and groundwater extraction have resulted in a significant lowering of the regional water table, causing isolation of surface waters from groundwater beneath most of the Subbasin. Shallow, perched groundwater often is present in the vicinity of surface water conveyances and below recharge facilities; however, these shallow zones are disconnected from the regional unconfined aquifer. Other localized shallow perched zones may exist elsewhere in the Subbasin, but these are not considered a significant source of groundwater.

Though surface water is not connected to groundwater in the Subbasin, shallow groundwater near the Kings River potentially responds to changes in river flows. As described in Chapter 5, the GSP monitoring plan recognizes that a data gap exists in this area to be filled with a shallow monitoring well. Data from shallow wells in this area, once they become available, will be evaluated to better understand the relationship between shallow groundwater above the A-Clay, flows in the Kings River, and shallow groundwater use. The need for additional monitoring of shallow groundwater in the future in this area will be evaluated by the GSAs.

Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are ecosystems that rely upon shallow groundwater for their sustainability. Depletion of groundwater and lowering of the water table has detrimental effects on GDE existence. GDEs differ from surface water dependent wetlands because they are sustained by natural surface water or artificially conveyed surface water. In some instances, such as the Kern Wildlife Refuge at the southern border of the Subbasin, a wetland may be artificially maintained by conveyed surface water delivery and deep groundwater pumping. Historically, the Tulare Lake region appears to have supported a mix of both GDEs and surface water dependent wetlands (Figure 3.2.8-1), which were mostly eliminated when upstream water diversions and impoundments drained the lake.

Remaining GDEs within the Subbasin were evaluated using the California Natural Resources Agency DWR Open Data "Natural Communities Commonly Associated with Groundwater" (NCCAG) database. The database contains two habitat indicators that could indicate the presence of GDEs: (1) wetland features commonly associated with surface expression of groundwater under natural unmodified conditions, and (2) vegetation types (phreatophytes) commonly associated with the subsurface presence of groundwater. It should be noted that this dataset does not represent DWRs determination of a GDE. However, it can be used as an initial screening tool for identifying GDEs within the Subbasin.

Figure 3.2.8-2 shows the distribution of remaining wetland features that could be associated with groundwater. Note how few wetlands remain compared to pre-development (Figure 3.2.8-1). The remaining wetland consists of semi-permanent/seasonally flooded lake shore wetlands; semi-permanent/seasonally flooded or saturated marsh land; and riparian seasonally or permanently flooded wetlands. The NCCAG database identified 23 species of phreatophytes and five vegetative habitats within the Subbasin that could be associated with GDEs (Figure 3.2.8-2). All listed wetlands and phreatophyte areas within ER GSA are not GDE's due to the lack of groundwater in the listed areas.

Most of these vegetation types/plant species are associated with riparian habitat that rely on percolation of imported surface water. Salt tolerant phreatophytes such as iodine bush, quail bush, alkali bulrush, curlyton knotweed, hardstem bulrush, shrubby seepweed, spinescale, alkali goldenbush, and tamarisk can be found in the alkali sink or in brackish water marsh habitat. These plants are typically found in areas of shallow perched groundwater with high salinity (Figure 3.2.8-2). The lateral extent of shallow perched groundwater is dependent on available recharge associated with surface water conveyances, occasional flood events, agricultural irrigation, evapotranspiration, and land reclamation in areas where tile subsurface drains have been installed. The subsurface tile drains have controlled groundwater elevations by subsurface drainage.

It is anticipated that the existing imported surface water supplies into the Subbasin will continue unabated into the foreseeable future and may even increase as additional water supply projects are developed. Hence leakage from the surface water conveyances will continue to seasonally recharge shallow groundwater in the vicinity of the existing riparian phreatophytes.

Limited studies have shown that groundwater pumping from the principal unconfined aquifer system in the immediate vicinity of the Kings River may induce limited drawdown (i.e., leakage) of shallow groundwater above the A-Clay into the regional aquifer system (P&P, 2009). The studies indicate that increased pumping does not significantly increase leakage, suggesting that the leakage rate primarily dependent based on the vertical conductivity of the A-Clay. It is anticipated that the groundwater pumping from the unconfined aquifer in the vicinity of existing riparian phreatophytes will not increase in the foreseeable future and may even decrease as additional water supply projects are developed. Hence, the combined effects of steady or increased surface water supplies and steady or decreased groundwater pumping in the vicinity of the existing riparian phreatophytes are not likely to adversely impact the availability of shallow groundwater in the vicinity of the existing riparian phreatophyte areas.

3.3 Water Budget Information

> **23 CCR §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.*

This section provides a quantitative description of the water budget for the Subbasin including an account of the inflows, outflows, and changes in storage in the Subbasin aquifer system over time. This includes historical, current, and projected water budget and the changes in the Subbasin's storage. Within a subbasin, if total outflows exceed total inflows, both groundwater levels and groundwater in storage will decline, and the subbasin may be considered in a state of overdraft. When inflows and outflows are in balance, both groundwater levels and groundwater in storage will remain stable over time. Safe Yield is that volume of groundwater that may be utilized within a subbasin without long-term overdraft.

The historical water budget information will be utilized to estimate future conditions related to supply, demand, hydrology, and surface water supply reliability to construct a baseline forecast to understand future projected conditions and for development of management actions and projects.

As discussed more fully in Section 3.3.7.1, agriculture in the Subbasin is primarily dependent on surface water deliveries from the Kings River system, not precipitation. The annual surface water deliveries from the Kings River system to the Subbasin for the period 1966 through 2016 were used to calculate the long-term average surface water deliveries of approximately 627,710 acre-feet per year (AF/Y) without the 2012–2016 drought years. Within the 1990-2016 study period, the 1998-2010 interval has average surface water diversions of approximately 620,630 AF, very close to the long-term average of 627,710 AF/Y (excluding the drought years). Hence, the 13-year period from 1998 through 2010 may be considered a cycle of "normal hydrology" where the average Kings River surface water deliveries are near the long-term mean. The 1998-2010 "normal hydrology" period includes 1 average, 6 above-average, and 6 below-average surface water delivery years.

3.3.1 Inflows, Outflows, and Change in Storage

The Subbasin's water budget describes the inflows to and outflows from the Subbasin's hydrogeologic system. Inflow and outflow can occur from the hydraulic boundaries of the system, from various sources within the model domain such as inflow from adjacent subbasins, rainfall, lakes, and seepage from rivers and canals, and from the exit points such as wells, drainage systems, or outflow to adjacent subbasins. The boundaries, sources, and sinks identified within the model domain are discussed below.

Inflows

Inflows consist of precipitation, surface water diversions for irrigation, imported groundwater, lakebed storage, intentional recharge, seepage from streams and conveyances, and groundwater inflow from adjacent subbasins.

Precipitation

Precipitation can be a significant source of water to the Subbasin and surrounding area in wet years. Given the large areal extent of the Subbasin and surrounding area, it was determined using a single weather station to estimate precipitation would be inadequate to represent the entire Subbasin. Instead, the PRISM database maintained by the Oregon State University was used to estimate monthly precipitation from January 1990 through December 2016 across the Subbasin (Figure 3.3.1-1). The PRISM database contains monthly total precipitation for the entire United States using a 4-kilometer grid. The monthly precipitation values are statistically derived values based on local weather stations and corrections for topographic variations. The monthly precipitation data were summed by Subbasin area to estimate the potential annual precipitation volume (Figure 3.3.1-1).

Not all rainfall is available for use by crops – some falls on impervious surface, some is taken up by dry soils, some is intercepted by foliage and evaporates before it can infiltrate, and some deep percolates and recharges groundwater. Monthly effective precipitation was calculated by multiplying the monthly PRISM data sets by the Precipitation / Effective Precipitation ratios presented in the Food and Agriculture Organization 56 (Allen et al. 1998) (Table 3.1.1-1, Figure 3.3.1-2). Effective precipitation varies annually in the Subbasin (Figure 3.3.1-1). Between 1990 and 2016, the estimated volume of effective precipitation not utilized by crops (i.e., deep percolated) ranged from 430 AF in a dry year (2013) to 80,580 AF in a wet year (2010) and averaged approximately 23,700 AF/Y within the Subbasin.

Data Gap: The volume of effective precipitation utilized by crops, taken-up by soil, and deep percolated needs to be quantified across the Subbasin based on soil types and crops grown.

Surface Water Diversions

Surface water diversions from external sources are another significant source of water to the Subbasin. There are 34 rivers, streams, canals, and diversions entering and within the Subbasin that have recorded diversions (Figure 3.1.1-5). Surface water delivery and diversion records within the Subbasin for the past 50-years were obtained via direct contacts with the various GSAs and member water management agencies within the GSAs (Table 3.3.1-1). Between 1966 and 2016, surface water diversions ranged from 107,210 AF in a dry year (2015) to 1,056,880 AF in a wet year (1982) and averaged approximately 590,700 AF/Y of water across the Subbasin (Table 3.3.1-1). If the drought years of 2012–2016 are ignored, the long-term average is approximately 627,710 AF/Y.

Between 1990 and 2016, surface water diversions ranged from 107,210 AF in a dry year (2015) to 1,038,050 AF in a wet year (1996) and averaged approximately 559,440 AF/Y of water across the Subbasin (Table 3.3.1-1).

The surface water diversions are not delivered uniformly across the Subbasin and are highly variable by GSA with most surface water diversion going to the ER GSA and least amount of surface water going to TCWA GSA (Figure 3.3.1-3).

Data Gap: The volume of surface water delivered needs to be better quantified by parcel and GSA by month across the Subbasin.

Imported Groundwater Supply

One unique feature of the Subbasin is the importation of groundwater supplies from adjacent subbasins. Interests within the ER and TCWA GSAs operate well fields in the adjacent Tule Subbasin and import the pumped groundwater into the Subbasin as an additional water supply. Between 1990 and 2016, ER GSA operated up to 52 wells in the Creighton Ranch well field, which delivered up to 68,730 AF in a dry year (2014) and as little as 0 AF in wet years (1996-1999) and averaged approximately 39,320 AF/Y in non-wet years. The TCWA GSA operated up to 51 wells in the Angiola Water District (WD) well field, which delivered groundwater to SWK GSA and TCWA GSA lands in the Tulare Lake Subbasin (about 60%) and to TCWA GSA lands in Tule Subbasin (about 40%). Between 1990 and 2016, the Angiola WD well field delivered up to 23,100 AF in a dry year (2009) and as little as 0 AF in wet years (1996-1999) and averaged approximately 15,950 AF/Y in non-wet years (Figure 3.3.1-4).

Data Gap: The volume of groundwater imported and applied needs to be better quantified by parcel and GSA by month across the Subbasin.

Lake Bottom Water Storage

Another unique feature of the Subbasin is the utilization of certain portions of the historical lake for storage of surface water inflows, including flood waters. This stored surface water is used as an irrigation supply, thereby reducing long-term demand for groundwater. Tulare Lake storage is occurring mostly in the ER GSA management area and also in a small area of the TCWA GSA. There is no Tulare Lake storage in MKR GSA, SWK GSA, or SFK GSA areas.

Lake storage facilities have the capacity to store approximately 70,000 AF at any given time. During flood events, as an example of conjunctive use, some fields can be flooded allowing for the storage of significant volumes of water, in some years up to 450,000 AF in the ER GSA management area (Figure 3.3.1-4). When available, the storage water is typically utilized to supplement surface water deliveries in lieu of groundwater pumping.

Data Gap: The volume of water stored in surface impoundments and applied as surface water needs to be better quantified by parcel and GSA by month across the Subbasin.

Intentional Recharge

Groundwater recharge in the Subbasin also occurs from intentional percolation of surface water in storage ponds and water banks. Kings County WD has performed intermittent intentional recharge operation in 25 basins totaling about 720 acres throughout the MKR GSA when water is available. Kings County WD also has operated a water bank on the Old Kings River channel since 2002. Approximately 73,600 AF of water has been recharged over this 17-year period via percolation through approximately 150 acres of ponds (Figure 3.3.1-5), and approximately 48,500 AF have been recovered utilizing five recovery wells since 2002. This leaves a positive balance of approximately 25,100 AF in the aquifer system as of 2016.

As part of a lawsuit settlement, Kings County WD has been infiltrating Kings River flood waters along the Old Kings River channel since the 1940s (referred to as Condition 8 water). Condition 8 water is surface water that naturally would have infiltrated along an approximately 7.75-mile reach of the Old Kings River channel during high river flow years had the river not been diverted for irrigation. Between 1990 and 2016, Condition 8 recharge has ranged from as little as 0 AF in most years and as much as 36,800 AF in flood years (1995) and averaged approximately 30,370 AF/Y in wet years (Figure 3.3.1-5).

The Corcoran irrigation District also owns and operates nine percolation basins totaling about 2,760 acres. Estimated percolation rates are about 0.25 ft/d. A review of aerial photographs suggests only one or two basins are typically utilized each year between March and September when surface water is available, percolating an estimated average of 23,500 AF/Y (Figure 3.3.1-5). During wet years, as much as 147,700 AF of water has been estimated to be percolated using these percolation basins.

In the Chamberlain Ranch area (ER GSA), 640 acres has been utilized for percolation basins. In 2017, approximately 5,000 AF was recharged.

Immediately adjacent to the eastern boundary of the ER GSA in the Tule Subbasin, there are recharge basins that are operated by ER GSA landowners. These recharge facilities are covered by a neighboring GSP.

Data Gap: The volume of intentional recharge needs to be better quantified by recharge facility by month across the Subbasin.

River and Canal Seepage

Seepage losses from river and canals provide another source of water to the Subbasin and surrounding areas. There are over 290 miles of major streams and canals within the Subbasin, in addition to many more miles of small distribution ditches on individual farms. Most of the stream and canals are unlined and can have significant seepage losses. Ownership of canal and river seepage is to be determined. There are a few anecdotal reports of seepage rates along a few reaches of some rivers and canals, but there are no known available seepage tests along the majority of the river and canal reaches in the Subbasin. Hence, river and canal seepage estimates are based on the calibrated groundwater model.

Between 1990 and 2016, seepage loss from rivers and streams are estimated to range between 60,440 AF in a dry year (2015) to 231,840 AF in a wet year (1993) and average approximately 141,360 AF/Y (Figure 3.3.1-6). Most of the seepage loss occurs on the Kings River in the MKR GSA and in the ER GSA (outside of the clay plug area) due to its size and number of canals delivering surface water to the GSA. The TCWA GSA management area has the lowest amount of seepage loss.

Data Gap: The volume of river and canal leakage needs to be better quantified by various river and canal reaches across the Subbasin.

Wastewater Treatment Plant Discharge

There are a number of small to mid-sized wastewater treatment plants (WWTPs) throughout the Subbasin operated by, including but not limited to, various cities, municipalities, the Department of Defense, Native American facilities, and manufacturing plants. At most of the WWTPs, treated wastewater is discharged into seepage ponds, used as recycled water, or utilized for irrigation by local farmers. The ratio of WWTP seepage to re-use is not well documented and needs further investigation.

Data Gap: The ratio of WWTP seepage to re-use is not well documented and needs further investigation. The volume of monthly WWTP seepage reaching groundwater needs to be better quantified by WWTP pond across the Subbasin.

Subbasin Boundary Groundwater Inflows

The Subbasin is located within the larger Tulare Lake Hydrologic Region and, except for the Kettleman Hills bordering the southwest potion of the Subbasin, the remaining Subbasin boundaries represent political not hydrogeological boundaries. As such. Groundwater is free to move across political boundaries into or out of the Subbasin. Groundwater inflows represent groundwater entering the Subbasin across its boundary from adjacent subbasins. Groundwater flowing into the Subbasin is considered a net gain of groundwater and has the potential to increase available storage with the Subbasin (Table 3.3.1-2a). Total inflow into the Subbasin ranges from about 83,220 AF (2011) to 181,210 AF(1990) and averaged about 118,310 AF/Y (Figure 3.3.1-7). The highest inflows are from the Kings (197,84 AF/Y) and Kern (24,910 AF/Y) subbasins. The inflow from the Kern Subbasin is misleading in that most of the groundwater from the Kern Subbasin is entering through the southeast corner of the Subbasin and then flowing out into the Tule Subbasin.

In the Upper Aquifer, inflow into the Subbasin ranges from about 32,180 AF (2011) to 60,940 AF (1990) and averages about 43,980 AF/Y (Table 3.3.1-2b). In the Lower Aquifer, inflow into the Subbasin ranges from about 51,040 AF (2011) to 120,270 AF (1990) and averages about 74,330 AF/Y (Table 3.3.1-2c).

Total Subbasin Inflows

Total inflows into the Subbasin consists of precipitation, surface water imports, groundwater imports, applied pond storage (flood waters), intentional recharge, seepage losses from surface water conveyances, seepage losses from WWTPs, and subsurface inflows from surrounding subbasins. During the 1990-2016 period, estimated total inflow ranged from 1,070,860 AF (2015) to 2,203,450 AF (1990) and averages about 1,584,140 AF/Y. Water balance inflows are summarized annually on Table 3.3.1-3 by Land Surface Water Budget and Subsurface Water Budget. The Subsurface Water Budget is further divided by Upper and Lower Aquifer zones for groundwater pumping, interbasin flow, and change is storage.

Outflows

Outflows consist of evapotranspiration, agricultural pumping, municipal pumping, agricultural drains, and groundwater outflow to adjacent subbasins. Litigation is pending regarding the outflow of surface water from the Subbasin.

Evapotranspiration

Crop evapotranspiration (Etc) is the largest outflow of water from the Subbasin. Etc varies seasonally and by crop type, typically peaking during the summer months (ITRC 2003). DWR crop data sets from 1995, 1998, and 2006 were used to estimate crop acreage on a 40-acre spacing from 1990 to 2006 throughout the Subbasin. Starting in 2007, CropScape started producing annual estimates of crop acreage on a 40-acre spacing. Annual crop demand was calculated for each crop type on a 40-acre basis as follows:

> Annual Crop Acreage (acres) * Annual Crop Etc (feet/yr) = ET_Demand (AF/Y)

Note some crop types do not receive irrigation water and have zero crop irrigation demand (Table 3.3.1-4). Crop irrigation demand, also referred to as farm demand was calculated as follows to account for this variable:

> (Crop ET-Demand (AF/Y) – Effective Precipitation (AF/Y)) / Irrigation Efficiency (percent) = Farm Demand (AF/Y)

Between 1990 and 2016, the total farm irrigation demand in the Subbasin ranged from approximately 624,650 AF (2015) to 1,232,450 AF (1999), with an average crop irrigation demand of approximately 1,018,560 AF/Y over this 26-year period (Table 3.3.1-2a; Figure 3.3.1-8). As shown in the DWR and CropScape data sets, the mix of crops grown and fallow lands has changed over time as agricultural practices were altered. A chart of annual crop demand shows total crop water demand has generally decreased since 2000 (Table 3.3.1-4). For example, cotton showed the most change with a decrease of near 50% between 1995 and 2016. Annualized tables and charts of crop demand for the Subbasin's GSAs are presented in the Model Report in Appendix D.

Data Gap: Crop distribution maps are not available for all years of the study period and those that are available may not capture double cropping or multi-cropping areas. Likewise, estimating ET demand based on typical crop evapotranspiration (ETc) data and assumed irrigation efficiencies may lead to errors in estimated demand. Better quantification of monthly Farm Demand is needed on a parcel and GSA basis across the Subbasin.

Municipal Pumping Demand

Municipal pumping of groundwater occurs in the Subbasin by the communities of Hanford, Lemoore, Armona, Stratford, and Corcoran (Table 3.1.11-1). Between 1990 and 2016, reported municipal pumping has ranged from 9,110 AF (1991) to 26,700 AF (2002) and averaged 14,910 AF/Y over this 26-year period (Figure 3.3.1-9). The municipal pumping demand varies seasonally, peaking in the summer months.

Agricultural Pumping Demand

Agricultural pumping is typically not recorded over much of California, including the Subbasin. However, agricultural pumping demand on a 40-acre spacing can be estimated as follows:

Farm Demand (AF/Y) – Surface Water Deliveries (AF/Y) = Un-Met Demand (AF/Y)

Un-Met Demand (AF/Y) – Return Flows (AF/Y) – Lake Bottom Water Storage (AF/Y) = Ag_Pumping Demand (AF/Y)

Where: Return Flows are recycled unused surface water

Lake Bottom Water Storage is surface water deliveries or flood waters stored in ponds

The Agricultural Pumping Demand per 40-acre spacing can then be summarized by each GSA (Figure 3.3.1-9). Although this simple water balance approach does not account for the areal distribution of surface water diversions or farm delivery requirements, it does provide a reasonable estimate of agricultural pumping in the Subbasin and GSA-specific scale. Based on this analysis, pumping demand in the Subbasin from 1990 through 2016 has ranged from 77,680 AF (2011) to 618,840 AF (1990) and averaged 318,410 AF/Y over this 26-year period (Table 3.3.1-2a; Figure 3.3.1-9).

In the Upper Aquifer, estimated pumping in the Subbasin ranges from about 126,310 AF (2011) to 363,970 AF (1990) and averages about 246,814 AF/Y (Table 3.3.1-2b). In the Lower Aquifer, estimated pumping in the Subbasin ranges from about zero AF (2011) to 254,870 AF (1990) and averages about 134,595 AF/Y (Table 3.3.1-2c).

Data Gap: The lack of accurate data regarding the location, completion intervals, and monthly pumping data for most agricultural water supply wells is likely the most significant data gap in the Subbasin. Accurate information regarding the location, completion intervals, and monthly pumping for the agricultural supply wells in the Subbasin would eliminate the need to estimate agricultural pumping based on assumed crop demand and would significantly reduce uncertainty in the Subbasin water balance. Better quantification of monthly agricultural pumping is needed on a parcel and GSA basis across the Subbasin.

Agricultural Drains

Agricultural drains are used beneath several areas of the Subbasin to keep soil from becoming waterlogged in the root zone by return flows. Typically, a tile or French drain system is used with tiles buried approximately 4 to 6 feet bgs draining to sumps. Subsurface drainage collected in the sumps is pumped via pipeline to evaporation basins. Locations vary of subsurface drains and evaporation basins within the Subbasin (Figure 3.1.10-1). Agricultural drainage volume were not available and were estimated with a numerical model. Between 1990 and 2016, estimated groundwater withdrawal from agricultural drains ranged from 0 to about 20,850 AF (2004), and averaged 5,720 AF/Y. These estimates may be low. Most of the agricultural drainage is occurring in the ER and TCWA GSAs (Figure 3.3.1-10). Between 1990 and 2016, the ER GSA estimated agricultural drain withdrawals ranged from 0 to 20,590 AF (2004) and averaged about 5,440 AF/Y. The TCWA GSAs groundwater withdrawals from drains ranged from about 0 to 1,190 AF (2008) and averaged about 54 AF/Y. Table 3.3.1-2a shows the contribution of agricultural drainage to the overall water balance.

Data Gap: The use and operation of agricultural drains in the Subbasin is not well documented and needs further investigation. The volume of monthly drain discharge needs to be better quantified by GSA across the Subbasin.

Subbasin Boundary Groundwater Outflows

The Subbasin is located within the larger Tulare Lake Hydrologic Region, and with the exception of the Kettleman Hills bordering the southwest portion of the Subbasin. Groundwater outflows represent groundwater exiting the Subbasin across its boundary in to adjacent subbasins. Groundwater flowing out of the Subbasin is considered a net loss of groundwater and has the potential to reduce available storage with the Subbasin (Table 3.3.1-2a; Figure 3.3.1-11). Outflow from the Subbasin ranges from about 111,280 AF (1990) to 160,350 (2016) AF, and averaged 136,520 AF/Y. The largest outflows are to the Kaweah, Kings, and Tule subbasins.

In the Upper Aquifer, outflow from the Subbasin ranged from about 42,520 AF (1993) to 60,070 AF (2016) and averaged about 43,980 AF/Y (Table 3.3.1-2b). In the Lower Aquifer, outflow from the Subbasin ranged from about 58,790 AF (1990) to 100,470 AF (2014) and averaged about 86,980 AF/Y (Table 3.3.1-2c).

Total Subbasin Outflows

Total outflows into the Subbasin consists of evapotranspiration, well pumping, agricultural drains, and subsurface outflows to surrounding subbasins. During the 1990-2016 period, estimated total outflow ranged from 1,529,580 AF (2015) to 2,783,110 AF (1990) and averaged about 1,968,130 AF/Y. Water balance outflows are summarized annually on Table 3.3.1-3 by Land Surface Water Budget and Subsurface Water Budget. The Subsurface Water Budget is further divided by Upper and Lower Aquifer zones for groundwater pumping, interbasin flow, and change is storage.

3.3.2 Annual Change in Groundwater Storage

Change in groundwater storage within an aquifer is the difference between the sum of the inflows and the sum of the outflows. An increase in aquifer storage results when the sum of the inflows exceeds the sum of the outflows. Conversely, a decrease in storage results when the sum of the outflows exceeds the sum of the inflows. When inflows equal outflows, no change in storage occurs. With a large basin such as the Subbasin, localized variability in the inflows verses the outflows may occur in areas where groundwater storage increases during a specific water year while conversely in other areas a decrease in storage may occur within the Subbasin. An example of this variability could be attributed to areas where recharge basins may be located as opposed to areas where heavy groundwater pumping may be occurring. During the 1990-2016 period, estimated total annual change in storage in the Subbasin storage ranged from – 392,280 AF (2015) to 361,230 AF (2011) and averaged about -85,690 AF/Y over this 26-year period (Table 3.3.1-2a; Figure 3.2.2-7).

In the Upper Aquifer, estimated total annual change in storage in the Subbasin ranged from about -392,440 AF (1990) to 197,340 AF (2011) and averaged about -142,210 AF/Y (Table 3.3.1-2b; Figure 3.2.2-8). In the Lower Aquifer, estimated total annual change in storage in the Subbasin ranged from about -113,050 AF (2014) to 275,064 AF (1993) and averaged about 56,520 AF/Y (Table 3.3.1-2c; Figure 3.3.2-1).

3.3.3 Quantification of Overdraft

As defined by DWR, overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of replenishment to the basin (DWR 2016b). Effects of overdraft can include land subsidence, groundwater depletion, and degradation of water quality and/or chronic lowering of groundwater levels. DWR Bulletin 118 defines critical overdraft as "when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (DWR 2016b).

The Subbasin sits at the lowest point of the Tulare Lake Hydrologic Region and receives both surface water inflows from several streams including Kings River, Kaweah River, St. Johns River, Tule River, and Deer Creek as well as the SWP. Nonetheless in some years, especially during extended drought cycles (e.g., 2012–2016), agricultural water demand exceeds the surface water inflows. This has led to the drilling of wells to develop groundwater resources to fulfill unmet water demand. Under recent historical conditions the average annual outflow exceeded the average annual inflow.

Overdraft is estimated using the historical water balance record beginning at the time when the net change in storage became negative, lasting over a period with no significant recovery in storage. As discussed in Sections 3.3.1.1 and 3.3.7.1, the period 1998-2010 represents a "normal hydrology period" with average surface water deliveries that were close to the long-term average surface water deliveries not counting the 2012–2016 drought. As such, the 1998-2010 period is a better for estimating the long-term "normal hydrology" than the 1990-2016 period which includes the exceptional drought.

Estimated overdraft (change in storage) was calculated over the Normal Hydrology Period of 1998 to 2010 and ranged from -296,280 AF (2008) to 220,649 AF (2006) and averaged about -73,760 AF/Y over this 13-year period (Table 3.3.1-2a; Figure 3.3.3a).

In the Upper Aquifer, estimated overdraft in the Subbasin was calculated over the Normal Hydrology Baseline Period of 1998 to 2010 and ranged from about -222,720 AF (2001) to 117,740 AF (2006) and averaged about -103,180 AF/Y (Table 3.3.1-2b; Figure 3.3.3b). In the Lower Aquifer, estimated overdraft over the Normal Hydrology Baseline Period ranged from about -85,580 AF (2008) to 136,360 AF (1998) and averaged about 29,410 AF/Y (Table 3.3.1-2c; Figure 3.3.3c). The Subbasin has been divided into management areas consisting of individual GSAs to quantify overdraft in each GSA area. The overall change in storage within the Subbasin and individual GSA management areas was calculated using the groundwater model. Table 3.3.1-2a through 3.3.1-2c, and Figures 3.3.3a through 3.3.3c shows the annualized amount of overdraft in each GSA management area and the Subbasin for the total aquifer system, upper aquifer, and lower aquifer.

3.3.4 Estimate of Sustainable Yield

Sustainable Yield is defined as the maximum quantity of water calculated over long-term conditions in the Subbasin including any temporary excess that can be withdrawn over a period of time without causing an undesirable result. Sustainability indicators are evaluated to determine when significant and unreasonable results occur indicating an exceedance in sustainable groundwater yields within the basin.

As presented in Chapter 4, the primary undesirable results of concern in the Subbasin are chronic lowering of groundwater levels, loss of groundwater storage, and subsidence. These undesirable results are all reflected in some way through the change in groundwater storage in the Subbasin. Hence, an estimate of sustainable yield has been developed by examining the causes and magnitude of changes in storage in the Subbasin.

As shown on Land Surface Water Budget (Table 3.3.1-3), the estimated applied pumped groundwater for irrigation for the 1998-2010 "normal hydrology" period averaged about -348,700 AF/Y. During the same period, the Subsurface Water Budget (Table 3.3.1-3) indicates that the total estimated deep percolation (deep infiltration of applied water, stream leakage, and intentional recharge) averaged about 335,360 AF/Y. This is a difference of only -13,340 AF/Y. In other words, net recharges off-sets about 96% of total groundwater pumped for irrigation from the Subbasin. Hence, within the Subbasin, net recharge and net agricultural pumping are in near balance.

The Subsurface Water Budget also shows that during the 1998-2010 "normal hydrology" period net subsurface interbasin outflows from the Subbasin averaged about -24,290 AF/Y or about 33% of the average change in storage (i.e., overdraft) in the Subbasin of about 73,770 AF/Y (Table 3.3.1-3). The outflows can be attributed to increased groundwater pumping in the surrounding subbasins, which is beyond the control of the GSAs in the Subbasin. Hence, the overdraft in the Subbasin during the 1998-2010 "normal hydrology" period resulting from actions within the Subbasin is approximately -49,480 AF/Y (-73,770 AF/Y + 24,290 AF/Y).

As indicated above, during the 1998-2010 "normal hydrology" the difference between average applied groundwater for irrigation (-348,700 AF/Y) and average net recharge (335,360 AF/Y) differs by only about -13,340 AF/Y. During this same period, the estimated overdraft due to agricultural pumping in the Subbasin averaged about -49,480 AF/Y. If agricultural pumping were reduced by an average of 49,480 AF/Y to about -299,220 AF/Y, the net change in storage should be close to zero or possibly positive. Hence, the current estimate of long-term sustainable yield for agricultural pumping is approximately -299,220 AF/Y over the historical average of 310,792 acres of irrigated land (Table 3.1.1-2) in the Subbasin.

3.3.5 Current Water Budget

The current water budget is represented by the last full calendar year (2016) in which data are available. Estimated values for 2016 include: farm demand 67,794 AF, surface water supply 227,760 AF, imported groundwater 70,860 AF, pumping groundwater 428,423 AF, net recharge 154,700 AF, and net interbasin flow of -58,250 AF. Total outflows of -588,770 exceed total inflows of 256,800 AF, resulting in a change in storage of -294,320 AF. The current water budget for this period is summarized on Table 3.3.1-3 by Land Surface Water Budget and Subsurface

Water Budget. The subsurface water budget is further divided by Upper and Lower Aquifer zones for groundwater pumping, interbasin flow, and change is storage.

3.3.6 Historical Water Budget

The historical water budget for the Subbasin covers a period of 27 years extending back to 1990 and is based on the set of available data records. Precipitation records span a period from 1899 to 2017 (Table 3.1.1-1). Evapotranspiration from the nearest California Irrigation Management Information System station covers a period of October 1982 through 2018. Surface water delivery data from the SWP is available since 1966, and GSA surface water delivery data on their canal systems are available since 1990. State and Tulare County land use records are available from 1990 to 2006 updated at 5-year intervals. USDA CropScape annual cropland data are available from 2007 to 2017. Groundwater pumping demand is based on both records of municipal pumping and projected rates of agricultural pumping as described in Section 3.3.1.2 from 1990 to the present. The historical water budget has been discussed in previous Sections 3.3.1 through 3.3.4 and is summarized annually on Table 3.3.1-3 for land surface water budget and subsurface water budget. The Subsurface Water Budget is further divided by Upper and Lower Aquifer zones for groundwater pumping, interbasin flow, and change in storage.

Subbasin inflows and outflows are calculated in the calibrated groundwater model based on general head boundary conditions that include groundwater elevations and groundwater flux. These are estimated based on historical groundwater elevations measured in wells at or near the Subbasin boundary and estimates of aquifer hydraulic parameters such as hydraulic conductivity, aquifer thickness.

Historical change in storage as described in Section 3.3.2 is the net difference between the inflows and the outflows. Change in storage is summarized annually on Table 3.3.1-3 by Subsurface Water Budget. The Subsurface Water Budget is further divided by Upper and Lower Aquifer zones for groundwater pumping, interbasin flow, and change is storage.

Historical Demands and Sustainability

Historical water conditions that affect sustainable yields include: (1) population growth in urban centers, 2) changes in agricultural demand, and 3) availability of surface water. Average agricultural water demand comprises 96% of total water use within the Subbasin, while urban use comprises 4%. Surface water deliveries have varied over time with a peak of 1,036,880 AF in 1996 to a low of 107,070 AF in 2015.

A review of U.S. Census Bureau data indicates the Kings County area exhibited a population of 151,336 as of 2018 (U.S. Census Bureau 2018) with a growth of approximately 48,632 people between 1990 and 2017, with most growth occurring in the Hanford-Lemoore area. The major urban areas saw increases in population of 25,602 people in Hanford, 12,733 people in Lemoore, and 8,471 people in Corcoran, accounting for 96% of the population growth in Kings County. These communities rely solely on groundwater for water supply. Estimates of urban pumping within the GSP area increased from 9,370 AF in 1990 to 18,410 AF in 2013 (Table 3.1.11). Reported urban pumping decreased during 2014-2016 in response to the drought.

Historical annual agricultural pumping demand of groundwater within the Subbasin is an estimated parameter dependent on several water balance components. It is dependent on crop type and the amount of row crops fallowed in a given year due to limited availability of surface water resources or economic circumstance. Historical agricultural pumping demand is calculated based on crop coefficient multiplied by reference evapotranspiration yielding crop evapotranspiration. Farm water demand is crop evapotranspiration minus effective precipitation divided by the irrigation efficiency of the irrigation method. Agricultural pumping is farm water demand minus applied surface water minus imported groundwater. Different crop types have different water requirements and changes in cropping pattern affect the amount of agricultural demand within the Subbasin. Historical crop demand is shown in tables and graphs in the Model Report in Appendix D. As shown by the tables and graphs, overall groundwater usage for agriculture has remained the top water user in the Subbasin and has varied over time since 1990 due surface water availability, climatic conditions, and other factors.

Heavy groundwater demand is directly associated with years of limited surface water supply. Fallowing of row crops during drought years offsets this increased demand to some extent. The relationship between available surface water deliveries, groundwater pumping, and crop demand impacts the water budget (Figure 3.3.6).

3.3.7 Projected Water Budget

The projected water budget for the Subbasin represents a hypothetical forecast for the 54-year period from 2017 through 2070 based on an assumed "normal hydrology" period and estimated future climate change impacts. This forecast provides the Subbasin's GSAs with a tool to allow flexibility in groundwater management and planning of sustainability projects. The projected water budget is based on current baseline conditions of groundwater and surface water supply, water demand, and aquifer response to allow for implementation of groundwater management and projects implemented under the GSP. Groundwater modeling of the forecast conditions will be used to evaluate long-term groundwater flow trends, change in storage, and long-term groundwater sustainability under different forecast conditions and proposed groundwater sustainability projects conducted by individual GSAs.

Increases in urban population increased demand for groundwater resources within these communities. The estimated 2018 population of Kings County of 151,366 is expected to reach 181,218 by the year 2035 (DOF 2019). Continued urban population growth will likely increase the demand on groundwater resources. Some of the increase in urban demand will be offset by the conversion of agricultural land into housing; however, urban demand will continue to incrementally increase water demand unless future aggressive water conservation is implemented. Additional surface water sources or improved management of groundwater resources (e.g., increased recharge) could help offset increased urban water demand. Municipal pumping was assumed to increase slowly from about 25,060 AF (2017) to about 30,160 AF (2070).

Data Gap: Better estimates of urban demand growth should be developed for the forecast models.

Establishment of the Normal Hydrology Baseline Period

Long-term precipitation records are often used to evaluate hydrologic cycles for watersheds and subbasins. Typically, the cumulative departure from the long-term mean precipitation is used to evaluate hydrologic trends. Periods where the cumulative departure starts and ends near the long-term mean are often considered a "normal" cycle. This approach is appropriate to use where the hydrologic cycle is dominated by precipitation. However, agriculture in the Subbasin is primarily dependent on surface water supplies not precipitation. Surface water deliveries to the Subbasin is dominated by deliveries from the Kings River system. The Kings River flows are managed by Pine Flat dam, so surface water deliveries on the Kings River do not necessary follow precipitation. For example, annual precipitation in the City of Hanford was 15.13 inches and 9.16 inches during 2010 and 2011, respectively. However, surface water deliveries from the Kings River were the reverse, at 706,100 AF and 1,037,100 AF during 2010 and 2011, respectively.

The Kings River surface water deliveries are the largest and most consistent source of surface water to the subbasin. There are occasional surface water (or flood water) deliveries to the Subbasin from the Kaweah River, St. Johns River, Tule River, Deer Creek, and the SWP, but these are relatively small compared to the Kings River deliveries. Therefore, surface water deliveries from the Kings River were used to evaluate the long-term hydrology of the Subbasin.

Annual surface water deliveries from the Kings River system to the Subbasin for the period 1966 through 2016 were used to calculate the long-term average surface water deliveries of approximately 590,700 AF/Y including the recent drought years. A plot of the annual surface water deliveries and cumulative departure shows that Kings River hydrology and associated water deliveries fluctuate widely depending upon snow pack and rainfall (Figure 3.3.7-1). As discussed in Sections 3.3.1.1 and 3.3.7.1, the period 1998-2010 represents a "normal hydrology baseline period" with average surface water diversions of approximately 620,630 AF, close to the long-term average of 627,710 AF/Y without the 2012–2016 drought years. The cumulative departure from average surface water deliveries shows, although the period between 1994 and 2016 starts and ends at the long-term mean, it would not be considered a "normal hydrology" period because it includes a part of an exceptional drought from 2012 to 2015 (Figure 3.3.7-1). Instead, a downward offset of the historical cumulative departure shows the 13-year period from 1998 through 2010 represents a period of "normal hydrology baseline period " cycle where the average is near the long-term mean (Figure 3.3.7-1).The 1998-2010 baseline period includes 1 average, 6 above-average, and 6 below-average surface water delivery years (Figure 3.3.7-1).

Normal Hydrology Forecast Period

During the 13-year 1998-2010 normal hydrology baseline period, Kings River surface water deliveries averaged about 620,633 AF/Y, just slightly below (1.13%) the 50-year long-term average of 627,710 AF/Y not including the 2012–2016 drought. These historical surface water deliveries used for the forecast were reduced to account for the permanent transfer of some SWP contracts out of the Subbasin.

The resulting 13-year "normal hydrology" cycle was used to create a 54-year forecast of future Kings River hydrology from 2017 through 2070. When the forecast was constructed in mid-2018, 2017 was already a known "wet" year with about 170% of Kings River flow, and 2018 was shaping up to be a relatively normal year. Hence, the 2017-2070 forecast was constructed using 2011 and 2010 as analogs for the 2017 and 2018 hydrology. The 13-year "normal hydrology" cycle was then repeated four times to complete the 54-year forecast (Figure 3.3.7-1).

Climate Change

The DWR provides guidance on how to incorporate climate change into hydrology forecasts. There are two basic approaches that have been used to simulate climate change in water resource modeling: (1) transient analysis and (2) climate period analysis (DWR 2018).

In a transient analysis, the climate change signal strengthens incrementally over time. In general, years further into the future are warmer than years closer to the beginning of the simulation, and the most severe changes to climate tend to occur toward the later years of the simulation. In California, where monthly precipitation variability is extreme, transient analysis can be difficult to interpret. In a transient analysis, monthly variability can completely obscure the climate change signal because each year of the simulation has both monthly variability and a climate change signal, making it difficult to determine which is causing shifts in precipitation.

In a climate period analysis, climate change is modeled as a shift from a baseline condition, usually historically observed climate where every year or month of the simulation it is shifted in a way that represents the climate change signal at a future 30-year climate period. Climate period analysis provides advantages in this situation because it isolates the climate change signal independent of the monthly variability signal. In a climate period analysis, monthly variability is based on the reference period from which change is being measured, meaning that all differences between the future simulation and the reference period are the result of the climate change signal alone.

Climate period analysis was utilized to modify the 54-year forecast of “normal hydrology” to account for future climate change. The 2017-2070 forecast incorporates climate period analysis using the 2030 and 2070 monthly change factors (CNRA 2018) for each forecast analog month (Figure 3.3.7-1). The 2030 monthly change factors were applied to the forecast months January 2017 through December 2030. The 2070 monthly change factors were applied to the forecast months January 2031 through December 2070. There is a notable increase in magnitude of the 2070 change factors compared to the 2030 change factors. This tends to result in wetter wet-periods and dryer dry-periods compared to the 2030 change factors. However, the 2070 climate change factors tend to average just 0.999 or just below average while the 2030 climate change factors tend to average about 1.011 times higher than average. As a result, the 2030 climate change factors tend to have a greater impact on long-term forecasts than do the 2070 climate change factors.

A chart of forecast Kings River surface water deliveries shows a comparison of annual normal forecasts, annual normal forecast with climate change, and the difference in annual surface water deliveries between the with- and without-climate change forecasts (Figure 3.3.7-1). The figure shows future climate change may, using the DWR mandated assumptions, result in more Kings River flows in some years, and less flow in other years compared to the baseline conditions.

54-Year Forecast Hydrology with Climate Change

The climate change factors were also applied to 54-year forecasts of monthly inflows (effective precipitation, SWP surface water deliveries, lake storage, and canal and river seepage) and outflows (agricultural demand) for the “normal hydrology” forecast. Outflows due to agricultural demand were based on current cropping patterns and account for maturing of young permanent tree crops and the replanting of tree crops on a 25-year cycle (except pistachios, which have a life span approaching 100 years). This methodology allows for the fallowing and replanting of non-permanent crops due to historical response of available surface waters.

3.4 Management Areas

23 CCR §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) basin that includes one or more management areas shall describe the following in the Plan:*

(1) The reason for the creation of each management area.

(2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.

(3) The level of monitoring and analysis appropriate for each management area.

(4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.

(c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.

In order to facilitate implementation of the GSP, management areas have been created for the Subbasin. There are five Primary Management Areas and two Secondary Management Areas. Each of these types of management areas are described in the following sections.

3.4.1 Primary Management Areas

Primary Management Areas have been formed from each of the five GSAs. (Figure 3.4.1-1). The formation of Primary Management Areas will facilitate data management and assist with the implementation and management of the GSP. Furthermore, each GSA has unique surface water and groundwater allocations and usage, and they are best positioned to develop BMPs and development of groundwater sustainability projects.

Minimum thresholds and measurable objectives developed for each GSA management area described in Chapter 4 will be based on the groundwater conditions within each individual GSA management area.

Groundwater data collected from each GSA will be entered into a Data Management System to facilitate analysis of measurable objectives and undesirable results. A groundwater model has been developed for the Subbasin and adjacent areas to assist sustainable groundwater management in and between individual GSAs. Each GSA will coordinate with adjacent GSAs and adjacent subbasins to monitor within the San Joaquin Valley Basin if undesirable results in the adjacent managements areas are being contributed to by activities within that GSAs management area. The GSAs will coordinate corrective action, if necessary.

3.4.2 Secondary Management Areas

Two Secondary Management Areas have been formed for the Subbasin (Figure 3.4.1-1). These two Secondary Management Areas are different from the Primary Management Areas and each other due to distinctly different groundwater conditions in each area. These two areas are the Clay Plug (Management Area A) and the Southwest Poor Quality Groundwater Secondary Management Area (Management Area B).

Clay Plug

The Tulare Lake clay layers are a significant controlling factor for groundwater movement in the Subbasin. The clay plug does not transmit groundwater and is a hydrologic "dead" zone. As such, the area has never been developed for groundwater extraction. The southern portion of Tulare Lake deposition is made up of continuous lacustrine deposits extending like a tap root through the interior portions of the lake to the top of the San Joaquin Formation, which is 2,600 to 3,000 feet bgs (Figures 3.1.4-2 through 3.1.4-4). The area with continuous lacustrine sediments from the surface to the underlying San Joaquin Formation is roughly 23 miles long by 12 miles wide. These sediments of continuous lacustrine deposits is called the clay plug. The clay plug does not transmit groundwater and is a hydrologic "dead" zone. As such, the area has never been developed for groundwater extraction.

Prior to amendment of the Water Quality Control Plan for the de-designation of MUN and AGR use of groundwater in areas of poor water quality in the Subbasin, characterization studies were conducted to evaluate the potential for the migration of poor water quality from the de-designated areas or the capture of poor quality water by wells near the de-designated area (KDSA et. Al. 2015). The results of these characterization studies are summarized in RWQCB Resolution R5-2017-0032 as follows: basin-wide groundwater flows to the center of the Tulare Lakebed, poor water quality is present in a shallow saline aquifer above the Corcoran Clay, and better water quality is present in the aquifer located below the Corcoran Clay.

A zone-of-capture analysis was also completed that determined if areas outside of the proposed de-designated areas could extract groundwater from within the de-designated area. The results indicated that wells near the horizontal boundary would not draw water from within the proposed de-designated area nor influence groundwater flow direction (RWQCB 2017b). The characterization studies and the zone-of-capture analyses confirmed that no active wells in the fringe areas will draw water within the proposed de-designation area zone nor be impacted by groundwater from within the proposed de-designated zone.

Because this area, due to its historical depositional environment, is isolated from the regional groundwater flow regime in the Subbasin, it is being treated differently than other areas for monitoring purposes and the establishment of compliance points.

Southwest Poor Quality Groundwater
As described in Section 3.2.5 and shown on Figure 3.2.4-1, groundwater in the southwest corner of the Subbasin contains very high TDS concentrations. The groundwater in this area has poor water quality and limited supply. This is evidenced by that fact that there are no agricultural wells in the area, and due to the lack of water supply development, it is being treated differently than other areas for monitoring purposes and the establishment of compliance points.

<u>Professional Declaration</u>

Chapter 3.0 – Basin Setting was prepared in general conformance with §354.12 of the water code either by and/or under the direct supervision of the appropriate professional as indicated herein.

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3A. BASIN SETTING ADDENDUM

This chapter functions as an addendum to Chapter 3, *Basin Setting*, which was prepared as part of the 2020 GSP and endorsed by a California licensed professional geologist. Therefore, Chapter 3 remains unaltered. However, as Chapter 3 presented data up to approximately 2015, this addendum has been created as an update and extension of the original chapter. The purpose is to incorporate updates from the 2022 Addendum and address comments in the SWRCB October 2023 Tulare Lake Subbasin Probationary Hearing Draft Staff Report (SWRCB, 2023). Additionally, specific comments from the SWRCB in email or direct communications (e.g., phone, virtual calls) have been taken into consideration. Moreover, this addendum presents supplementary data to support the hydrogeologic conceptual model outlined in the initial Chapter 3 (Wood 2020). This additional information is crucial for enhancing understanding of the basin and establishing sustainable management criteria.

Additionally, the previously submitted Tulare Lake Subbasin Annual Reports covering the years from 2015 to 2022 include supplementary data regarding water levels, subsidence, water quality land use, and water usage. These aspects are evaluated and presented in each respective report. The sections below provide updates to Chapter 3, utilizing the original section headings. Only the subsections that have been revised are indicated under these headings.

3A.1 Hydrogeologic Conceptual Model Addendum

> **23 CCR §354.14(a)** *Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterize the physical components and interactions of the surface water and groundwater systems in the basin.*

Since the submission of the 2020 GSP, the acquisition of new data and further hydrogeologic analysis have led to refinements in the hydrogeologic conceptual model established in 2020. These refinements are detailed below, with each described in relation to the corresponding subsection in Chapter 3.

3A.1.1 Lateral Basin Boundaries and Geologic Features that Affect Groundwater Flow

3A.1.1.1 Kettleman Hills Anticline

The anticlinal structure of the Kettleman Hills is relevant to subsidence profiles along the California Aqueduct within the subbasin. The structure has contributed to a lower clay content in sediments and shallower bedrock in this portion of the Tulare Lake Subbasin. Historical subsidence in the vicinity of the Kettleman City (near Milepost 173 of the California Aqueduct) has been less than 0.5ft of subsidence since 1967 (DWR, 2019). North of this structure (outside the Tulare Lake Subbasin), higher subsidence rates have been observed along the California Aqueduct.

3A.2. Groundwater Conditions

> **23 CCR §354.16** *Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions based on the best available information…*

3A.2.1 Recent Groundwater Elevation Data and Flow

The following sections complement Section 3.2.2 of Chapter 3 by providing additional data for the development of sustainable management criteria.

3A.2.1.1 Groundwater Level Trends Since 2015

Since 2016, groundwater level monitoring in over 70 representative monitoring site (RMS) wells provides a comprehensive distribution of water-level responses across the Subbasin and in each aquifer zone (Appendix G). These data are more comprehensive than the data sets available for the 2020 GSP in terms of geographic extent and the number of measurements across the Subbasin.

For the unconfined aquifer, water-level data indicate there were increases in groundwater storage at many locations during the wet years of 2017 and 2019. During this wet period, fall groundwater levels (the lowest groundwater level during a given year) increased by as much as 40 feet across the Subbasin. These water-levels were substantially higher than water-levels at the end of the 2015 drought cycle. The wet years of 2017 and 2019 replenished aquifer storage in the unconfined aquifer and recovered water levels to above the levels in 2015. During the ensuing dry cycle between 2019 and 2022, Fall groundwater levels at most locations in the unconfined aquifer decreased by as much as 40 feet. During this period of drought, groundwater pumping reduced the groundwater storage in the unconfined aquifer, leading to a temporary state of overdraft. However, in 2023, the area experienced extremely wet conditions and flooding, which replenished the aquifer storage and again raised the water levels above those recorded in 2015.

For the confined aquifer, water-level data show a similar pattern with higher water levels at most locations during the wet years of 2017 and 2019; lower water levels during the dry cycle between 2019 and 2022; and recovery of water levels again in 2023. This cyclical pattern is expected to continue in the future. The response of both the confined and unconfined aquifers to the wet conditions and associated flooding in 2023 was significant, as there was a minimal decline in water levels during the summer of that year, as evidenced by the continuous water level transducer data presented in Appendix G, Section 2.

3A.2.2 Vertical Groundwater Gradients

This section aids in addressing the 2023 SWRCB Deficiency GL-2a comment (SWRCB, 2023), which recommends additional investigation and quantification of the connection between vertical gradients between zones in relation to the inflow and outflow of the basin water budget, aiming to resolve basin overdraft.

Further investigation and quantification of groundwater fluxes between the B- and C-Zones are necessary to refine the subbasin water budget. The lack of characterization of groundwater flux between these zones is considered a data gap. Although clustered wells have been installed and monitored in the MKR GSA, there has not been a targeted data collection program to assist in determining vertical gradients. Also, there is a lack of identified clustered wells in the B- and C-Zones in other GSAs. To address this data gap, new well clusters in the B- and C-Zones will be installed. Additional wells will be installed adjacent to existing ones, or to newly accessible wells provided by landowners. Targeted data will be collected to determine vertical gradients and associated fluxes, aiding in the overall estimation of the subbasin water budget.

Additional discussion of the existing water flux data is presented in Section 3A.4, Water Budget Information.

3A.2.3 Groundwater Quality

This section is included to facilitate the identification of constituents of concern as required to address Deficiency 3 presented in the DWR Incomplete Determination letter dated January 28, 2022. Deficiency 3 specifies that the 2020 GSP fails to identify sustainable management criteria for degraded water quality. This section presents background information to establish the constituents of concern, which are later elaborated on in Chapter 4, *Sustainable Management Criteria* and Chapter 5, *Monitoring Network*.

3A.2.4 Background

Characterization of historical groundwater quality conditions within the Subbasin up to 2015 were discussed in the 2020 GSP. The constituents of concern (COC) addressed included salinity, represented as total dissolved solids (TDS), arsenic, nitrate, and volatile organic compounds (VOCs). However, the presentation of these data did not delineate their distribution in relation to the principal aquifers. Additional COCs were identified in the 2022 GSP Addendum such as uranium, sulfate, and chloride. A detailed discussion on each of these constituents across the primary aquifers is presented below. Additional efforts have been made to increase monitoring around the de-designated areas shown on Figure 3A.2.4-1 as discussed in Chapter 5, *Monitoring Networks*.

3A.2.5 Screening Criteria

The data used for the discussion below is sourced from the Groundwater Ambient Monitoring and Assessment (GAMA) Program online database, established by the California State Water Resources Control Board (SWRCB). In this discussion, the constituents are compared against state and federal secondary maximum contaminant levels (SMCLs) for TDS, sulfate, and chloride. The concentrations of arsenic, nitrate, uranium, 1,2,3-trichloropropane (1,2,3-TCP), and dibromochloropropane (DBCP) are compared to the primary maximum contaminant levels (MCLs).

Under California Code of Regulations (CCR) Title 22 (Title 22), SMCLs are categorized as "recommended," "upper," and "short-term." For the discussions presented herein, the upper SMCLs are utilized as the reference standards.

3A.2.5.1 TDS

Figure 3A.2.5-1a (sub-maps A-D) illustrates the pre-2015 distribution of TDS in groundwater across the Subbasin. Figure 3A.2.5-1b (sub-maps A-D) illustrates the post-2015 distribution of TDS in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

Concentrations below the recommended SMCL (e.g., 500 mg/L for TDS) are preferred for higher consumer acceptance. Concentrations up to the upper SMCL (e.g., 1,000 mg/L for TDS) are considered acceptable when it is not reasonable or feasible to provide water with lower concentrations. Concentrations up to the short-term SMCL (e.g., 1,500 mg/L for TDS) are deemed acceptable only on a temporary basis for existing community water systems, pending the construction of treatment facilities or the development of new acceptable water sources.

Sources of TDS, or salinity, include naturally occurring and anthropogenic sources. Naturally occurring sources include brackish and saline marine connate waters that exist within the de-designated area and at depth beneath the useful aquifers throughout most of the Central Valley. A detailed discussion of these sources is provided in Section 3.2.5.

3A.2.5.2 Nitrate

Figure 3A.2.5-2a (sub-maps A-D) illustrates the pre-2015 distribution of nitrate as nitrogen (N) in groundwater across the Subbasin. Figure 3A.2.5-2b (sub-maps A-D) illustrates the post-2015 distribution of nitrate as N in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

Sources of nitrate are anthropogenic, mostly related to agricultural practices. A discussion of these sources is provided in Section 3.2.5.

3A.2.5.3 Arsenic

Figure 3A.2.5-3a (sub-maps A-D) illustrates the pre-2015 distribution of arsenic in groundwater across the Subbasin. Figure 3A.2.5-3b (sub-maps A-D) illustrates the post-2015 distribution of arsenic in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

The sources of arsenic are naturally occurring. A discussion of these sources is provided in Section 3.2.5.

3A.2.5.4 Uranium

Figure 3A.2.5-4a (sub-maps A-D) illustrates the pre-2015 distribution of uranium in groundwater across the Subbasin. Figure 3A.2.5-4b (sub-maps A-D) illustrates the post-2015 distribution of uranium in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

Sources of uranium are naturally occurring in sediments sourced from the Sierra Nevada.

3A.2.5.5 1,2,3-TCP

Figure 3A.2.5-5a (sub-maps A-D) illustrates the pre-2015 distribution of 1,2,3-TCP in groundwater across the Subbasin. Figure 3A.2.5-5b (sub-maps A-D) illustrates the post-2015 distribution of 1,2,3-TCP in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

Sources of 1,2,3-TCP are anthropogenic. A discussion of these sources is provided in Section 3.2.5.

3A.2.5.6 DBCP

Figure 3A.2.5-6a (sub-maps A-D) illustrates the pre-2015 distribution of DBCP in groundwater across the Subbasin. Figure 3A.2.5-6b (sub-maps A-D) illustrates the post-2015 distribution of DBCP in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

DBCP is a manufactured chemical that does not occur naturally in the environment. Prior to 1979, DBCP was primarily used as a soil fumigant for the control of nematodes in over 40 different crops in the United States (GAMA, 2010). Today very small quantities of DBCP are manufactured only for the purpose of chemical synthesis of other compounds.

3A.2.5.7 Sulfate

Figure 3A.2.5-7a (sub-maps A-D) illustrates the pre-2015 distribution of sulfate in groundwater across the Subbasin. Figure 3A.2.5-7b (sub-maps A-D) illustrates the post-2015 distribution of sulfate in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

Sources of sulfate are both naturally occurring and anthropogenic. Naturally occurring sources are related to sulfate-rich minerals found within sediments. Anthropogenic sources are mostly related to agricultural practices. A discussion of these sources is provided in Section 3.2.5.

3A.2.5.8 Chloride

Figure 3A.2.5-8a (sub-maps A-D) illustrates the pre-2015 distribution of chloride in groundwater across the Subbasin. Figure 3A.2.5-8b (sub-maps A-D) illustrates the post-2015 distribution of chloride in groundwater across the Subbasin. Maps A, B, and C depict this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Map D represents the distribution for wells with unknown screen intervals.

The presence of chloride in groundwater can result from various sources, including naturally occurring ones such as weathering of soils and salt-bearing geological formations, as well as anthropogenic sources like the deposition of salt spray, road de-icing salt usage, and contributions from wastewater into freshwater sources.

3A.2.5.9 Constituents of Concern

Based on the information presented in Sections 3.2.5, the following constituents of concern (COCs) have been defined. These COCs are further discussed in Chapter 4, *Sustainable Management Criteria* and Chapter 5, *Monitoring Network*.

- Salinity (measured TDS)
- Nitrate (measured as nitrogen)
- Arsenic
- Uranium
- 1,2,3-TCP

- DBCP
- Sulfate
- Chloride

3A.3 Integrated Tulare Lake Database

Since the development of Chapter 3, the GSAs have established an integrated Well Completion database to provide updated well location and construction data. This database is constructed using information from the United States Geological Survey Online System for Well Completion Reports, Kings County well permits, and the DWR Groundwater Ambient Monitoring & Assessment Groundwater Information (GAMA) databases. A comprehensive discussion of the assembly and analysis of the database is provided in Appendix I.

3A.3.1 Updated Well Completion Information

Each well record in the database is assigned to a specific aquifer zone based on the screen interval and the interpolated surfaces of the clay layers (A-Clay and E-Clay), which delineate the depth and extent of the three aquifer zones. The contours used in the interpolation for the A-Clay and E-Clay were based on an original map prepared by Croft (1972) that was modified by the USGS (Faunt et al, 2009) as shown in Chapter 3 Figures 3.1.8-1 and 3.1.8-3. The depths of these surfaces were subsequently calibrated using data from Aerial Magnetic Surveys and borehole logs (see Appendix I). Wells are classified as A-Zone, B-Zone, or C-Zone based on the following criteria:

- A-Zone well records = Well screen interval located above the A-Clay
- B-Zone well records = Well screen interval located above the E-Clay and not above the A-Clay
- C-Zone well records = Well screen interval located below the E-Clay

Well records with multiple screen intervals were assigned to the aquifer zone based on the deepest screened interval. In cases where well records lacked complete screen interval information, the analysis either utilized the available incomplete data or assumed the bottom of the screen interval to be 10 feet above the well completion depth.

A number of wells in the database are likely no longer active, but they will remain in the database until a formal verification of the well's status is obtained through a well registration program discussed in Chapter 6, *Projects and Mangement Actions*. The usable lifespan of some of the wells has likely been exceeded and well depths would suggest that some wells have been dewatered prior to the implementation of SGMA in January 2015. Two previous studies estimated well retirement ages at 28 years in the Central Valley (Pauloo et al 2020), and 33 years in Tulare County (Gailey et al 2019). The GSAs understand that the database needs to be further refined and will be updated through an on-going well registration program discussed in Chapter 6, *Projects and Management Actions*. The expectation is that as the well database is refined the number of wells will remain the same but are likely to be deeper to account for historical drought periods.

3A.3.2 Beneficial Uses of Wells by GSA

Each well record in the database is also assigned one of six beneficial-use categories: agriculture, domestic, municipal, industrial, water supply, and unknown. Table 3A.3.2-1a summarizes the distribution of wells by type. Agriculture beneficial-use accounts for more than half of the beneficial uses in the subbasin and domestic uses are slightly less than half of the total. Together, municipal, industrial, water supply, and unknown wells comprise approximately 5% of the total records. The beneficial use classifications were determined at the time each well was drilled, and it is possible that those may have since changed. As implementation of the GSP progresses, the accuracy of the well database will improve through the well registration program discussed in Chapter 6, *Projects and Management Actions*.

Table 3A.3.2-1a: Well Records Counted by Well Type

Planned Use	Count
Agriculture	1,797
Domestic	1,573
Municipal	89
Industrial	54
Water Supply	16
Unknown	25

Table 3A.3.2-1b presents the number of well types within each of the five GSAs. Well records were assigned to each GSA based on the geographical location of the well records in relation to the boundaries of each GSA. The data indicates that the Mid-Kings River GSA includes the largest number of well records, followed by the South Fork Kings GSA and the El Rico GSA. Collectively, the Southwest Kings GSA and the Tri-County Water Authority (TCWA) have fewer than 10 domestic wells.

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Table 3A.3.2-1b: Well Records Counted by GSA and Well Type

GSA	Planned Use	Count
El Rico GSA	Agriculture	218
	Domestic	37
	Industrial	1
	Irrigation / Industrial	5
	Municipal	2
	Unknown	1
	Water Supply, Other	2
Mid-Kings River GSA	Agriculture	1066
	Dairy	4
	Domestic	1170
	Industrial	10
	Irrigation / Industrial	8
	Livestock	2
	Municipal	41
	Public	8
	Stock Or Animal Watering	5
	Unknown	20
	Water Supply, Other	3
South Fork Kings GSA	Agriculture	462
	Dairy	1
	Domestic	359
	Industrial	1
	Irrigation – Landscape	1
	Irrigation / Industrial	10
	Livestock	1
	Municipal	20
	Public	4
	Stock Or Animal Watering	2
	Unknown	6
	Water Supply	1
	Water Supply, Other	5
Southwest Kings GSA	Agriculture	22
	Domestic	6
	Industrial	1
	Irrigation / Industrial	2
	Municipal	10
	Public	1
	Water Supply, Other	5
Tri-County Water Authority	Agriculture	29
	Domestic	2

3A.4 Water Budget Information

> **23 CCR §354.18(a)** *Each Plan shall include a water budget for the basin the provides an accounting an 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 volume of water stored. Water budget information shall be reported in tabulate and graphical form.*

The following section has been added in response to SWRCB comment GL-2a, which requested further investigation and quantification of the components of the basin water budget, including inflows and outflows to support resolution of basin overdraft.

3A.4.1 Pumping and Storage Changes

The groundwater balance derived from the groundwater model presented in the 2020 GSP offers the most comprehensive overview of various components contributing to the water balance, including inflows and outflows from model boundaries, recharge, leakage from streams and fluxes between aquifers. The primary purpose of revisiting the water balance from the 2020 groundwater model was to more distinctly establish pumping reduction targets in each aquifer that would not cause long-term overdraft.

Implementation of the 2020 GSP has included estimates of total pumping in the subbasin based on satellite imagery of evapotranspiration (ET). This methodology does not produce information on which aquifer is being pumped to satisfy the observed ET. The 2020 groundwater model produced a water balance for each aquifer, which was utilized to estimate the amount of pumping from the confined and unconfined aquifers since 2015, as determined from satellite imagery.

3A.4.1.1 Unconfined (Upper) versus Confined (Lower) Aquifer Pumping

A linear relationship between total pumping and pumping from the unconfined upper and lower confined aquifer was observed in the 2020 groundwater model water balance. As shown below, pumping in each aquifer is linearly correlated to total pumping. Extending the data from this relationship to distinguish unconfined versus confined pumping from 2015 to 2023 assumes that the pre-SGMA relationship has remained consistent since 2015. The measurement of pumping from both aquifers is currently recognized as a data gap and is being addressed as part of GSP implementation, including initiatives such as well registration and metering. However, in the absence of recent comprehensive data due to this recognized gap, the ability to accurately assess and manage groundwater pumping rates remains limited until the implementation of well registration and metering initiatives under the GSP. While this relationship varies from year to year and over time, this assumption cannot be verified until there is metering or some form of self-reporting on pumping rates from each aquifer. Figure 3A.4.1-1 displays the correlation between total pumping and pumping in both the upper unconfined and lower confined aquifers as depicted in the 2020 groundwater model. These relationships were used to convert total pumping measured since 2015 based on ET measurement to a distinct pumping value for each aquifer since 2015.

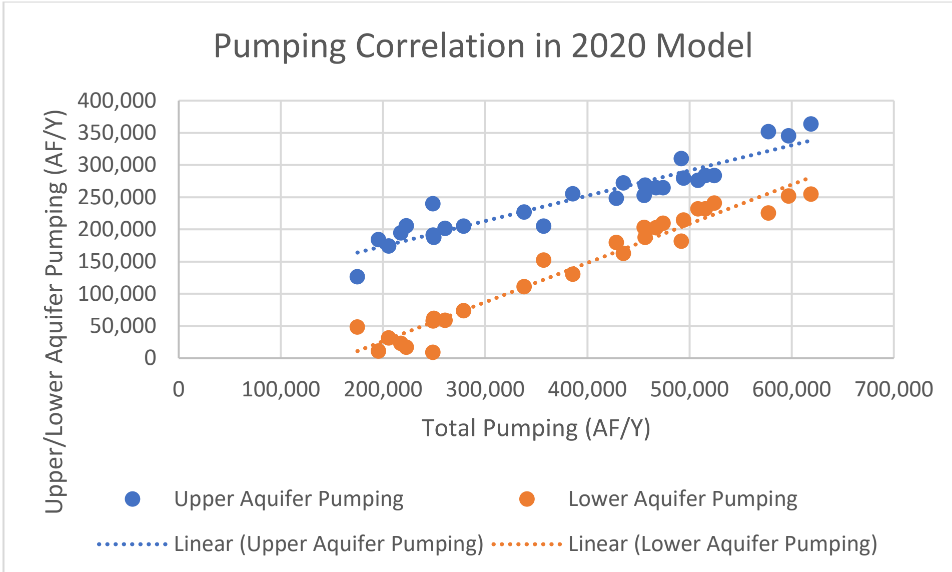


Figure 3A.4.1-1: Pumping Correlation in 2020 Model

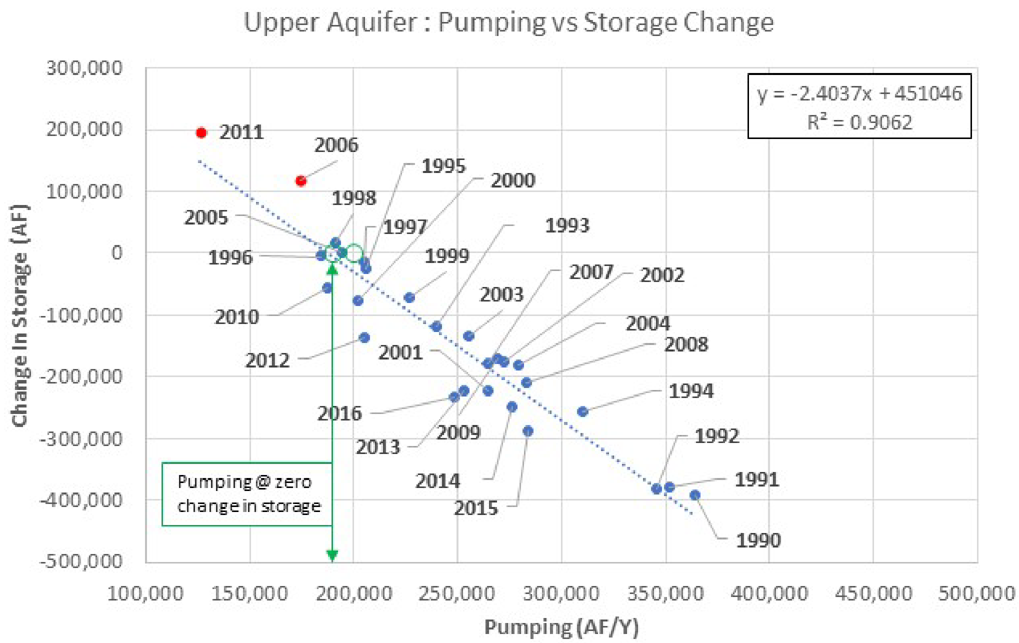
3A.4.1.1 Unconfined (Upper) versus Confined (Lower) Storage Change

The model water balance was then used to evaluate overdraft and changes in aquifer storage. Figure 3A.4.1-2 shows the correlation between pumping and storage change in both aquifers from the 2020 groundwater model. Unsurprisingly, there is a strong linear relationship between pumping and storage change over the model period of 1990-2015, with positive storage increases during years of high recharge/low pumping and negative storage depletion during years with low recharge/higher pumping. Note that the red symbols on the plot for 2005 and 2011 represent wet years where there is low storage loss or an increase in storage. The point at which an annual overdraft begins is where the change in storage is less than zero. For the confined aquifer, the model predicts that overdraft begins at a pumping rate of about 150,000 acre-feet per year (AFY). For the unconfined aquifer, annual overdraft (depletion of groundwater storage) begins at a pumping rate of about 180,000 AFY.

The total combined "safe yield" (i.e., the pumping rate that produces zero change in storage) predicted by the model is 330,000 AFY, which is similar to the value suggested by Wood (Chapter 3) of 370,000 AFY in the 2020 GSP. As noted by Wood, the value of 370,000 AFY was qualified as a sustainable yield that assumed about 40,000 AFY of recharge offset, which would net to a value of 330,000 AFY. In other words, the "sustainable yield" proposed by Wood (Chapter 3) presumes that 40,000 AFY of increased recharge would occur and produce a net zero change in storage across the Subbasin. The safe yield estimates for each aquifer (150,000 AFY for the confined aquifer and 180,000 AFY for the unconfined aquifer) were used to define pumping reductions relative to recent pumping since 2015 that would achieve the measurable objectives outlined in Chapter 4.

The primary purpose of revisiting the water balance from the 2020 groundwater model was to establish target pumping reductions in each aquifer that would not cause long-term overdraft. Additional modeling is needed to better characterize conditions that lead to long-term overdraft in each aquifer and this modeling will be conducted as part of GSP implementation. In addition to more refined overdraft analysis, the model will address the effect of high recharge years on water-level recovery. For the unconfined upper aquifer, there are only three years (1998, 2006 and 2011) in which the model predicts an increase in aquifer storage (these are also wet years with higher recharge and lower pumping). For the confined aquifer, there are many years with increases in aquifer storage, and the wet years of 1998, 2006 and 2011 resulted in a near equilibrium (zero storage change) condition. With the more robust recent datasets now available, the boundary conditions and calibration methods can be refined and, in coordination with surrounding groundwater basins, improve the accuracy and precision of the water balance and associated predictions of groundwater levels, depletion of aquifer storage, and subsidence.

The relationship between groundwater levels in the confined aquifer and resulting ground subsidence is particularly difficult to determine without additional groundwater modeling. As described in Chapter 3, *Basin Setting*, subsidence occurs because of many different variables, including the depth and thickness of the confining layer, pumping volumes, annual and cumulative recharge volumes, and year-over-year patterns of water-level changes in the aquifers. As discussed in Chapter 4, *Sustainable Management Criteria*, this complicates setting the minimum threshold values for groundwater level in the confined aquifer.



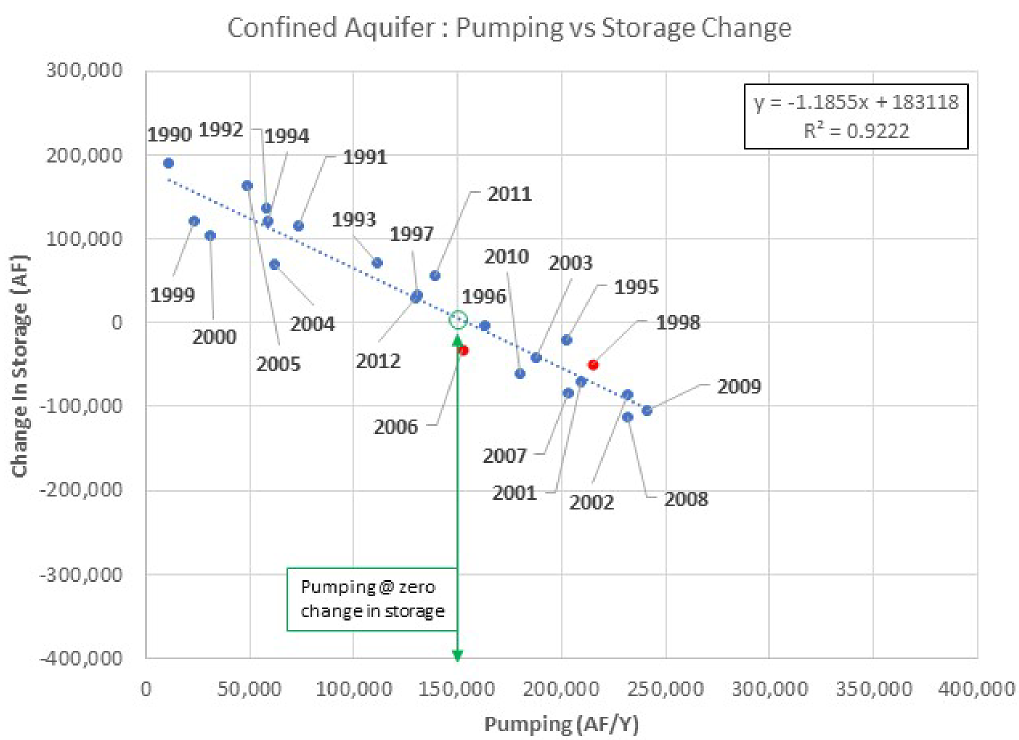


Figure 3A.4.1-2 Upper Aquifer and Confined Aquifer Pumping vs Storage Change

3-3A.5 Land Subsidence

Land subsidence has been documented to be occurring in the SJV and thus in the Subbasin since the 1920's. Ireland et al. (1984) indicate that approximately 4 feet (ft) of subsidence occurred at the town of Hanford and 1 ft in Kettleman City between 1926 and 1970. Figure 3A.5.0-1 shows the magnitude of subsidence within the Tulare Lake Subbasin for the period between 1949 and 2005. The southern part of the basin, including Kettleman City, has experienced subsidence in the range of 0 to 5 ft over that time period, whereas within the cities of Hanford, Lemoore, and Corcoran, subsidence has been measured between 10 and 30 ft during that time period. Subsidence in the SJV and thus in the subbasin is primarily attributed to compaction of subsurface clay layers (i.e., fine-grained soils) in response to groundwater extraction (e.g., Ireland et al. 1984, Faunt et al. 2015).

As sketched in Figure 3A.5.0-2, groundwater in the SJV occurs in a shallow unconfined or partially confined aquifer and a deep confined aquifer that comprises fine-grained aquitards interbedded with coarser-grained aquifers. The shallow and deep aquifers are separated by a laterally extensive lacustrine clay layer (aquitard) known as the Corcoran Clay (Galloway et al. 1999). This clay layer is also described as the E-Clay (Croft 1972). Groundwater in the aquifers is replenished primarily by infiltration through stream channels near the valley margins, and secondarily by precipitation.

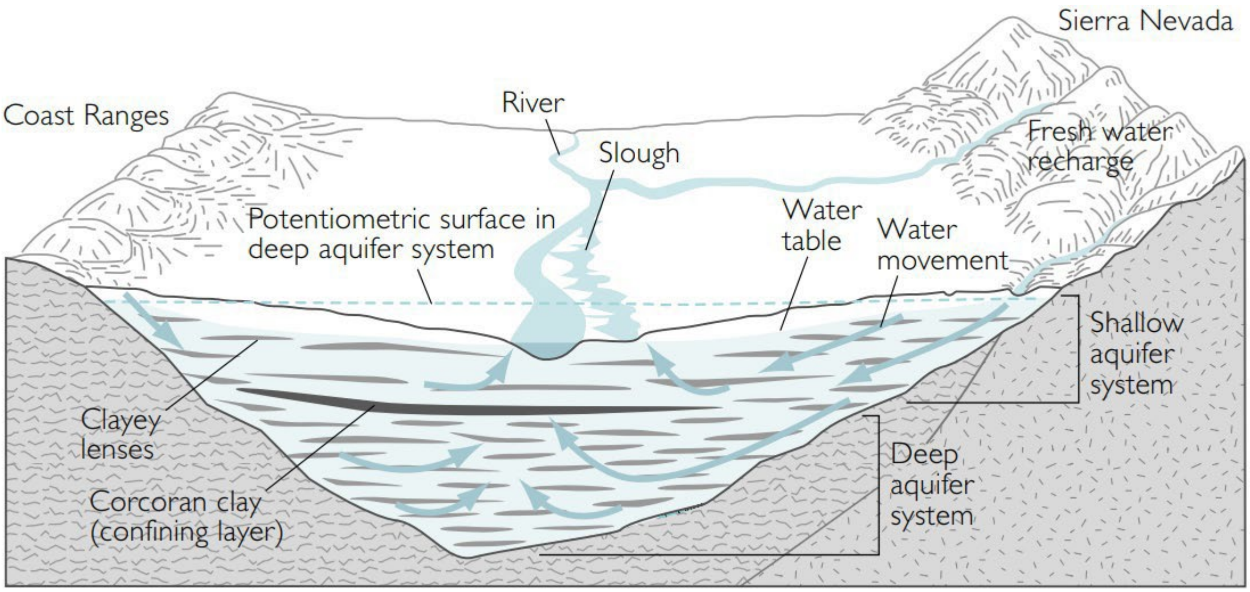


Figure 3A.5.0-2: Geological Sketch of the San Joaquin Valley Depicting the Shallow and Deep Aquifer Systems Separated by the Corcoran Clay Layer (figure from Galloway et al. 1999)

Mendenhall et al. (1916) describe that in the early 20th century, wells in the confined aquifer flowed under gravity (i.e., artesian conditions). Figure 3A.5.0-3 presents the area of flowing wells and approximate contours of groundwater elevation within the confined aquifer that were developed by Mendenhall et al. (1916) for the approximate period of 1905 to 1907, when extraction of groundwater resources in the SJV was still under development. Figure 3A.5.0-4 shows similar contours for the Spring of 1952 that were developed by Davis et al. (1959). Inspection of Figure 3A.5.0-4 from Mendenhall et al. (1916) shows that the elevation of groundwater in the confined aquifer under the cities of Corcoran and Lemoore was in the range of 180 feet, and approximately 220 ft under the city of Hanford in the 1905 to 1907 period. Approximately 45 years later, the elevation of the groundwater had dropped to approximately 120 ft under the City of Corcoran, approximately 130 ft under Lemoore, and approximately 160 ft under Hanford (Figure 3A.5.0-4). More recent data such as the hydrograph of groundwater elevation for well 20S20E28E003M that is plotted in Figure 3A.5.0-5 shows that groundwater pumping has continued to lower the elevation of groundwater within the confined aquifer elevations in the range of 140 ft and -150 ft between 1985 (highest) and 2015 (lowest). For reference, well 20S20E28E003M is located approximately 10 miles south-southwest from Lemoore and 14 miles west-northwest from Corcoran.

The next subsections will describe the mechanics of subsidence and the relationship between subsidence and groundwater levels in the confined aquifer.

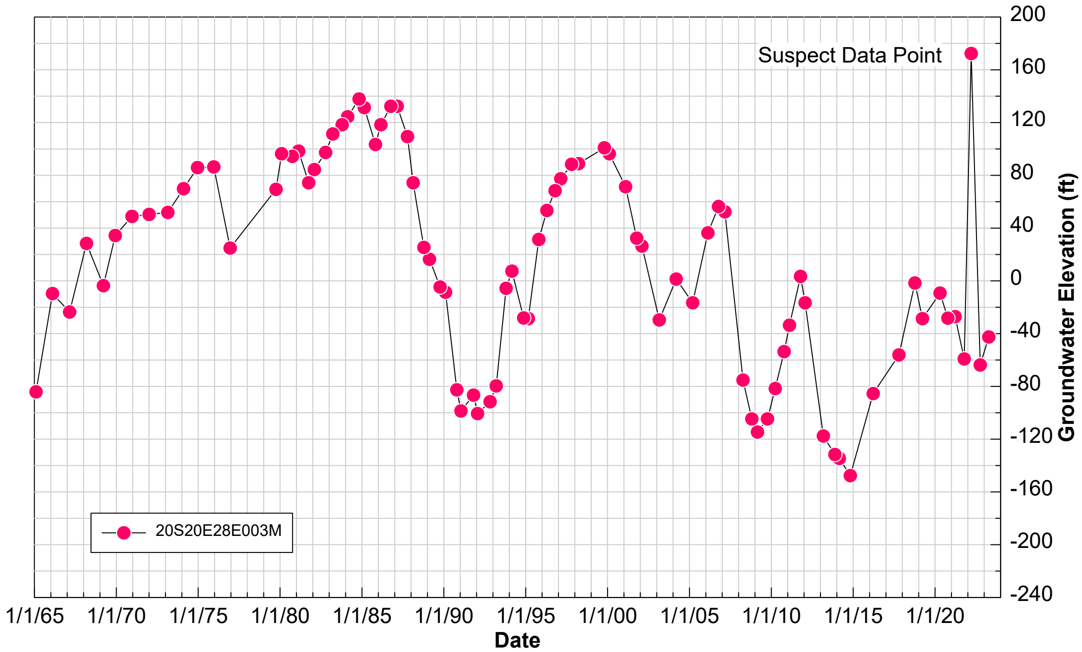


Figure 3A.5.0-5: Hydrograph of Groundwater Elevation in Well 20S20E28E003M since February 1965

3A.5.1 Effective Stress Concept

The effective stress in the soil (i.e., the formational material of coarse-grained aquifers and fine-grained aquitards) has a significant influence on the mechanical response of a soil element. For example, a change in the effective stress of a soil element causes a change of its volume (see Section 3A.5.2).

The effective stress concept is sketched in Figure 3A.5.1-1. The soil column used to illustrate the concept was drawn to be somewhat representative of the conditions in the SJV where an upper aquifer is separated from a lower confined aquifer by a relatively thick aquitard (i.e., the Corcoran Clay layer), and the lower aquifer is underlain by bedrock. The sketch of Figure 3A.5.1-1 is also meant to illustrate the groundwater conditions that are likely to have prevailed prior to the installation of wells and pumping in the SJV. As shown, there is a piezometric level in the confined aquifer that is measured in a piezometer that coincides with the elevation of the water table in the upper aquifer.

The effective vertical stress (σ'_v) acting between soil particles (or soil grains) at an arbitrary horizontal plane (Eq. 3-1) is equal to the difference between the total stress (σ_t) and the pore-fluid pressure or pore water pressure (u).

$$\sigma'_v = \sigma_t - u \qquad \text{Eq. 3-1}$$

The total stress is defined as the stress applied by the weight of soil and water above the arbitrary plane, and the pore-fluid pressure is equal to the height of the water column above the arbitrary plane multiplied by the unit weight of water (i.e., 62.4 pounds per cubic foot [pcf]). On the column in Figure 3A.5.1-1, the pore-fluid pressure at the arbitrary horizontal plane is defined by the height of the water column (z_{w1}). As groundwater is pumped from the upper aquifer, the elevation of the piezometric surface decreases as depicted in Figure 3A.5.1-2, such that the height of the water column above the arbitrary plane decreases and is equal to z_{w2}. The total stress at the arbitrary plane maintains approximately the same value in the initial condition and the final condition, but since the value of the pore-fluid pressure decreases, the effective stress increases. Such an increase in the stress between particles leads to a reduction of the volume, which can manifest at the ground surface as subsidence.

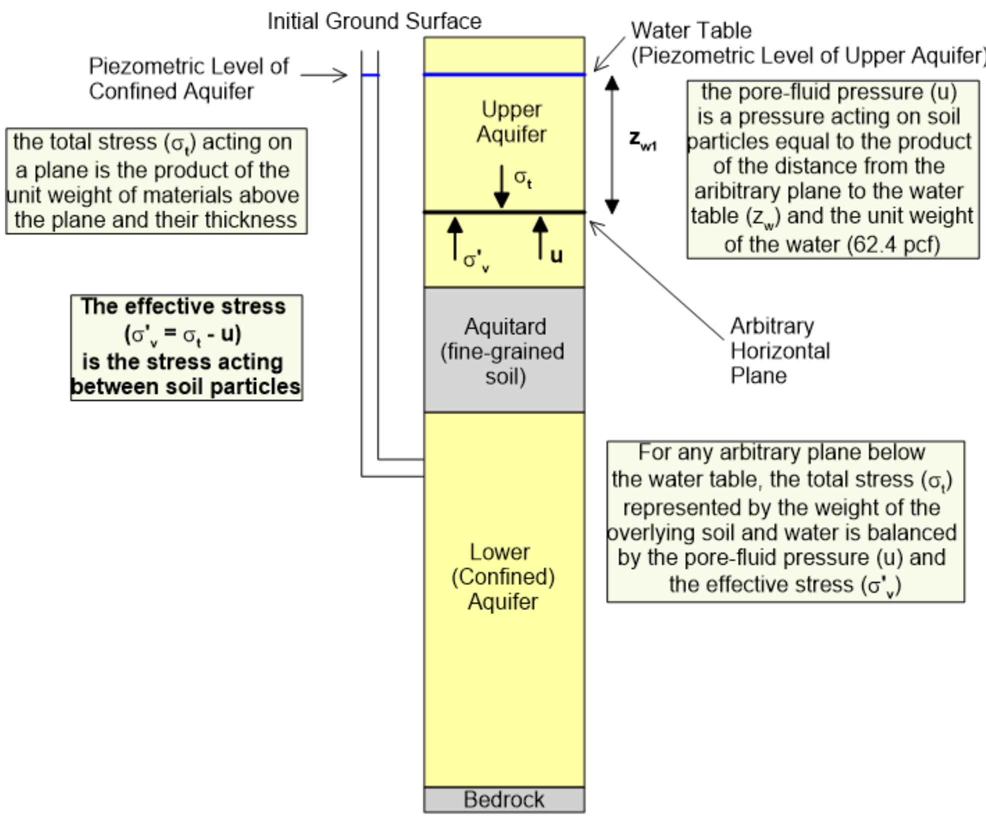


Figure 3A.5.1-1: Illustration of the Principle of Effective Stress Using a Simplified Soil Column for the SJV

Different piezometric levels in the upper and lower aquifers are purposefully depicted in Figure 3A.5.1-2 because these levels will fluctuate in response to transient groundwater pumping in wells screened within each of these aquifers. The magnitude of the pore water pressure (u) in the soil within the soil column depicted in Figure 3A.5.1-2 will depend on the distance between the horizontal plane at the depth of interest and the piezometric surface corresponding to the aquifer at the depth of interest.

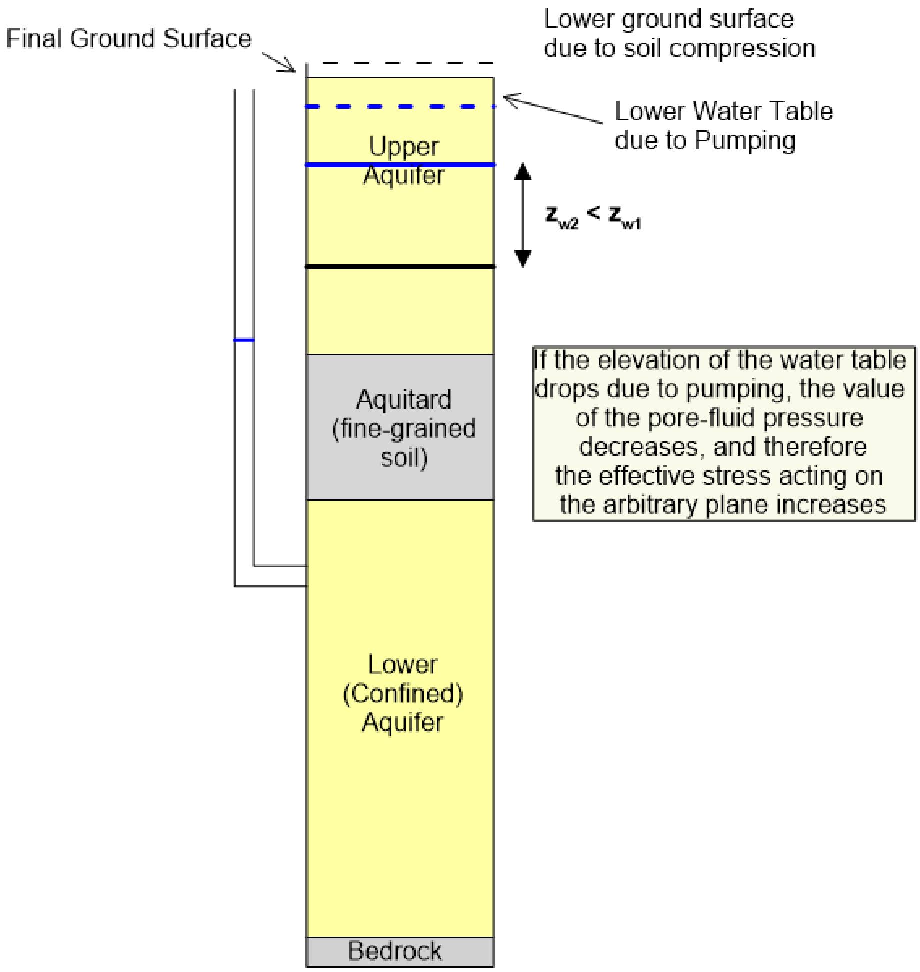


Figure 3A.5.1-2: Illustration of the Effect of a Change in Effective Stress Caused by Changes in Piezometric Levels Using a Simplified Soil Column for the SJV

3A.5.2 Consolidation of the E-Clay

When a soil is loaded, it will compress (i.e., decrease in volume) because of 1) deformation of soil grains, 2) compression of air and water in the voids[1], and/or 3) squeezing out of water and air from the voids between soil particles (Holtz and Kovacs 1981). At typical loads, the deformation of soil grains is negligible. In soils below the water table, which is most of the soil column in the SJV, water occupies the pore space between soil particles; therefore, compression of the fluid in the

[1] Soils are an assemblage of individual small particles. Voids refers to the space between particles.

voids is also negligible. Thus, the main component of volume change in the SJV is caused by squeezing of water from the voids.

Changes of the effective stress of the soil lead to changes in the volume that the soil occupies in space. An increase of the effective stress causes a decrease of the volume of the soil and vice-versa (although volume change may not be elastic, some increase in volume may occur upon a decrease in effective stress). The amount of volume change due to a change in the effective stress depends on the compressibility of the soil material. For the column in Figure 3A.5.1-2, a change in volume is represented by a change in the elevation of the ground surface, as such an increase in the effective stress causes downward movement of the ground surface (i.e., subsidence). Compression (i.e., consolidation) of the aquitard in Figure 3A.5.1-2 due to an increase in the effective stress is assumed to propagate to the ground surface and manifest as subsidence.

In fine-grained soils (i.e., aquitards), volume change is higher than in coarse-grained soils and irreversible when effective stress increases beyond the highest value it has previously experienced In the simplified ground model columns illustrated in Figures 3A.5.1-1 and 3A.5.1-2, a change in volume is equivalent to a change in height or thickness of the soil layer. The change in height (Δh) caused by a change in the effective stress, or the amount of "primary consolidation," can be estimated by implementing Eq. 3-2 (Holtz and Kovacs 1981), where H_0 is the initial thickness of the soil layer, RR and CR are properties of the soil layer known as recompression ratio and compression ratio, respectively, σ'_p is also a property of the soil that is known as the preconsolidation stress and describes the highest vertical effective stress to which the soil element has been subjected for a sustained period of time in the geologic past, and σ'_{v_i} and σ'_{v_f} are the initial and final effective stress in the soil layer.

$$\Delta h = H_0 \left[RR \cdot log \frac{\sigma'_p}{\sigma'_{v_i}} + CR \cdot log \frac{\sigma'_{v_f}}{\sigma'_p} \right] \qquad \text{Eq. 3-2}$$

When the soil layer (or soil element) is subjected to an effective stress that is equal to the highest stress that it has been subjected to, then the soil is described as normally consolidated, $\sigma'_{v_i} = \sigma'_p$, and the first term inside the bracket of Eq. 3-2 is zero such that Eq. 3-2 can be expressed as Eq. 3-3.

$$\Delta h = H_0 \left[CR \cdot log \frac{\sigma'_{v_f}}{\sigma'_{v_i}} \right] \qquad \text{Eq. 3-3}$$

Consolidation is a time-dependent process. When a load is applied to saturated soil (i.e., soil that has no air in the voids between soil particles), the effective stress does not change immediately. Instead, the load is immediately transferred to the water in the voids causing an increase in the pore water pressure. The excess in the pore water pressure caused by the load decreases over time as water flows to areas within the soil layer with lower pressures (i.e., the pressure gradient causes flow in the soil). As pore water pressures dissipate, the load is transferred to the soil skeleton and the effective stress increases. The rate of dissipation of the excess pore water pressure is controlled by what is known as the "coefficient of consolidation" (c_v), which is related to the hydraulic conductivity (i.e., permeability) of the soil. Thus, soils that exhibit relatively high hydraulic conductivity, such as coarse-grained deposits (i.e., sands and gravels) will undergo changes in effective stress following the application of a load much faster than soils that exhibit relatively low hydraulic conductivity, such as fine-grained deposits (i.e., silts and clays).

Fine-grained soils also exhibit "secondary compression," which can be described as compression at constant stress that follows the culmination of primary consolidation. The amount of subsidence caused by secondary compression (Δh_s) can be estimated according to Eq. 3-4 (Holtz and Kovacs 1981), where $C_{\alpha\varepsilon}$ is the secondary compression ratio, t_p is the time at the end of primary consolidation, and t is the time at which Δh_s is desired.

$$\Delta h_s = H_0 \left[C_{\alpha\varepsilon} \cdot log \frac{t}{t_p} \right] \qquad \text{Eq. 3-4}$$

The sketch in Figure 3A.5.2-1 shows how settlement (vertical axis) of a clayey soil unit, which manifests at the ground surface as subsidence, develops over time (horizontal axis in logarithmic units of time). Once a stress change is applied at time = 0, the pore-fluid is slowly squeezed out until primary consolidation is complete and the pore-fluid pressure is stable across the soil unit. Subsequently, secondary compression begins and leads to additional settlement at an approximately constant rate (when plotted against the log of time).

The main purpose of Figure 3A.5.2-1 is to show that subsidence cannot be completely stopped once a stress change has been applied and maintained for a period of time. Areas of the SJV that have experienced subsidence will continue to exhibit subsidence for some time, albeit at a lower rate, even if piezometric levels are returned to levels preceding groundwater pumping in the SJV.

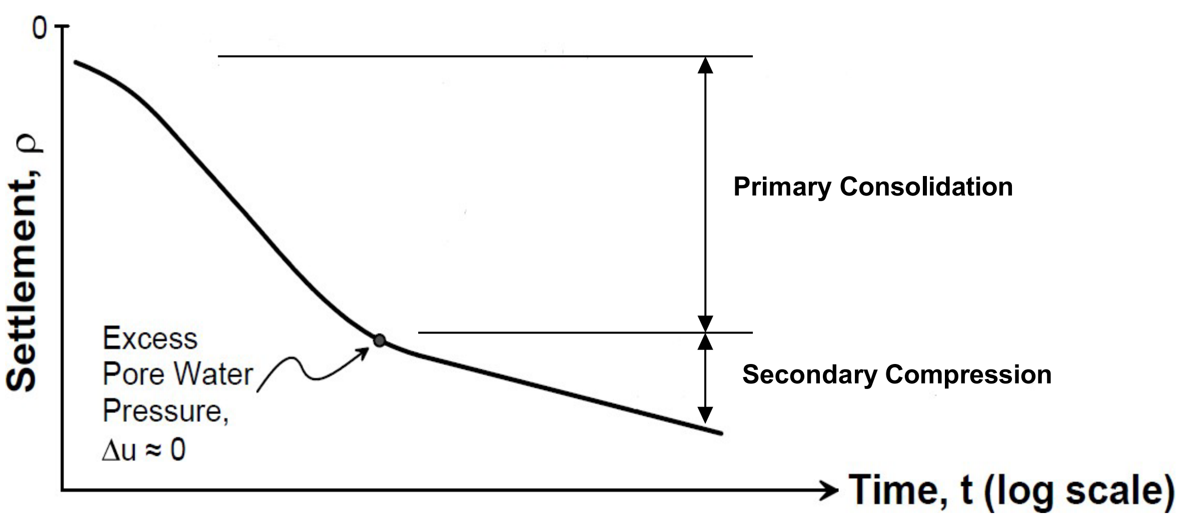


Figure 3A.5.2-1: Time Rate of Settlement Due to Consolidation and Compression

3A.5.3 Consolidation Properties of the Corcoran Clay

As discussed in Section 3.1.8.3 of the GSP, the Corcoran Clay is composed of dark-greenish gray, mainly diatomaceous, silt, clay, silty clay, and sand that was deposited in a lake that occupied the SJV (Croft 1972). The relevance of the composition of the Corcoran Clay is that its diatomaceous constitution makes it much more compressible than other fine-grained soils encountered within the SJV. For example, Figure 3A.5.3-1 presents a plot of results of consolidation tests (also known as consolidation curves) from a study by the USBR on fine-grained specimens (i.e., clays) recovered in borings advanced throughout the SJV (Johnson 1984). The plot shows how void ratio (e), which is the ratio of the volume of voids in a soil element and the volume of solids in the soil element, changes as vertical stress is increased in a test specimen. The test results typically show curves that have a relatively flat portion at low stresses (e.g., less than 10 pounds per square inch [psi]) followed by an acute or more subdued inflection beyond which the slope of the curve becomes steeper. The rate at which the void ratio decreases describes the compressibility of the soil and the stress at which the curve changes from relatively flat to steeper is the preconsolidation stress (σ'_p) mentioned in Eq. 3-2. The slope of the portion of the consolidation curve to the left of the inflection point represents the compression index (C_r), which is related to the compression ratio (CR) of Eq. 3-2 through Eq. 3-5 below.

$$CR = \frac{C_r}{1 + e_0} \qquad \text{Eq. 3-5}$$

The consolidation curves shown on Figure 3A.5.3-1 mostly include results from specimens recovered above and below the Corcoran Clay. Only one consolidation curve, the result plotted using a solid line on Figure 3A.5.3-1, is from a specimen from the Corcoran Clay. This consolidation curve exhibits significantly higher compressibility than the curves from clays above and below the Corcoran Clay, and the magnitude of compression ratio (CR) for this specimen is approximately 1.0.

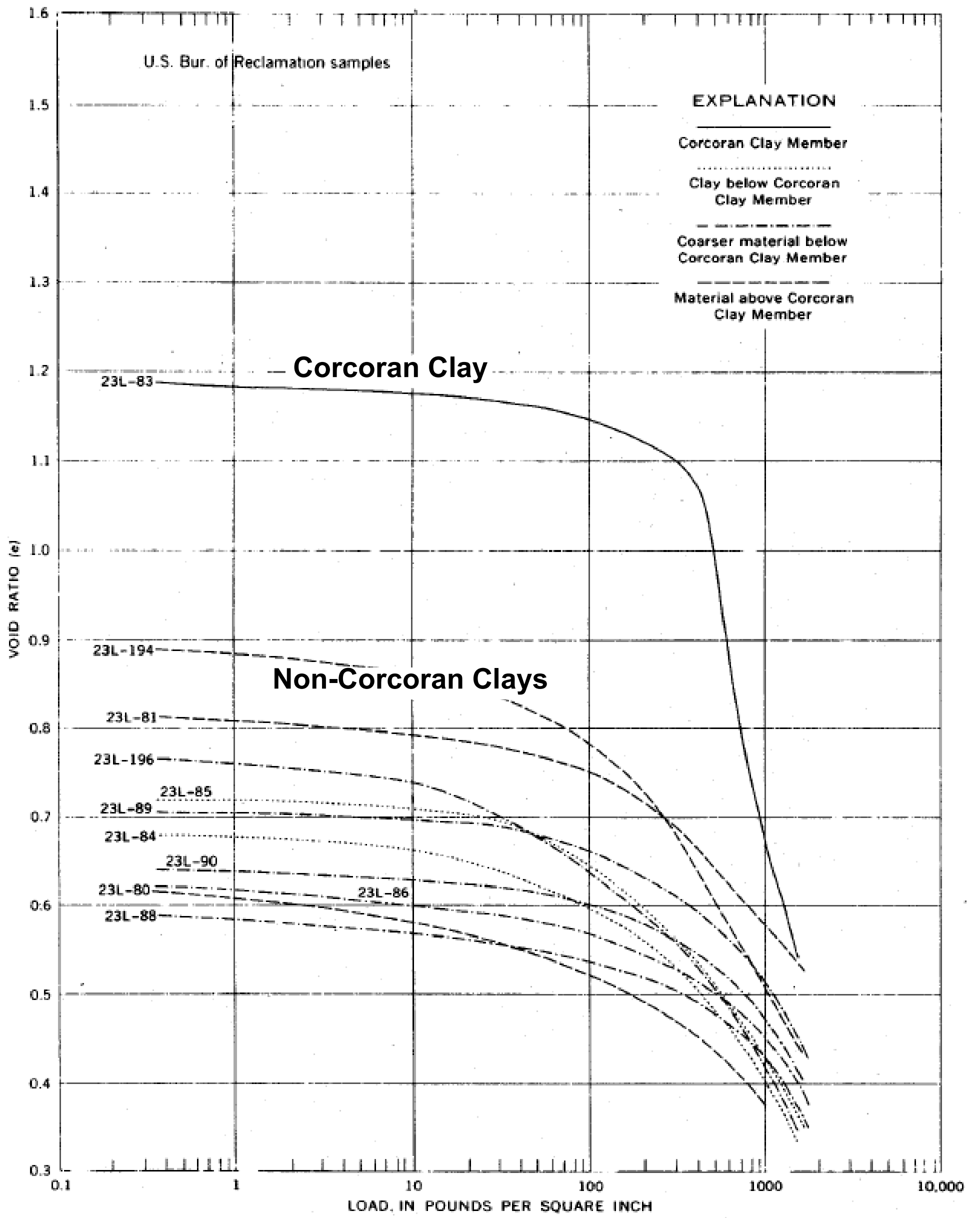


Figure 3A.5.3-1: Plots of Results of Consolidation Tests for Clayey Soils Recovered in the SJV Showing the Relationship Between the Log of Vertical Stress and the Void Ratio

The higher compressibility of the Corcoran Clay is expected given its diatomaceous nature. Studies by Mesri et al. (1975), Shiwakoti et al. (2002), Diaz-Rodriguez and Gonzalez-Rodriguez (2013), and Sonyok and Bandini (2019), to name a few, have shown that diatomaceous soils have been found to be significantly more compressible than non-diatomaceous soils. Some of these studies have been carried out to study "Mexico City clay," which is primarily diatomaceous and has been the primary cause of significant amount of subsidence in Mexico City following groundwater extraction.

3A.5.4 Estimation of the Magnitude of Subsidence

As discussed in the previous section, pumping from wells installed in the deep confined aquifer began over 100 years ago and has led to a significant decrease in the elevation of the piezometric surface within the confined aquifer. This led to an increase in the (effective) stress between soil particles, and thus consolidation of the aquitard which manifests as subsidence at the ground surface.

Evaluation of extensometers installed throughout the SJV have shown that, although other clay layers above the Corcoran Clay contribute to subsidence, the Corcoran Clay and clay units below the Corcoran Clay have the greatest contribution to the total amount of subsidence (Ireland et al. 1984). This is illustrated below in Figure 3A.5.4-1, which shows a plot developed by Ireland et al. (1984) that shows the ratio of the amount of compaction (i.e., consolidation) measured in extensometers and the amount of subsidence measured at ground surface against the depth of the extensometer. The plot indicates that a 1,000-foot-deep extensometer in a subsidence area would record approximately 60% of the total amount of subsidence measured at ground surface, whereas a 2,000-foot-deep extensometer would record nearly 100% of the amount of subsidence.

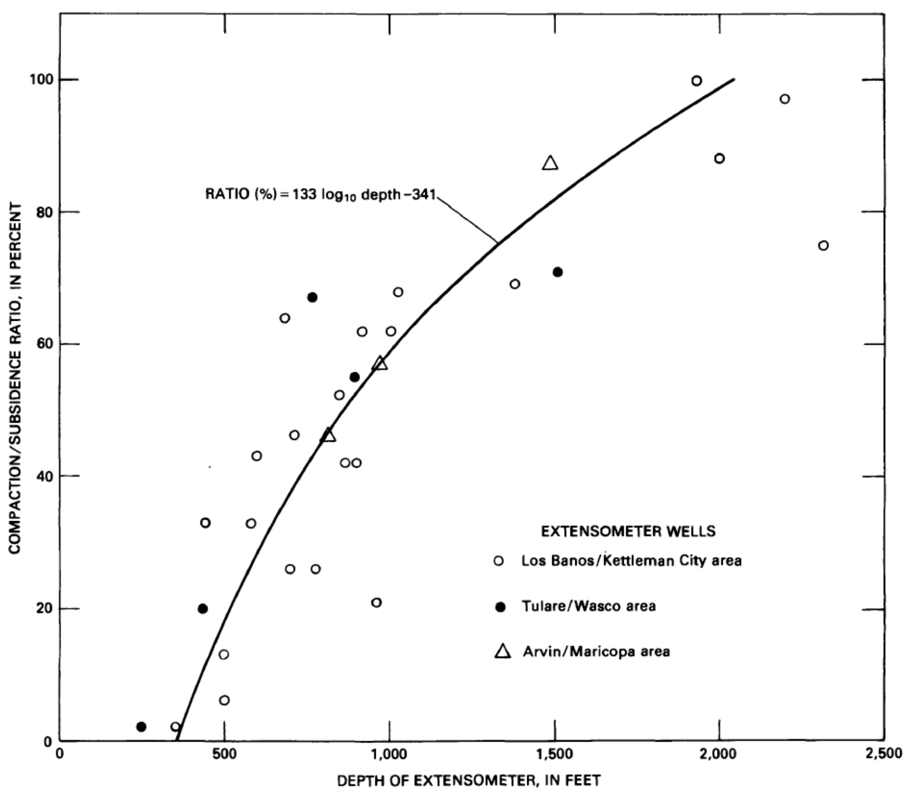


Figure 3A.5.4-1: Relationship Between Compaction/Subsidence Ratios to Depth at Extensometer in the SJV (from Ireland et al. 1984)

The magnitude of consolidation of the Corcoran Clay and therefore the approximate amount of subsidence at ground surface can be estimated using a simplified ground model such as the one shown on Figure 3A.5.3-1 and Eq. 3-3. This model can be used to evaluate the effect of some of the parameters that affect the amount of consolidation that occurs in the Corcoran Clay. From left to right, Figure 3A.5.4-2 includes plots that illustrate the effect that 1) the thickness of the Corcoran Clay, 2) the depth to the top of the clay, and 3) the magnitude of the drop in piezometric level in the clay have on the total amount of consolidation (i.e., subsidence). As shown on these figures, when all else is equal, the amount of subsidence

increases as the thickness of the clay increases,

decreases as the depth to the top of the clay measured from ground surface increases, and

increases as the magnitude of the reduction of the piezometric surface increases.

Of the parameters modeled with the example illustrated in Figure 3A.5.4-2, only the elevation of the piezometric surface of the lower (confined aquifer) can be controlled. The other parameters depend on local and regional geological conditions.

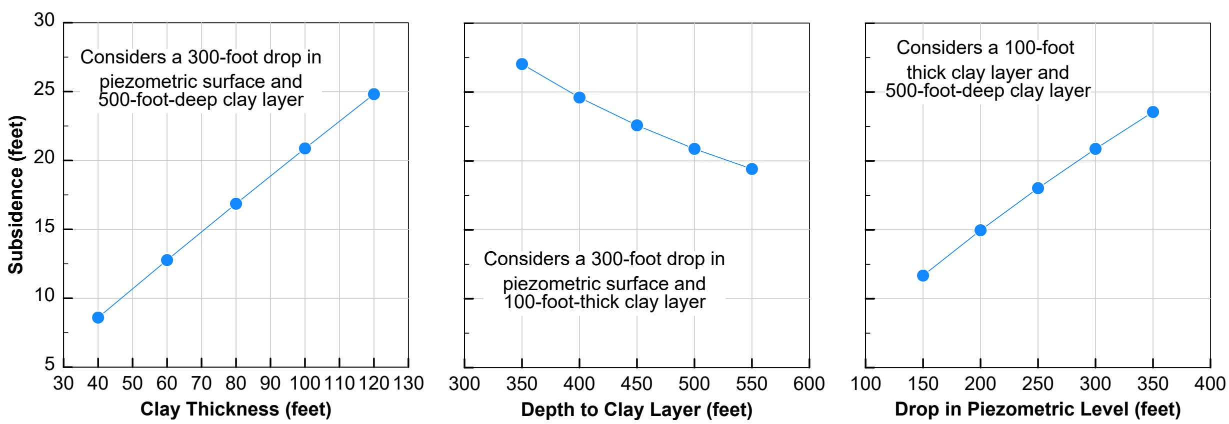


Figure 3A.5.4-2: Parametric Estimates of the Magnitude of Subsidence That Can Develop at Ground Level Using a Simplified Model

3A.5.5 Subsidence in the Tulare Lake Subbasin

As shown in Figure 3A.5.0-1, the magnitude of subsidence has not been uniform within the Subbasin. The southern portion of the subbasin has experienced a significantly lower amount of subsidence than the northern and central portions of the subbasin where there appears to be a northwest to southeast trending zone where subsidence reaches the highest measured values. The northernmost portions of the subbasin also experience lower amounts of subsidence. These patterns of subsidence are similar to what has been measured with InSAR between June 2015 and January 2023, as shown in Figure 3A.5.5-1 and Figure 3A.5.5-2. These figures also present the thickness (Figure 3A.5.5-1) and the depth to the top of the Corcoran Clay (Figure 3A.5.5-2).

As can be noticed from these figures, in the northern portion of the subbasin, the magnitude of subsidence is highest near Lemoore and Corcoran and near the Kaweah notch and into the Kaweah subbasin. The magnitude of subsidence is lower at and around the town of Hanford and to the northeast of the basin. This pattern correlates to the thickness of Corcoran Clay, which is about 80 ft near Corcoran, 60 ft near Lemoore, and 20 ft near Hanford, and thins out to the north and northwest (Figure 3A.5.5-1). The magnitude of subsidence thus correlates to the thickness of the Corcoran clay in these areas (when assuming that the drop in the piezometric level is similar).

Similarly, Figure 3A.5.5-2 shows that the cities of Corcoran and Lemoore are in areas where the depth to the top of the Corcoran clay is in the range of 450 to 500 ft, whereas the depth to the clay decreases to the north and increases to the south. The lower amount of subsidence in the southern portions of the basin may be explained by this pattern.

3A.5.5.1 Time Rate Effects of Subsidence

As discussed, subsidence in the SJV primarily occurs as water is essentially squeezed out of fine-grained aquitards (i.e., consolidation) due to effective stress increases induced by decreased piezometric levels. The fine-grained nature of the aquitards (i.e., clayey soil units) causes the outflow of water to be relatively slow. As such, subsidence resulting from groundwater extraction does not all occur instantaneously, but rather can occur over extended periods of time (e.g., Lees et al. 2021, Borchers and Carpenter 2014, Lofgren and Klausing 1969). It is important to understand this time lag in evaluating current and projected subsidence, in that current/ongoing subsidence is in part related to historical activities. The time-dependent process of subsidence caused by consolidation is as follows:

As the piezometric level decreases due to pumping below previous established values, (in Figure 3A.5.1-1, the previous established value is the piezometric elevation described as the initial condition), water in the pores of coarse-grained soils drains out relatively quickly causing a change in the pore-fluid pressure and an increase in the vertical effective stress. However, given that fine-grained soils have much lower permeability than coarse-grained soils, the change in the pore-fluid pressure, and thus the change in effective stress, is relatively slow. If the time period during which the water table is lowered due to pumping is shorter than the time period 3-23anagemed for the fine-grained soil to fully drain, and the initial water table elevation is reestablished, then only a portion of the fine-grained layer is affected by the temporarily reduced pore-fluid pressure and the effective stresses only increases in that portion of the soil layer. The portion of the fine-grained layer affected by the increase in effective stress consolidates (compresses and decreases in volume), which is manifested at ground surface as subsidence. The magnitude of subsidence is affected by the portion of the soil layer that drained (or partially drained) and was affected, albeit temporarily, by the higher value of effective stress.

If the time period during which the water table is lowered due to pumping is long enough to allow the fine-grained soils to fully drain, then the entire layer is subjected to increased vertical effective stress and the magnitude of subsidence at ground surface is larger. Completion of “primary consolidation” is said to have occurred in the fine-grained layer when the pore-fluid pressure in the entire layer is consistent with the new elevation of the piezometric surface and the effective stress at an arbitrary plane is constant over time.

After primary consolidation and at constant effective stress, clayey soil units continue to decrease in volume due to secondary compression. The magnitude of the decrease in volume over time due to secondary compression is greatest when the applied effective stress is equivalent to the maximum effective stress applied to the soil unit in the past. Using the sketch of Figure 3A.5.1-1, the magnitude of secondary compression will be highest if the final water elevation condition is maintained. However, secondary compression will decrease if the water elevation rises back to the initial condition and the effective stress in the soil decreases from its maximum value.

3A.5.6 Relationship between Subsidence and Groundwater Levels in the Subbasin

The theoretical relationship between subsidence measured at the ground surface and a reduction of the piezometric level in the confined aquifer below the Corcoran Clay was presented and discussed in the previous sections. Empirical evidence of the relationship between groundwater levels in the confined aquifer and subsidence is available for the Subbasin and is presented in this section of the report. The interrelationship between water levels and subsidence has also been described and documented by others such as Green (1964), who showed the relationship between the rate of subsidence and the fluctuation of groundwater levels in Santa Clara Valley and also compared subsidence estimates with measurements. An example of this interrelationship is presented below in Figure 3A.5.6-1.

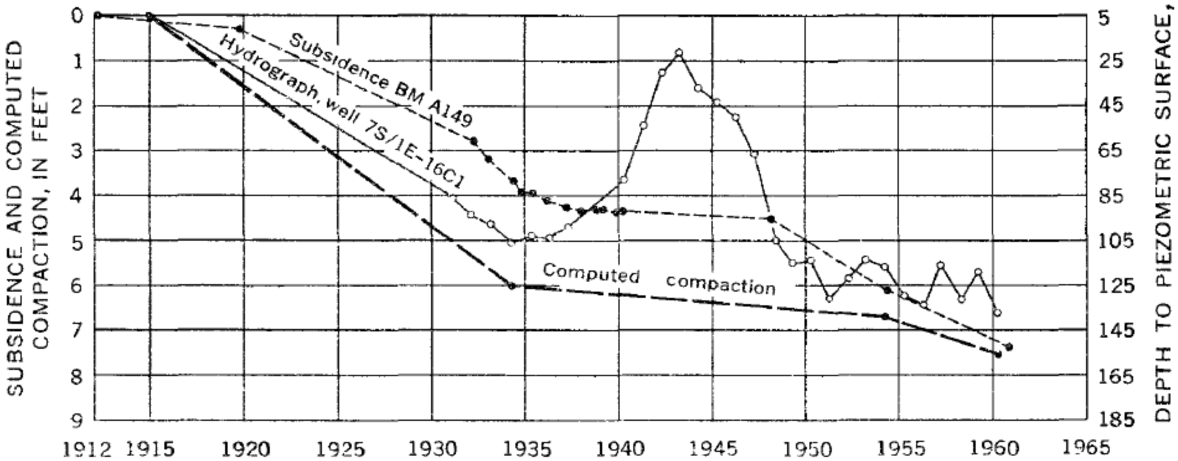


Figure 3A.5.6-1: Measured and Computed Subsidence at Core Hole 7S/1E-16C6 and Hydrograph of a Nearby Well (presented in Green 1964)

Figure 3A.5.6-2 shows the location of the subsidence monitoring stations that are part of the existing subsidence monitoring network. The location of wells that are screened within Zone C (i.e., below the Corcoran Clay) is also provided in Figure 3A.5.6-2.

A first example of the relationship between the magnitude of subsidence and groundwater elevation is presented in Figure 3A.5.6-3, which provides plots of the amount of subsidence measured at station CRCN within the City of Corcoran together with the elevation of groundwater in wells ER_S-173 and 21S22E07J001M. Subsidence measurements at CRCN are available on an almost daily basis since late September of 2010; however, the data in the groundwater wells exhibit greater paucity. The record for well ER_S-173 is more complete than in well 21S22E07J001M, but both wells exhibit years with one, two or zero measurements. For example, there were no measurements in well ER_S-173 for the time period between August 2, 2016 and October 3, 2018 (i.e., no data for 2 years) and no measurements at well 21S22E07J001M between October 22, 2018 and March 6, 2020.

The following can be observed from the subsidence and groundwater elevation plots shown on Figure 3A.5.6-3:

The City of Corcoran experienced approximately 8.5 ft of subsidence between September 2010 and September 2023.

The rate of subsidence at CRCN for the period between January 1, 2013, and January 1, 2016, was 1.0 ft/year. Similarly, the rate of subsidence for the period between March 1, 2010, and October 1, 2022, was 0.9 ft/year.

The rate of subsidence was subdued and in the range of 0 ft/year in 2011, 2017, and in the present time (i.e., 2023). These periods of time (i.e., with low rate of subsidence) coincide with higher elevation of the groundwater level in the nearby observation wells.

The elevation of the groundwater in well ER_S-173 was at its lowest recorded values and in the range of -140 and -220 ft during the time period between January 1st, 2013, and January 1st, 2016 when subsidence exhibited a rate of 1 ft/year. There are data gaps when subsidence was exhibiting a lower rate, but groundwater levels in the range of -100 ft and above in well ER_S-173 appear to coincide with near zero subsidence.

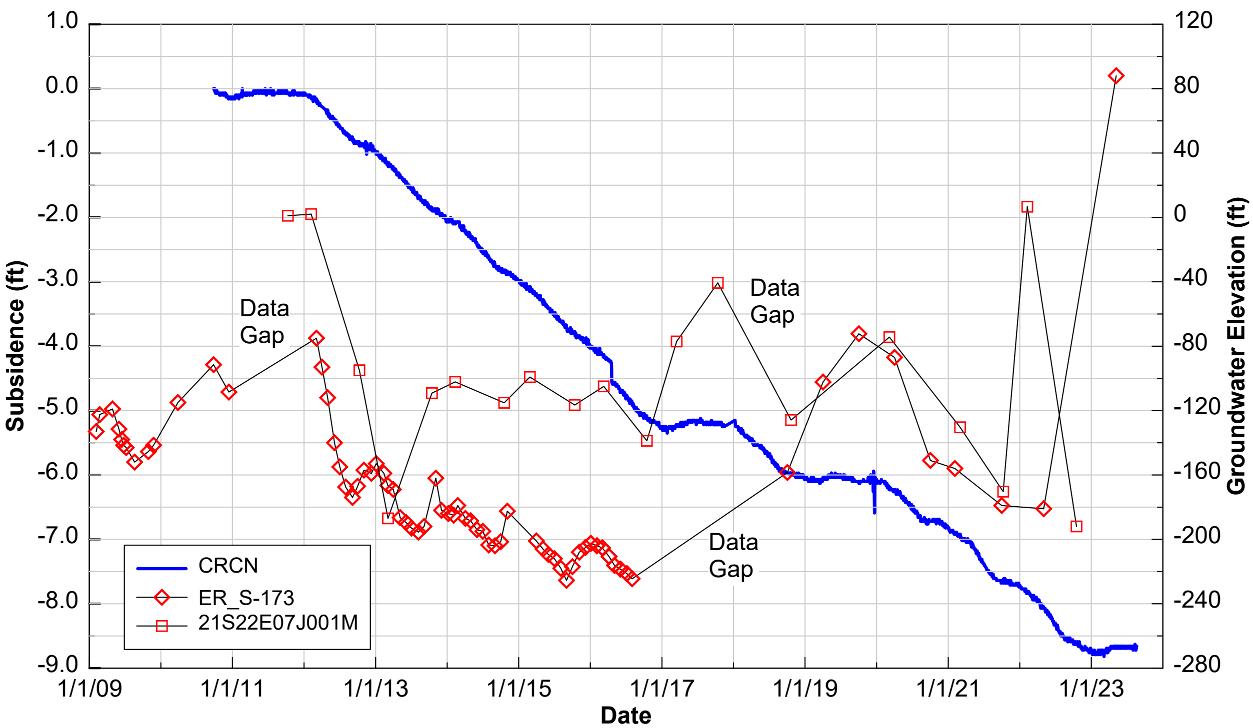


Figure 3A.5.6-3: Plots of Subsidence Measured at Station CRCN and Groundwater Elevations Measured at Wells ER_S-173 and 21S22E07J001M

A second example of the relationship between subsidence and the fluctuation of groundwater in the confined aquifer is presented in Figure F-17, which provides plots of the amount of subsidence measured at stations SUB028, SUB061, and SUB102 located in the western part of the Subbasin together with the elevation of groundwater in proximally located wells 20S20E28E003M and 20S20E07H001M (see Figure 3A.5.6-4). Subsidence measurements at the SUB028, SUB061, and SUB102 is only available since June 2010, and for the period between June 2010 and September

2019, there are only four data points. However, the following can be observed from the plots on Figure 3A.5.6-4:

The average rate of subsidence at SUB028 between January 1, 2012, and April 1, 2016, was 0.6 ft/year. More recently, in the period between October 9, 2020, and September 26, 2022, the rate of subsidence was 0.8 ft/yr.

The average rate of subsidence at SUB061 between June 1, 2010, and April 1, 2016, was 0.5 ft/year. More recently, in the period between September 28, 2021, and September 14, 2022, the rate of subsidence was 0.7 ft/yr.

At SUB102, the rate of subsidence between June 1, 2010, and December 1, 2016, was 0.4 ft/year, and 0.6 ft/year between October 9, 2020, and September 26, 2022.

The rate of subsidence was subdued at SUB028, SUB061, and SUB102, between 2019 and 2020 with values of 0.3 ft/year, 0.13 ft/year, and 0 ft/year, respectively.

The periods of time that experienced the highest rates of subsidence are associated with the periods of time when the groundwater elevations were lowest, and vice versa.

The period of time between 2020 and 2021 when subsidence was lowest in this area of the basin coincides with groundwater elevations in the two wells that are above -40 ft.

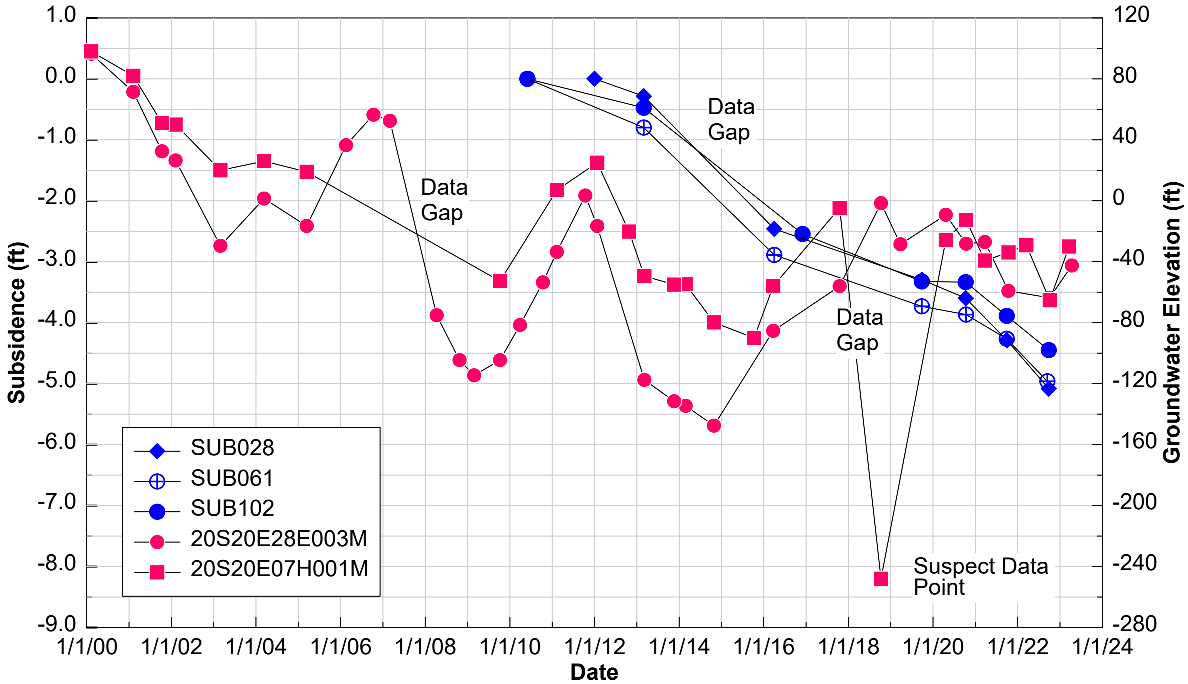


Figure 3A.5.6-4: Plots of Subsidence Measured at Subsidence Station SUB028, SUB61, and SUB102 and Groundwater Elevations Measured at Wells 20S20E28E003M and 20S20E07H001M

Although paucity of subsidence and groundwater data makes it difficult to identify a correlation between groundwater level fluctuations in observation wells and the rate of subsidence, the evaluation described in the previous examples is considered to constitute evidence of a correlation between the rate of subsidence and the elevation of groundwater within the confined aquifer (i.e., below the Corcoran Clay). The theory of consolidation discussed in previous sections and the empirical data presented above provide the basis to develop an approach for controlling the rate of subsidence in the Subbasin through the adjustment and control of the elevation of groundwater in the confined aquifer. This approach will be implemented to achieve the sustainability goals that is discussed in Chapter 4 of this GSP.

4. SUSTAINABLE MANAGEMENT CRITERIA

> **23 CCR §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.*

The Sustainable Groundwater Management Act (SGMA) defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of GSP implementation. Development of the sustainable management criteria for the Tulare Lake Subbasin (Subbasin) was based on available information and data developed for the Hydrogeologic Conceptual Model (HCM), the characterization of groundwater conditions, and the water budget (DWR 2017b).

Sustainable management criteria include:

Management Criteria	Description of Management Criteria
Sustainability Goal	A succinct qualitative statement including objectives and desired conditions for the groundwater basin, how the basin will get to the desired condition, and why the measures planned will lead to success
Measurable Objective	Quantitative goals that reflect the basin's desired groundwater conditions that allow the basin to achieve the sustainability goal within 20 years
Minimum Threshold	The quantitative value that represents the groundwater conditions at a monitoring site when exceeded may cause undesirable results in the basin
Undesirable Results	A situation that occurs when conditions related to any of the six sustainability indicators become significant and unreasonable

These criteria for the Subbasin were developed through the assessment of sustainability indicators and the identification of significant and unreasonable conditions for each indicator. The indicators are measured at representative monitoring sites in each representative monitoring management area of the Subbasin.

Sustainability Indicators

Sustainability indicators are intended to represent groundwater attributes that are indicative of the overall health of the aquifer system and its ability to sustain the beneficial uses that aquifers provide.

Under SGMA, sustainability indicators and the undesirable results that can occur for each indicator, are:

- Chronic lowering of groundwater levels that produce a significant and unreasonable depletion of supply if continued over the planning and implementation horizon.
- Significant and unreasonable reduction of groundwater storage.

- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletion of interconnected surface water that has significant and unreasonable adverse impacts on beneficial uses of the surface water.

Based on the information presented in Chapter 3, there is sufficient evidence to eliminate seawater intrusion and interconnected surface water as indicators of sustainability in the Subbasin. The remainder of this chapter will address the other four sustainability indicators.

4.1 Sustainability Goal (Reg. § 354.24)

The sustainability goal of the Subbasin is to ensure that by 2040 the basin is being managed to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results. This goal will be met by balancing pumping with available water supply to stabilize declining groundwater levels such that pumping will not cause shallow wells to go dry; cause degradation of groundwater quality; or cause land subsidence. The GSAs will implement measures to stabilize long-term trends of declining groundwater levels in the three primary local aquifers, understanding that water levels will fluctuate seasonally and year-over-year. The GSAs also recognize that groundwater management is closely tied to surface water availability, which affects groundwater demand within the basin. Achieving the sustainability goal has potential implications on land use and socio-economic conditions in the Subbasin. Implementation of the GSP will recognize the socio-economic values in the basin, including agricultural production, residential/commercial development, and access to potable groundwater supply for existing beneficial uses.

The conditions within the subbasin and each GSA will be considered sustainable when:

- The Subbasin is continuously operated within its sustainable yield.
- Groundwater levels fluctuate within an operational range that consistently returns groundwater levels to similar levels when cyclical wet/dry cycles recur.
- Groundwater management activities prevent groundwater quality degradation, subsidence, and shallow wells going dry as a result of groundwater pumping.
- The CA Aqueduct within the Tulare Lake Subbasin area is not impacted by inelastic subsidence.

The GSAs within the Subbasin are committed to collaboratively managing the groundwater resources and will implement appropriate management actions, including intensive monitoring and reporting on local groundwater conditions, groundwater pumping restrictions, impact mitigation efforts and the development of projects that enhance groundwater supply. The Groundwater Sustainability Plan development process was conducted with transparency and inclusivity, ensuring that the local community and stakeholders are actively involved, and their voices are heard in shaping the programs and projects.

4.2 Overview of Measures to Achieve Sustainability Goal

To realize the objectives set forth in the GSP, a multipronged approach encompassing various measures will be employed over the next two decades and sustained thereafter. These measures are integral to guiding the Subbasin towards a sustainable groundwater future and include:

1. **Pumping Reduction**
    - **Metering:** Voluntary or mandatory metering program to monitor and manage pumping and required pumping reductions in each aquifer.
    - **Allocation:** Voluntary or mandatory pumping allocations in each aquifer to achieve interim milestones.
2. **Well Mitigation Plans**:
    - **Impact Mitigation**: Well mitigation strategies that ensure access to groundwater supply for domestic uses from existing wells.
    - **Well Rehabilitation**: Well modification or restoration initiatives where necessary to ensure access to groundwater supply for domestic uses.
3. **Policy and Regulatory Compliance**:
    - **Policy Development**: Formulating and enacting groundwater management policies with sufficient public outreach and input, and coordination with other state and local agencies.
    - **Regulatory Enforcement**: Ensuring compliance with management actions, policies, and penalties as appropriate.
4. **Management Actions**:
    - **Accelerated Implementation**: Prioritize management actions, such as pumping reduction, to address key management issues within the Subbasin by the year 2026.
    - **Adaptive Management**: Utilizing adaptive strategies to respond to evolving conditions and insights from ongoing analysis of monitoring data and stakeholder interactions.
5. **New Infrastructure**:
    - **Storage and Distribution**: Augmenting water storage and distribution capacities to improve efficiency.
    - **Surface Water Augmentation**: Initiating projects to increase surface water supply, thereby reducing groundwater dependency.

- **Recharge Basins**: Target of 1,000 additional acres of infiltration facilities to enhance recharge capacity
- **Aquifer Storage and Recovery:** Pilot testing of injection recharge to the confined aquifer to enhance storage capacity and increase hydraulic heads in the confined aquifer.

6. **Monitoring Programs**:
    - **Refined RMS Network and Associated Monitoring**: Implement additional monitoring locations and technologies for key sustainability indicators including groundwater level, groundwater quality, and subsidence.
7. **Groundwater Modeling**:
    - **Model Updates and Predictive Analysis**: Enhanced modeling to evaluate pumping strategies and effects on associated groundwater-levels, hydraulic gradients, and sustainability metrics. Annual calibration enhancements to confirm and refine model parameters. Annual forecasting of future groundwater trends and the impact of any adjustments to management actions.
8. **Sustainability Initiatives**:
    - **Long-term Projects**: Initiate on-going activities to improve public awareness and action regarding groundwater sustainability such as education on domestic well maintenance, water conservation (both domestic and irrigation) and pollution prevention.
    - **Community Involvement**: Engaging stakeholders and the local community to foster collaborative decision-making and transparency.
9. **Education and Awareness**:
    - **Stakeholder Engagement**: Maintaining continuous interaction with stakeholders and the local populace.
    - **Awareness Programs**: Implementing educational programs to promote sustainable water usage and increase awareness.

These strategies, elaborated in Chapters 6 and 7 of the GSP, represent a comprehensive framework, encompassing both immediate and long-term actions essential for the sustainable management of the Subbasin's groundwater resources. Through this holistic approach, combining, infrastructural improvements, demand reduction, and community engagement, the GSAs are committed to steering the Subbasin towards a sustainable and resilient groundwater future.

4.3 Sustainable Management Criteria for Groundwater Levels

> **23 CCR §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.*

4.3.1 Groundwater Level Representative Monitoring Sites (RMS) and Areas (RMA)

Unconfined (A-Zone and B-zone)

The RMAs for both A-Zone and B-Zone aquifers were established using Thiessen polygons to group wells with similar depth (Figures 4.2.4-1 and 4.2.4-2). A Thiessen polygon is a way of dividing space into distinct regions or polygons based on a set of points. This approach aims to ensure that the data collected from an RMS well within an RMA reflects the conditions within the designated polygon.

The Thiessen polygons were drawn around well locations from the Subbasin Integrated Database, based on their screen intervals using the K-Means clustering methodology to group them. This process optimizes for clusters where the wells have similar completion depths. Each Thiessen polygon represents an area within which there are approximately the same number of wells with similar completion intervals. A more detailed discussion of the methodology used to develop the RMAs is provided in Appendix I.

In the A-Zone, polygons drawn around well clusters using K-Means clustering resulted RMAs that may include up to sixty-six wells. In the B-Zone, each RMA includes up to about 120 wells. Smaller polygons indicate higher well density, and larger polygons indicate lower well density.

One RMS location is assigned to each RMA. In some cases, the RMS location is an existing well that the GSA has a monitoring agreement established with the landowner or in other cases, has installed dedicated monitoring well. In some RMAs, a well has not yet been identified or installed for that RMS location. For a detailed listing of the RMAs and their corresponding RMS wells, refer to Tables 4.3.1-1a through 4.3.1-1c.

Within each RMA, statistics can be calculated regarding well completion and well type (i.e. domestic vs agricultural). In the future, stratigraphic analysis and local pumping well interactions can be evaluated to address local conditions or locally specific management issues. This methodological approach provides each GSA with a valuable tool to consider variations in well completion, water use, and aquifer geometry/properties that enables targeted groundwater management strategies to manage sustainability indicators; their associated undesirable results; and the magnitude of impacts associates with specific minimum thresholds. Each RMS well for each aquifer zone (A-, B- and C-zone) is uniquely assigned to a specific RMA. No RMA shares more than one RMS well, ensuring that each RMA is exclusively associated with a single RMS well for clear and distinct monitoring. As part of GSP implementation, each GSA will identify or install an RMS well for RMAs that do not yet have a dedicated RMS location. In the absence of an existing RMS location, RMAs are grouped to conduct analyses of impacts or to define when a measurable objective or minimum threshold is reached (see Section 4.3.3).

Confined (C-Zone) Aquifer

The RMS network for the confined aquifer is based on the subsidence RMS network because of the close association between groundwater level and subsidence. Subsidence is measured at many locations throughout the Tulare Lake Subbasin using a combination of InSAR (remotely sensed ground elevations) and ground-based benchmarks. A total of 33 Subsidence RMA's have been developed in which multiple subsidence measurements will be aggregated and compared to minimum thresholds and measurable objectives. Within each RMA, at least one C-zone well will also be monitored for groundwater level.

Subsidence measurements will be aggregated within the C-Zone RMA's shown on Figure 4.2.4-3 to calculate an average subsidence in that RMA. The aggregate subsidence measurement will be applied as follows:

The average total subsidence in the RMA will be compared to minimum threshold, along with the median, maximum and minimum within each RMA.

The average rate of subsidence in the RMA will be compared to measurable objective, along with the median, maximum and minimum within each RMA.

4.3.2 Undesirable Results for Groundwater Level

23 CCR §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.*

SGMA regulations require the definition of undesirable results include the following:

- The cause of groundwater conditions occurring throughout the basin that would lead to or has led to the undesirable results based on information described in the basin setting, and the other data or models as appropriate (Reg. § 354.26(b)(1)).
- The criteria used to define when and where 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 (Reg. § 354.26(b)(2))
- Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects in the basin (Reg. § 354.26(b)(3)

Undesirable results occur when groundwater conditions within the Subbasin cause a significant and unreasonable impacts to a sustainability indicator.

Cause of Conditions Leading to Undesirable Results for Groundwater Level

Unconfined Aquifer: Groundwater declines in the unconfined aquifer are primarily related to regional pumping rates that disrupt the equilibrium water balance and cause a decline in aquifer storage. This manifests itself as declining groundwater levels. The groundwater level in a well at any point in time represents a dynamic balance between groundwater inflows and groundwater outflows into the area. Groundwater inflows include natural or artificial recharge that reaches an aquifer and inflows from adjacent groundwater basins. Groundwater outflows includes pumping, outflows to adjacent groundwater basins, and other discharges such as evapotranspiration that lowers a shallow water table. There is an inherent seasonal fluctuation in groundwater storage and associated water-level fluctuation. During the winter and early spring, recharge is generally higher and pumping rates are generally lower, so groundwater levels rise as groundwater storage increases. During the late spring and summer, recharge is generally low and pumping rates are generally higher, so groundwater levels decline as groundwater storage decreases. The volume of groundwater storage increase during the winter/spring varies from year-to-year and is highly dependent on the amount of winter precipitation and associated spring run-off. The volume of groundwater storage decrease during the summer also varies from year-to-year and is highly dependent on the amount of pumping during that summer. Long-term year-over-year declines in aquifer storage occur when: 1. There are successive years of low winter precipitation and associated run-off that reduce inflows to the aquifer or 2. There are successive years of high groundwater pumping that exceeds the previous season's inflows.

Confined Aquifer: Long-term groundwater declines in the confined aquifer are primarily related to regional pumping rates that disrupt the equilibrium water balance and cause a decline in aquifer storage. However, water levels in a confined aquifer represent the pressure head beneath the confining layer, and the storage coefficient for a confined aquifer is much lower than the unconfined aquifer (by orders of magnitude). Therefore, when pumping occurs, the reduction in pressure head also results in compaction of the confining layer. This relationship to compaction and associated ground subsidence creates a close relationship between pumping, groundwater level and subsidence. Declining water levels by themselves are not a driver for undesirable results; rather the subsidence that occurs from the declining water levels are the driver for undesirable results in the confined aquifer.

Like the unconfined aquifer, the groundwater level in a well in the confined aquifer also represents a dynamic balance between groundwater inflows and groundwater outflows into the area. Groundwater inflows to the confined aquifer originate primarily from outside the Tulare Lake Subbasin as mountain front recharge along the Sierra Foothills. Groundwater outflows includes pumping, outflows to adjacent groundwater basins. The ability to control groundwater levels in the confined aquifer through management of pumping rates is also dependent on inflows from outside the Tulare Lake Subbasin.

The 2020 4-7anagementer model evaluated dynamic equilibrium in both the confined and unconfined aquifer and the results of this model are applied in developing interim milestones for pumping reductions.

Criteria to Define Undesirable Results for Groundwater Level

An undesirable result for chronic lowering of groundwater level occurs when groundwater conditions throughout the Subbasin cause significant and unreasonable impacts to the viability of domestic, agricultural, municipal, industrial wells over the implementation period of the GSP. The GSAs intend to maintain sufficient access to groundwater for all beneficial users while recognizing natural multi-year cycles of decreasing and increasing water levels during dry and wet periods.

The SMC for groundwater level defines an undesirable result with respect to a numerical threshold (a minimum threshold) which would cause a significant and unreasonable loss of beneficial uses for water supply. The minimum threshold for groundwater level that defines the undesirable result is a groundwater level that would make a water supply well unusable for supply purposes.

The RMS network is used to determine whether an undesirable result has occurred or may be occurring based on the percentage of RMS locations exceeding a minimum threshold during a single sampling event. Exceedance of the minimum threshold at a single RMS location does not constitute an undesirable result across the Subbasin, but the GSAs will investigate all exceedances and consider additional monitoring, investigation or mitigation in any RMA that experiences an exceedance.

Statement of Undesirable result for the Unconfined Aquifer: An undesirable result is considered to occur for the chronic lowering of groundwater levels when 20 percent of the RMS wells in either the A-zone or B-zone aquifer have exceeded minimum threshold levels in a single monitoring event. For the A-zone, there are a total of 30 RMAs. Out of these, 24 RMAs are located outside the area that has been de-designated, so an undesirable result would occur when the minimum threshold is exceeded in two RMAs. For the B-zone, there are a total of 44 RMAs. Out of these, 38 RMAs are located outside of the de-designated areas, so an undesirable result would occur when the minimum threshold is exceeded in four RMAs. Many, but not all RMAs have an existing RMS well that is monitored. If water levels in an RMS well drops below the minimum threshold and is adjacent to an RMA that does not yet have an RMS location, the adjacent RMA will be assumed to have also reached its minimum threshold. In this situation, one RMS exceedance causes two RMA exceedances that would "count" towards the 20% RMS threshold for defining an undesirable result.

In addition, the GSAs will respond to any landowner-reported loss of beneficial use and will initiate an investigation to determine whether the cause of the landowner-reported loss is the result of declining groundwater levels. Furthermore, if one RMA area reaches the minimum threshold (which is not an undesirable result), GSAs will initiate an investigation of wells within that RMA to determine whether beneficial uses have been lost or are at risk as a result of declining water level.

Statement of Undesirable result for the Confined Aquifer: The subsidence undesirable result is a proxy for the undesirable result and minimum threshold for groundwater level in the C-zone. When an undesirable result for subsidence is occurring, an undesirable result for chronic lowering of groundwater level in the confined aquifer is also occurring. An undesirable result is considered to occur for ground subsidence (See Section 4.7) when 10 percent of the RMS locations for subsidence in any RMA reach the total subsidence minimum threshold (See Section 4.7).

A well in the confined aquifer does not "go dry" from pumping, but declining water levels can affect the pumping lift or drop below the pump setting. However, there is no data on pump settings for wells in the confined aquifer, so a decline in water level that would affect pumping capacity cannot be determined. By focusing on subsidence prevention, a conservative and protective framework for managing groundwater levels is also established. This approach not only addresses the immediate concern of subsidence but also curtails the risks associated with reaching critically low pumping levels.

Potential Effects to Beneficial Users

Unconfined Aquifer

The number of existing beneficial uses in the unconfined that could be impacted from the undesirable result can be calculated based on an analysis of the Subbasin database and the quantitative minimum threshold for each RMA. The GSAs recognize that even a single exceedance of a minimum threshold at an RMS location could indicate impacts to multiple wells in that RMA. Therefore, the Subbasin has developed a shallow well mitigation plan to address well impacts, whether they occur from a single exceedance in one RMA or from an undesirable result that affects multiple RMAs across the Subbasin. The number of potentially affected wells in each RMA at the proposed minimum threshold is described in the Well Database, Appendix I.

As shown on Tables 4.3.1-1a and 4.3.1-1b, based on the minimum thresholds in the designated RMA's up to 33 wells in the A-zone and 178 wells in the B-zone could be impacted if the undesirable result is reached (two RMAs in the A-zone or four RMAs in the B-zone). The maximum number of potentially impacted wells in any single RMA is 18 wells for the A-zone (RMA # A-6) and 69 wells for the B-zone (RMA # B-23).

Note that it is suspected that well registration efforts will show that there are fewer active wells than are reflected in the available databases, so the number of potentially affected wells is expected to decrease. Well construction has varied greatly over time and the construction depth of all wells in the subbasin is not yet known. Since well permits to abandon dry wells rarely get processed, the expectation is that the well registration efforts will reflect that many of the shallowest wells in the databases are no longer active. These shallowest wells are included in the calculation of potentially affected wells. A more detailed description of the well registration efforts is included in Chapter 6. Also, as part of the well mitigation program, the GSAs will respond to any landowner-reported loss of beneficial use; will investigate the cause of that loss of use; and will restore the well's function if the reported loss is the result of declining groundwater levels.

There is a second type of impact to beneficial users of the unconfined aquifer that will result from pumping reductions. Avoidance of undesirable results may require pumping reductions for wells pumping more than 500 AF per year in the unconfined aquifer. This required pumping reduction may cause impacts to beneficial uses and users that have historically been allowed to pump. The 2020 groundwater model predicted that an equilibrium water balance for the unconfined aquifer (zero change in aquifer storage), was achieved at a pumping rate of about 200,000 AF/Y. Recent pumping of the unconfined aquifer is estimated as much as 300,000AF/Y. The total amount of pumping reduction necessary to stabilize long-term declines in groundwater level and achieve the measurable objective for water levels in the unconfined aquifer could therefore be as high as 100,000 AF/Y. The spatial distribution of these impacts amongst individual beneficial users of the unconfined aquifer will need to be resolved through actual metering of pumping from the confined aquifer and an allocation process as part of GSP implementation.

Confined Aquifer

Because the minimum threshold for groundwater levels in the confined aquifer is based on the observed total subsidence, the number of existing beneficial uses of groundwater in the confined aquifer that could be impacted from the undesirable result cannot be easily calculated using the Subbasin database and associated well completion information. The database has no data on pump settings, so a decline in water level that would affect pumping capacity cannot be determined. However, avoidance of undesirable results for subsidence (and, by proxy, groundwater levels in the confined aquifer) will require pumping reductions in the confined aquifer. Therefore, the impact to beneficial uses and users in the confined aquifer is primarily related to the loss of groundwater supply in wells that have historically been allowed to pump. The 2020 groundwater model indicated that a zero-change in aquifer storage in the confined aquifer was achieved at a pumping rate of about 150,000 AF/Y. Recent pumping rates from the confined aquifer in dry years are estimated to be over 300,000 AF/Y. Therefore, the potential impact to beneficial uses in the confined aquifer are a pumping reduction of up to 150,000 AF/Y during a dry year. The spatial distribution of these impacts amongst individual beneficial users of the confined aquifer will need to be resolved through actual metering of pumping from the confined aquifer and an allocation process as part of GSP implementation.

4.3.3 Minimum Thresholds for Groundwater Level

23 CCR §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.*

Unconfined (A-Zone) Aquifer

The minimum threshold for Groundwater Level at RMS locations in the Unconfined A-Zone aquifer is 10 feet below the lowest observed or extrapolated groundwater elevation in 2015 at that well. A review of water level data indicates that groundwater levels have historically fluctuated about 10 feet over a multi-year cycle of wet or normal years, followed by dry years. This 10-foot value is then subtracted from the lowest water level elevation in 2015. This allows for one additional “post-2015” cycle of changing hydrologic conditions and drought cycle.

For RMS wells that lack water level data back to 2015, the 2015 groundwater level was extrapolated based on existing data at that well or data from surrounding wells. In RMAs lacking RMS wells, the 2015 groundwater level will be estimated based on data from surrounding RMAs or other data obtained through the well registration process. The proposed minimum threshold for groundwater levels is summarized in Tables 4.3.1-1a, 4.3.1-1b and 4.3.1-1c. for each aquifer zone and RMS/RMA.

As described previously, the GSAs have developed well mitigation plans to address potential impacts to A-zone wells and will respond to any landowner-reported loss of beneficial use. Furthermore, if one RMS reaches the minimum threshold, GSAs will initiate an investigation of wells within that RMA to determine whether beneficial uses have been lost, or are at risk, and, if warranted initiate well mitigation as appropriate.

Unconfined (B-Zone) Aquifer

For the B-Zone aquifer, the minimum threshold is 30 feet below the lowest water level elevation recorded in 2015. It is assumed that wells completed above the 2015 monitored levels went dry prior to SGMA. Hydrograph data reveal that, over a cycle spanning approximately 5 years, groundwater levels typically vary by approximately 30 feet. This cycle consists of wet or average precipitation years followed by dry years. This 30-foot value is then subtracted from the lowest water level elevation in 2015. Again, this approach allows for one additional “post-2015” cycle of changing hydrologic conditions and drought cycle.

For RMS wells that lack water level data back to 2015, the 2015 groundwater level was extrapolated based on existing data at that well or data from surrounding wells. In RMAs lacking RMS wells, the 2015 groundwater level was estimated or extrapolated based on data from surrounding RMAs. Table 4.3.1-1a and Table 4.3.1-1b present the minimum threshold for groundwater levels at each RMS location.

As described previously, the GSAs have developed well mitigation plans to address potential impacts to B-zone wells and will respond to any landowner-reported loss of beneficial use. Furthermore, if one RMS reaches the minimum threshold, GSAs will initiate an investigation of wells within that RMA to determine whether beneficial uses have been lost, or are at risk, and, if warranted initiate well mitigation as appropriate.

Confined (C-Zone) Aquifer

Wells completed below the Corcoran Clay tap into a pressurized aquifer that produces standing water levels above the elevation of the Corcoran Clay. The lowering of groundwater level in the confined aquifer from pumping is a primary cause of subsidence. Therefore, the minimum threshold for subsidence is used as a proxy for the minimum threshold for groundwater level. If the minimum threshold for subsidence is observed, the minimum threshold for groundwater level in the confined aquifer will also be assumed to occur in that RMA.

A single minimum threshold value for groundwater level in the confined aquifer, at a specific RMS location, does not provide a quantitative standard or condition that avoids an undesirable result for subsidence (see Section 4.7.3). Furthermore, direct measurement of subsidence across most of the Subbasin is possible from InSAR and provides a very accurate and spatially distributed measurement. A single measurement of confined groundwater level at a specific RMS location in the confined aquifer is a less reliable indicator of the undesirable result because there is no simple correlation between a single groundwater elevation measurement and the subsidence undesirable result. Table 4.3.1-1c presents the minimum threshold for groundwater levels at each RMA and RMS location in the confined aquifer selected as a potentiometric groundwater elevation that is 50 feet above the top of the E-Clay.

Per Cal. Code of Regs. Tit. 23, § 354.20 – Management Areas, The El Rico GSA has developed separate land subsidence management areas for the confined aquifer, referred to as “land subsidence sub-regions” that use a consistent subbasin undesirable results definition, but define different minimum thresholds and different measurable objectives than the basin at large. This is described in

J.

4.3.4 Measurable Objectives for Groundwater Level

> **23 CCR §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.*

Unconfined (A-Zone) Aquifer

The measurable objective for the unconfined aquifer (A-zone) is to maintain groundwater levels at or above the minimum levels observed in 2015 and establish a zero or near-zero rate of long-term groundwater level decline. The 2015 water level was selected as it represented the start of the SGMA implementation process. The conditions that define the measurable objective are groundwater levels in the unconfined aquifer that are sufficiently higher than the minimum threshold to enable continued long-term beneficial use. This will produce a pattern of seasonal groundwater fluctuation that increases during the winter/spring in response to recharge and decreases during the summer/fall in response to pumping. Long-term declines in groundwater level will be managed by regulated pumping so that there is no long-term decline in aquifer storage. The measurable objectives for each representative well are listed on Table 4.3.1-1a and Table 4.3.1-1b.

Unconfined (B-Zone) Aquifer

The measurable objective for the unconfined aquifer (B-zone) is to maintain groundwater levels at or above the minimum levels observed in 2015 and establish a zero or near-zero rate of long-term groundwater level decline. The 2015 water level was selected as it represented the start of the SGMA implementation process. The conditions that define the desired result are groundwater levels in the unconfined aquifer that are sufficiently higher than the minimum threshold to enable continued long-term beneficial use. This will produce a pattern of seasonal groundwater fluctuation that increases during the winter/spring in response to recharge and decreases during the summer/fall in response to pumping. Long-term declines in groundwater level will be managed by regulated pumping so that there is no long-term decline in aquifer storage. The measurable objectives for each representative well are listed on Table 4.3.1-1a and Table 4.3.1-1b.

Confined (C-Zone) Aquifer

The measurable objective for subsidence is a proxy for the measurable objective for groundwater levels in the confined aquifer. Like the minimum threshold for groundwater level in the confined aquifer, if the subsidence measurable objective is achieved, then the measurable objective for groundwater level will also be achieved. The measurable objective for subsidence is a zero or near-zero rate of subsidence (i.e. in feet per year). The subsidence measurable objective will not be achieved unless groundwater levels in the confined aquifer stabilize to a level at or above the critical head that initiates subsidence. This stabilization will not be achieved without a reduction in pumping from the confined aquifer. In essence, the measurable objective for the confined aquifer is reduced pumping; which will produce stable water-levels in the confined aquifer; which will then result in an observed ground subsidence rate of zero or near-zero.

The specific groundwater level that achieves the subsidence measurable objective at a specific well or RMS location cannot be determined without further groundwater modeling and implementation of pumping reductions in the confined aquifer. The monitoring and modeling will define the new equilibrium groundwater level in the confined aquifer (at the associated sustainable pumping rate) that achieves a stabilized rate of subsidence that is at or near zero. Based on previous modeling for the 2020 GSP (see Chapter 3), a pumping rate of 150,000 AF/Y corresponds to an equilibrium groundwater level where there would be no long-term decline in groundwater level and therefore minimize subsidence. Therefore, interim milestones towards the measurable objective for groundwater levels in the confined aquifer are expressed as pumping reductions (see Section 4.3.3.5).

4.3.5 Operational Flexibility for Groundwater Level

Operational flexibility allows for fluctuation in groundwater levels due to seasonal and annual variations and potential multi-year drought conditions. It also takes into account a level of uncertainty for future conditions. The operational flexibility is the difference between the measurable objective and minimum threshold.

For the unconfined aquifer, the operational flexibility for groundwater level is approximately 10 feet for the A-zone and 30 feet for the B-zone. Based on historical operations, this provides a level of flexibility that has allowed operations to be maintained through a typical 3-5 year drought cycle.

For the confined aquifer, the historical operational flexibility in groundwater pumping will be reduced so that the subsidence undesirable result is not reached. Additional monitoring and modeling is needed to determine what flexibility remains with respect to groundwater levels in specific areas or wells.

4.3.6 Interim Milestones for Groundwater Level

The interim milestones are intended to provide numerical metrics for GSAs to track progress toward meeting the subbasin's sustainability goal and measurable objectives. Rather than set an interim milestone based on water levels, the interim milestones are set based on reductions in pumping in each aquifer. This is because the measurable objectives for groundwater level are now based on 2015 groundwater levels and it appears that pumping since 2015 has exceeded the originally estimated sustainable pumping rates.

Unconfined (A-Zone and B-zone) Aquifer

The 2020 groundwater model predicted that an equilibrium water balance for the unconfined aquifer (zero change in aquifer storage), was achieved at a pumping rate of about 200,000 AF/Y. Recent pumping of the unconfined aquifer is estimated to be on the order of 300,000AF/Y. The total amount of pumping reduction necessary to stabilize long-term declines in groundwater level and achieve the measurable objective for water levels in the unconfined aquifer is therefore about 100,000 AF/Y. Continued monitoring and modeling will occur during implementation to establish groundwater levels that correspond to these levels of pumping reduction. The interim milestones for pumping reduction in the unconfined aquifer are summarized below:

- 2020-2025: 20,000 AF/Y unconfined pumping reduction
- 2025-2030: 20,000 AF/Y unconfined pumping reduction
- 2030-2035: 30,000 AF/Y unconfined pumping reduction
- 2035-2040: 30,000 AF/Y unconfined pumping reduction

The rate at which unconfined pumping decreases may change as recharge projects are developed or if there are multi-year periods of high natural recharge that push groundwater levels significantly higher, as they did in 2023. Continued modeling and analysis of relationships between annual recharge, water levels, and pumping may reveal additional flexibility in pumping patterns that will still achieve the measurable objective of maintaining water levels at or above 2015 levels. Establishing the flexibility to shift pumping from the confined to the unconfined aquifer is an important analysis that will be carried out during implementation to conjunctively manage pumping in both the confined and unconfined aquifers while achieving measurable objectives. Conjunctive management of pumping may also require a more active management approach for agricultural demand, where pumping limits or allocations vary from year to year in response to expected or recent hydrologic conditions (similar to surface water allocation), as opposed to long-term dedicated pumping allocations.

A final consideration is the impact of extreme events like the 2023 flooding event and pumping in surrounding subbasins on achieving the measurable objectives for groundwater level. The 2020 groundwater model predicted an equilibrium water balance for the unconfined aquifer (zero change in aquifer storage), using model boundary conditions that assumed specific groundwater levels and inflows/outflows to the Tulare Lake Subbasin. It also assumed historical rates of recharge and frequencies of wet years; and did not simulate the effect of extreme events like the flooding that occurred in 2023. Future changes in inflows and outflows to the Tulare Lake Subbasin will also affect the equilibrium water balance that would achieve the measurable objective to maintain groundwater levels at or above the minimum levels observed in 2015 and establish a zero or near-zero rate of long-term groundwater level decline.

Confined (C-Zone) Aquifer

Like the unconfined aquifer, the interim milestones were set based on reductions to groundwater pumping rather than specific groundwater levels. Reductions in confined aquifer pumping are necessary to stabilize water levels and achieve a zero or near-zero rate of subsidence. The 2020 groundwater model predicted that an equilibrium water balance for the confined aquifer (zero change in aquifer storage), was achieved at a pumping rate of about 150,000 AF/Y. Pumping of the confined aquifer since 2015 is estimated to be on the order of 300,000AF/Y during dry years. The total amount of pumping reduction necessary to stabilize long-term declines in groundwater level for the confined aquifer to achieve an equilibrium water balance is therefore about 150,000 AF/Y. Continued monitoring and modeling will occur during implementation to establish groundwater levels that correspond to these levels of pumping reduction. The interim milestones for pumping reduction in the confined aquifer are summarized below:

- 2020-2025: 50,000 AF/Y confined pumping reduction
- 2025-2030: 50,000 AF/Y confined pumping reduction
- 2030-2035: 30,000 AF/Y confined pumping reduction
- 2035-2040: 20,000 AF/Y confined pumping reduction

The accelerated rate at which confined pumping decreases (compared to the unconfined aquifer) is necessary to avoid an undesirable result for subsidence. The current rate of subsidence is on the order of 1 foot per year, so aggressive pumping reduction is needed in the first 6-10 years of implementation to avoid an undesirable result.

Similar to the unconfined aquifer, reductions in confined aquifer pumping could be adjusted depending on how subsidence rates change; as recharge projects are developed; or if there are multi-year periods of high natural recharge. Also, as described in Section 4.3.3.3, it may be feasible to shift some pumping from the confined aquifer to the unconfined aquifer. However, this strategy also requires ensuring that the unconfined aquifer does not reach minimum thresholds for water levels. Continued modeling and analysis of relationships between annual recharge, water levels, pumping and subsidence will be necessary to justify changes or shifts in confined pumping. Conjunctive management of pumping may also require a more active management approach for agricultural demand, where pumping limits or allocations vary from year to year in response to expected or recent hydrologic conditions (similar to surface water allocation) as opposed to long-term dedicated pumping allocations.

4.4 Sustainable Management Criteria for Reduction in Groundwater Storage

4.4.1 Groundwater Level Representative Monitoring Sites (RMS) and Areas (RMA)

The RMS/RMA network for groundwater storage is the same network used for groundwater levels. Subsidence measurements will be aggregated within the C-Zone RMA's shown on Figure 4.2.4-3 to calculate an average subsidence in that RMA. The aggregate subsidence measurement will be applied as follows:

> The average total subsidence in the RMA will be compared to minimum threshold, along with the median, maximum and minimum within each RMA.
>
> The average rate of subsidence in the RMA will be compared to measurable objective, along with the median, maximum and minimum within each RMA.

4.4.2 Undesirable Results for Groundwater Storage

> **23 CCR §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.*

SGMA regulations require the definition of undesirable results include the following:

- The cause of groundwater conditions occurring throughout the basin that would lead to or has led to the undesirable results based on information described in the basin setting, and the other data or models as appropriate (Reg. § 354.26(b)(1)).
- The criteria used to define when and where 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 (Reg. § 354.26(b)(2))
- Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects in the basin (Reg. § 354.26(b)(3)

Undesirable results occur when groundwater conditions within the Subbasin cause a significant and unreasonable impacts to a sustainability indicator.

Cause of Conditions Leading to Undesirable Results

Like groundwater declines, the causes leading to undesirable results are primarily related to regional pumping rates that disrupt the equilibrium water balance and cause a decline in aquifer storage. This manifests itself as declining groundwater levels. The represents a dynamic balance between groundwater inflows and groundwater outflows. Groundwater inflows include natural or artificial recharge that reaches an aquifer and inflows from adjacent groundwater basins. Groundwater outflows includes pumping, outflows to adjacent groundwater basins, and other discharges such as evapotranspiration that lowers a shallow water table. There is an inherent seasonal fluctuation in groundwater storage and associated water-level fluctuation. During the winter and early spring, recharge is generally higher and pumping rates are generally lower, so groundwater levels rise as groundwater storage increases. During the late spring and summer, recharge is generally low and pumping rates are generally higher, so groundwater levels decline as groundwater storage decreases. The volume of groundwater storage increase during the winter/spring varies from year-to-year and is highly dependent on the amount of winter precipitation and associated spring run-off. The volume of groundwater storage decrease during the summer also varies from year-to-year and is highly dependent on the amount of pumping during that summer. Long-term year-over-year declines in aquifer storage occur when: 1. There are successive years of low winter precipitation and associated run-off that reduce inflows to the aquifer or 2. There are successive years of high groundwater pumping that exceeds the previous season's inflows.

Pumping is the primary cause of undesirable results, but natural cycles of wet and dry years also factor into the magnitude and duration of imbalances in the equilibrium between inflows and outflows.

Criteria to Define Undesirable Results

The amount of groundwater in storage (i.e., groundwater volume) in an unconfined aquifer is a function of the saturated thickness of the aquifer, the area of the aquifer, and the storage coefficient. For a confined aquifer, the entire aquifer is saturated and the amount of storage is proportional to the pressure head in the confined aquifer, the area of the aquifer, and the storage coefficient (which is lower than for an unconfined aquifer). Groundwater levels are intrinsically part of the definition of groundwater storage, so a groundwater level or a pattern of groundwater fluctuations has a direct correlation to the accretion or depletion of groundwater storage. Therefore, groundwater level undesirable results and associated minimum thresholds for the unconfined aquifer are a proxy for the undesirable result for depletion of groundwater storage in the unconfined aquifer.

Potential Effects to Beneficial Users

Since groundwater level undesirable results and associated minimum thresholds are a proxy for the undesirable result for depletion of groundwater storage in the unconfined aquifer, the potential effects to beneficial users are the same as described in Section 4.3.

4.4.3 Minimum Thresholds for Groundwater Storage

23 CCR §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.*

Since groundwater level undesirable results and associated minimum thresholds are a proxy for the undesirable result for depletion of groundwater storage in the unconfined aquifer, the minimum thresholds are the same as described in Section 4.3.

4.4.4 Measurable Objectives for Groundwater Storage

23 CCR §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.*

Since groundwater level undesirable results and associated minimum thresholds are a proxy for the undesirable result for depletion of groundwater storage in the unconfined aquifer, the measurable objectives are the same as described in Section 4.3.

4.4.5 Operational Flexibility for Groundwater Storage

Since groundwater level undesirable results and associated minimum thresholds are a proxy for the undesirable result for depletion of groundwater storage in the unconfined aquifer, the operational flexibility is the same as described in Section 4.3.

4.4.6 Interim Milestones for Groundwater Storage

Since groundwater level undesirable results and associated minimum thresholds are a proxy for the undesirable result for depletion of groundwater storage in the unconfined aquifer, the interim milestones are the same as described in Section 4.3.

4.5 Sustainable Management Criteria for Groundwater Quality

While current water quality in the Subbasin is generally well suited for current and future uses, groundwater quality concerns exist in localized areas as previously discussed in Chapter 3. Community and other public supply wells within the subbasin are already monitored for a wide range of contaminants including the chemicals of concern, by the water purveyors under Title 22.

Groundwater impacts are typically enforced by local agencies and state level programs. These agencies rely on existing regulations and policies to define undesirable results related to the deterioration of groundwater quality. The agencies and coalitions include the Irrigated Lands Regulatory Program (ILRP), Groundwater Ambient Monitoring and Assessment Program (GAMA), Regional Water Quality Control Board (RWQCB), Central Valley Salinity Alternatives for Long-term Sustainability Program (CV-SALTS), and cities and communities within the Subbasin.

The GSAs recognize that they only have authority related to groundwater pumping policies. However, the GSAs will review and analyze publicly available routine groundwater monitoring data reported by community and non-community public supply systems wells to monitor if groundwater pumping may be exacerbating groundwater quality concerns. The GSAs will also enforce pumping restrictions that may not be within the jurisdiction of other Agencies if pumping restrictions are shown to be a cause of groundwater quality concerns.

The undesirable results and associated minimum thresholds are based on concentrations protective of human health as applicable for the respective chemicals of concern identified and discussed in Chapter 3.

4.5.1 Groundwater Level Representative Monitoring Sites (RMS) and Areas (RMA)

The method for defining RMAs for water quality aligns with the established framework for water-level RMAs in zones A, B, and C, as depicted in Figures 4.2.4-1 to 4.2.4-3. This approach ensures consistency in monitoring efforts by utilizing the same RMA boundaries and several of the same RMS wells for both water quality and water level assessments within these zones. Additionally, it enables comparisons between water quality C-Zone monitoring and subsidence at the RMA, facilitating an understanding of potential influences of subsidence on water quality.

4.5.2 Undesirable Results for Groundwater Quality

23 CCR §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.*

SGMA regulations require the definition of undesirable results include the following:

- The cause of groundwater conditions occurring throughout the basin that would lead to or has led to the undesirable results based on information described in the basin setting, and the other data or models as appropriate (Reg. § 354.26(b)(1)).
- The criteria used to define when and where 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 (Reg. § 354.26(b)(2))
- Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects in the basin (Reg. § 354.26(b)(3)

Undesirable results occur when groundwater conditions within the Subbasin cause a significant and unreasonable impacts to a sustainability indicator.

Cause of Conditions Leading to Undesirable Results

There are several potential causes of groundwater quality impacts that could lead to undesirable results. Some of these causes are not part of the GSAs focus and responsibility, including:

- Application of agricultural nutrients or concentrated animal feeding operations (CAFO) waste discharge leading to groundwater impacts, such as nitrates.
- Release from fuel storage tanks leading to petroleum hydrocarbons impacts to groundwater; and
- Releases regulated or unregulated waste discharge streams from wastewater treatment facilities, septic systems, etc.

Groundwater quality degradation, potentially resulting in undesirable outcomes, is tied to the GSAs responsibility regarding groundwater pumping. This activity can cause water quality issues through the migration of contaminant plumes. Additionally, academic research suggests that pumping from deep wells, which may be associated with subsidence of confining layers, has caused naturally occurring geologic constituents (such as arsenic and uranium) to leach out of clay layers and become mobile in groundwater, potentially leading to groundwater quality impacts.

Criteria to Define Undesirable Results

An undesirable result would be the significant and unreasonable reduction/degradation in groundwater quality caused by groundwater pumping or GSA projects, such that the groundwater is no longer generally suitable for current and future uses. The criteria that determine whether water quality has degraded to an undesirable level are defined by three standards. These include the Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs) set by the Division of Drinking Water (DDW) of the California State Water Resources Control Board (SWRCB), along with Water Quality Objectives (WQOs) specific to agricultural uses. These standards serve as benchmarks to assess whether the activities of the GSA, such as groundwater extraction, lead to significant and unreasonable degradation of groundwater quality. If groundwater pumping or GSA projects develop impacts such that groundwater degrades to the point where the constituents of concern exceed the MCLs, SMCLs, or WQOs, it would be considered an undesirable result under SGMA.

Unlike primary MCLs, which are set to protect public health, SMCLs are drinking water standards based on consumer acceptance levels. In other words, they are set based on factors such as taste and odor. When determining compliance with SMCLs in drinking water as it is served to consumers, measurements are taken either at the groundwater source or at the entry points of the distribution system. This means that the drinking water standard applies after the water has undergone treatment, which often includes filtration. When SMCLs are used as water quality objectives, these values are applied directly to the water body, which has not undergone any treatment or filtration. Among the constituents of concern mentioned below, TDS, chloride, and sulfate have Title 22 SMCLs reported as recommended, upper, and short-term SMCLs. The upper SMCLs are used as criteria in this discussion due to the already existing elevated concentrations of these constituents in the subbasin (refer to Section 3 in the Chapter 3 Addendum).

Descriptions of the criteria for each constituent of concern (COC) are provided below.

- Salinity (measured as TDS) – TDS concentrations are compared to the SMCL upper limit of 1,000 mg/L.
- Nitrate (measured as Nitrogen [N]) – Nitrate concentrations are compared to the MCL of 10 mg/L for Nitrate as N. This level indicates high nitrate levels for potable water use.
- Arsenic – Arsenic concentrations, which are a public health concern in drinking water, are compared to the MCL of 0.0010 mg/L (10 µg/L). A federal MCL for arsenic of 10 µg/L has been in effect since January 2006. Prior to these standards, both California and federal MCLs for arsenic were set at 50 µg/L.
- Uranium – Uranium in drinking water is compared to the MCL of 20 picocuries per liter (pCi/L). Notably, the USEPA has a different MCL for uranium, set at 30 µg/L. However, California follows its own standard of 20 pCi/L.
- Sulfate – Sulfate concentrations are compared to the upper limit of the SMCL, which is 500 mg/L.
- Chloride – Chloride concentrations, which are reported as the Cl^- ion, are evaluated against the upper limit of the SMCL, which is 500 mg/L.
- 1,2,3-TCP – Concentrations of 1,2,3-TCP are compared to the MCL of 0.005 µg/L.

As noted in Section 3.3 of the Chapter 3 addendum, a large portion of the Subbasin has had its agricultural (AGR) and municipal (MUN) groundwater uses in the A-Zone and B-Zone de-designated within the Basin Plan (SWRCB R5- 2017-0032) due to salinity. Currently, these areas are not required to be monitored by the Tulare Lake Basin Plan Amendment, unless there are proposed projects that would necessitate monitoring. If this designation changes in the future, the development of groundwater quality criteria will be prepared accordingly for these areas.

However, monitoring will occur to ensure that the salinity is not migrating away from the de-designated areas.

Statement of Undesirable Result: Degraded water quality in any aquifer zone is considered an undesirable result when the screening criteria for a specific COC (as outlined in Section 4.5.1.6) are exceeded in 20 percent of the RMS wells during a single monitoring event.

Potential Effects to Beneficial Users

Should undesirable results occur with respect to groundwater quality, the amount of usable groundwater in the Subbasin could be reduced. If treatment is not feasible, this degradation could affect the groundwater supplies for agricultural, municipal, industrial, and domestic needs. Additional costs would be incurred as some treatment could be needed, some supply wells may have to be deepened or their pumps lowered, new wells may have to be drilled, and yields may be reduced. Also, should undesirable results occur with respect to groundwater quality, the amount of usable groundwater in storage may be reduced.

4.5.3 Minimum Thresholds for Groundwater Quality

> **23 CCR §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.*

As stipulated in Section 354.28 I(4) of the GSP Regulations, minimum thresholds are established based on a deterioration of groundwater quality (CCR, 2016). Consequently, this GSP is structured to prevent actions that might displace groundwater constituents already identified in the Subbasin, thereby causing a significant and unreasonable impact that would not have occurred otherwise.

Constituents of concern must meet two criteria:

1. They must have an established level of concern such as an MCL, SMCL, or WQO.
2. They must have been present in the Subbasin at levels above the level of concern.

Based on the groundwater quality review in Section 3.3 of the Chapter 3 Addendum, seven COCs were identified. These COCs may impact both agricultural wells and potable water supply wells in the Subbasin. The minimum threshold for each COC was set at the lowest criteria based on MCLs, SMCLs, or WQOs and are presented in Table 4.5.3-1.

Table 4.5.3-1: Minimum Thresholds for Water Quality

Constituent of Concern	Minimum Threshold
Salinity (measured as TDS)	1,000 mg/L
Nitrate (measured as N)	10 mg/L
Arsenic	0.0010 mg/L
Uranium	20 pCi/L
Sulfate	500 mg/L

Chloride	500 mg/L
1,2,3-TCP	0.005 µg/L

The current well networks, which are monitored for various purposes and managed by different entities, include diverse types of water quality parameters in their existing programs. In the future, the RMS wells in the corresponding zones will be sampled for the complete set of seven COCs and compared to their respective minimum thresholds, as outlined in Table 4.5.3-1.

The minimum thresholds for water quality degradation in the RMS wells are established with the aim of preventing additional exceedances in existing wells. For wells where water quality already exceeds the minimum threshold in 2015, the minimum threshold is set to 20% greater than the historical high concentration.

4.5.4 Measurable Objectives for Groundwater Quality

23 CCR §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.*

The measurable objectives for groundwater quality degradation represent the target value for groundwater quality in the Subbasin. For wells within the monitoring network (either existing or future wells), where concentrations of the chemicals of concern have a recent history of being below MCLs, the measurable objective is to maintain water quality at potable water standards, or in other words, below MCLs for the chemicals of concern. In situations where monitoring network wells (either existing or future wells) have a recent history of being above MCLs for contaminants of concern, the measurable objective is for the wells to maintain stable or improving groundwater quality trends regarding the identified chemicals of concern.

4.5.5 Interim Milestones for Groundwater Quality

No interim milestones have been set for the water quality indicator. Consistent with current practices by groundwater pumping agencies, and to proactively monitor conditions before minimum threshold are exceeded, data will be reviewed for increased constituent of concern levels approaching the MCL, and when appropriate, the GSAs will contact the well owner to discuss concerns of levels approaching the MCL.

4.6 Sustainable Management Criteria for Depletion of Interconnected Surface Water

As described in Chapter 3, prior to development in the late 1800s and early 1900s, groundwater and surface waters were interconnected around the Subbasin, resulting in extensive wetlands, a nearly persistent Tulare Lake. Groundwater levels in the unconfined aquifers were near the ground surface beneath much of the Subbasin. During development of the region, the four major rivers draining into Tulare Lake were dammed, and Tulare Lake itself was reclaimed and converted to agricultural land. As a result, groundwater levels in the unconfined aquifer declined and streams draining into Tulare Lake became disconnected from the regional unconfined aquifer system. The Kings, Kaweah, and Tule rivers have been continuously losing streams since at least 1990 (See

Chapter 3). Shallow, perched groundwater is still often present in the vicinity of surface water conveyances and below recharge facilities. However, these shallow zones are also disconnected from the regional unconfined aquifer.

Limited studies have shown that groundwater pumping from the principal unconfined aquifer system in the immediate vicinity of the Kings River does not induce significant drawdown (i.e., leakage) of surface water to shallow groundwater into the unconfined aquifer (P&P, 2009). In other words, this study indicates that pumping does not cause depletion of interconnected surface water. Further study of depletion of interconnected surface water will be carried out and, if warranted, SMCs for Depletion of Surface Water will be developed. As described in Chapter 6, the surface water depletion is recognized as a data gap exists to be filled with one or more shallow monitoring wells designed specifically to evaluate interconnections with the Kings River.

4.7 Sustainable Management Criteria for Land Subsidence

As described in the Chapter 3 Addendum Background to Land Subsidence section 3A.5, subsidence has been occurring in the Subbasin since the 1920's. The phenomenon is primarily attributed to consolidation of the Corcoran Clay layer in response to a reduction of the elevation of the piezometric surface in the confined aquifer due to groundwater withdrawal in excess of the recharge rate of the aquifer.

4.7.1 Subsidence Representative Monitoring Sites (RMS) and Areas (RMA)

Subsidence is measured at multiple locations throughout the Tulare Lake Subbasin using a combination of InSAR (remotely sensed ground elevations) and ground-based benchmarks. The InSAR measurement locations represent individual RMS locations that will be monitored quarterly or monthly. The subsidence value provided by InSAR for each monitoring period will be compared to the previous time-period at that same location to calculate a rate of subsidence. That same subsidence value will be compared to the October 2020 time period to calculate the total rate of subsidence.

Subsidence is measured at many locations throughout the Tulare Lake Subbasin using a combination of InSAR (remotely sensed ground elevations) and ground-based benchmarks. A total of 33 Subsidence RMA's have been developed in which multiple subsidence measurements will be aggregated and compared to minimum thresholds and measurable objectives. Within each RMA, at least one C-zone well will also be monitored for groundwater level.

Subsidence measurements will be aggregated within the C-Zone RMA's shown on Figure 4.2.4-3 to calculate an average subsidence in that RMA. These aggregate subsidence measurements will be applied as follows:

The average total subsidence in the RMA will be compared to minimum threshold, along with the median, maximum and minimum within each RMA.

The average rate of subsidence in the RMA will be compared to measurable objective minimum threshold, along with the median, maximum and minimum within each RMA.

4.7.2 Undesirable Results for Land Subsidence

23 CCR §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.*

Per SGMA definitions in the California Water Code 10721, an undesirable result for subsidence occurs when subsidence interferes with surface land uses. In this context, "land uses" refer to man-made infrastructure such as roads, buildings, canals, wells, levees, and rail roads. Land uses also refer to land surface areas that may become inundated during flooding or other high flow events.

Cause of Conditions Leading to Undesirable Results

A piece of infrastructure is seldom damaged by subsidence when all the points of that infrastructure move vertically downwards by the same amount and at the same time. The negative effects of subsidence on infrastructure are typically associated with differential subsidence between points on the infrastructure that exceeds design values for that specific piece of infrastructure. Engineering design in areas that are known to experience subsidence typically incorporate subsidence into those designs, or recognize that retrofitting or mitigation may be necessary to maintain that infrastructure over time.

Differential subsidence refers to the change in elevation over a given distance over a given time period. Differential subsidence is expressed in terms of slope gradient or angular distortion, where the difference in change in elevation over a given period of time between two contiguous points is divided by the horizontal distance between them. This value is then multiplied by 100 to express it as a percentage. Since differential subsidence numbers are small (i.e., fractions of one percent), another way to express differential subsidence is using fractions. For example, if a 0.1 ft change in elevation difference was measured between two points that are 100 ft apart, then 0.1 ft/100 ft = 0.001 (or 0.1%). The change in slope between the two points can also be expressed in fractions as 1/1,000 (i.e., 1 ft of subsidence over a distance of 1,000 ft).

Although differential subsidence is the factor that affects the performance of infrastructure, it is difficult to directly measure differential subsidence at a basin scale such that at any given location, it can be compared against the individual types of infrastructure that it may impact. As such, the undesirable result is instead defined in terms of the total amount of subsidence, which is the total change in vertical elevation of a point or area relative to a baseline elevation. As described in Section 4.7.1, total subsidence represents the accumulated incremental effect of cyclical changes in groundwater level in the confined aquifer. The incremental changes in ground surface elevation are expressed as a subsidence rate in feet per year. These incremental changes "accumulate" over time, resulting in an observed total subsidence (in feet) at the ground surface that could be detrimental to certain types of infrastructure. In order to calculate total subsidence, a reference time point is necessary to calculate the accumulation of annual subsidence rates. As described in Section 4.7.1, the point in time from which total subsidence is calculated is the year 2020.

Criteria to Define Undesirable Results

The RMS network is used to determine whether an undesirable result has occurred or may be occurring based on the percentage of RMS locations in each RMA exceeding a minimum threshold during a single sampling event. Exceedance of the minimum threshold at a single RMS location does not constitute an undesirable result across the Subbasin. Figure Subsidence measurements will be aggregated into the C-Zone RMA's shown on Figure 4.2.4-3 shows the distribution of RMS locations (InSAR stations) and RMAs that will be used to aggregate subsidence measurements. An undesirable result is defined as 10% of RMS locations (InSAR stations) exceeding the minimum threshold during a quarterly sampling event.

Because the criteria are defined as a total amount of subsidence; and because subsidence is process that has been ongoing for many years; a time reference point was selected to define how total subsidence is calculated. This time-reference point is 2020, which is the point in time that the technical analysis of subsidence data was available undesirable result was made.

4.7.3 Minimum Thresholds for Land Subsidence

23 CCR §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.*

The minimum thresholds for subsidence are defined as a magnitude of total subsidence that leads to the undesirable result that was defined for each type of infrastructure in Section 4.7.2. The quantitative value for the minimum threshold is described in this section for canals and flood protection levees and flooding. Minimum thresholds for roads, bridges, buildings, wells, and pipelines are not defined because, as discussed in Section 4.7.2, subsidence alone does not have a detrimental effect on the performance of these infrastructure.

The process for defining the minimum threshold (See Section 4.7.3) is based on an assessment of the amount of subsidence that causes any of the following:

California Aqueduct: Subsidence that causes any loss of conveyance in the aqueduct.

Local Canals and Streams: Subsidence that causes as a loss of conveyance of 20%. This was a subjective determination that did not include a detailed analysis of all possible canal delivery circumstances and associated "significant and unreasonable interference" with surface water conveyance. In some situations, a 20% loss of conveyance could be easily mitigated, while in others this loss of conveyance could cause significant interference with delivery, but 20% is considered a conservative value to use to calculate a subsidence minimum threshold.

Flood Protection Levees in the FEMA 100-year Flood Zone: Subsidence that causes a reduction of the slope of a canal or stream feeding a flood zone, leading to a rise in the water level beyond a 3-foot freeboard of the canal or stream; or a 3-foot reduction of the top elevation of the levee itself with respect to the flood elevation; thus reducing the capacity to contain flood waters. The freeboard design value of 3 feet is referenced in Urban Levee Design Criteria (2012) published by California DWR.

Subsidence near the California Aqueduct

DWR has expressed that any loss of conveyance in the California Aqueduct is an undesirable result. Therefore, the minimum threshold for subsidence along the California Aqueduct is 0 ft.

Subsidence near Irrigation Canals and Streams

The minimum threshold for subsidence near local canals and streams was defined based on a calculation of how subsidence would reduce conveyance capacity (See Appendix J: Undesirable Results, MTs, and MOs for Ground Subsidence) in the Last Chance Ditch System, Kings River, Lemoore Canal System, and Kaweah River.

The amount of subsidence that causes a loss of conveyance or flow rate of 20% was calculated to be a minimum of 6 feet for sections of these five canals that flow north to south through areas where subsidence is currently occurring. In other words, 6 feet or more of additional subsidence in these areas could cause a reduction the slope of the channel and an associated 20% loss of conveyance capacity. The process that was followed to relate exceedance of minimum thresholds with undesirable results related to local canals and streams is illustrated in Figure 4.7.4-1.

Subsidence in 100-year Flood Zones and Associated Flood Protection Levees

There are many factors that affect the ability of flood zones to transmit and distribute flood waters throughout the flood zone, including changes to the land use in the watershed; changes to or lack of maintenance of infrastructure such as levees, canals, embankments; or changes in precipitation patterns due to climate change. So, although a minimum threshold is evaluated with respect to subsidence only, subsidence management alone will not protect flood zones.

The4-25anagemm threshold for subsidence in the 100-year Flood Zone and Associated Flood Protection Levees is 6 feet (the same as for canal conveyance capacity). Using a uniform minimum threshold for subsidence, in concept, prevents differential subsidence from occurring. As described in Appendix J, differential subsidence is potentially more damaging to infrastructure compared to uniform subsidence. If a different minimum threshold were assigned in flood zones, it could result in differential subsidence if pumping was then concentrated in areas with higher thresholds for total subsidence. A 3-foot "freeboard" associated with canals and levees is referenced in Urban Levee Design Criteria (2012) published by California DWR and commonly used as a conceptual design parameter. However, loss of freeboard from subsidence would only occur if the ground surface adjacent to a canal or stream was dropping at a different rate than the ground surface within the canal or beneath the levee. This would create a differential subsidence. So, for example, given the same flood event, a 3-foot increase in water level behind a levee would only occur if the ground surface adjacent to the levee was dropping at a lower rate than the levee itself. Using the 6-foot threshold as an example, it is highly unlikely that a subsidence of 6 feet behind a levee would occur when the levee itself had subsided by 9 feet. Therefore, a uniform minimum threshold of 6 feet based on conveyance capacity should also be protective of differential subsidence related to threshold height of water behind a levee in a flood zone.

Per Cal. Code of Regs. Tit. 23, § 354.20 – Management Areas, The El Rico GSA has developed separate land subsidence management areas for the confined aquifer, referred to as "land subsidence sub-regions" that use a consistent subbasin undesirable results definition, but define different minimum thresholds and different measurable objectives than the basin at large. This is described in Appendix J.

4.7.4 Measurable Objectives for Land Subsidence

> **23 CCR §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.*

The measurable objective for subsidence is defined as a zero or near-zero subsidence rate by the year 2040. The current rate of subsidence is on the order of 1 foot per year. The rate at which subsidence rates decrease is expected to be proportional to the rate at which pumping decreases in the confined aquifer. Between now and 2040, there will be continued subsidence as pumping restrictions are implemented in the confined aquifer. However, the minimum threshold for subsidence establishes that no more than 6 additional feet of subsidence will occur.

An important uncertainty associated with this measurable objective is the effect of long-term residual subsidence caused by secondary compression of the confining layer. Subsidence continues long after the initial pressure changes in the confined aquifer have occurred and even after water levels in the confined aquifer have recovered. This is a complex phenomenon, and it is not linear. Quantification of "near-zero" is not possible with the currently available data. While the objective is to achieve a zero rate of subsidence, the historical pattern of pumping has created a long-term subsidence response may result in a non-zero residual subsidence rate that will continue for some time after 2040. However, as described in Chapter 6, further characterization, testing, and modeling of subsidence response will be initiated to calculate the equilibrium "near-zero" residual subsidence rate and when it might be achieved.

Per Cal. Code of Regs. Tit. 23, § 354.20 – Management Areas, The El Rico GSA has developed separate land subsidence management areas for the confined aquifer, referred to as "land subsidence sub-regions" that use a consistent subbasin undesirable results definition, but define different minimum thresholds and different measurable objectives than the basin at large. This is described in Appendix J.

4.7.5 Interim Milestones for Land Subsidence

Interim milestones for subsidence are set based on a reduction from the current rate of 1 foot per year to a rate of 0 feet per year by the year 2040 in each Subsidence RMA. The interim milestones are expresses as a percentage reduction from the current average subsidence in each RMA. These percent reductions as summarized below:

- 2025-2030: Average Subsidence rate of 0.65 ft/yr
- 2030-2035: Average Subsidence rate of 0.15 ft/yr
- 2035-2040: Average Subsidence rate of 0.05 ft/yr
- 2040: Average subsidence rate of 0 ft/yr

As described previously, while the objective is to achieve a zero rate of subsidence, the historical pattern of pumping has created a long-term subsidence response that cannot be completely controlled by reductions in pumping. Furthermore, subsidence is a regional phenomenon and regional pumping reductions in the confined aquifer will likely be necessary to achieve a zero or near-zero subsidence rate.

Per Cal. Code of Regs. Tit. 23, § 354.20 – Management Areas, The El Rico GSA has developed separate land subsidence management areas for the confined aquifer, referred to as “land subsidence sub-regions” that use a consistent subbasin undesirable results definition, but define different minimum thresholds and different measurable objectives than the basin at large. This is described in Appendix J.

5. MONITORING NETWORK

> **23 CCR §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 outlines the framework for monitoring networks essential for the implementation and evaluation of this GSP. It highlights the importance of data collection on key sustainability indicators for groundwater, such as levels, land subsidence, quality, and storage changes. These efforts are crucial for tracking progress toward achieving groundwater sustainability and ensuring adherence to SGMA requirements.

SGMA requires each subbasin to establish a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term groundwater trends and related surface conditions (23 California Code of Regulations [CCR] §354.34). A comprehensive monitoring network is essential to evaluate GSP implementation and measure progress towards groundwater sustainability. The sustainability indicators necessary to comply with SGMA monitoring and reporting requirements include chronic lowering of groundwater levels, reduction of groundwater storage, degraded water quality, land subsidence, seawater intrusion and depletions of interconnected surface water.

While the default position under SGMA for GSAs is that all six sustainability indicators apply to a basin, SGMA allows for a sustainability indicator to not apply in a basin, based on evidence that the indicator does not exist and could not occur. In the Subbasin, there is sufficient evidence to eliminate two of the sustainability indicators from further consideration – seawater intrusion and depletion of interconnected surface waters. The evidence for eliminating these two indicators is presented in Chapter 3, *Basin Setting.*

Monitoring programs for these indicators are described below including the history of the monitoring efforts, the proposed monitoring to comply with SGMA, and the adequacy and justification for each monitoring network. The monitoring programs for each sustainability indicator are outlined, covering the proposed monitoring strategies, their adequacy and scientific underpinnings, and the historical context of each program, all in alignment with SGMA guidelines. The monitoring of groundwater pumping, recharge, and surface water deliveries is discussed in Chapter 3, *Basin Setting*.

5.1 Description of Monitoring Network

23 CCR §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 affects 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.

This chapter describes the current and developing monitoring networks in the Subbasin that will collect data to determine short-term, seasonal, and long-term trends in groundwater and surface conditions related to the sustainability indicators. Data collection from the monitoring networks will provide information necessary to support the implementation of this Plan, evaluate the effectiveness of this Plan, and guide decision making by the GSAs.

Representative Monitoring Sites (RMS) are designated locations used to collect data for assessing compliance with sustainability goals. The number of existing and proposed RMS locations are summarized by GSA and Sustainability Indicator in Table 5.1.0-1.

Table 5.1.0-1 Summary of Existing & Proposed Monitoring Network Sites

Existing RMS Network	Water Level	Water Quality	Land Subsidence
Mid-Kings River GSA	45	58	12
South Fork Kings GSA	16	28	5
El Rico GSA	9	10	7
Southwest Kings GSA	2	3	4
Tri-County Water Authority GSA	2	2	1
Total	74	101	29
Proposed Additions to RMS Network	**Water Level**	**Water Quality**	**Land Subsidence**
Mid-Kings River GSA	3	1	3
South Fork Kings GSA	7	5	1
El Rico GSA	7	7	3
Southwest Kings GSA	2	2	1
Tri-County Water Authority GSA	2	3	1
Total	21	18	9

Monitoring networks have been established for each sustainability indicator. Table 5.1.0-2 identifies the location, type of facility (well, extensometer, etc.), existing monitoring program, sustainability indicators monitored, data collection frequency, and aquifer zone monitored. The networks for water levels, water quality, and subsidence monitoring utilize representative monitoring areas (RMAs) that encompass each aquifer zone. Each RMS is intended to be representative of conditions within an RMA. As described in Chapter 4, *Sustainable Management*

Criteria, the GSAs intend to have at least one RMS in each RMA. The following sections provide information on each applicable sustainability indicators monitoring network.

Due to the complexity of the hydrogeologic setting in the Subbasin as discussed in Section 3.1, Hydrogeologic Conceptual Model, the aquifer is divided into three aquifer zones for groundwater level monitoring:

► The A zone is the shallow portion of the aquifer above the A-Clay (Figure 5.2.1-1).

► The B zone is the unconfined portion of the aquifer above the E-Clay (Corcoran Clay) and below the A-Clay where the A-Clay is present (Figure 5.2.1-2).

► The C zone is the confined portion of the aquifer below the E-Clay (Figure 5.2.1-3).

Within the B-zone, there is a lacustrine clay (the C-clay) situated between the A-Clay and the E-Clay that is an important horizon in the southern part of the subbasin near the historical Tulare Lakebed. Most groundwater extraction by public supply wells near the lakebed involves pumping water from beneath the C-Clay (KDSA et al. 2015). The water found above the C-Clay in the clay plug area is typically too saline for municipal (MUN) or agricultural (AGR) use and has been exempted from being designated for these beneficial uses (RWQCB 2017a). The GSAs will assess groundwater level data in regions where the C-Clay is present. If future groundwater data suggests a need to delineate specific portions of the aquifer between the C- and E-Clays as distinct aquifer zones, the GSAs may consider making such distinctions at that time. For a visual representation of the C-Clay, refer to Figure 3.1.8-2, and for information on the characteristics of various lacustrine clay layers, see Section 3.1.8.3.

The groundwater management level monitoring network considers the Tulare Lake Basin Plan Amendment (BPA) in areas designated for non-municipal (MUN) and non-agricultural (AGR) uses (see Chapter 3, Sections 3.1.7.2, Water Quality Method, and 3.1.8.3, Aquitards, along with Section 5.4.3, Water Quality, for more details). These areas overlap with portions of the El Rico, Tri-County Water Authority, and Southwest Kings GSAs. Groundwater monitoring in these areas and aquifer zones, as decided by the GSAs that overly this area, is not proposed due to poor water quality and in the case of the clay plug areas, layers that do not produce water. These areas include Secondary Management Area A (Figures 5.2.1-1 through 5.2.1-3) and Secondary Management Area B (Figures 5.2.1-1 and 5.2.1-2). Secondary Management Areas A and B are in the areas de-designated for AGR and MUN use and currently are not required to have new monitoring for water quality according to the Regional Water Quality Control Board (RWQCB), Tulare Lake BPA unless projects are proposed in these areas that would trigger new monitoring (see Chapter 3, Sections 3.1.7.2, Water Quality Method, and 3.1.8.3, Aquitards, and Section 5.4.3, Water Quality, below). In this event, these facilities could be incorporated into the monitoring network as part of the SGMA requirements.

Other sites are monitored for groundwater levels in the Subbasin and provide additional data to prepare groundwater level maps. These locations are not RMSs and are subject to change based on data availability. Information related to the wells is provided in the annual reports. Monitoring is not proposed in areas outside of the Subbasin. Data sharing agreements are being developed or will be developed with adjacent groundwater subbasins to evaluate boundary conditions.

5.1.1 Monitoring Network Objectives

23 CCR §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 various monitoring programs include the following:

Establish baseline groundwater levels and groundwater quality and record long-term trends going forward;

Use data gathered to generate information for water resources evaluations and annual changes in water budget components;

Determine the direction of groundwater flow;

Provide comparable data from various locales within the Subbasin;

Demonstrate progress toward achieving measurable objectives, interim milestones, and minimum thresholds described in the GSP as they relate to the Sustainable Management Criteria; and

Monitor impacts to the beneficial uses or users of groundwater.

The path to achieving the objectives of the monitoring network includes collecting and evaluating the data needed for the GSAs to monitor the Subbasin's progress in meeting measurable objectives, interim milestones, and avoiding minimum thresholds relative to groundwater conditions and impacts to beneficial users of groundwater. The data collected through the monitoring network will also help quantify changes in the water budget components.

5.1.2 Monitoring Network Design Criteria

New monitoring locations will be developed, and existing networks enhanced using an approach similar to the Data Quality Objective (DQO) process to guide the site selection. The DQO process follows the U.S. Environmental Protection Agency (EPA) Guidance on Systematic Planning Using the Data Quality Objective Process (EPA 2006). The DQO process is also outlined in the California Department of Water Resources (DWR) Best Management Practices for the Sustainable Management of Groundwater – Monitoring Networks and Identification of Data Gaps (DWR 2016e) and Monitoring Protocols, Standards, and Sites (DWR 2016f). While the DQO process was not developed specifically to guide the selection of new monitoring locations under SGMA, it does provide a repeatable process for site selection and evaluation so that the GSAs approach site selection in a similar manner.

5.1.3 Overview of Existing Programs

Various agencies and private entities currently have existing programs in place that monitor groundwater levels, groundwater quality, and land subsidence. These programs will continue to be utilized for future data collection and will be coordinated with SGMA monitoring requirements. If data from these sources becomes unavailable in the future, the monitoring network will be modified to monitor for the appropriate sustainability indicator. Below are the various programs currently in place that will be described further in Section 5.2.

Groundwater Levels

Kings County WD

Apex Ranch

KRCD

California Statewide Groundwater Elevation Monitoring (CASGEM)

Municipal monitoring programs

Corcoran ID

Private landowners in parts of ER GSA

Groundwater Quality

- Semi-Annual Monitoring performed by the GSAs

Municipal public supply wells monitoring programs

Groundwater Ambient Monitoring and Assessment Program

ILRP

Central Valley Salinity Alternatives for Long-term Sustainability

Groundwater monitoring at sites with RWQCB wastewater discharge requirements

Groundwater monitoring at subsurface drainage evaporation ponds

Land Subsidence

United States Geological Survey (USGS) Monitoring

California Department of Water Resources ALTAMIRA InSAR subsidence data

National Aeronautics and Space Administration (NASA) Monitoring

Central Valley Spatial Reference Network (CVSRN) Continuous Global Positioning System (CGPS) Stations

KRCD network

Kaweah Delta Water Conservation District (KDWCD) benchmarks

California Aqueduct subsidence monitoring benchmarks

University Navigation Satellite Timing and Ranging Consortium (UNAVCO)

National Geodetic Survey (formerly U.S. Coast and Geodetic Survey)

United States Army Corps of Engineering (USACE)

5.1.4 Consistency with Standards

23 CCR §354.34(g) *Each Plan shall describe the following information about the monitoring network:*

(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

The data gathered through the monitoring networks will be consistent with the standards identified in 23 CCR §352.4 related to Groundwater Sustainability Plans. The main topics of 23 CCR §352.4 are outlined below:

- Data reporting units (water volumes including surface water deliveries, estimates of groundwater pumping, etc., reported in acre-feet [AF], etc.)
- Monitoring site information (site identification number, description of site location, etc.)
- Well information reporting (CASGEM well identification number or other unique identifier, measuring point elevation, casing perforations, etc.)
- Map standards (data layers, shapefiles, geodatabases submitted in accordance with the procedures described in Article 4 of the SGMA regulations – Procedural issues related to submission of plans and public comment to those plans, etc.)
- Hydrograph requirements (hydrographs shall use the same datum and scaling to the greatest extent practical, etc.). Hydrographs will also be plotted showing depth to water as well as groundwater elevation.

5.2 Groundwater Levels

5.2.1 Overview of Proposed Monitoring

Proposed monitoring for groundwater level network includes 74 existing RMS locations with an additional 21 locations to be added for a total of 95 locations to monitor water levels across the Subbasin (Figures 5.2.1-1 to 5.2.1-3).

Groundwater level monitoring will use existing and proposed wells, including monitoring, irrigation, municipal, industrial, and domestic wells, as RMS locations. Groundwater level monitoring has been conducted semi-annually across the Subbasin since the 1950s by various entities including Kings County Water District (KCWD), Kings River Conservation District (KRCD), Corcoran Irrigation District (ID), the Department of Water Resources (DWR), the United States Bureau of Reclamation (USBR), and private landowners. While not all wells have available logs or construction information, efforts are in place to collect supplemental data. Since 2009, under the CASGEM program, DWR has required local agencies to report groundwater levels, with Kings County WD, KRCD, and Tulare Lakebed water agencies participating and reporting semi-annually. These agencies will continue their semi-annual monitoring and potentially expand to meet SGMA requirements, ensuring measurements are collected in October and again in March for consistency. Data collection protocols will adhere to DWR's Best Management Practices for Sustainable Groundwater Monitoring.

5.2.2 Groundwater Elevation Monitoring Network

The monitoring network is composed of aquifer specific wells screened across three aquifer zones: the A-Zone, B-Zone, and C-Zone. As discussed in Chapter 4, *Sustainable Mangement Criteria*, the Subbasin was divided into Representative Management Areas (RMAs) with each area contain a similar number of wells. Areas of intensive pumping and proximity to cities such as Hanford, Lemoore, Corcoran, and unincorporated communities are given priority for a higher density of RMAs. The RMAs are discussed in detail in Section 4.3.

A representative monitoring site (RMS) was then identified for each RMA using the existing monitoring network. The monitoring network for the Subbasin will utilize existing wells that are currently monitored for groundwater level and additional wells will be added to ensure each RMA contains at least one RMS location. Figures 5.2.1-1 to 5.2.1-3 show the locations of the RMS and RMAs for monitoring water levels.

For the C-Zone (below the E-Clay), the RMA layout is based on a grid pattern to facilitate subsidence monitoring, with the objective of installing one RMS location per 36 square mile Township that is entirely within the Subbasin. For the A- and B-zone Zone (above the E-Clay), the RMA layout is based on a polygonal pattern that incorporates well density (see Chapter 4).

The current monitoring network includes 16 A-Zone wells, 35 B-Zone wells, and 23 C-Zone wells (see Tables 4.3.1-1a, 4.3.1-1b, 4.3.1-1c, and 5-.1.0-2). To ensure each RMA contains one RMS location, additional wells will be identified or installed (7 A-Zone, 7 B-Zone, and 7 C-Zone additional wells). The GSAs are currently working with well owners to negotiate access agreements to wells in RMAs lacking an RMS.

In addition to the RMS locations, groundwater levels are also measured in other networks for specific purposes including:

Kings County WD: The Kings County WD encompasses a land area of approximately 143,000 acres between Tulare Lake Subbasin and Kaweah Subbasin. Water level measurements are taken semi-annually on average from 255 wells in both the spring and fall. The Kings County WD's monitoring program is divided into two distinct monitoring programs: (1) Apex Ranch Conjunctive Use Project Monitoring Program and (2) a district-wide monitoring program. The Kings County WD began routinely measuring groundwater levels district-wide in the 1950s. The district-wide data collection effort also includes data sharing with adjacent districts and groundwater basins and evaluates groundwater levels in the A- and B-Zones.

Apex Ranch Conjunctive Use Project Monitoring Program: The monitoring network consists of 40 to 45 off-site and on-site, agricultural, domestic, and dedicated monitoring wells. Several of the monitoring wells, both on site and off site, are equipped with data loggers that allow for data collection at set intervals and flexibility in the frequency that the data can be collected. These data are continuously recorded throughout the year.

KRCD: Current groundwater level monitoring program includes semi-annual groundwater level measurements (WRIME 2005). KRCD also samples wells for the KRWQC-ILRP Groundwater Trend Monitoring.

Corcoran ID: The Corcoran ID monitors water level elevation in approximately 74 wells. Based on available data it appears that about 45 percent (%) of these wells are perforated above the Corcoran Clay in the B zone and about 55% are perforated below the Corcoran Clay in the C zone. Most Corcoran ID wells have some pumping records. The number of wells pumped in Corcoran ID can change from year to year.

CASGEM Wells: DWR collects groundwater levels reported by local agencies and reports them through the CASGEM program. There are 17 wells that CASGEM monitored in the Subbasin, but those duties have been transferred to the GSAs.

Municipal Wells: Most municipal wells are available for water level and/or water quality monitoring in Hanford, Lemoore, Corcoran, Armona, Home Garden, Kettleman City, Stratford, and others.

Private Wells in El Rico GSA: There are approximately 99 private wells in El Rico GSA with reported historical pumping records and construction information, and 30 wells with some water level data. Of the 30 wells with water level data, 8 appear to be B zone (above the Corcoran Clay) and 22 appear to be perforated below the Corcoran Clay in the C zone.

Wells in Adjacent GSAs: Groundwater level data from adjoining subbasins will also be collected through data sharing agreements to help provide better interpretation of GSA boundary flow conditions. Long-term agreements are in development to collect/share data with other subbasins.

Monitoring Frequency and Density

Groundwater levels will be collected in the spring (March) and fall (October) of each year. The spring water level measurements are designed to capture the recovery of groundwater levels after a seasonal period of minimal demand. The fall measurement would capture a period after peak irrigation and summertime peak urban demands have declined, thereby showing the cumulative impacts on the groundwater basin before the seasonal winter and spring recovery has taken place.

Continuous water level measurements are collected from some wells using pressure transducers. The continuous data provides a better understanding of the temporal trends in water levels. Wells with transducers installed are labeled on Figure 5.2.1-1 through 5.2.1-3. Data from the transducers is collected during each semi-annual monitoring event and is stored in the DMS after review. Graphs showing the available transducer data are provided in Appendix G.

If more frequent data collection is required to demonstrate progress toward sustainability, monitor impacts to beneficial use of groundwater, monitor groundwater levels more closely, and/or quantify annual or seasonal changes in groundwater conditions, then the GSAs will re- evaluate the monitoring network and make changes as appropriate.

The density of RMS wells in the A- and B-zone is designed to meet the density requirements in the DWR Best Management Practices for the Sustainable Management of Groundwater – Monitoring Networks and Identification of Data Gaps (DWR 2016e). CASGEM guidelines (DWR 2012) reference the Hopkins and Anderson (Hopkins 2016) approach which incorporates a relative well density based on the amount of groundwater used within a given area. The proposed monitoring network incorporates this concept and is tied to the number of wells in a given area. Each RMA was established to include approximately the same number of similarly constructed wells. As shown on Figures 5.2.1-1 to 5.2.1-3 , the areal size of each RMA varies greatly depending upon the concentration of wells because the northern portion of Subbasin contains many more wells compared to the southern portion.

5.2.3 Groundwater Elevation Monitoring Protocols

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the Monitoring Protocols, Standards, and Sites Best Management Practices (DWR, December 2016b).

5.2.4 Identification of Groundwater Elevation Data Gaps

23 CCR §354.38 *(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.*

(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
The location and reason for data gaps in the monitoring network.

The general types of data gaps to consider for monitoring networks include :

1. Temporal data gaps: Insufficient frequency of monitoring.
2. Spatial data gaps: Insufficient number or density of monitoring sites in a specific area.
3. Well construction and pumping data gaps: Data may be available but lack associated well information to interpret the data. Pumping and well construction data are often needed to understand and interpret water levels or water quality results.

Temporal Data Gaps

Some of the current wells used for data collection have not been measured consistently year after year, and therefore, temporal data gaps exist ranging from one year to over a decade. The GSAs designed a data collection program that assures semi-annual data collection. The monitoring efforts will increase the reliability of groundwater level readings given their importance to active management and compliance documentation. If a water level reading cannot be collected at a given well, the reason will be documented. The GSAs will determine if or when additional attempts will be made to collect that data. Temporal adjustments may be made for the different aquifer zones or in certain areas. For example, semi- annual water level readings in wells screened above the A-Clay is probably sufficient to capture seasonal and long-term trends in most of the A Zone aquifer because water levels in the aquifer are relatively stable in most of the area. Near the Kings River it may be desirable to collect more frequent data from above the A-Clay to better understand the relationship between the river and shallow groundwater. Also, in areas where there is more pumping from below the E-Clay, it may be desirable to collect data more frequently due to relatively rapid changes in head pressure in confined aquifers. More frequent data may also be needed from the aquifer above the E-Clay in areas where it is the main aquifer in which wells are perforated. The need to collect more frequent data and from which aquifer zone is being addressed by the individual GSA.

Spatial Data Gaps
As noted above, there are spatial data gaps throughout the Subbasin related to the RMAs. As mentioned, each RMA will require at least one RMS location. The number of RMS locations that need to be identified or installed is discussed in Section 5.2.2.

Spatial data gaps are primarily in the southern/southwestern region of the Subbasin where groundwater use is rare due to poor water quality. The salinity issues in these southern and southwestern portions have led to their de-designation in the Basin Plan (SWRCB R5-2017-0032), exempting them from mandatory monitoring by the Regional Water Quality Control Board (RWQCB) under the current Tulare Lake Basin Plan Amendment. Monitoring would only be required if proposed projects potentially impact these areas. Should the designation or monitoring requirements change, strategies for Specific Management Conditions (SMCs) and a comprehensive monitoring program will be developed to address these needs. Given the low utility of groundwater for the overlying landowners, extensive management or monitoring of this resource in these areas is not considered a priority. In addition, this includes the lakebed area due to lack of productive strata in addition to poor water quality in that area.

In other areas of the Subbasin, data gaps are primarily due to the lack of known well construction. There are also spatial data gaps in the northern portion of the Subbasin, primarily related to well distribution in the various aquifer zones (Figures 5.2.-1 to 5.2.1-3).

Pumping and Well Construction Data Gaps
Currently, most of the wells monitored in unincorporated areas are privately owned. Most groundwater users have not kept track of how much water they have pumped or have not disclosed how much they have pumped. Currently, total pumping is estimated using satellite imagery for ET, but this method does not distinguish how much is being pumped from each aquifer. The GSAs are considering direct measurement of groundwater pumping, which may include flow meters installation and reporting requirements. In addition to pumping data gaps, well location and completion data may be incomplete. These data gaps will be addressed through the well registration program.

5.2.5 Plans to Fill Groundwater Elevation Data Gaps

23 CCR §354.38(d) *Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.*

The current RMS groundwater level network has spatial and well construction data gaps that will be addressed within 5 years. Additional well construction information is needed for 2 existing A-zone wells, 4 existing B-zone well, and 7 existing C-zone wells. As discussed in Section 5.1.5, an additional 11 A-Zone, 18 B-Zone, and 15 C-Zone wells need to be identified or installed so that there is one RMS location within each RMA. The GSAs will try to fill these data gaps using existing wells if possible, but will construct dedicated monitoring wells as funding becomes available. The spatial and well construction data gaps for existing wells will be filled using the following approaches:

Well Registration Program As part of proposed well registration programs (see Chapter 6), well completion reports (WCRs) will be collected and reviewed, along with ancillary information from the landowner such as accurate location information and relevant historical operations information.

Proposed RMS locations for RMAs that do not currently have an RMS well will be identified through the well registration program.

Video inspection. If well completion information for an existing or proposed RMS location is still lacking after well registration, a video survey may be conducted to determine the total depth and perforated interval. Video inspections can be performed when the pump is pulled for other reasons and the GSAs can work with well owners to obtain existing videos. If a video inspection is not possible, other RMS locations in each RMA will be considered before proposing a new dedicated monitoring well.

Construct a dedicated monitoring well: Dedicated monitoring wells are relatively expensive to construct, and their installation will depend on available funding. Dedicated monitoring wells will be constructed if an existing private well with a willing landowner cannot be found through the well registration process.

Installation of Additional Monitoring Wells

New dedicated monitoring wells are recommended to be 4-inch Schedule 80 polyvinyl chloride (PVC) casings. Deep monitoring wells installed below the E-Clay are recommended to be 5- or 6-inch Schedule 80 PVC casings. This will ensure that representative water quality samples may be collected at these locations. Additional groundwater quality information will be collected and reviewed from agencies and entities currently monitoring for groundwater quality. Monitoring wells constructed in subsiding areas or deep monitoring wells extending below the Corcoran Clay may need to be designed with compression sections to help avoid collapse of the casings as decided by the individual GSA. Blank casing sections should be steel instead of PVC and casing centralizers should be installed. If abandoned wells are included in monitoring networks they need to be re-developed prior to beginning data collection to ensure they are not plugged and to remove any accumulated downhole equipment lubricant (oil), if present. Groundwater level data collected from these wells would need to be evaluated annually to ensure they continue to provide valid data. If the collected data appears to deviate from nearby wells in the same aquifer zone the wells will need to be re-developed as needed.

Site Selection

> **23 CCR §354.34(g)** *Each Plan shall describe the following information about the monitoring network:*
>
> *(1) Scientific rationale for the monitoring site selection process.*

The following rationale will be used to add new RMS wells or move existing RMS wells:

Add wells to ensure that one RMS well is located in each RMA for each aquifer zone.

Avoid wells perforated across multiple aquifer zones for RMS wells, especially wells penetrating the Corcoran Clay and/or the A-Clay.

Select wells that have access during semi-annual water level readings, preferably wells that do not have gates or access issues.

Select sites for dedicated monitoring wells as far as possible from existing active wells.

Active wells are preferred over idle or unused wells.

Select wells with available construction information (i.e., depth, perforated interval).

Select existing wells over constructing monitoring wells where feasible.

Figures 5.2.1-1 through 5.2.1-3 show existing RMS wells and locations of proposed RMSs to address data gaps.

5.3 Groundwater Storage

Groundwater storage calculations can be made directly using the groundwater-level monitoring network or indirectly using a groundwater flow model. Groundwater storage change will be calculated annually for each aquifer using groundwater level contour maps from each monitoring period. In addition, groundwater released from clays due to subsidence will also be evaluated annually from data collected from the land subsidence monitoring network. Groundwater storage changes will also be evaluated every 5 years using the groundwater flow model.

5.3.1 Groundwater Storage Monitoring Network

For the purposes of annual reporting, groundwater level contour maps serve as a crucial tool for estimating annual changes in storage. This is achieved by comparing groundwater contours of the current year with those from the previous year. The derived change in hydraulic head is subsequently multiplied by specific yield values to accurately estimate the change in groundwater storage.

The process for calculating storage capacity includes the following steps:

1. Calculate average depth to groundwater for each specific yield area.
2. Multiply the height of water within each depth zone by the specific yield for that depth zone and by the area of that specific yield area within the Plan area.
3. Sum the total storage capacity for all areas.
4. Compare storage capacity from one year to the next.

A multi-year average will be evaluated and compared to long-term trends to understand the impact of the implementation of the GSP.

5.3.2 Groundwater Storage Monitoring Frequency and Density

Groundwater storage changes will be calculated annually, based on the fall groundwater levels. Annual groundwater storage changes for each GSA will be calculated so that individual GSAs can evaluate progress towards meeting measurable objectives and interim milestones. As discussed above, the GSAs will continue to collect data from more wells than those at the RMS locations. This additional data, in conjunction with data from the RMS locations, will be used to prepare groundwater contour maps, which are then utilized to estimate storage change.

In addition, groundwater released from clays due to subsidence will also be evaluated annually using data collected from the land subsidence monitoring network. Groundwater storage changes will also be evaluated every 5 years using the groundwater flow model.

5.3.3 Groundwater Storage Monitoring Protocols

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the Monitoring Protocols, Standards, and Sites Best Management Practices (DWR, December 2016b).

5.3.4 Identification of Data Gaps

The most significant data gaps in the groundwater storage change monitoring network include:

- Information on well construction related to understanding groundwater levels and pumping from the different aquifer zones;
- Aquifer testing data on storativity, specific yield, and hydraulic conductivity/ transmissivity of each aquifer to better define groundwater flow and seasonal groundwater storage changes;
- Shallow groundwater level data near rivers, creeks, and canal systems to characterize recharge; and
- Groundwater levels from wells with known construction along the Subbasin boundary that could better characterize groundwater flows in and out of the Subbasin, especially in the B- and C- Zones.

Other data gaps in the groundwater storage network are the same as in the groundwater level monitoring network, as described above, as storage change is dependent on changes in groundwater levels.

5.3.5 Plans to Fill Data Gaps

Data gaps in the storage change monitoring network will be filled as data gaps in the groundwater level network are filled, as discussed in Section 5.2.

- **Well Registration Program**. A well registration program will provide well construction information to better understand how much water is being pumped from each zone. After the construction of wells in the Subbasin is better understood, then the amounts being pumped from each aquifer zone can be managed.
- **Aquifer Testing**. Existing and new RMS locations will be considered for aquifer testing to measure local transmissivity and storage coefficients. New dedicated monitoring well locations will include an aquifer test. Testing will be conducted in coordination with updates to the groundwater model so that testing data is collected in areas that will improve the model.
- **Coordination with Adjacent Subbasins**. The Subbasin is surrounded by five other critically overdrafted subbasins. Coordination with adjacent subbasins and the development of additional groundwater level monitoring facilities will be needed along the edge of the Subbasin to estimate the amount of groundwater flow in and out of each subbasins. From the groundwater modeling evaluations, it is clear that if conditions in

adjacent subbasins don't improve, it will impact the ability of the Subbasin to achieve sustainability.

- **Recharge/Conveyance Loss Measurements**. There are many surface water right holders in the Subbasin that are partnering with local GSAs. The current measuring facilities on rivers, creeks and canals have been developed for surface water delivery and flood control purposes. Developing new measuring locations in order to refine information on recharge and conveyance losses will be important for water budgets and change in storage estimates. The GSAs will continue to work with their partners to develop new facilities as needed.

Site Selection
The site selection process for wells in the storage change monitoring network used the same criteria as the groundwater levels monitoring network. The same criteria as outlined in Section 5.1.3, Design Criteria, may be used to add additional wells into the storage change monitoring network as the water level monitoring network is the same.

5.4 Seawater Intrusion

The Subbasin is more than 100 miles from the Pacific Ocean, and, therefore, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the Subbasin. As a result, seawater intrusion is not discussed hereafter in this chapter. Saline water intrusion from up-coning of deep saline groundwater is a potential problem and will be monitored as part of general water quality monitoring.

5.5 Groundwater Quality

Groundwater quality is affected both by impacts human activities and naturally occurring processes. Groundwater quality varies widely across the basin. The local member agencies and stakeholders of the GSAs have established multiple groundwater quality monitoring programs. These programs aim to support various State agencies, local irrigation districts, conjunctive use programs, and General Plans. For more information on existing groundwater quality monitoring in the Subbasin, please refer to Section 3.2.5.

5.5.1 Groundwater Quality Monitoring Network

The groundwater quality monitoring network will employ the same RMAs and associated RMS locations established for water levels, as depicted in Figures 5.2.2-1 through 5.2.2-3. An RMA will include at least one RMS well for groundwater quality. The purpose of the groundwater quality network will be to: 1) understand if groundwater pumping is causing or exacerbating groundwater quality concerns; and 2) if so, whether pumping restrictions would restore groundwater quality or whether other mitigation measures are necessary. Proposed monitoring for groundwater quality network includes 88 existing RMS locations with an additional 10 locations to be added for a total of 98 locations to monitor water levels across the Subbasin (Figures 5.2.2-1 to 5.2.2-3).

RMS locations for groundwater quality were selected based on their ability to adequately represent groundwater quality conditions and indicate long-term, regional changes in groundwater quality. RMS locations were selected using the following criteria :

- Sufficient Spatial Distribution (i.e. at least one well in each RMA)
- Availability of Historical Data
- Known Well Construction Information
- Inclusion in a Current Monitoring Program
- Professional Judgement

Notably, south of Stratford and Corcoran, the groundwater quality diminishes, and portions of the Tulare Lakebed in the A-Zone and B-Zone have been de-designated as not suitable for municipal, domestic, agricultural irrigation, and stock watering supply (RWQCB 2017). Therefore, RMS locations are limited in the de-designated area, with a focus on RMS locations adjacent to the de-designated area. Additionally, more RMS locations may be installed upon further evaluation of monitoring data and/or if land use changes.

Data collected from the RMS wells will be used to identify concentration trends before minimum thresholds are reached. Groundwater quality results will be reported as part of the Subbasin Annual Report which is submitted to DWR every year by April 1st. The GSAs will observe analytical trends annually and evaluate whether the results are indicative of GSP-related activities and need further assessment. If further assessment is needed, the GSAs collect confirmation samples and collectively investigate the cause of groundwater quality issues.

5.5.2 Groundwater Quality Monitoring Frequency and Density

Groundwater quality measurements for the proposed monitoring network will be collected on a semi-annual basis. Accordingly, water quality samples will be tested for the COCs identified in Section 3A.2.3 of the Chapter 3 Addendum. All wells in the monitoring program across each zone will be sampled for these COCs.

The density of the groundwater quality representative wells is one well per RMA for each zone. Like the water level monitoring network, the groundwater quality monitoring network will require additional RMS locations be identified or installed. Some of these locations will be identified as part of the planned well registration program. This is an initial density; the GSAs may add additional locations to maintain a denser network as required to manage the Subbasin.

5.5.3 Groundwater Quality Monitoring Protocols

Detailed monitoring protocols for collecting and monitoring groundwater quality data are provided in Appendix H: Sampling and Analysis Plan (SAP). The protocols for sampling groundwater quality are derived from DWR’s Best Management Practices (BMP) for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites (CA DWR, 2016a). The BMP encompasses protocols for equipment selection, setup, usage, field evaluation, sample collection techniques, sample handling, and sample testing.

The SAP was developed to detail the monitoring protocols for collecting and monitoring groundwater quality data in the Subbasin, notably in the areas adjacent to the de-designated areas. The SAP is intended to formalize field techniques and procedures that Subbasin agencies may already have in place for their respective existing long-standing monitoring programs, or to establish protocols for new monitoring programs.

The groundwater quality sampling protocols outlined in the SAP confirm that:

- Data for groundwater quality are collected from the correct location.
- Data for groundwater quality are accurate and can be reproduced.
- Data represent conditions that provide relevant information for appropriate basin management and align with the data quality objectives.
- Data are managed in a manner that guarantees their integrity.
- All pertinent information is documented for normalization, if required, and data comparison

As outlined in Section 3A.2.3 of the Chapter 3 Addendum, the Constituents of Concern (COCs) include the following:

- Salinity (measured as Total Dissolved Solids or TDS)
- Nitrate (measured as Nitrogen)
- Arsenic
- Uranium
- Sulfate
- Chloride
- 1,2,3-Trichloropropane (1,2,3-TCP)

The groundwater quality monitoring program will be assessed annually and more in-depth as part of the 5-year GSP review. Changes to the sampling frequency may be made because of concentration trends either moving towards or away from measurable objectives. In addition, as data gaps are filled with newly constructed wells or newly accessible existing wells, the monitoring network will be adapted to maximize the effective coverage area. Conversely, wells may be removed from the monitoring network program if well construction or accessibility becomes an issue with land or well owners.

5.5.4 Identification of Groundwater Quality Data Gaps

Current data gaps in monitoring groundwater quality include a lack of detailed well construction information for wells across the Subbasin, particularly for shallow domestic wells as outlined in Section 5.5.5. The absence of these well completion details complicate the assessment of whether the monitoring network can effectively address water quality concerns.

Furthermore, spatial and temporal data gaps in COC concentrations of result in an incomplete understanding of their impacts and distribution, making it challenging to identify concentration trends. This issue is compounded by inconsistent sampling and monitoring of COCs and key geochemical parameters, including reduction-oxidation potential, dissolved oxygen, and pH, which are crucial for assessing the impact of geochemical reactions, particularly concerning arsenic and uranium.

5.5.5 Plans to Fill Groundwater Quality Data Gaps

To fill the identified data gaps, the GSAs have already implemented well registration programs across the Subbasin. Once the well registration programs are completed, the adequacy of the water quality monitoring network will be reevaluated and adjusted accordingly.

The GSAs will coordinate with other agencies to identify wells that are already being monitored within the areas identified as data gaps. For identified wells that are sampled by other agencies but not for the COCs, the GSAs will request that the COCs be added to the sampling list.

If additional sampling cannot be incorporated into existing programs, the GSAs will identify existing wells that can be sampled and will sample them on an annual basis for the COCs. If existing, wells cannot be sampled, the GSAs will install for new monitoring wells for sampling. Figures 5.2.2-1 through 5.2.2-3 show the locations of the existing monitoring network and locations of proposed RMS locations.

Site Selection

The selection of groundwater quality monitoring sites is partly driven by the location of city/municipal and other community well locations. Additionally, the KRWQC-ILRP has several well locations north of the clay plug (de-designated area). Currently, the GSAs are proposing not to sample for groundwater quality in de-designated areas. The locations for future groundwater quality sampling will likely be from monitoring wells that are constructed with funds from state or federal programs in data gap areas. The GSAs will work collaboratively with the agencies that are currently performing groundwater quality monitoring.

5.6 Land Subsidence

Land subsidence monitoring in the Subbasin utilizes InSAR measurement sites to serve as RMS locations. There is InSAR coverage over the majority of the Subbasin that provides monthly subsidence data that can be analyzed at specific points to create time series charts and cumulative subsidence calculations to delineate subsidence patterns. Additional land subsidence information comes from the Central Valley Spatial Reference Network (CVSRN) Continuous Global Positioning System (CGPS) stations and a network of benchmark stations monitored by the Kings River Conservation District (KRCD) and the High Speed Rail Authority (HSRA). Supplementary data for assessing subsidence throughout the Subbasin is also available from the entities mentioned in Section 5.1.3.

Figure 5.2.3-1 displays the locations of RMS benchmarks and InSAR stations within the Subsidence Representative Monitoring Area (RMA) grid. Detailed discussions on land subsidence can be found in Section 3A.5 and Appendix J. The GSAs have identified land subsidence, primarily due to excessive groundwater extraction potentially affecting vital infrastructure, as a critical sustainability indicator, as outlined in Section 3A.5. The GSAs have cataloged potential critical infrastructure within the Subbasin in Section 3A.5 and Appendix J, noting that designs for infrastructure projects, such as the California High-Speed Rail, can be adapted to account for ongoing subsidence.

Collaboration between individual GSAs and other agencies or authorities may occur to address subsidence effects as necessary. Adaptive management strategies or policies for deep groundwater pumping will be developed by the GSAs as required.

The Subbasin is bordered by the California Aqueduct from Kettleman City southwards, running along the western edge of the SWK GSA adjacent to the alluvial groundwater basin. GSAs will continue their efforts in gathering and analyzing data from subsidence monitoring sites near the California Aqueduct and Interstate 5.

The GSAs have set a minimum threshold for subsidence at 6 feet of additional cumulative subsidence. The GSAs have set a measurable objective of a near-zero rate of subsidence by the year 2040. The Sustainable Management Criteria for Land Subsidence are detailed in Section 4.7 Appendix J for the El Rico Subbasin and Appendix J for the rest of the Subbasin.

The Subbasin land subsidence monitoring network will utilize data and subsidence evaluations from a variety of agencies including USGS, NASA, UNAVCO, CVSRN, KRCD, and KDWCD to verify areas of subsidence. Current DWR subsidence monitoring along the California Aqueduct is in cooperation with the USGS (Sneed, Brandt, and Solt 2018). If data from these sources becomes unavailable in the future, a new or expanded monitoring network may be established to monitor land subsidence. The agencies and methods used for measuring subsidence are discussed below.

The GSAs are exploring partnerships with KRCD and similar organizations to potentially expand the land subsidence monitoring efforts in the Subbasin. The plan also suggests installing two extensometers in areas where subsidence is well-documented, dependent on acquiring necessary funding or forming partnerships with DWR or USGS. Land subsidence measurement and monitoring activities involve multiple stakeholders, including USGS, KRCD, USACE, UNAVCO, and several private firms. Collaborative initiatives among USGS, the National Geodetic Survey (formerly known as the U.S. Coast and Geodetic Survey), and DWR have led to comprehensive investigations, helping to delineate and understand subsidence phenomena in the San Joaquin Valley.

As funding becomes available, the expansion of subsidence monitoring infrastructure may incorporate extensometers for in-depth, discrete subsidence monitoring, specifically in or near locations depicted in Figure 5.2.3-1.

5.6.1 Subsidence Monitoring Network

USGS Monitoring Network

The Tulare Lake Subbasin subsidence monitoring network includes CGPS stations, benchmark stations, and use of Interferometric Synthetic Aperture Radar (InSAR). The USGS network does not have an extensometer in the Subbasin. Proposed monitoring for groundwater level network includes 29 existing RMS subsidence benchmark stations with an additional 9 locations to be added for a total of 38 locations to monitor subsidence across the Subbasin (Figures 5.2.3-1 and

Table 5.1.0-2). Below is a description of the various methods used in the USGS Monitoring Network.

InSAR. During the last decade, the USGS and other groups have been using data from radar emitting satellites referred to as InSAR. This form of remote sensing compares radar images from each pass of an InSAR satellite over a study area to determine changes in the elevation of the land surface (USGS, 2017). InSAR has a relative accuracy within fractions of an inch.

LiDAR. DWR and USBR utilize LiDAR coupled with land elevation surveys to monitor subsidence. LiDAR utilizes a laser device that is flown above the Earth's surface. The accuracy of LIDAR is known to be less than a tenth ($1/10^{th}$) of a foot as measured in root-mean-square deviation and very similar to that of surveying.

A San Joaquin Valley land subsidence monitoring network consisting of 31 extensometers was installed in the 1950s to quantify subsidence occurring in the San Joaquin Valley. This monitoring did not target the Tulare Lake bed area.

NASA Monitoring Network

NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from DWR's ALTAMIRA InSAR dataset to produce subsidence maps. More information can be found on DWR's Natural Resources Datasets (TRE ALTAMIRA InSAR, 2024) California Open Data Portal under NASA JPL InSAR Subsidence Data (California Open Data Portal, 2024).

Continuous Global Positioning System Stations

The CGPS stations provide daily horizontal and vertical data, with records starting as early as 2004. One CGPS station is located south of Kettleman City. The Plate Boundary Observatory (PBO) and the Scripps Orbit and Permanent Array Center (SOPAC) upload and process data from the network of CGPS stations and produce graphs depicting the horizontal and vertical change in a point's location through time. More Information on CGPS stations can be found at the UNAVCO website (UNAVCO 2024).

Central Valley Spatial Reference Network

The California Department of Transportation's Central Region has developed a network featuring CGPS stations that are permanently in place and operate continuously. This network, known as the CVSRN, includes stations positioned along highway corridors to provide real time corrections for surveyors, and others to use in post processing. Within the Subbasin there are two CVSRN stations, one is located near Corcoran and the other is located adjacent to Highway 43, Lemoore and Highway 198. In addition, PBO CGPS stations will be included in the CVSRN network in the future (Caltrans 2024).

Kings River Conservation District

KRCD monitors a network of new and existing benchmarks, targeting a density of approximately 7 miles, where possible. Figure 5.2.3-1 shows the locations of the benchmarks in their monitoring system (Thiede 2016).

Kaweah Delta Water Conservation District
KDWCD has a subsidence monitoring program with one benchmark monument in the Subbasin in the MKR GSA (Figure 5.2.3-1). KDWCD surveys the benchmark monuments twice a year in February and September.

5.6.2 Subsidence Monitoring Frequency and Density

> **23 CCR §354.36** *Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:*
>
> *(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.*
> *(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators…*
> *(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.*

InSAR data is available quarterly and the subsidence monitoring network is surveyed annually in the Subbasin. Subsidence change will generally be reported by GSA. Subsidence occurs on a regional scale with varying degrees occurring throughout the Subbasin.

The network of Representative Monitoring Sites (RMS) within the Subbasin is designed to address the requirements of the four sustainability indicators that are relevant to the Subbasin. It leverages both existing wells, rich in construction details and historical groundwater data, and, where necessary, introduces clusters of new wells for enhanced coverage. This method addresses the challenge of variability in groundwater conditions across the Subbasin, allowing for comprehensive monitoring of different aquifer zones from targeted locations. By defining Minimum Thresholds (MTs), Measurable Objectives (Mos), and interim milestones, the strategy aims to fill data gaps effectively, ensuring the sustainable management of the Subbasin's groundwater resources to meet both current and future needs.

For subsidence monitoring, the GSAs will depend on the strategic placement of existing subsidence monitoring points and regional subsidence mapping. This approach aims to adequately cover the Subbasin initially. InSAR measurements provide coverage over the majority of the Subbasin and will serve as RMS. Additionally, two Continuously Operating Reference Stations (CORS), LEMA and CRCN, have been identified as being in locations potentially suitable for subsidence RMS, highlighting the integrated approach to monitoring subsidence across the Subbasin.

5.6.3 Monitoring Protocols

§352.2 *Each Plan Shall include monitoring protocols adopted by the Agency for data collection and management, as follows:*

(d) Monitoring protocols shall be developed according to best management practices.
(e) The agency may rely on monitoring protocols included as part of the best management practices developed by the Department or may adopt similar monitoring protocols that will yield comparable data.
(f) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.
§354.34(i) *The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.*

Land subsidence is monitored by the various agencies using established methodologies and technologies as listed above Section 5.6.1. Therefore, the NFKGSA will not be actively engaged in monitoring for subsidence but will rather collect and evaluate land subsidence data from existing agency programs. Land subsidence monitoring will generally follow the protocols identified in the *Monitoring and Protocols, Standards, and Sites BMP* (DWR, 2016b).

5.6.4 Identification of Data Gaps

As has been described, the ability to predict the amount and rate of subsidence and or to evaluate the correlation between groundwater extraction and subsidence requires an understanding of the depth to the Corcoran Clay, the thickness of the Corcoran Clay, the compressibility of the Corcoran Clay, the maximum stress to which the Corcoran Clay has been subjected in the past (i.e., lowest sustained groundwater level in the confined aquifer), and the local and regional groundwater level in the aquifer. The data gap that is currently considered to have the greatest effect on the uncertainty in land subsidence evaluations is the paucity of historical data of the local and regional groundwater elevation in the lower aquifer to define the maximum past stress (i.e., lowest sustained groundwater elevation in the confined aquifer) in the Corcoran Clay and to calibrate a groundwater model. A secondary data gap is the compressibility of the Corcoran Clay, which can be evaluated with measurements at extensometers combined with co-located groundwater elevation and ground surface subsidence measurements.

5.6.5 Plans to Fill Data Gaps

The main data gap will be filled by developing a database with continuous groundwater elevation readings in the confined aquifer at RMS wells paired with contemporaneous measurements of ground surface elevation (i.e., subsidence) through a combination of InSAR data and subsidence RMS stations. Each RMS is to contain at a minimum, one RMS well and one Subsidence station.

5.6.6 Site Selection

Land subsidence in the Subbasin is monitored through agency and government land subsidence surveying programs. The data generated by these programs are considered adequate both spatially and temporally as InSAR/LiDAR mapping covers the entire Subbasin, and because the area is closely monitored due to existing subsidence. However, individual GSAs may develop subsidence monitoring programs as needed that may include surveys of wells, or measurement of pumping water levels in deep wells in known subsidence areas. The regional InSAR/LiDAR maps will be used to identify these areas.

If additional monitoring locations are added, such as the proposed extensometers, the following scientific rationale will be used:

Add stable benchmark sites that can be easily accessed and surveyed.

Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.

5.7 Consistency with Standards

23 CCR §352.2 *Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:*

(a) Monitoring protocols shall be developed according to best management practices;
(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.;
(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

23 CCR §354.40 *Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.*

The data gathered through the monitoring networks will be consistent with the standards identified in 23 CCR §352.4 related to Groundwater Sustainability Plans. The main topics of 23 CCR §352.4 are outlined below:

Data reporting units (water volumes including surface water deliveries, estimates of groundwater pumping, etc., reported in acre-feet [AF], etc.)

Monitoring site information (site identification number, description of site location, etc.)

Well information reporting (CASGEM well identification number or other unique identifier, measuring point elevation, casing perforations, etc.)

Map standards (data layers, shapefiles, geodatabases submitted in accordance with the procedures described in Article 4 of the SGMA regulations – Procedural issues related to submission of plans and public comment to those plans, etc.)

Hydrograph requirements (hydrographs shall use the same datum and scaling to the greatest extent practical, etc.). Hydrographs will also be plotted showing depth to water as well as groundwater elevation.

5.7.1 Monitoring Protocols for Data Collection and Monitoring (Reg. § 352.2)

The DQO process will be used to develop monitoring protocols that assist in meeting Mos and sustainability goals of this GSP (EPA 2006). The DQO process includes the following:

State the problem;

Identify the goal;

Identify the inputs;

Define the boundaries of the area/issue being studied;

Develop an analytical approach;

Specify performance or acceptance criteria; and

Develop a plan for obtaining data.

Groundwater level, groundwater quality (if the GSAs participate in groundwater quality monitoring), and land subsidence monitoring will generally follow the protocols identified in the DWR Best Management Practices for the Sustainable Management of Groundwater – Monitoring Protocols, Standards, and Sites (DWR 2016f). Monitoring Protocols will be reviewed at least every five years as part of the periodic evaluation of the GSP and updated as needed. The GSAs may develop standard monitoring forms in the future if deemed necessary.

The following comments and exceptions to the Best Management Practices (BMPs) should be noted:

SGMA regulations require that groundwater levels be measured to the nearest 0.1-foot. The BMP suggests measurements to the nearest 0.01-foot; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10- or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot.

The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well then readings to the nearest foot are likely the best one can achieve. As well, a methodology will need to be developed to keep track of the amount of oil in these wells, and if possible, have the oil removed when the pump is removed for other reasons.

Water level data will be collected and sounding equipment maintained using standard operating procedures. When feasible well sounding equipment will be dedicated for either irrigation or domestic wells.

Wells will be surveyed to a horizontal accuracy of 0.5 foot, preferably to 0.1 foot or less.

In subsiding areas periodic measurements may be required to determine the elevations of the measuring points for measured wells. Individual GSAs may develop subsidence monitoring programs as needed.

Unique well identifiers will be labeled on all public wells, and on private wells if permission is granted.

The BMPs state that static groundwater elevation measurements should be taken preferably within a one- to two-week period. This is likely not feasible due to the large number of wells in the Subbasin and the differing seasonal high groundwater conditions by GSA. As described above, for semi-annual (two times per year) monitoring, measurements are to be taken in October for the seasonal low groundwater condition and February through April for the seasonal high groundwater condition depending on the GSA. In addition, where groundwater quality and funding allows, individual GSAs may install data loggers in wells, most likely in dedicated monitoring wells and a select subset of existing wells.

If a vacuum or pressure release is observed, then water level measurements will be measured every five minutes until they have stabilized.

In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified by measuring the well to double-check the measurement. If there is a reason that the person measuring the well can determine for why the measurement is inconsistent, it will be noted.

For water quality monitoring (if or when the GSAs perform water quality sampling), field parameters for pH, electrical conductivity, and temperature will only be collected when required for the parameter being monitored. Determining if a well has been purged adequately may be ascertained by calculating a run time before sampling. For irrigation wells, samples will be taken when the well has been running long enough that an adequate volume has been removed (typically 3 to 5 well bore volumes and field parameters are stable).

5.8 Assessment and Improvement of Monitoring Network (Reg. § 354.38)

23 CCR §354.34(f) *The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:*

(1) Amount of current and projected groundwater use.
(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

This section reviews and evaluates the adequacy of the monitoring network, identifies data gaps, and describes methods to fill data gaps.

5.9 Data Storage and Reporting

23 CCR §352.6 *Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.*

The monitoring programs within the GSAs will be coordinated within the Subbasin. RMS well locations, construction, and groundwater level data are shared or will be shared amongst the different GSAs. In addition, the monitoring programs described in this Chapter were reviewed by the GSAs and will be consistent throughout the Subbasin. Similarly, data reported to DWR will be collected and reported in a consistent format. GSP development and implementation will depend on the Data Management System's (DMS) ability to support GSP activities. The DMS shall also allow for upload and storage of information.

The GSAs have a consultant to develop a DMS to store and retrieve the necessary information for annual reporting. This database standardizes the basin-wide collection of data. The GSAs have been provided data templates which allows them to collect and enter the necessary information in a standardized format for integration into the DMS. The DMS is a repository for data storage and will be used to help generate the required information for annual reporting for the Subbasin. Some features in the DMS are linked to a Geographic Information System (GIS) when applicable (i.e., monitoring locations, crop boundaries and groundwater contours). A schematic of the DMS structure showing the DMS table relationships is included as Figure 5.9.0-1.

The DMS includes information on monitoring sites related to the Sustainable Management Criteria. The data will be subject to several levels of quality control; first, when the GSA representatives enter the data, and again when the consultant evaluates the data when preparing annual reports, and a third level when the results are reviewed by the GSAs. The DMS for the Subbasin shall be secure and will be able to generate information to support reporting as requested by the GSAs. Standardized data-entry data templates will help stakeholders organize their data so that it transfers to the DMS efficiently to reduce the amount of time spent on data entry and quality control.

The DMS will include the necessary elements required by the regulations, including:

Well location and construction information (where available)

Water level readings and hydrographs including water year type

Seasonal groundwater elevation contours

Estimated groundwater extraction by category

Total water use by source

Estimate of groundwater storage change, including maps and tables

Graph with Water Year type, Groundwater Use, Annual and Cumulative Storage Change

Subsidence Monitoring Locations

Figure 5.9.0-2 shows some examples of tables and associated fields in the DMS. The DMS table fields allow for addition of required or needed fields. The data can be combined to generate the required information for annual reporting. For example, total water use by source would be combined using information from the groundwater extraction and surface water usage tables. Additional items may be added to the DMS in the future as needed or required.

Data will be obtained by each GSA and submitted to the consultant for inclusion in the DMS. The required data will be aggregated and summarized for reporting to DWR. Groundwater contours

will be prepared outside of the DMS using GIS analysis because of the need to evaluate the integrity of the data and generate a static contour set that has been reviewed for quality assurance and should not change once approved. Groundwater storage calculations are also performed outside of the DMS, then the results of those calculations will be uploaded to the DMS for annual reporting. Groundwater use by sector estimates, surface water deliveries by diversion point, intentional recharge, and land use data will be prepared by the GSAs using the data-entry data templates and then uploaded to the DMS for annual reporting and evaluations of trends. Surface water delivery records are maintained by the surface water agencies in separate systems already, and that data is collected by each GSA and provided to the DMS as an aggregate total by GSA. A description of how the DMS addresses required elements of a DMS and annual reporting requirements listed in the Table 5.9.0-1 The GSAs may choose to have their own separate system for additional analysis.

5.10 Data and Reporting Standards

23 CCR §352.4 Data and Reporting Standards

a) The following reporting standards apply to all categories of information required of a plan.
b) Monitoring sites shall include the following:
....c) The following standards apply to wells:

....d) Maps submitted to the Department shall meet the following requirements:

....e) Hydrographs submitted to the Department shall meet the following standards:

Table 5.10.0-1 lists the reporting standards that will be used for implementation of the GSP.

The monitoring sites will include the following information:

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

A description of the type of monitoring, type of measurement taken, and monitoring frequency.

Location, elevation of the ground surface, and identification and description of the reference point.

A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described.

The following standards will apply to all wells:

Wells used to monitor groundwater conditions installed during GSP implementation will be constructed according to applicable construction standards, and the following information in both tabular and geodatabase-compatible shapefile form will be provided:

- CASGEM well identification number. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by the Department, as described in Section 353.2.
- Well location, elevation of the ground surface and reference point, including a description of the reference point.
- A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.
- Casing perforations, borehole depth, and total well depth.
- Well completion reports, if available, from which the names of private owners have been redacted.

- Geophysical logs, well construction diagrams, or other relevant information, if available.
- Identification of principal aquifers monitored.
- Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

For GSP wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions, a schedule for acquiring monitoring wells with the necessary information, or a demonstration to DWR that such information is not necessary to understand and manage groundwater in the basin, will be provided.

Well information used to develop the basin setting will be maintained in the DMS.

Maps submitted to the DWR will have the following:

Data layers, shapefiles, geodatabases, and other information provided with each map, will be submitted electronically to the DWR in accordance with SGMA-prescribed procedures.

The maps will be clearly labeled and will contain a level of detail to ensure that the map is informative and useful.

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

Hydrographs submitted to the DWR will:

Be submitted electronically to the DWR in accordance with SGMA-prescribed procedures.

Include a unique site identification number and the ground surface elevation for each site.

Use the same datum and scaling to the greatest extent practical.

6. PROJECTS AND MANAGEMENT ACTIONS TO ACHIEVE SUSTAINABILITY GOAL (REG. § 354.44)

6.1 Introduction

The key to GSP implementation is active management of groundwater in the Subbasin. The GSAs have agreed that each GSA is responsible for groundwater sustainability by mitigating for the impact of their pumping. This will be accomplished by the implementation of management actions focused on demand reduction and the development of projects that augment water supply through the use/capture of surface water. This chapter presents the mix of projects and management actions chosen by each GSA to meet sustainability.

Each GSA proposed their method to achieve sustainability utilizing a combination of projects and management actions. Projects and management actions are supported by the best available science and data. They are proposed and will be implemented in the most effective manner toward creating a sustainable yield for each sustainability indicator. The GSAs and member agencies have already begun to implement the projects and management actions since 2020.

Management actions are programs or policies developed with the objective of active groundwater management through reducing water demand, improving data gathering, and/or protecting water quality. Each GSA will implement management actions specific to their needs and will further develop and refine their own management actions as needed to achieve sustainability.

As implementation continues, communication and engagement efforts will be shifted to educational and informational awareness of the requirements and processes for reaching groundwater sustainability. Active involvement of all stakeholders will continue to be encouraged, public notices will be provided for any public meetings, and prior to imposing any fees. Public outreach will be conducted by the individual GSAs with collaborative Subbasin-wide efforts when target audiences span more than one GSA boundary.

The projects and management actions are presented by each GSA to address the unique challenges in their areas to achieve sustainability. Some of the projects and management actions are repeated under each GSA to indicate subbasin wide efforts and how each GSA is implementing the actions. In some cases, selected GSAs have already implemented a policy while other GSAs are still developing similar policies. It should be noted that the GSAs remain committed to achieving Subbasin wide sustainability and continue to meet on a regular basis to discuss and coordinate implementation efforts.

Based upon work documented previously, each GSA has an estimated annual storage change target to meet to be sustainable, based upon best available data and groundwater model results. This section identifies the projects and management action targets envisioned to achieve sustainability. These preliminary amounts will be reevaluated, and conditions monitored while efforts are implemented. This will allow the GSA to compare the anticipated versus resulting change in groundwater levels, as well as other sustainability criteria to determine if additional measures need to be employed to achieve sustainability.

The projects are summarized in Tables 6.1.0-1 by GSA sorted by year of implementation. Table 6.1.0-1 presents each of the required elements for each project as currently available. Descriptions for the projects are presented below with selected projects presenting more detailed information. Costs for implementing each project were developed using information from previous projects in the Subbasin and were updated since the 2020 GSP.

6.2 Mid-Kings River GSA

As part of the 2020 GSP, the average annual storage change for the MKR GSA was estimated at negative 28,490 AF. The MKR GSA plans to pursue active groundwater well registration, requirements for groundwater flowmeters, groundwater pumping limits, a prop 218 election to develop a land based assessment and groundwater pumping charges, shallow dry well mitigation, subsidence mitigation, recharge basin development, improvements to existing basins in the area, , improvement to conveyance systems and expanded surface water delivery system. Table 6.1.0-1 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary.

6.2.1 Project 1: Well Registry

The MKR GSA adopted a policy in November 2022 to register all active groundwater wells, including domestic wells, within the GSA boundaries. A copy of the well registration policy is included in Appendix K. The GSA in coordination with the Kings CWD began working with some landowners in 2023 to assist in development of the policy. In early 2024, a system to manage the well location, depth and meter readings had been developed, and landowners were asked to visit the office to locate their wells and provide information related to well depth, construction and whether it had a flow meter. The GSA intends to focus primarily on agricultural wells because they use the most groundwater in the area. The GSA will work to conduct outreach to domestic well owners to make them aware of GSA services and the need to collect level and quality information from willing participants. Registering domestic wells will aid the GSA in efforts to protect shallow wells in the area. For more information on the MKR GSA Groundwater Well Registration Policy, please visit the MKR GSA website (www.midkingsrivergsa.org).

6.2.2 Project 2: Groundwater Well Meter Policy

The MKR GSA adopted a policy in November 2022 that requires landowners within the MKR GSA that have active groundwater wells to have flow meters installed. A copy of the well meter policy is included in Appendix K. The MKR GSA views this policy as necessary to develop a defendable view of groundwater extracted in the GSA and is consistent with Section 10725.8 of the California Water Code. The flow meters are required to have a totalizer for volume pumped and provide instantaneous flow. The policy required the meter be installed consistent with the manufacturer's specifications and have an accuracy of at least plus or minus five percent (+/- 5%). For more information on the MKR GSA Active Groundwater Well Meter Policy, please visit the MKR GSA's website (www.midkingsrivergsa.org).

6.2.3 Project 3: Groundwater Pumping "Cap" Policy

Project Benefits

The groundwater pumping "cap" policy is intended to reduce the highest amounts of pumping in order to reduce the number shallow dry wells, the amount of subsidence and the amount of groundwater level decline in the MKR GSA area.

Project Status and Schedule

The MKR GSA has been considering the components of this policy since the fall of 2023. The MKR GSA has recently held public meetings related to the groundwater pumping "cap" policy and the proposed fees related to mitigation efforts. The MKR GSA Board passed the initial groundwater pumping "cap " policy on March 26, 2024 and plans to collect initial groundwater flowmeter readings at the beginning of April 2024.

Permitting and Regulatory Process

The determination, implementation and enforcement of groundwater allocations will require no permits from any county, state or federal agency.

Legal Authority

Section 10726.4(a)(2) of the California Water Code grants the GSA the authority to "control groundwater extractions by regulating, limiting, or suspending extractions from individual groundwater wells or extractions from groundwater wells in the aggregate … or otherwise establishing groundwater extraction allocations." To monitor groundwater extractions, a "[GSA] may require through its [GSP] that the use of every groundwater extraction facility within the management area of the groundwater sustainability agency be measured by a water-measuring device satisfactory to the [GSA]." (Water Code, § 10725.8(a).)

Project Details

The MKR GSA adopted a Pumping "Cap" Policy in March 2024. The MKR GSA understands that it is charged with eliminating long-term declining groundwater levels and subsidence through the SGMA Implementation Period. The primary tool used to accomplish this will be through groundwater pumping reductions. Pumping reductions will be adjusted over time as monitoring information (groundwater levels, estimated change in groundwater storage, subsidence, groundwater quality changes, number of dry wells) is gathered and initial reduction efforts can be evaluated for effectiveness. The pumping "cap" amounts will be evaluated annually and considered relative to the established Measurable Objectives and Minimum Thresholds for the area as well as the mitigation efforts that ere implemented the prior year.

There are three primary aquifers in the area, however not all are present at every location. In the far northeast, there is generally just one aquifer. Further southwest, the Corcoran Clay is present and creates an unconfined/semiconfined aquifer above it (B-zone) and a confined aquifer below (C-zone). On the west side of the MKR GSA there is a very shallow perched aquifer (A-zone), then deeper there is the previously mentioned semiconfined aquifer above the Corcoran Clay (B-zone) and the confined aquifer below the Corcoran Clay (C-zone). Overpumping from, or pumping that causes groundwater levels to reach new low levels, in the shallow perched aquifer (A-zone, generally west of Hanford) and the unconfined/ semiconfined aquifer above the Corcoran Clay (B-zone) is understood to be the most significant cause of dry shallow rural domestic wells in the MKR GSA. Overpumping from, or pumping that causes groundwater levels to reach new low levels, in the confined aquifer below the Corcoran Clay (C-zone) is understood to be the most significant cause of subsidence in the MKR GSA area. It is also understood that there is a small component associated with groundwater storage reductions (overdraft) in the semiconfined aquifer above the Corcoran Clay (B-zone).

The MKR GSA views that it is not in the jurisdiction of the GSA to define groundwater rights. The MKR GSA views its responsibility as estimating the amount of groundwater that can sustainably be pumped in the area given current conditions. The current policy goal is to begin the transition towards sustainable groundwater use in the area by eliminating a significant amount of over pumping. As conditions change throughout the area and more is learned about groundwater responses to management strategies, the GSA's approach to sustainable pumping will be refined. However, the MKR GSA is committed to eliminating the Undesirable Results in the area through pumping restrictions if necessary. The MKR GSA understands that totalizing groundwater flowmeters are helpful management tools for all landowners, and provide valuable direct measurement information that is very difficult to estimate through other indirect means.

The policy acknowledges the three main aquifers (A, B and C zones) in the area and that there needs to be limits to pumping related to the management issues in each zone (see Table 6.2.3-1 below). The depth of the well being used determines the amount that can be pumped per acre. The zone amounts are not additive, as only one can be used per acre. The pumping "cap" is a maximum annual use, and cannot be carried over into a coming year. The allowable pumping amounts are tied to a 12 month period of April 1 through March 31, with the initial limits beginning in April 2024. Wells that are primarily rural domestic and pump less than two (2.0) acre-feet/year are excluded from the policy. Groundwater pumping fees will be charged to develop funding for shallow well mitigation, subsidence mitigation and recharge basin project development. If a groundwater pumper pumps more than the allowed amount, the policy describes a penalty rate of $500/AF and the overused amount being deducted from the following years allowable pumping for that pumper.

Table 6.2.3-1 MKR GSA Initial Groundwater Allocation	
A-Zone	0.5 AF/ac
B-Zone	3.0 AF/ac
C-Zone	2.0 AF/ac

Non-domestic groundwater pumping data will be collected and evaluated on a quarterly basis. For parties compliant with the MKR GSA flow meter policy, flow meter readings will be used. For parties not yet in compliance with the flow meter policy, pumping estimates will be developed using crop evapotranspiration data with other appropriate assumptions. The MKR GSA will continue to utilize evapotranspiration (ET) data from Land IQ during the transition from ET data to full groundwater meter data. The ET data will serve as a check to the reported groundwater pumping values.

For more information on the MKR GSA Groundwater Pumping "Cap" Policy, please visit the MKR GSA's website (www.midkingsrivergsa.org).

6.2.4 Project 4: MKR GSA Funding

The MKR GSA was formed in late 2016 as a joint powers authority (JPA) between Kings CWD, the City of Hanford and the County of Kings. Since then the GSA's finances have mostly been supported by the JPA members and available grants from DWR. In order to begin the active management of groundwater resources in the MRK GSA area it was necessary to develop funding from local landowners and groundwater pumpers to develop a reliable administrative and operational agency, as well as funding for needed mitigation efforts and project development. Once the magnitude of the various cost components were developed the MKR GSA began working towards a Proposition 218 election that would ask local landowner to approve both a land based assessment to fund GSA administration and operations, and also groundwater pumping fees to fund mitigation efforts and project development. The fee study and assessment roll were finalized on February 26, 2024. The Fee Study, which is available on the MKR GSA website, presented a maximum MKR GSA Budget for 2024 – 2028.

The maximum land based assessment involved in the MKR GSA Proposition 218 election is $25 per acre per year. The assessment would apply to parcels larger than two acres. If successful, the land based assessment would develop a maximum annual budget of $2.0 million. The efforts funded by the land based assessment include the employment of GSA staff, the funding of continued GSP development and revisions, the funding for the MKR GSA's portion of annual reports to DWR, continuing efforts to register wells in the area, efforts to develop needed dedicated monitor wells, consultant services, and the repayment of JPA partner seed funding. The MKR GSA has been operating with a part-time manager since it was formed and currently views that several new staff positions will be needed to accomplish the commitments being made to active management and mitigations efforts.

The maximum groundwater pumping charges involved in the MKR GSA Proposition 218 election is $95 per acre-foot. The most significant portion of that maximum pumping charge relates to shallow well mitigation. If successful through the Proposition 218 election, the groundwater pumping charge is estimated to develop a maximum annual budget of $6.0 million. The maximum groundwater pumping charge would apply to the two shallower groundwater pumping zones (A and B zones), as those zones are where shallow wells are being impacted. The pumping charge related to shallow well mitigation would be considered and set each year by the MKR GSA Board in order to be sufficient to address the expected costs within the MKR GSA. The MKR GSA understands that as progress is made related to stabilizing groundwater levels in the area, the amount of funding needed for shallow well mitigation should diminish.

A significant portion of the maximum pumping charge for the deepest zone of pumping (C zone, below the Corcoran Clay) relates to subsidence mitigation. If successful through the Proposition 218 election, the groundwater pumping charge is estimated to develop a maximum annual budget of $1.0 million. In the MKR GSA, subsidence mitigation is envisioned to potentially involve projects to repair canal systems that have been impacted by subsidence or deep municipal wells that suffer impacts from subsidence within the MKR GSA. The pumping charge related to subsidence mitigation would be considered and set each year by the MKR GSA Board in order to be sufficient to address the expected costs. The MKR GSA understands that as progress is made related to eliminating subsidence in the area, the amount of needed funding for subsidence mitigation should diminish and not be needed before the end of the Implementation Period.

A portion of groundwater pumping charge for all three zones of pumping will also fund recharge basin development projects. If successful through the Proposition 218 election, the groundwater pumping charge is estimated to develop a maximum annual budget of $2.5 million. The MKR GSA goal is to develop an additional 1,000 acres of recharge basins to put local flood waters to beneficial use and thereby improve groundwater quality and supplement the available amount of groundwater in the area. The budgeted amount is intended to facilitate the development of roughly 50 acres of recharge basin per year through 2039.

There will be a Proposition 218 Public Hearing for the land-based assessment and the groundwater pumping fees on April 23, 2024. If successful, the MKR GSA could begin charging groundwater pumping fees as early as May 2024. The initial billing for groundwater pumping would likely happen in July 2024 or August 2024, with invoices being likely due in September 2024 or October 2024. The land-based assessment is intended to be collected by Kings County along with other property related taxes twice a year. The initial funds from the land based assessment would like become available to the GSA in early 2025.

For more information on the MKR GSA Prop 218 Election, please visit the MKR GSA's website (www.midkingsrivergsa.org).

6.2.5 Project 5: Shallow Well Mitigation Policy

The MKR GSA adopted a shallow well mitigation policy in February 2024 to address impacts to shallow wells. A copy of the well mitigation policy is included in Appendix K. The MKR GSA understands that it is charged with eliminating long-term declining groundwater levels, subsidence and protecting groundwater quality from over pumping through the SGMA Implementation Period. The MKR GSA understands that the collective agricultural pumping in the area is the vast majority (90 percent or more) of groundwater pumping and is the most significant cause of local declining groundwater levels and local subsidence. Overpumping from or pumping that causes groundwater levels to reach new low levels, in the shallow perched aquifer (A-zone, generally west of Hanford) and the unconfined/ semiconfined aquifer above the Corcoran Clay (B-zone) is understood to be the most significant cause of dry shallow rural domestic wells in the MKR GSA. The MKR GSA understands that there are several rural residential owners that currently need shallow well mitigation assistance and are working with local non-profits. If groundwater pumping fees are passed the Prop 218 election, Mitigation will be provided for the cost to develop and outfit a new groundwater well to reestablish the use of groundwater that was lost, for emergency services while the well is redeveloped and for technical assistance. Mitigation services will begin to be provided as soon as funding for the efforts are secured. Mitigation efforts are envisioned to initially be accomplished through consultants and eventually transition to GSA staff.

6.2.6 Project 6: Additional Dedicated Monitor Wells

The MKR GSA has found that the monitoring information from dedicated monitor wells to be very useful in evaluating conditions in the area. Data from the existing dedicated clustered/nested monitor wells that with data loggers showing groundwater level conditions in the separate local aquifers are regularly reviewed to monitor conditions. The MKR GSA plans to develop several more dedicated monitor wells over the next several years at locations that can be protected so that the collected information is reliable. The planned dedicated clustered/nested monitor wells will also be equipped to facilitate groundwater quality testing. Part of the MKR GSA's annual budget (roughly $300,000) will be dedicated to installing additional monitoring wells. The MKR GSA has several identified locations and if the land based assessment is successfully passed through the MKR GSA Prop 218 election, funding for this effort will begin in early 2025.

6.2.7 Project 7: Expanded Monitoring Network

The MKR GSA plans to expand the existing monitoring network significantly in the GSA area for groundwater level and groundwater quality. State Board staff have pointed out that the monitoring network described in the 2022 TLS GSP Revision was mostly comprised of existing agricultural wells and existing municipal wells. There was concern expressed that the monitoring network did not provide sufficient information on rural domestic wells to evaluate whether they were adequately being protected. The MKR GSA plans to reach out to rural domestic owners during the well registration process and during other focused efforts to find willing rural homeowners that will allow their wells to be monitored for groundwater level and groundwater quality. The MKR GSA also plans to add additional wells of all kinds across the GSA in areas where there are gaps in the current monitoring network. Part of the MKR GSA's annual budget (roughly $150,000) is dedicated to monitoring conditions and adding additional monitoring sites. The MKR GSA has several locations in mind for the expansion of the monitoring network and if landowner are agreeable, they will be incorporated soon. If the land based assessment is successfully passed through the MKR GSA Prop 218 election, funding for this effort will begin to be available in early 2025.

6.2.8 Project 8: Esajian Basin

The construction of the Esajian Basin was a high priority project for the MKR GSA to complete to capture flood water releases. The project consisted of the construction of an 80-acre recharge basin located adjacent to The Peoples Ditch (see Figure 6.2.8-1. Construction of the project began in 2020 and was completed in January 2023 just in time to receive flood waters. During 2023, the basin recharged more than 7,000 acre-feet of flood waters. There are some excavation efforts that continue, but the basin is mostly complete.

6.2.9 Project 9: Griswold Basin

The Griswold basin will create an approximate 70-acre recharge area between the Old River Channel and the Riverbank Ditch, allowing the basin to fill up to 102 feet of floodwater (see Figure 6.2.8-1). The basin are designed to capture floodwaters in wet years and will benefit the local communities by providing flood protection, reducing groundwater demand by converting agricultural land to recharge basins, and increasing groundwater aquifer recharge. The project will potentially generate approximately 5,000 acre-feet of water recharge over the first 5 years of the GSP Implementation Period.

Project Benefits

The Griswold basin lies within an Underrepresented Community, Fringe Community, Disadvantaged Community, Economically Disadvantaged Community or Environmentally

Disadvantaged Community as defined by California Environmental Protection Agency (CalEPA) (see Figure 6.2.8-1). Both cities and rural communities within the Subbasin rely on groundwater pumping as the primary source for drinking water. Most rural schools, homes and communities pump groundwater from the shallow aquifer above the Corcoran Clay. Groundwater recharge will directly and positively impact small water systems and private shallow domestic wells by increasing the reliability and availability of groundwater for consumption every human being. In addition, a stabilizing or increase of groundwater aquifers can reduce pumping costs and negate the occurrence and costs of well damage and dry wells in undesirable aquifer conditions.

Circumstances for Implementation
The Griswold basin is fully funded through the DWR SGM Round I Implementation grant. The funding included both design and construction costs. Currently the project design has been completed and the project is currently advertised for contractor bids with construction expected to be completed by the end of 2024.

Project Status and Schedule
As mentioned above, the project design has been completed and the contractor bids are expected by June. The current project schedule anticipates the project will be completed by the end of 2024.

Permitting and Regulatory Status
The project has received a waiver from California Environmental Quality Act (CEQA) under the Governor's Executive Order N-7-22, the project has received a CEQA waiver from DWR.

Legal Authority
The Kings CWD owns the property where the basin will be built and has the legal authority to construct the basin.

6.2.10 Project 10: New Basin Development

The following are projects that the MKR GSA is pursuing in some form of development and are planned to be pursued with recharge basin funding from groundwater pumping fees. The projects will benefit the local communities by providing flood protection, reducing groundwater demand by converting agricultural land to recharge basins, and increasing groundwater aquifer recharge. These projects would receive floodwater through existing water rights that would be accessible though agreement with Kings CWD. After development these facilities would be operated with metered surface water diversions, monitored groundwater levels, and tested groundwater quality to ensure that recharge efforts are protecting local groundwater quality and being accurately accounted for. Please see Figure 6.2.8-1 that depicts there general location.

- Riverside Ditch System
    - o Dover Ave – 50 acres
  - Excelsior Ave – 10 acres
  - 11th Ave – 10 acres
      - o 12.75 Ave – 20 acres
- Settlers Ditch System

  - Dover Ave – 70 acres
  - 6^{th} Ave – 65 acres
  - Flint Ave – 40 acres
  - Grangeville Ave – 40 acres
- Peoples Main System
  - 6^{th} Ave – 80 acres
  - 8^{th} Ave – 55 acres
  - Elder Ave – 50 acres
  - Lopez Expansion – 15 acres
  - Flint Ave – 20 acres
- Peoples East Branch System
  - 8.5 Ave – 10 acres
- Last Chance System
  - 13.5 Ave – 35 acres
  - South Lacey – 20 acres
  - Hanford-Armona Road – 15 acres
  - 16^{th} Ave – 40 acres
  - South Armona – 15 acres
  - Idaho Ave – 20 acres
  - Iona Ave 1 – 25 acres
  - Houston Ave – 10 acres
  - Iona Ave 2 – 15 acres
  - 12^{th} Ave – 40 acres
- Kings County Water District Projects

The following are projects that the Kings CWD is pursuing. The projects will benefit the local communities by providing flood protection, reducing groundwater demand by converting agricultural land to recharge basins, and increasing groundwater aquifer recharge. These projects would receive floodwater through existing water rights. After development these facilities would be operated with metered surface water diversions, monitored groundwater levels, and tested groundwater quality to ensure that recharge efforts are protecting local groundwater quality and being accurately accounted for. Please see Figure 6.2.8-1 that depicts there general location.

- Dutra Basin – KCWD has purchased property for a 50 acre basin near Highway 43 and Elder Avenue. KCWD previously conducted a TowTEM Geophysical Investigation through Ramboll in spring 2022. This area was used by KCWD during the 2023 flood to deliver floodwater using temporary pumps through funding from DWR. KCWD is currently evaluating the site and plans to begin CEQA evaluation, design and permitting soon. The Dutra Basin site is planned to be developed in 2025.
- Last Chance Basin – KCWD continues to work with Last Chance Water Ditch Company on property near the Kings River along Dover Avenue that they own that could be developed into a recharge basin. The property is currently being leased until the end of 2024, and discussions continue about a possible basin.
- Cody Slough – KCWD has a current project to improve the turnout facilities to the existing Cody Slough and continues to have discussions with the current landowner on the potential expansion of the Cody Slough. Conceptual Design and Cost Estimates have been developed for the basin expansion.
- Railsback Basin – KCWD has made an offer on the property for the Railsback Basin expansion, but it appears the owner is looking for a price significantly above fair market value for the expansion area. KCWD is pursuing the development of improved diversion and measurement facilities for the existing basin. There improvements are anticipated to make the basin significantly more productive for recharge efforts. KCWD continues to pursue development of this site, depending on the related costs to acquire the property.
- Lopez Basin – Currently KCWD has improved diversion and measurement facilities for the existing basin out for bid. The improvements are anticipated to make the basin significantly more productive for recharge efforts. The efforts are planned to be completed by the end of 2024.

6.2.11 Project 11: Initial Groundwater Recharge Policy

This policy was developed in June 2023 to allow landowners to develop recharge facilities for floodwater that could justify future additional amounts of groundwater pumping. The policy requires registration of the facilities prior to the effort beginning, access for monitoring, identification of monitoring locations and facilities, and the metering of surface water delivered to the facility. Over the last year the MKR GSA has understood that the State Board will also require monitoring of surface water quality and groundwater quality at these locations. The policy describes that landowners can receive credit for pumping in future years only if the pumping occurs in the same aquifer that is being recharged and within one mile of the recharge location. Also, the credited pumping amount is 75% of recharge the year after recharge and decreases every year until the credited amount is 0% in the 5th year after recharge. Th e objective of the policy is to enable local landowners with access to floodwater to safely recharge and offset some of the limitations from the groundwater pumping "cap" policy. For more information on the MKR GSA Initial Private Groundwater Recharge Policy, please visit the MKR GSA's website (www.midkingsrivergsa.org).

6.2.12 Project 12: System Improvements

The KCWD has indicated that some improvements will be made to their and that will be considered as part of GSP implementation. These improvements include:

- System Evaluations – Independent Ditch – The Ditch Company continues discussions with KCWD on efforts to develop easements and right-of-way so that the facility can be preserved long-term. There is a need for a measurement facility and diversion structure at the head of this system. As previously mentioned, it appears that some differential subsidence has impacted diversion capacity over time.
- Riverside Ditch Extension – KCWD has been approached by some landowners at the end of the existing Riverside Ditch system about whether an extension of the existing system could be developed to deliver surface water to additional landowner. The representatives of the landowner have developed a rough schematic for the desired extension. KCWD conveyed to the landowner representative that the landowner in the new service area would need to provide significant financial contributions to the potential effort if it was pursued. It is unclear where the effort will go at this point, but KCWD continues to view this as a potential system improvement project that could deliver wet year water to a mostly unserved area in terms of surface water.

6.2.13 Project 13: Land Fallowing

Some landowners in the MKR GSA have expressed interest in developing a land fallowing program in the MKR GSA area. Generally, one of the goals of the MKR GSA is to keep as many acres in agricultural production as possible as that activity is critical to the local economy and develops a significant portion of the County tax base. However, there are some examples of programs that have been developed in the Kaweah Subbasin to reduce groundwater pumping. The MKR GSA will continue to investigate potential ways to work with local landowners to reduce groundwater pumping and may pursue a policy for land fallowing in the future if funding is available for the effort.

6.3 South Fork Kings GSA

As part of the 2020 GSP, the average annual storage change for the SFK GSA was estimated at a negative 37,840 AF. Table 6.1.0-1 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary.

6.3.1 Project 1: Kings River Sedimentation Removal

The Kings River Conservation District (KRCD) had previously identified sections along the Kings River in need of reclamation to restore 100-year flood capacity along the channel. KRCD identified one critical area along the South Fork Section located between Jackson Avenue bridge and Empire Weir 1 within the SFK GSA. The SFK GSA agreed that this is important project as removing accumulated sediments will reclaim capacity for water flows and bring entitled irrigation and floodwaters to be used in lieu of groundwater pumping.

The project included the preparation of design drawings and specifications, selection of the contractor, and removal of accumulated sediments. All within three months in order to complete the project before water was released in the Kings River. Due to the unanticipated early flood flows in the river, the project was suspended short of its original goals but is considered complete. The removal of the sediments allowed the South Fork to accommodate the flood flows and minimized the pressure on the levee systems.

6.3.2 Project 2: Well Registry

The SFK GSA will conduct a well survey requesting landowners to provide information on existing wells including well construction and meter details which will be used to evaluate the need for metering. The well registration program will identify all wells located within the GSA, including domestic supply wells. The GSA will work with local governmental (Kings County, etc.) and non-governmental agencies (NGOs) to conduct outreach to domestic well owners.

The SFK GSA already has a data collection portal prepared and operational on its website to collect well registration information. The SFK GSA coordinated closely with the North Kings GSA to utilize the same developer to prepare both portals in order to easily incorporate shared data on wells already in the Irrigated Lands Regulatory Program (ILRP). Landowners who are members of the Kings River Water Quality Coalition have the ability to streamline the well registration process by allowing the two systems to share data. In addition, SFK GSA will utilize the TLSB database to begin outreach to identified well owners to update the information into the well portal. A link to the well Registration portal can be found on the SFK GSA webpage (https://southforkkings.org/well-registration/).

6.3.3 Project 3: Well Mitigation

The SFK GSA is currently developing a well mitigation policy and evaluating options to fund the program. It is anticipated that the program will closely resemble the MKR GSA well mitigation program and will be completed by September 2024. This time is necessary to allow for stakeholder outreach including to a newly formed Growers Advisory Group and to incorporate comments received.

6.3.4 Project 4: Groundwater Allocations

The SFK GSA is currently developing a groundwater allocation policy and evaluating options to fund the program. It is anticipated that the program will closely resemble the MKR groundwater allocations program with aquifer specific requirements. The SFK GSA anticipates completing the groundwater allocation policy by September 2024. This time is necessary to allow for stakeholder outreach including to a newly formed Growers Advisory Group, local communities, and other interested parties.

6.3.5 Project 5: Aquifer Storage and Recovery Program

The SFK GSA is evaluating the use of an Aquifer Storage and Recovery (ASR) program as an alternative method to recharge groundwater. Due to water quality concerns and the presence of the Corcoran Clay throughout the GSA, there are limited opportunities for surface recharge. As a result, the GSA has proposed implementing an ASR program, through the use of injection wells. The GSA was awarded a grant from the California Resilience Challenge to implement an ASR

Pilot Test. The findings of the Pilot Test favored the development of ASR program. The program has also been implemented in the neighboring Westside Subbasin.

Project Benefits
The objective of the proposed ASR program is to directly contribute to meeting measurable objectives of chronic lowering of groundwater levels, reduction in groundwater storage, and land subsidence through aquifer recharge via injected water. The benefits include storage of surface water with provisions for required leave-behind quantities, which contribute additional water to the groundwater aquifer. Unlike recharge through percolation basins or on-farm recharge approaches the ASR program is able to target recharge at a particular depth interval providing a significant advantage in providing recharge to the Lower Aquifer. The project will also improve water quality through the injection of water with lower TDS and other constituents than native groundwater. The ASR program is also anticipated to contribute to the economic sustainability of the region by increasing the reliability of water resources during dry periods.

Circumstances for Implementation
Implementation of the ASR program is contingent on preparation of a programmatic California Environmental Quality Act (CEQA) document and preparation of a Report of Waste Discharge (ROWD). The ROWD would need to be approved by both the Regional Board and the California DDW. Upon approval, landowners will have the opportunity to store water and generate groundwater credit. Actual injection and recovery volume and timing will be at the discretion of individual landowners. Continued participation by landowners may be subject to the initial success of the program, availability of water for injection along with other considerations. As a result, the timeline for implementation is expected to occur over a period of years and full adoption of the program by 2030.

Project Status and Schedule
On receipt of regulatory approvals and adoption of the GSP, landowners within the GSA will be eligible to participate in the ASR program possibly as early as 2026. Since participation in the ASR program is voluntary, it is difficult to predict the timeline for full project implementation. The timeline for full implementation will be re-evaluated based on the program's initial success, which is largely dependent on surface water availability and rate of adoption by well owners. However, it is estimated that the ASR program will be fully implemented by 2030. Since water will be directly injected into the aquifer system, benefits to the aquifer system should be immediate and commensurate with the amount of water injected and level of landowner participation in the program.

Permitting and Regulatory Status
California Water Code section 13260 requires a ROWD be submitted to the Regional Board for injection wells used as part of an ASR program. The GSA will prepare a ROWD to the Central Valley Regional Board allowing for approval of 50 ASR wells within the GSA. The goal of the ROWD is to demonstrate compliance with the State Board's Water Quality Order 2012-0010 as well as the Antidegradation Policy 68-16. The programmatic ROWD includes results from a pilot study conducted in 2017 and a numerical model currently under preparation to establish adequate safeguards and protections for water quality in drinking water wells.

Legal Authority

The policy of the State of California is to encourage the conjunctive use of surface and groundwater. (Water Code, § 1011.5). Toward that end, the GSA can implement the ASR Program through its authority to regulate extractions outlined in Sections 10726, 10726.2 and 10726.4 of the California Water Code. SGMA also authorizes a GSA to engage independently in activities related to the "spreading, storing, retaining, or percolating into the soil [] waters for subsequent use or in a manner consistent with a [GSP]." (Water Code, § 10726.2(b).) Further, Section 10726.5 of the California Water Code grants the GSA the authority to enter into agreements with private parties to facilitate the implementation of a GSP. Under this authority, the GSA can contract with individual landowners to implement the ASR Program.

Subject to the GSA's coordination and administration to avoid undesirable results and material injury to other users and to the Subbasin, the use of the aquifer to store surface water underground for subsequent beneficial use is recognized by the California Water Code. Section 1242 of the California Water Code defines a beneficial use with regard to underground storage "if the water so stored is thereafter applied to the beneficial purposes for which the appropriation for storage was made," provided that appropriate regulatory approvals have been granted and that common law rights to native water and storage are not impaired. The GSA will coordinate the ASR program to ensure that both the storage and recovery of banked water does not cause or contribute to undesirable results or material injury to other users.

6.3.6 Expanded Monitoring Network

The groundwater monitoring network for water levels and water quality is expected to be increased in the SFK GSA with the installation of dedicated monitoring wells. The wells are expected to be installed in all three aquifers. The SFK GSA plans to install multiple dedicated monitor wells over the next several years at locations that can be protected so that the collected information is reliable. The planned dedicated clustered/nested monitor wells will also be equipped to facilitate groundwater quality testing.

The GSA expects to pass a groundwater pumping fee with a portion dedicated to installing additional monitoring wells. The GSA will begin to start identifying possible locations once the pumping fees is successfully passed. The funding for this effort is expected to be in place by 2025 with well installation continuing for several years.

6.4 Southwest Kings GSA

As part of the 2020 GSP, the average annual storage change for the SWK GSA was estimated at positive 10,820 AF (surplus), thus projects to mitigate overdraft are not currently needed in this GSA. However, the SWK GSA has agreed to implement several management actions. In addition, the SWK GSA has indicated to the other GSAs in the Subbasin that it would be interested in financially participating in projects elsewhere in the Subbasin if doing so would affordably increase the water supply to the SWK GSA. Table 6.1.0-1 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary.

6.4.1 Project 1: Well Registry

Similar to all the GSAs in the Subbasin, the SWK GSA will require all well owners within its boundaries to register their wells. While the program is still in development, the GSA expects to utilize a program like those being proposed by neighboring GSAs. With a very limited number of wells with the GSA boundaries, the well registration program will include direct outreach to landowners. The GSA will also work with local agencies and NGOs to help identify domestic well owners. The Program will further specify outreach efforts and detail the selected funding option.

6.4.2 Project 2: Well Mitigation

The SFK GSA is currently developing a well mitigation policy and evaluating options to fund the program. It is anticipated that the program will closely resemble the MKR well mitigation program and will be completed by August 2024. The SWK GSA is prepared to mitigate any shallow domestic wells impacted due to falling water levels. Again, with a limited number of wells active in the GSA, the funding for the well impacts is anticipated to be through a groundwater pumping fee. The program will specify outreach efforts and present the selected funding option.

6.4.3 Project 3: Meter Policy

Back 2020, the GSA implemented a meter policy which required the installation of meters on all active production wells but did not fully enforce the policy as the subbasin moved towards utilizing remote sensing data measuring evapotranspiration to calculate groundwater pumping. However, the GSA is committed to enforcing the policy to get a complete understanding of the amount of groundwater usage.

The meter policy Is included in Appendix K. The policy requires that meters be installed in accordance with manufacturers specification and have an accuracy of at least plus or minus five percent (±5%). The policy also requires that well owners report their meter readings every six months.

6.4.4 Project 4: Well Permitting Policy

The SWK GSA understands the importance of limiting subsidence in the area of the California Aqueduct and is preparing a policy requiring a subsidence study be conducted for any new well drilled in the GSA. The policy will also require that any well applicant also submit their subsidence evaluation to the DWR State Water Project team. The GSA expects that the policy will be completed by June 2024.

The GSA previously supported the Kettle City CSD for the subsidence evaluation for a new backup well required when the State Water Project cut deliveries to the community from approximately 400 AF to 50 AF. The GSA, at no charge to the community, performed a subsidence evaluation for submittal to the DWR State Water Project team. After a review of the submitted evaluation, DWR agreed with the findings that the well would not contribute substantially to subsidence along the Aqueduct and agreed to let the CSD proceed with the well.

6.5 El Rico GSA

Based on 2020 GSP, the average annual storage change for the ER GSA is estimated at negative 20,810 AF. The El Rico GSA is focused primarily on reducing subsidence in the area with a program of demand reduction by implementing groundwater allocations and crop fallowing in dry years. Table 6.1.0-1 summarizes the combination of projects and management actions that are proposed to offset the change in storage to achieve sustainability within the GSA boundary.

6.5.1 Project 1: Well Registry

A well survey requesting landowners to provide information on existing wells including well construction is already underway in the EL Rico GSA. The well registration program was included as part of the Rules and Regulations adopted by the GSA in December 2023. The well registration program will identify all wells located within the GSA, including domestic supply wells. The GSA will work with local governmental (Kings County, etc.) and non-governmental agencies (NGOs) to conduct outreach to domestic well owners. The well registration program includes penalties of up to $500 per facility for failure to register the well.

The well registration program requires that each well owner provide the following:

- Identify the Assessor's Parcel Number (APN) each well is located on;
- A copy of the Well Completion Report filed with DWR and if that is not available, provide well completion details;
- The location and coordinates of well and the state ell number; and
- The type of installed flowmeter.

6.5.2 Project 2: Well Meter Program

As discussed above in Project 1 Well Registry, the GSA Rules and Regulations approved by the GSA included requirements for the installation of meters on every well with an exclusion for De minimis users. The meters were required to be installed by March 2024.

Landowners are required to report monthly pumping data on a quarterly basis. These requirements apply to non-operational wells until the landowner submits evidence to the GSA of proper abandonment.

6.5.3 Project 3: Well Mitigation

The El Rico GSA is currently developing a well mitigation policy and evaluating options to fund the program. It is anticipated that the program will closely resemble the MKR GSA well mitigation program and will be completed by July 2024. The El Rico GSA is prepared to mitigate any shallow domestic wells impacted due to falling water levels. Again, with a limited number of wells active in the GSA, the funding for the well impacts is anticipated to be through a groundwater pumping fee. The program will specify outreach efforts and present the selected funding option.

6.5.4 Project 4: Initial Groundwater Allocations

The El Rico GSA understands that the effective management of groundwater pumping within the Subbasin is a necessary strategy to avoid significant and unreasonable levels of impacts. This management action will require the GSA to allocate and manage groundwater pumping to avoid undesirable results. A groundwater pumping allocation program was adopted by the El Rico GSA to meet these requirements in December 2023.

The groundwater allocation program began in October 2023 and will continue through the implementation period to 2040.

Landowners with historically irrigated land with the GSA boundary, excluding lands with the City of Corcoran or owned by the Tulare Lake Drainage district, are eligible for a groundwater allocation. The sustainable yield value is estimated at this time and will be revised as the Updated Tulare Lake Groundwater model is completed in 2025.

Year	Sustainable Yield (estimated)	Transitional Allocation	Total Annual Allocation
2024 – 2029	0.5 AF/AC	1.5 AF/AC	2.0 AF/AC
2030 – 2034	0.5 AF/AC	1.0 AF/AC	1.5 AF/AC
2035 – 2039	0.5 AF/AC	0.5 AF/AC	1.0 AF/AC
2040 and beyond	0.5 AF/AC	0 AF/AC	0.5 AF/AC

In addition to the allocation, any surface water banked within the GSA by a landowner shall be credited to the landowners account if is recharged at an approved banking site.

The penalty for exceeding the groundwater allocations is up to $500/AF for any landowner pumping in excess of total Allocation and groundwater credits.

6.5.5 Project 5: Salyer Basin

CID continues to excavate Salyer Reservoir (Section 1 Reservoir) to create additional flood water storage and groundwater percolation benefits. CID's goal over the next 10 years is to increase storge between 10,000 to 15,000 acre-feet and provide additional groundwater recharge.

6.5.6 Project 6: Improvements to Conveyance Systems

Corcoran Irrigation District (CID) continues their project to create an efficient conveyance system. For conservation purposes, CID has enclosed roughly 1.75 miles of open channel in its well field conveyance system in 2021. There is a total of approximately 3.75 miles of enclosed well ditch conveyance. CID's goal over the next 10 years is to enclose over 20 miles of conveyance channels for conservation purposes.

CID plans to construct new pipelines and replace inefficient canal systems with large diameter pipelines. These pipelines will be used to convey water with a higher efficiency than gravity canal systems and are proposed to service a greater area within the district. The proposed project is estimated to add up to twenty miles of pipelines. The pipe diameters in the range of 24-inch to 60-inches. The underutilized lands are approximately 800 acres to 1,500 acres of lands where water can be stored and or infiltrated when water is available.

CID plans to increase conveyance capacity to maximize the unused intentional recharge capacity of existing ponds. The key component is to increase the size of the conveyance system utilizing additional unused but available flood flows for recharged. The increased flows will be recharged in an area with existing recharge capabilities that will also be modified to allow for increased percolation abilities in existing ponds. This project proposed to increase the flood delivery system from approximately 650 cubic feet per second (cfs) to approximately 1,200 cfs creating an additional 550 cfs or 1,090 AF/day compared to existing conditions.

6.5.7 Project 7: Flood MAR

CID plans to modify existing conveyance systems within the CID boundary to supply water for recharge as well as storage. The goal is to have the capacity to divert water around the CID, to areas where the water can be used for On Farm Flood Capture, Aquifer Storage and Recovery, Above Ground Storage as well as irrigation when water is available and groundwater recharge. This project will increase the volume of water that can be captured and utilized within CID boundaries.

CID has proposed an Aquifer Storage and Recovery project that will use Scheduled and Flood water to recharge the lower aquifer utilizing existing wells that are perforated below the Corcoran clay layers. It is assumed that wells can recharge the lower aquifer at flow rated equal to half the production rate of the well. An assumption of 1.5 cfs per well can recharge back into the lower aquifer. This project proposes to use 50 wells for 20 days. The benefit from this project would be 3,000 AF/yr.

6.5.8 Project 8: Land Fallowing Program

The El Rico GSA has had a robust land fallowing program for decades based on their expected surface water deliveries into the area. The fallowing program uses flexible cropping patterns to adjust to available water supply, as opposed to overplanting permanent crops that create a fixed demand in excess of average sustainable supplies. During drought years, as much as 63,000 acres may be fallowed in the El Rico GSA.

The GSA is committed to continuing the land fallowing programs during the GSP implementation period and expects to expand the program as groundwater allocations take effect. The program also encourages the development of annual crops which provide the needed flexibility.

6.5.9 Project 9: Subsidence Mitigation Plan

The El Rico GSA is committed to mitigating impacts to canals and levees impacted by subsidence these impacts could range loss of conveyance in the canal to lowering of the levee protection. First the GSA will prepare a Subsidence Study to further evaluate the conditions that causing the subsidence and correlation between groundwater pumping and land subsidence. The study will consist of the installation of additional wells, benchmarks, and possibly extensometers. The study will also further identify the impacts of groundwater pumping in the areas surrounding the Subbasin.

Based on the results of the study, a subsidence mitigation plan will be prepared to address the impacts to critical infrastructure. While the plan is being developed, the GSA will address impacts to the canals and levees as they are identified. The mitigation plan will identify the criteria for further impact and how those impacts should be addressed.

6.6 Tri-County Water Authority

The average annual storage change for the Tri-County Water Authority (TCWA) GSA is estimated at surplus 2,560 AF. Although in surplus, Table 6.1.0-1 summarizes the combination of projects and management actions that are proposed to further secure the positive change in storage to maintain sustainability within the GSA boundary.

6.6.1 Project 1: Groundwater Allocations

TCWA passed and began implementing a Groundwater Extractions Allocations policy in 2021. The policy was specifically prepared to assist landowners to transition from current pumping levels to a sustainable value. A copy of the Groundwater Extractions Allocations policy is included in Appendix K.

All owners of parcels 5 acres or larger were eligible to participate in the groundwater allocation program. Smaller parcels were exempted from the program. All eligible parcels were provided a sustainable yield allocation harmonized across TCWA. The sustainable yield allocations is continually evaluated and is subject to adjustment at each GSP update.

In addition to sustainable yield, landowner developed credits can be developed through landowner water banking and recharge projects or other projects that help mitigate undesirable results. TCWA subsequently prepared a Groundwater Recharge Policy that presents the requirements to receive recharge credits and the amount of water that needs to left behind in the aquifer.

Again, the objective of the policy was gradually reducing groundwater pumping to sustainable levels. Therefore, additional credits were allocated to landowners referred to as Overdraft Transitional Groundwater Allocation. Th e transitional overdraft allocation was divided into two tiers with Tier 1 consisting of a yearly cap and a five-year cap. A civil penalty of $125/AF is charged for the entire amount of Tier 1 pumping. Tier 2 is any groundwater extraction above Tier 1 with a civil penalty of $500/AF.

Water Blocks	Tier 1 Five-Year Block
2021 - 2025	12 AF/AC (2.4 AF/YR)
2026 - 2030	7.5 AF/AC (1.5 AF/YR)
2031 - 2035	5 AF/AC (1.0 AF/YR)
2036 -2040	2.5 AF/AC (0.5 AF/YR)

6.6.2 Project 2: Well Registration Program

TCWA will require all well owners within its boundaries to register their wells. While the program is still in development, the GSA expects to utilize a program similar to one proposed by neighboring GSAs. With a very limited number of wells with the GSA boundaries, the well registration program will include direct outreach to landowners. The GSA will work with local governmental (Kings County, etc.) and non-governmental agencies (NGOs) to conduct outreach to domestic well owners. TCWA expects to complete the program by December 2024.

The well registration program requires that each well owner provide the following:

- Identify the Assessor's Parcel Number (APN) each well is located on;
- A copy of the Well Completion Report filed with DWR and if that is not available, provide well completion details;
- The location and coordinates of well and the state well number; and
- The type of installed flowmeter.

6.6.3 Project 3: Well Mitigation

The SFK GSA is currently developing a well mitigation policy and evaluating options to fund the program. It is anticipated that the program will closely resemble the MKR GSA well mitigation program and will be completed by August 2024. The TCWA is prepared to mitigate any shallow domestic wells impacted due to falling water levels. Again, with a limited number of wells active in the GSA, the funding for the well impacts is anticipated to be through an existing groundwater pumping fee.

6.6.4 Project 4: Well Meter Program

TCWA implemented a well meter program to collect groundwater extraction data from all non-domestic wells. The meter program requires that owners of all non-domestic wells install and maintain water meters. In order to provide standard data, the program list specifications for for the meters based on American Water Works Association (AWWA) Standard C700 and that the meters have flowrate indicators and totalizers. The program also specifies meter sizing, installation requirements, and maintenance be conducted in accordance with AWWA Standard M6. This standard also specifies meter calibration requirements. Landowners are required to report pumping data on a semi-annual basis.

6.6.5 Project 5: Land Repurposing Program

TCWA is currently participating in the Multibenefit Land Repurposing Program (MLRP) for the Tule Subbasin funded through the Department of Conservation (DOC). The MLRP seeks to repurpose agricultural lands to reduce reliance on groundwater while providing community health, economic wellbeing, water supply, habitat, and climate benefits. As part of the MLRP process, TCWA is developing and GSA specific plan that address how the program will be implemented. The plan is currently under preparation with stakeholder input from local communities, landowners, and the agricultural community.

Once the plan is developed, it will include a variety of options for landowners to consider when repurposing their land. While the plan is being developed for the neighboring Tule Subbasin, it will also be applicable to lands within the Tulare Lake Subbasin.

7. PLAN IMPLEMENTATION

GSP implementation began with the submittal of 2020 GSP and will continue in the Tulare Lake Subbasin (Subbasin). The Groundwater Sustainability Agencies (GSAs) will continue their efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the Subbasin to avoid future undesirable results related to groundwater usage. The GSAs have ongoing efforts to coordinate with a diverse range of stakeholders and beneficial users to improve the monitoring network and begin implementation of projects and management actions.

This chapter presents the proposed Plan Implementation including implementation costs, funding options, schedule, data management systems, annual reporting, and periodic evaluations.

7.1 Estimate of GSP Implementation Cost

23 CCR §354.6 *Agency Information. When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:*

(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The Subbasin's GSP was developed by the five GSAs within the Subbasin as a singular document to address groundwater overdraft. GSAs and member agencies will coordinate and implement the actions outlined in this GSP. As such, the implementation is anticipated to be performed by multiple agencies. The two main items that need to be funded as part of the GSP implementation include on-going administrative costs and project costs. Other costs include plans to fill data gaps and preparation of periodic GSP updates.

7.1.1 Administrative Costs

These expenses encompass the annual operational costs of the GSAs, which include staff salaries, data collection and reporting, outreach, legal fees, consultant fees, and other administrative expenses. However, these do not cover the costs specific to agency project implementation. The estimated annual cost per GSA ranges from $600,000 to $1,000,000. These costs are detailed in Table 7.1.1-1.

7.1.2 Project Costs

Project costs include planning, capital, financing and operations and maintenance of infrastructure. Each GSA within the Subbasin is responsible for implementing its own projects to reach sustainability. Costs will vary depending on the type and size of projects required to reach sustainability for each GSA. Total costs for the Subbasin are identified in Chapter 6. Several of these projects have already been constructed and implemented by the agencies within the Subbasin and are included in the GSP as the project benefits are just starting to be realized. Each GSA will identify the funding source and plan for their respective projects as discussed in Section 7.2.

7.2 Schedule for Implementation

23 CCR §350.4 *General Principles. Consistent with the State's interest in groundwater sustainability through local management, the following general principles shall guide the Department in the implementation of these regulations.*

(f) A Plan will be evaluated, and its implementation assessed, consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon.

Implementation of the GSP will result in the sustainable yield of groundwater resources in the Subbasin by year 2040. The schedule of projects and management actions is based on agency specific information presented in Chapter 6. Table 6.1.0-1 includes the anticipated start date for each project.

7.3 Identify Funding Alternatives

23 CCR §354.6. *Agency Information. When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:*

The GSAs are pursuing a variety of funding alternatives. All of the GSAs have already passed Proposition 218 elections, which secured funds to generate sufficient revenue for the on-going administrative costs. The costs of future Proposition 218 elections will be handled by each GSA.

Project costs will be covered by a variety of funding mechanisms to be determined by the project proponent. These include the project proponent directly funding the project, the GSA raising funds through Proposition 218 process, grant funding, groundwater pumping fees, overdraft penalties, and grant funding.

7.4 Data Management System

23 CCR §352.6. *Data Management System. Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.*

The five GSAs have developed a data management system (DMS) to store collected data necessary for the active management of the Subbasin. As stated in Chapter 5, *Monitoring Network*, future data will be gathered to develop annual reports, as well as provide necessary information for future and ongoing update to the groundwater models at five-year intervals upon GSP implementation. The DMS that that has been developed is a geographical relational database that includes information on water levels, surface water diversions, land elevation measurements, and water quality testing. The DMS allows the GSAs to share data and store the necessary information for annual reporting.

The DMS is on local servers and data is transmitted semi-annually to form a single repository for data analysis for the Subbasin's groundwater, as well as to allow for preparation of annual reports. GSA representatives have access to data and are able to ask for a copy of the regional DMS. The DMS currently includes the necessary elements required by the regulations, including:

- Well location and construction information for the representative monitoring points (where available)

- Water level readings and hydrographs including water year type
- Land based measurements
- Water quality testing results
- Estimate of groundwater storage change, including map and tables of estimation
- Graph with Water Year type, Groundwater Use, Annual Cumulative Storage Change

Reporting generated from data from the GSA's will include but is not limited to:

- Seasonal groundwater elevation contours
- Estimated groundwater extraction by category
- Total water use by source

Additional items may be added to the DMS in the future as required. Data is entered into the DMS by each GSA. The majority of the data is then be aggregated to the entity that is responsible for the regional DMS and summarized for reporting to DWR. Groundwater contours are prepared outside of the DMS because of the need to evaluate the integrity of the data collected and generate a static contour set that has been reviewed and will not change once approved. Groundwater storage calculations are performed in accordance with the method described in Section 3.2.3, outside of the DMS. Results are uploaded to the DMS for annual reporting and trend monitoring. Since most of the pumping in the Subbasin is not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the methods developed by GSAs and uploaded to the DMS for annual reporting and trend analysis. Surface water deliveries are maintained by the surface water agencies in existing separate systems, so the data are collected by each GSA and provided to the DMS as an aggregate total by GSA. Table 6.1.0-1 provides how the DMS addresses each required element of the DMS and annual reporting requirements.

7.5 Annual Reporting

23 CCR § 356.2 *Annual Reports. Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:*

(a) General information, including an executive summary and a location map depicting the basin covered by the report.

(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:

(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:

(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.

(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.

(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.

(5) Change in groundwater in storage shall include the following:

(A) Change in groundwater in storage maps for each principal aquifer in the basin. (B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

I A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

The GSAs will provide the Plan Manager the required information of groundwater levels, extraction volume, surface water use, total water use, groundwater storage changes and progress of GSP implementation for the Annual Report in accordance with the timelines required to meet the April 1st deadline each year.

The annual report is anticipated to have an outline similar to the following:

- Chapter 1– Introduction
- Chapter 2– Land use and Surface Water Supplies
- Chapter 3– Groundwater Pumping
- Chapter 4– Sustainable Management Criteria
- Chapter 5– Monitoring Network Changes

- Chapter 6– Groundwater Projects and Management Actions Status

In addition to the required Subbasin-wide reporting to DWR, the annual report needs to include the following:

- Member and Participating agency project/program specific progress and status updates
- Newly identify projects and programs added to the project list
- Updates on changes in membership or organizational changes
- Policy changes or modifications
- New information collected in data gaps
- Area specific investigations or improvements
- Stakeholder engagement and outreach efforts
- GSA funding status

7.6 Periodic Evaluations

23 CCR §356.4 *Periodic Evaluation by Agency. Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:*

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.
(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.
(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.
(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.
(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:
   a. An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.
   b. If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.
   c. The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.
(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.
(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.
(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.
(i) A description of completed or proposed Plan amendments.
(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.
(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733.

The annual report will include updates or changes to the GSP or policy changes by the GSA's. Certain components of the GSP may be re-evaluated more frequently than every five years, if deemed necessary. This may occur, for example, if sustainability goals are not adequately met, additional data are acquired, or priorities are altered. Those results will be incorporated into the GSP when it is resubmitted to DWR every five years.

In addition, the annual report will provide an assessment to DWR in accordance with the regulatory requirements, at least every five years. The assessment will include and provide an update on progress in achieving sustainability including current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to measurable objectives and minimum thresholds, changes in monitoring network, summary of enforcement or legal actions, and agency coordination efforts in accordance with 23 CCR §356.4.

As projects and management actions are being considered to mitigate for overdraft many of the projects and management actions will have implications to the farming economy within the Subbasin. Overdraft mitigation measures consist of the following project and management actions:

- Infiltration basins
- Storage ponds
- New water delivery systems
- Maintenance to existing water delivery systems
- Crop rotation
- Fallowing of lands
- Pumping restrictions

These project and management actions will reduce the farmable acres, and initiate restriction of groundwater pumping. A reduction in farmable acres may result in adverse effects (e.g., reduction in jobs). On the other hand, groundwater pumping restrictions will result in positive effects (e.g., reduction in pumping costs and drilling of new wells).

> **Reduction in Farmable Acreage:** Kings County anticipates a lack of water sources for agricultural production has the potential to impact employment statistics in the area (Nidever 2014). In 2014, Kings County residents experienced and average of 15% unemployment in February, according to a report released by the state Employment Development Department, compared to an unadjusted rate of 8.5% for California and 7% for the nation as a whole.
>
> **Reduction in Pumping:** Transitioning the Subbasin area to sustainable groundwater management is expected to impact the agricultural sector in three ways. First, institutional restrictions on groundwater extraction are likely to alter the mix of crops grown in the region and the amount produced. Second, stabilized groundwater elevations are predicted to reduce groundwater pumping costs over time, thereby lowering costs of production. Third, stabilized groundwater elevations are expected to reduce the need for capital investment to refurbish wells and develop additional wells (RMC Water and Environment 2015).
>
> However, the reduction in groundwater pumping section states there will be an equalization of cost associated with higher groundwater levels due to pumping restrictions. This does not address the increase in the unemployment rate associated with the reduction in pumping (e.g., demand reduction). At this time

there is not sufficient information to develop a financial impact due to demand reduction.

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2024 Tulare Lake Subbasin GSP
Tables

Table 1.3.0-1 GSP Requirements

Requirements
Groundwater conditions must be adequately defined and monitored to demonstrate the GSPs are achieving the sustainability goals for the basin
GSAs must be sufficiently defined and compatible to evaluate the effect of GSPs on adjacent basins
GSPs must meet substantial compliance standards
A GSA shall provide a description of basin setting and establish criteria that will maintain or achieve sustainable groundwater management
DWR will consider state policy regarding to the human right to water when implementing these regulations
The GSP sustainable groundwater management criteria, projects, and management actions should be based on the level of understanding of the basin setting including an understanding of uncertainty and data gaps
A GSP must achieve the sustainability goals for the basin in 20 years

Table 1.5.0-1 Participating GSA Contact Information

GSA	Plan Manager	Address	Telephone	Email
Mid-Kings River	Dennis Mills, General Manager	200 North Campus Dr. Hanford, CA 93230	(559) 584.6412	Dennis.kingscwd@outlook.com
El Rico	Jeof Wyrick, Chairman	101 W. Walnut St. Pasadena, CA 91103	(626) 583.3000	jwyrick@jgboswell.com
South Fork Kings	Ceil Howe, Director	321 C Street Lemoore, CA 93245	(559) 423.5875	chowejr@westlakefarmsinc.com
Southwest Kings	Jared Hutchings, General Manager	944 Whitley Ave. Suite E. Corcoran, CA 93212	(559) 992-8980	jhutchings@angiolawd.org
Tri-County Water Authority	Deanna Jackson, Executive Director	944 Whitley Ave. Suite E. Corcoran, CA 93212	(559) 762.7240	djackson@tcwater.org

Table 1.5.1-1 GSA Member Agencies

GSA	GSA Member Agencies	
Mid-Kings River	■ Kings County Water District ■ City of Hanford	■ Kings County
El Rico	■ Alpaugh Irrigation District ■ City of Corcoran ■ Corcoran Irrigation District ■ Kings County ■ Lovelace Reclamation District No. 739	■ Melga Water District ■ Salyer Water District ■ Tulare Lake Basin Water Storage District ■ Tulare Lake Drainage District
South Fork Kings	■ City of Lemoore ■ Empire West Side Irrigation District ■ Stratford Irrigation District	■ Stratford Public Utility District ■ Kings County
Southwest Kings	■ Dudley Ridge Water District ■ Tulare Lake Reclamation District No. 761	■ Kettleman City Community Services District ■ Tulare Lake Basin Water Storage District ■ Kings County
Tri-County Water Authority	■ Angiola Water District ■ Kings County	■ Deer Creek Storm Water District ■ Wilbur Reclamation District #825

Table 2.0.0-1 Land Use in Tulare Lake Subbasin (2014)

Land Use Classification	Percent of Total Area
Commercial	0.3%
Deciduous Fruit and Nuts	14.6%
Field Crops	30.1%
Grain and Hay Crops	6.2%
Idle	22.9%
Industrial	0.3%
Pasture Crops	7.1%
Residential	0.4%
Riparian Vegetation	2.8%
Semi agricultural	1.8%
Truck, Nursery, and Berry Crops	6.0%
Urban	3.8%
Urban Landscape	0.1%
Vineyards	1.5%
Water Surface	2.0%
Young Perennials	0.1%
TOTAL	**100.0%**

Table 2.0.0-2 Primary Water Uses and Water Sources

Groundwater Sustainability Agency	Water Use Sector (Agency / Water Company)	Water Use	Water Source Type
El Rico GSA	Alpaugh Irrigation District	Irrigation	Groundwater
	City of Corcoran	Residential Commercial Residential	Groundwater
	Corcoran Irrigation District	Irrigation Recharge	Kings River Kaweah River St. John's River
	Corcoran Irrigation Company	Irrigation Recharge	Kings River Kaweah River St. John's River
	Peoples Ditch Company	Irrigation Recharge	Kings River
	Last Chance Water Ditch Company	Irrigation Recharge	Kings River
	Lakeside Canal Company	Irrigation Recharge	Kaweah River St. John's River CVP
	Tulare Lake Basin Water Storage District	Irrigation	Kings River Kaweah River St. John's River Tule River SWP
Tri-County Water Authority GSA	Angiola Water District	Irrigation Recharge	SWP CVP Kings River Tule River Deer Creek Groundwater Poso Creek
	Atwell Island Water District	Irrigation	Groundwater
	Deer Creek Storm Water District	Flood Control	Deer Creek Poso Creek
	W. H. Wilbur Reclamation District #825	Irrigation	Poso Creek
Mid-Kings River GSA	City of Hanford	Residential Commercial Industrial	Groundwater
	Armona Community Services District	Residential Commercial	Groundwater
Mid-Kings River GSA (Continued)	Home Garden Community Services District	Residential	Groundwater
	Kings County Water District	Irrigation Recharge Banking	Kings River Kaweah River St. John's River CVP
	Lakeside Irrigation Water District & Canal Company	Irrigation Recharge	Kaweah River St. John's River CVP
	Peoples Ditch Company	Irrigation Recharge	Kings River
	Last Chance Water Ditch Company	Irrigation Recharge	Kings River
	Santa Rosa Rancheria	Residential Commercial	Groundwater
Southwest Kings GSA	Dudley Ridge Water District	Irrigation	SWP
	Tulare Lake Reclamation District #761	Irrigation	Kings River SWP Groundwater
	Tulare Lake Basin Water Storage District	Irrigation	Kings River Kaweah River St. John's River Tule River SWP
	Kettleman City Community Services District	Residential Commercial Industrial	SWP Groundwater (emergency supply)
South Fork Kings GSA	Lemoore Canal and Irrigation Company	Irrigation	Kings River
	Stratford Irrigation District	Irrigation	Kings River
	Stratford Public Utility District	Residential Commercial	Groundwater
	Santa Rosa Rancheria	Residential Commercial	Groundwater
	City of Lemoore	Municipal	Groundwater

Table 2.3.1-1 Summary of Applicable Plans

County	Plan	Online Source
Kings County	Kings County 2035 General Plan (adopted January 2010, includes Land Use, Circulation, Noise, Open Space, Resource Conservation, Health and Safety, and Air Quality Elements; Housing Element updated January 2016; Dairy Element adopted July 2002)	https://www.countyofkings.com/departments/community-development-agency/information/2035-general-plan
	Armona Community Plan (2009)	https://www.countyofkings.com/home/showdocument?id=13505
	Home Garden Community Plan (2015)	https://www.countyofkings.com/home/showdocument?id=13507
	Kettleman City Community Plan (2009)	https://www.countyofkings.com/home/showdocument?id=13509
	Stratford Community Plan (2009)	https://www.countyofkings.com/home/showdocument?id=3106
	City of Hanford – 2035 General Plan (April 2017)	http://www.cityofhanfordca.com/document_center/Planning/Plans/Hanford%20General%20Plan/2035%20General%20Plan%20%20Policy%20Document. pdf
	City of Lemoore – 2030 General Plan (May 2008)	http://lemoore.com/communitydevelopment/general-plan/
	City of Corcoran – 2025 General Plan (March 2007), 2005-2025 General Plan Enhancement (November 2014)	http://www.cityofcorcoran.com/civica/filebank/blobdload.asp?BlobID=3796
County of Tulare	County of Tulare – 2030 General Plan (August 2012)	http://generalplan.co.tulare.ca.us/documents/GP/001Adopted%20Tulare%20County%20General%20Plan%20Materials/000General%20Plan%202030%20Part%20I%20and%20Part%20II/GENERAL%20PLAN%202012.pdf
Kern County	Kern County – General Plan (September 2009)	https://kernplanning.com/planning/pl anning-documents/general-plans- elements/

Table 2.5.3-1 Beneficial Uses and Users by GSA

Stakeholder Group	Description
Mid-Kings River GSA	
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users.
Domestic Well Owners	There are domestic wells within the Mid-Kings River GSA, and it is understood that many rural domestic users will fall into the "de minimis extractor" category, so further work is being conducted to understand to what extent domestic users will be affected by GSP requirements.
Public Water Systems	Armona CSD, Home Garden CSD and Hardwick Water Company, as well as several transient public water systems for school districts are included in this category (Kings River-Hardwick, Pioneer, Hanford Christian).
Municipal Water Systems	City of Hanford
Local Land Use Planning Agencies	City of Hanford and Kings County
California Native American Tribes	See Appendix B, Section C.2
Disadvantaged Communities	Armona, Home Garde, Hardwick
Entities monitoring and reporting Subbasin groundwater elevations	Kings CWD monitors groundwater levels within its service area and is providing a subset of that information to the KRCD for submission to the CASGEM system.
South Fork Kings GSA	
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users.
Domestic Well Owners	There are domestic wells within the South Fork Kings GSA, and it is understood that many domestic users will fall into the "de minimis extractor" category, so further work is being conducted to understand to what extent domestic users will be affected by GSP requirements.
Municipal Well Operators	City of Lemoore, Stratford PUD
Local Land Use Planning Agencies	City of Lemoore, Kings County
California Native American Tribes	See Appendix B, Section C.2
Disadvantaged Communities	Community of Stratford
Entities monitoring and reporting Subbasin groundwater elevations	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. South Fork Kings GSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.
Southwest Kings GSA	
Agricultural Users	Approximately 99% of the GSA is composed of agricultural lands. Representatives of the agricultural community are currently involved on the GSA Board of Directors.
Domestic Well Owners	Only one or two landowners utilize a domestic well and are represented on the Board of Directors through member agencies.
Municipal Well Operators	Kettleman City CSD relies solely on surface water supply (effective October 2019). Their municipal wells are a back-up source to provide well water to residential and commercial customers within the GSA boundary in emergency situations when surface water is not accessible.
Local Land Use Planning Agencies	Kings County
California Native American Tribes	See Appendix D, Section C.2
Disadvantaged Communities	Kettleman City
Entities monitoring and reporting Subbasin groundwater elevations	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. Southwest Kings GSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.
El Rico GSA	
Agricultural Users	Represented through many of the GSA member agencies and/or by Kings County.
Domestic Well Owners	Represented through member agencies including Kings County or via exemption for small amounts of groundwater extraction.
Municipal Well Operators	City of Corcoran
Public Water Systems	City of Corcoran
Local Land Use Planning Agencies	City of Corcoran, Kings County
Surface Water Users	Represented through GSA member agencies
Disadvantaged Communities	City of Corcoran
Entities monitoring and reporting Subbasin groundwater elevations	Represented by GSA member agencies including TLBWSD that collects and reports data for multiple members of the agency via the Tulare Lake Coordinated Groundwater Management Plan.
Tri-County Water Authority GSA	
Agricultural Users	Composed almost entirely of agricultural users, including nut grower commodity groups and other agricultural use growers.
Domestic Well Owners	There are domestic wells within the GSA area, but because SGMA excludes "de minimis extractors," it is anticipated that the GSP will exclude domestic wells from such requirements.
Local Land Use Planning Agencies	Kings County
Federal Government	Bureau of Land Management
Entities monitoring and reporting Subbasin groundwater elevations	Angiola WD, TLBWSD

Table 3.1.1-1 Historical Hanford Precipitation (Inches), Tulare Lake Subbasin SGMA Model, Kings County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1899	M	M	M	M	M	M	M	M	0	0.67	M	0.87	M
1900	1.38	0	1.18	1.04	M	M	M	M	M	M	M	M	M
1901	M	M	M	M	M	M	M	T	1.04	T	M	0.15	M
1902	0.4	2	1.78	0.47	0.09	M	0	M	0	0.36	1.67	0.56	M
1903	1.31	0.38	1.71	0.5	0	0	0	0	0	0.05	0.47	0.15	4.57
1904	0.52	2.03	2.05	0.72	0	0	0	0	2.48	0.84	0.31	1.16	10.11
1905	1.28	1.09	2.1	0.56	0.65	0	0	0	0.07	0	1.16	0.23	7.14
1906	1.59	1.92	4.05	0.62	2.06	0.02	0	0	0	0	M	M	M
1907	M	M	M	M	M	M	M	M	M	M	M	M	M
1908	M	M	M	M	M	M	M	M	M	M	M	0.31	M
1909	M	M	M	M	M	M	M	M	M	M	M	M	M
1910	M	M	M	M	M	M	M	M	M	M	M	M	M
1911	M	M	M	M	M	M	M	M	M	M	M	M	M
1912	M	0.02	3.24	1.52	0.27	0	0	0	0	0	0.61	0.21	M
1913	1.26	1.55	0.34	0.78	0.76	0.06	0.08	0	M	M	M	1.35	M
1914	4.36	1.25	0.37	0.11	M	1.06	0	0	0	0	0.02	M	M
1915	M	M	0.3	1.37	M	M	M	M	M	M	M	M	M
1916	4.68	M	M	M	0.16	M	M	0.28	0.47	1.09	M	1.35	M
1917	M	M	M	M	0.31	M	M	M	M	M	M	M	M
1918	M	4.5	3.43	M	M	M	M	M	0.88	0.12	M	M	M
1919	M	M	1.01	0.15	0.1	M	M	M	M	M	M	M	M
1920	M	2.72	3.05	0.24	M	M	M	M	M	M	M	M	M
1921	M	0.89	M	M	0.87	M	M	M	M	M	M	M	M
1922	M	M	M	M	M	M	M	T	M	M	M	M	M
1923	M	M	M	2.43	M	M	M	M	M	M	M	0.22	M
1924	M	M	1.86	M	0	M	M	T	0	0.65	M	2.12	M
1925	M	M	1.58	M	M	M	0	M	0	M	M	M	M

See Acronyms and Abbreviations list for definitions.

Table 3.1.1-1 Historical Hanford Precipitation (Inches), Tulare Lake Subbasin SGMA Model, Kings County, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1926	0.82	1.44	0.2	2.67	T	0	0	0	0	0.76	3.67	0.65	10.21
1927	1.33	2.52	2.04	0.18	0.06	T	0	0.04	T	1.67	1.63	0.78	10.25
1928	0.09	0.96	1.55	0.08	0.1	0	0	0	0	T	1.47	1.69	5.94
1929	0.81	0.61	1.4	0.81	0	0.24	T	0	0.03	0	0	0.42	4.32
1930	1.66	1	1.66	0.15	0.37	0	0	0.02	0.38	0.07	0.67	0.3	6.28
1931	2.32	0.72	0.07	0.91	0.2	1.12	0	0.08	0.08	0	1.36	2.54	9.4
1932	1.85	1.52	0.47	0.71	0.13	0	0	0	0	0	0.28	0.93	5.89
1933	3.12	0.16	0.72	0.28	0.41	0.07	0	0	0	0.15	0	1.01	5.92
1934	0.17	1.53	0.05	0	0.22	0.14	0	0	0	1.06	2.15	1.84	7.16
1935	2.5	1.77	2	2.05	0	0	0.03	0	0.06	0.51	0.4	0.89	10.21
1936	0.66	4.7	0.97	0.55	T	T	0	0	0	1.84	0	2.87	11.59
1937	1.95	2.46	2.23	0.22	0	0	0	0	0	0.11	0.21	2.16	9.34
1938	1.76	3.51	4.59	1.15	0.11	0.17	0.07	0	0.13	0.19	0.19	1.42	13.29
1939	1.54	0.77	1.44	0.82	T	0.12	0	0	0.04	0.57	0.06	0.22	5.58
1940	3.53	3.61	0.99	0.18	T	T	0	0	0	0.85	T	3.61	12.77
1941	1.51	3.9	2.05	2.41	T	T	0	T	0	0.9	0.57	3.11	14.45
1942	1.21	0.88	0.94	1.19	0.16	0	0	M	0	0	0.43	1.1	M
1943	2.73	1.14	3.35	0.87	0	0	0	0	0	0.03	0.22	1.03	9.37
1944	1.28	2.97	0.22	0.86	0.28	0.23	0	0	0.02	0.23	2.25	0.97	9.31
1945	0.26	2.71	1.81	0.16	0.1	0.17	0	0	T	0.71	1.15	1.51	8.58
1946	0.34	1.53	2.56	0.07	0.41	0	0.11	0	0	1.33	1.1	2.06	9.51
1947	0.41	0.49	0.56	0.11	0.41	0	0	0	T	0.59	0.29	0.51	3.37
1948	0	0.44	1.46	1.55	0.54	0	0	0	0	0.03	0.01	0.99	5.02
1949	0.51	0.85	1.94	0.07	0.53	0	0	T	0	0	0.6	0.68	5.18
1950	1.93	1.13	1.1	0.4	0	0	0.08	0	0	0.34	0.63	1.06	6.67
1951	1.24	0.76	0.22	1.17	0.07	0	0	0	0	0.08	1.11	2.39	7.04
1952	3.08	0.27	2.18	0.79	0.01	0.02	T	0	0.17	0.05	0.65	2.96	10.18
1953	1.1	0.27	0.34	0.83	0.29	0.02	T	0	0	0.02	1.01	0.09	3.97
1954	1.89	0.78	2.21	0.52	0.34	0.08	0	0	0	0	0.66	1.61	8.09

See Acronyms and Abbreviations list for definitions.

Table 3.1.1-1 Historical Hanford Precipitation (Inches), Tulare Lake Subbasin SGMA Model, Kings County, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1955	3.25	1.31	M	M	0.9	0	0	M	0	0.02	0.92	4.67	M
1956	1.2	0.38	0.1	0.73	0.83	0	0	0	0	0.72	0	0.15	4.11
1957	1.39	1.17	0.56	0.67	0.63	0	0	0	0	0.2	1.39	1.41	7.42
1958	1.85	2.3	3.92	2.04	0.24	0	0	T	0.88	0	0.23	0.16	11.62
1959	0.86	1.9	0.11	0.52	T	0	0	T	0.11	0	0	0.17	3.67
1960	0.8	1.71	0.61	0.57	0	0	0.02	0	0	0.53	2.61	0.03	6.88
1961	1.34	0.22	0.67	0.22	0.37	0	0	0	0	0	1.11	1.28	5.21
1962	0.71	4.88	1.06	0	0.11	0	0	0	0.01	0.1	0	0.19	7.06
1963	1.19	1.68	1.37	2.88	0.56	0.17	0	0	0.33	0.75	1.23	0.29	10.45
1964	0.61	0.02	0.94	0.64	0.2	0	0	0.34	0	0.95	1.31	1.44	6.45
1965	1.18	0.33	0.33	1.6	0	0	0	0.05	0.07	0.05	2.15	1.97	7.73
1966	0.63	0.71	0.1	0	0.07	0.06	0.04	0	0.29	0	1.28	2.57	5.75
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1967	1.41	0.05	2.42	2.95	0.07	0.23	0	0	0.31	0	1.99	0.5	9.93
1968	0.57	0.64	1	0.5	0.08	0	0	0	0	1.33	0.98	1.64	6.74
1969	6.69	4.54	0.79	0.85	0.32	0.21	0.07	0	0.15	0.05	0.51	0.7	14.88
1970	1.6	1.33	1.42	0.16	0	T	T	0	0	T	2.4	1.23	8.14
1971	0.35	0.19	0.23	0.4	1.44	0	0	T	0.04	0.06	0.41	1.87	4.99
1972	0.04	0.35	0	0.23	0	0	0	0	0.24	0.21	2.9	0.65	4.62
1973	M	2.29	2.2	0.12	M	M	0	0	0	M	M	M	M
1974	2.97	0.11	1.75	0.03	0	0	0	0	0	0.65	0.24	1.4	7.15
1975	0.09	2.26	M	0.49	0	0	0	0	0.96	M	0.05	0.22	M
1976	T	2.94	0.19	1.47	0.03	0.51	0	0.22	1.47	0	1.15	0.96	8.94
1977	0.59	0.03	0.43	0	0.91	0.07	0	0	0	0.05	0.66	2.85	5.59
1978	2.22	5.05	4.12	1.71	0	0	0	0	1.1	0	0.79	0.5	15.49
1979	2.19	1.61	1.16	0.03	0	0	0.04	0	0.08	0.41	0.62	0.41	6.55
1980	2.9	2.71	1.28	0.05	0.04	0	0	0	0	0.09	0	0.2	7.27
1981	1.77	0.86	2.1	0.68	0.17	0	0	0	0	0.76	1.08	0.29	7.71
1982	0.84	0.38	3.52	1.75	0	0.45	0.18	0	0.64	1.03	2.15	0.71	11.65

See Acronyms and Abbreviations list for definitions.

Table 3.1.1-1 Historical Hanford Precipitation (Inches), Tulare Lake Subbasin SGMA Model, Kings County, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1983	3.74	2.59	3.39	1.63	0.04	0	0	0.05	0.82	0.43	1.66	1.22	15.57
1984	0.01	0.42	0.27	0.18	0	0	0	0	0	M	M	M	M
1985	0.59	M	0.7	0.12	0	0	M	0	T	M	2.11	0.66	M
1986	1.46	2.6	3.43	0.5	0	0	T	T	0.15	0	0.21	0.77	9.12
1987	1.77	2.07	2.02	0.06	0.13	0.05	0	0	0	0.58	0.47	1.7	8.85
1988	1.37	0.4	0.93	1.99	0.07	0	0	0	0	0	1.31	2.29	8.36
1989	0.17	1.04	0.85	0.02	0.39	0	0	T	0.67	0.32	0.2	0	3.66
1990	1.66	1.1	0.3	0.97	0.87	0	T	T	T	0.01	0.22	0.15	5.28
1991	0.31	0.12	6.62	0.19	T	0.12	0	0	0.11	0.41	0.14	M	M
1992	1.4	2.82	0.85	0.1	T	0	0.01	0.01	T	0.58	T	2.62	8.39
1993	3.88	2.48	2.16	0.07	0.08	0.3	0	0	0	0.24	0.64	0.66	10.51
1994	0.94	1.45	1.02	0.72	0.66	0	T	0	1.06	0.35	1.54	0.33	8.07
1995	4.7	0.51	4.77	0.65	0.87	0.04	T	0	T	0	T	1.59	13.13
1996	1.68	2.89	2.27	0.85	0.1	T	0	0	0	2.43	0.69	3.27	14.18
1997	3.02	0.12	0.21	0	0	T	T	0	0.06	0.09	1.96	1.8	7.26
1998	2	4.05	2.63	1.68	1.31	0.44	0	0	T	0.68	0.63	0.65	14.07
1999	3.01	0.56	0.43	1.37	0	0	0	T	0.01	0	0.15	T	5.53
2000	1.8	3.28	1.59	0.97	0.48	0.35	0	0	0.03	1.31	T	0.05	9.86
2001	1.98	1.48	1.24	1.12	0	0	0.09	0	T	0.18	1.84	1.99	9.92
2002	0.87	0.31	1.04	0.03	0.01	0.82	0	0	0	0	1.42	1.14	5.64
2003	0.24	1.08	1.01	1.5	0.62	0	T	0.07	0	0	0.49	2	7.01
2004	2	2.18	0.29	0.02	0.01	0	0	0	0	2.06	0.52	2.23	9.31
2005	2.63	1.58	2.24	0.71	0.83	0	0	T	0.01	0.01	0.19	2.07	10.27
2006	3.54	0.55	2.72	3.39	0.53	0	0	0	0	0.06	0.22	1.01	12.02
2007	0.65	0.89	0.26	0.33	0.01	0	0	0.12	0.37	0.35	0.12	1.32	4.42
2008	2.18	1.18	T	0	0.11	0	0	0	0	0.15	1.04	1.49	6.15
2009	0.8	1.86	0.2	0.02	0.41	0.22	0	0	0.18	1.32	0.28	1.42	6.71
2010	2.64	1.91	0.34	1.65	0.17	0	0	0	0	0.64	1.32	6.46	15.13
2011	1.52	1.53	2.87	0.3	0.4	1.04	0	0.08	0.01	0.55	0.8	0.06	9.16

See Acronyms and Abbreviations list for definitions.

Table 3.1.1-1 Historical Hanford Precipitation (Inches), Tulare Lake Subbasin SGMA Model, Kings County, California (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2012	M	M	M	1.39	0.03	M	T	0	0	0.28	0.49	1.9	M
2013	0.22	0.48	0.79	0.08	0.17	0	0	0	0.01	T	0.33	0.16	M
2014	0.3	1.38	0.27	0.35	T	0	0	0	0.03	0	0.94	2.52	5.79
2015	0.08	0.72	0.02	0.77	0.1	0	0.45	0	0	0.38	0.91	1.4	4.83
2016	2.56	0.58	1.99	0.57	0.02	0.09	0	0	0	0.76	0.4	1.6	8.57
2017	3.7	2.8	0.31	1.02	0.36	0.01	0	0.01	0.17	0.06	0.21	0.08	8.73
Mean	1.59	1.5	1.47	0.75	0.25	0.09	0.01	0.01	0.15	0.38	0.82	1.24	8.28
Min	6.69	5.05	6.62	3.39	2.06	1.12	0.45	0.34	2.48	2.43	3.67	6.46	15.57
	1969	1978	1991	2006	1906	1931	2015	1964	1904	1996	1926	2010	1983
Max	0	0	0	0	0	0	0	0	0	0	0	0	3.37
	1948	1900	1972	2008	2018	2015	2017	2016	2016	2014	1980	1989	1947

Source: https://w2.weather.gov/climate/xmacis.php?wfo=hnx.

Notes:
M – Data missing
T – Trace precipitation

See Acronyms and Abbreviations list for definitions.

Table 3.1.1-2 Historical Land Use, Tulare Lake Subbasin SGMA Model, Kings County, California

Tulare Lake Subbasin	1990-1995 (Acres)	1996-1998 (Acres)	1999-2006 (Acres)	2007 (Acres)	2008 (Acres)	2009 (Acres)	2010 (Acres)	2011 (Acres)	2012 (Acres)	2013 (Acres)	2014 (Acres)	2015 (Acres)	2016 (Acres)	Average (Acres)
Tulare Lake Subbasin														
Alfalfa Hay and Clover	41,604	32,564	54,301	72,459	80,600	71,504	69,685	38,789	42,131	49,318	35,820	29,665	24,245	45,987
Almonds (Adolescent)			2,908			5,127	7,927	3,222	4,464	7,476	6,526	6,222	5,365	2,470
Almonds (Mature)	7,682	5,241	4,550	12,897	11,825	9,826	8,374	10,140	10,818	11,441	12,876	15,046	15,105	7,852
Almonds (Young)		3,278	9,290	16,538	25,966	14,678	20,887	13,968	14,564	20,341	17,678	16,983	21,576	9,557
Berries	20								1	2		0		5
Carrot Single Crop								11	5	12	2	2	16	2
Citrus (no ground cover)			25		13	14	4	120	29	100	89	22	9	21
Corn and Grain Sorghum	14,280	38,896	29,349	39,271	31,762	34,643	23,031	33,780	29,175	27,566	22,638	18,826	17,400	25,404
Cotton	159,534	180,960	124,764	109,605	88,304	72,441	98,167	105,541	88,993	89,317	63,385	44,532	73,720	118,794
Dairy Single Crop*	3,816	4,077	4,385											2,438
Fallow Land*	193,695	138,392	89,606	65,169	85,144	99,688	90,192	152,391	172,697	172,486	195,172	237,790	200,972	136,159
Forest*	420	809	2,955	6	5	46	5			1		4	0	952
Grain and Grain Hay	28,708	48,533	62,962	19,266	27,870	27,406	25,980	7,758	9,968	11,194	12,213	21,196	19,069	34,833
Melons	250	56	284				14	2	11	7	797	18	86	170
Misc. field crops	17,116	12,819	51,311		2			0			2			18,531
Onions and Garlic	457	479	770			7	1,358	411	302	94	502	149	644	483
Open Water*	5,568	9,092	8,968	5,576	4,296	4,049	5,434	7,703	5,443	5,045	6,824	5,919	5,435	6,637
Pasture and Misc. Grasses	2,500	5,029	5,615	50,688	44,232	66,944	53,080	14,680	13,368	15,355	33,551	15,744	13,743	14,473
Pistachio (Adolescent)								170	218	370	882	3,575	3,836	335
Pistachio (Mature)	4,694	3,808	3,804	6,096	1,907	934	404	394	380	348	330	485	469	2,888
Pistachio (Young)		1,580	4,390	4,351	4,259	8,527	8,083	12,985	14,676	15,878	19,195	22,678	22,570	6,247
Pomegranates (Adolescent)											3	16	27	2
Pomegranates (Young)				61	1,705	545	256	5,012	804	1,395	2,207	1,312	3,111	608
Potatoes, Sugar beets, Turnip etc..	5,736	1	209	6		3		9		41		2	2	1,331
Riparian*		668	1,120	517	134	398	615	226	138	313	239	248	194	477
Small Vegetables	1,599	647	4,518	20	2	13	212	142	133	244	165	78	198	1,643
Stone Fruit (Adolescent)			1,478			14	66	100	125	69	47	191	170	412
Stone Fruit (Mature)	7,070	4,985	3,854	1,314	544	168	18	3	23	41	23	27	39	3,206
Stone Fruit (Young)		1,827	4,185	672	1,609	1,573	2,502	1,077	712	1,641	1,340	1,183	713	1,770
Tomatoes and Peppers	5,634	1,627	14,676	117	2	110	12	21,482	23,670	7,114	11,922	19,211	23,420	9,203
Urban, Industrial*	12,654	17,391	19,875	33,427	34,711	44,471	32,218	32,091	28,576	29,366	33,901	30,530	30,930	22,128
Wine Grapes with 80% canopy	2,948	3,226	5,779	5,588	3,499	2,240	2,746	5,361	9,228	4,655	6,472	4,672	10,985	4,565
Winter Wheat*				72,238	67,458	50,451	64,526	48,212	45,118	44,530	30,950	19,420	21,690	17,207
Tulare Lake Subbasin Irrigated Crop Acreage	**299,832**	**345,557**	**389,021**	**338,951**	**324,102**	**316,717**	**322,806**	**275,156**	**263,796**	**264,018**	**248,665**	**221,837**	**256,519**	**310,792**
Tulare Lake Subbasin Total Crop Acreage	**515,986**	**515,986**	**515,931**	**515,883**	**515,849**	**515,821**	**515,796**	**515,779**	**515,768**	**515,759**	**515,751**	**515,747**	**515,741**	**496,788**

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year

See Acronyms and Abbreviations list for definitions.

Table 3.1.5-1 Generalized Stratigraphic Column for Tulare Lake Subbasin

System	Series	Geologic Unit		Lithologic Character	Maximum Thickness (feet)	Water-Bearing Character	Areas Where Important
QUATERNARY	Holocene	Tulare Formation	Flood Basin Deposits	Interbedded silt, clay, and fine sand. Interfingers with and age equivalent to Younger Alluvium.	<50	Poorly permeable, poor quality water, unconfined.	Not important source of water.
QUATERNARY	Holocene	Tulare Formation	Younger Alluvium	Interstratified and discontinuous beds of clay, silt, sand, and gravel, primarily located on recent alluvial fans and along stream channels. Interfingers with flood-basin and lake bed deposits.	0 - 100	Highly permeable, but largely unsaturated or seasonally saturated. Serves as conduit for recharge to underlying units.	May provide sufficient supplies for domestic and stock use where saturated.
QUATERNARY	Pleistocene	Tulare Formation	Older Alluvium	Poorly to well sorted fine to coarse sand, gravel, silt and clay. Represents older alluvial fan material and contains well-developed soil profiles and hardpan horizons. Interfingers with lacustrine clays.	300 - 500	Moderately to highly permeable, unconfined and semiconfined. Yields large quantities of water to wells, major aquifer.	Important source of groundwater on eastern and northern portions of TLSB.
QUATERNARY	Pleistocene	Tulare Formation	Lacustrine Deposits	Corcoran Clay is extensive reduced clay formed in large fresh-water lake in late Pleistocene that extended throughout most of the San Joaquin Valley. Has been deformed across valley axis and has been dated at about 600,000 Ma.	50 - 200	Poorly permeable, forms major aquitard within San Joaquin Valley.	Occurs beneath nearly the entire TLSB, including Tulare Lake. Important aquitard on eastern and northern portions of TLSB.
QUATERNARY	Pleistocene	Tulare Formation	Lacustrine Deposits	Tulare Lake bed clays are thick deposits that extend vertically from the surface beneath the former lake. These beds interfinger with alluvial and continental deposits to the east and west. Croft (1972) identified several of these interfingering lacustrine clay beds as the A-D and F clays. His E-clay is equivalent to the Corcoran Clay (above).	0 - 3,000	Poorly permeable, forms significant barrier to lateral groundwater flow in the TLSB and lateral tongues can form local confining conditions in alluvial and continental deposits.	Tulare Lake bed forms clay plug on western portion of TLSB. A and C clays are thin (10 - 60 feet) beds that may be important aquitards on the northern and eastern portions of TLSB.
TERTIARY	Pliocene	Tulare Formation	Continental Deposits, undifferentiated	Poorly to moderately sorted fine to medium sand, silt, gravel, and clay. Deposits may be reduced or oxidized. Provenance may be from Sierra Nevada or Coast Ranges. Sierran deposits typically arkosic and coarser grained than Coast Ranges deposits. Deposits from each provenance interfingering in an east-west line, depending upon major transgressive deposition from each mountain range.	2,000+	Poorly to moderately permeable, semi-confined to confined conditions. Yields significant quantities of groundwater, especially below Corcoran Clay.	Important source of groundwater on eastern and northern portions of TLSB and northwest and southeast of TLSB.
TERTIARY	Pliocene	San Joaquin Formation	Marine Deposits	Poorly sorted fine-grained sandstone, siltstone, and mudstone.	1,500+	Exposed in Kettleman Hills, dips steeply to east beneath Tulare formation. Semi-consolidated to consolidated, containing connate water of poor quality. Formation is poorly permeable and forms substantial aquitard at base of Tulare Formation.	No known beneficial uses of water, typical TDS of 3,000 to 20,000 mg/L.
TERTIARY	Pliocene	Etchegoin Formation	Marine Deposits	Silty and clayey sands, sandy silt, silty clay, blue sandstone, and conglomeratic sandstone.	3,000+	Exposed in Kettleman Hills, dips steeply to east beneath San Joaquin formation. Fine grained, interbedded nature, contains saline water.	No known wells into formation, not expected to be an aquifer.
TERTIARY	Miocene	Santa Margarita Formation	Marine Deposits	Fairly well-sorted to well-sorted gray sandstone.	0 - 600	Contains good quality water and yields significant water to wells for irrigation in places. However, sodium chloride front exists about 7 to 10 miles east of Highway 99.	Extensively used as aquifer in area from Terra Bella to Richgrove, east of Highway 99. Not an important aquifer in the TLSB.
TERTIARY	Eocene/Oligocene	Other Tertiary Sediments (undifferentiated)	Marine and Non-Marine Deposits		----	Few formations that contain usable water quality.	Too deep to be of concern in or near TLSB.
PRE-TERTIARY	Paleozoic/Mesozoic	Metamorphic and Igneous Rocks	Basement Complex	Crystalline rocks of metamorphosed sedimentary and igneous rocks invaded by largely granitic plutonic rocks.	----	Largely impermeable, contain fractures, faults, and joints that may yield small quantities of water to domestic and stock wells.	Used as water source only in foothills and mountain areas of Sierra Nevada.

Notes: Generalized stratigraphic column after Hilton et al., 1963; Croft and Gordon, 1968; Davis et al., 1959; Loomis, 1990; and Wood, 2018.

See Acronyms and Abbreviations list for definitions.

Table 3.1.11-1 Annual Specified Well Field Pumping, Tulare Lake Subbasin SGMA Model, Kings County, California

Date	El Rico GSA Well Field (AF/Y)	Creighton Ranch Well Field (AF/Y)	Corcoran ID Well Field (AF/Y)	Angiola Well Field (AF/Y)	Westlands Well Field (AF/Y)	Municipal Well Fields (AF/Y)	Apex Ranch Well Field (AF/Y)
1990	70,716	27,222	87,977	34,500	67,131	9,370	--
1991	57,509	38,484	84,438	23,396	98,656	9,109	--
1992	80,012	27,255	72,348	33,494	98,344	9,666	--
1993	11,395	4,035	14,248	5,956	44,056	10,208	--
1994	48,043	17,986	78,297	16,389	72,674	10,928	--
1995	2,897	905	7,145	-	27,589	10,775	--
1996	-	-	20,261	-	28,516	12,719	--
1997	-	-	15,586	-	27,000	12,775	--
1998	-	-	2,484	-	20,988	11,555	--
1999	-	-	33,406	-	37,185	13,087	--
2000	14,910	2,849	40,672	6,784	43,392	13,421	--
2001	89,799	41,120	64,353	23,244	65,947	13,895	--
2002	68,933	35,843	64,736	26,537	66,530	26,701	-
2003	32,420	10,856	62,246	22,429	40,841	19,349	526
2004	82,875	47,511	74,007	26,805	42,115	18,777	912
2005	-	468	20,138	662	14,744	16,536	-
2006	-	72	14,034	141	16,526	15,822	6,939
2007	69,863	40,266	85,434	32,894	40,373	17,221	6,319
2008	92,269	52,980	79,362	32,502	63,519	18,432	5,435
2009	78,097	45,292	81,493	37,798	69,904	16,354	7,677
2010	36,129	17,740	29,669	22,568	34,895	15,271	6,345
2011	606	314	7,328	11,336	15,509	17,042	-
2012	95,154	52,325	70,008	19,388	55,298	17,467	9,044
2013	100,275	66,005	78,175	30,528	70,940	18,411	4,970
2014	108,976	68,726	69,880	27,695	94,077	16,930	298
2015	116,254	61,050	67,982	30,220	90,723	16,146	-
2016	126,886	53,113	67,982	29,047	93,853	14,555	-
1990-2016 Average	51,260	26,386	51,618	18,308	53,382	14,908	4,847
1998-2010 Average	43,484	22,692	50,156	17,874	42,843	16,648	4,879
Well Count	99	52	98	51	150	30	5

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-1 Historical Kings River Diversions, Tulare Lake Subbasin SGMA Model, Kings County, California

	GSA	Mid Kings River					South Fork Kings							Southwest Kings										El Rico													Tri-County Water Authority										
	Agency	Peoples Ditch Company	Last Chance Water Ditch Co.				Stratford Irrigation District	Empire West Side Irrigation District			Lemoore Canal & Irrigation Company					Dudley Ridge Water District-Monthly Diversions Assumed																															
Kings River Water Years	Diversion	*Peoples Canal- MKRGSA Total*	*Last Chance Canal- MKRGSA Total*	*Lakeside IWD*	Imported Water	Mid Kings	Stratford Canal	Empire West Side ID total from SWP	Empire West Side Canal	Westlake Canal	Lemoore Canal	Imported Water	South Fork Kings River	*Blakeley Canal-Kings River & Lateral A*	TLBWSD Lateral C, T203	Dudley Ridge State Turnout (DR-1), T201	Dudley Ridge State Turnout (DR-1B), T202	Dudley Ridge State Turnout (DR-1A), T204	Dudley Ridge State Turnout (DR-2), T205	Dudley Ridge State Turnout (Paramount), T207	Dudley Ridge State Turnout (DR-3), T208	Imported Water, Angiola/Green Valley Well Fields, City of Lemoore and Westlands RD 761	Southwest Kings	*Empire Weir No. 2 (over #2 weir to river extension, River Water) Modified Total-(Empire Weir No. 2 minus Tri-County Kings River*	*TLBWSD Lateral A, T200 (State Water)-Modified Total-(SWP Total for Lateral A minus Tri-County Entitlement, Then 20% taken*	*TLBWSD Lateral B, T206 (State Water)-Modified Total-(SWP Total for Lateral B minus Tri-County Entitlement)*	Lakelands Canal-Total	Tulare Lake Canal	*Melga Canal-Diversion of Peoples Canal, El Rico GSA Total*	Kern River	*Deer Creek-30% of Deer Creek Total*	Tule River-El Rico	Kaweah River	*Loon Oak/New Deal- Diversion of Last Chance, El Rico GSA Total*	Imported Water	El Rico	Poso Creek	*TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A*	*TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B*	Tule River-Tri-County	*Deer Creek-70% of Deer Creek Total*	White River	Kings River-Tri-County	Other Water	Imported Water	Tri-County	Annual Totals
		(acre-feet per year)																																													
71%	1966	107,763	50,356	-	-	158,119	2,158	-	4,770	3,604	96,079	-	106,612	20,559	-	-	-	-	-	-	-	-	20,559	2,404	-	-	14,225	17,831	71,842	-	-	-	-	21,581	-	127,884	-	-	-	-	-	-	-	-	-	0	413,173
197%	1967	136,889	78,468	-	-	215,358	3,947	-	9,622	5,861	109,323	-	128,753	29,187	-	-	-	-	-	-	-	-	29,187	82,883	-	-	71,671	42,476	91,260	-	-	-	-	33,629	-	321,919	-	-	-	-	-	-	-	-	-	0	695,217
49%	1968	75,809	31,878	-	-	107,688	3,540	1,780	13,636	12,718	91,478	-	123,153	19,692	0	3,312	949	2,372	11,388	9	5,694	-	43,416	4,673	6,208	10,256	17,218	49,218	50,540	-	-	-	-	13,662	-	151,775	-	923	2,768	-	-	-	-	-	-	3,690	429,722
256%	1969	107,636	61,339	-	-	168,975	1,139	50	2,878	6,056	87,537	-	97,659	534	0	3,942	1,130	2,824	13,554	11	6,777	-	28,771	196,219	1,751	2,893	40,568	0	71,757	-	-	-	-	26,288	-	339,477	-	260	781	-	-	-	-	-	-	1,041	635,924
78%	1970	76,723	38,772	-	-	115,495	1,884	3,548	5,359	7,305	93,441	-	111,538	0	0	5,077	1,455	3,637	17,456	15	8,728	-	36,366	0	0	0	52,483	0	51,149	-	-	-	-	16,617	-	120,248	-	0	0	-	-	-	-	-	-	0	383,648
69%	1971	86,815	35,321	-	-	122,137	4,376	5,391	4,665	10,280	96,498	-	121,210	10,521	0	5,158	1,478	3,695	17,735	15	8,867	-	47,469	0	28,648	47,329	28,610	490	57,877	-	-	-	-	15,138	-	178,091	-	4,257	12,771	-	-	-	-	-	-	17,028	485,935
50%	1972	51,631	38,190	-	-	89,820	4,062	5,216	6,188	5,133	80,465	-	101,065	20,920	0	5,333	1,528	3,820	18,335	15	9,168	-	59,119	1,099	62,463	103,195	0	7,305	34,420	-	-	-	-	16,367	-	224,849	-	9,282	27,846	-	-	-	-	-	-	37,128	511,981
125%	1973	139,667	62,672	-	-	202,339	4,411	5,233	5,964	6,543	86,382	-	108,534	22,249	0	4,429	1,269	3,172	15,228	13	7,614	-	53,973	530	27,591	45,583	19,101	31,948	93,111	-	-	-	-	26,860	-	244,723	-	4,100	12,300	-	-	-	-	-	-	16,400	625,968
122%	1974	137,406	68,454	-	-	205,860	4,082	4,085	9,291	10,508	102,115	-	130,081	37,966	0	8,390	2,404	6,010	28,849	24	14,425	-	98,069	14,906	34,058	56,123	55,482	28,336	91,604	-	0	-	-	29,337	-	309,845	0	5,157	15,472	1,402	0	0	0	0	-	22,032	765,886
92%	1975	109,458	43,937	-	-	153,395	4,570	5,803	8,763	10,939	104,388	-	134,463	36,603	0	10,191	2,920	7,300	35,040	29	17,520	-	109,602	11,905	53,639	89,737	41,833	53,125	72,972	-	0	-	-	18,830	-	342,042	0	7,224	21,671	224	0	0	2,642	0	-	31,760	771,261
32%	1976	37,828	2,255	-	-	40,083	4,284	5,811	5,915	5,004	70,925	-	91,940	22,247	0	7,770	2,226	5,566	26,716	22	13,358	-	77,906	0	28,360	47,863	3,493	45,170	25,219	-	0	-	-	967	-	151,071	0	3,541	10,624	0	0	0	9,154	0	-	23,320	384,320
23%	1977	43,393	9,542	-	-	52,935	2,203	2,120	1,598	557	42,067	-	48,545	8,903	0	3,633	1,041	2,603	12,493	10	6,246	-	34,930	1,732	11,813	21,197	0	4,003	28,929	-	0	-	-	4,090	-	71,762	0	635	1,905	0	0	0	950	0	-	3,490	211,662
201%	1978	125,769	71,577	-	-	197,346	2,859	409	10,627	9,312	80,567	-	103,774	26,094	0	7,455	2,136	5,340	25,632	21	12,816	-	79,494	33,029	2,139	3,073	31,904	49,511	83,846	-	3,000	-	-	30,676	-	237,179	1,500	624	1,873	2,476	7,000	1,000	11,956	0	-	26,430	644,222
101%	1979	125,680	64,463	-	-	190,143	6,434	1,565	15,449	9,523	107,578	-	140,549	52,496	0	9,685	2,775	6,938	33,302	28	16,651	-	121,876	2,523	55,518	97,690	34,336	32,856	83,787	-	0	-	-	27,627	-	334,337	0	4,271	12,814	185	0	0	6,575	0	-	23,846	810,750
178%	1980	101,388	64,365	-	-	165,753	3,981	805	16,100	11,566	103,714	-	136,165	53,639	0	10,061	2,883	7,207	34,594	29	17,297	-	125,710	41,353	20,733	34,131	37,277	29,258	67,592	-	1,800	-	-	27,585	-	259,729	900	3,163	9,488	2,611	4,200	600	2,819	0	-	23,780	711,136
61%	1981	89,091	47,482	-	-	136,572	4,435	7,966	7,841	9,437	89,111	-	118,790	42,806	0	9,213	2,640	6,599	31,677	26	15,839	-	108,800	8,761	78,820	140,237	9,180	19,710	59,394	-	0	742	78,485	20,349	-	415,677	0	5,033	15,099	223	0	0	8,983	0	-	29,338	809,178
181%	1982	127,200	65,413	-	-	192,613	4,479	4,379	9,396	20,983	100,153	-	139,389	41,213	0	6,968	1,997	4,992	23,960	20	11,980	-	91,130	45,602	21,698	36,788	54,659	77,268	84,800	-	5,660	63,476	171,808	28,034	-	589,793	2,830	2,598	7,793	3,090	13,207	1,887	12,547	0	-	43,951	1,056,876
261%	1983	60,994	48,013	-	-	109,007	3,808	0	6,097	10,389	58,631	-	78,926	22,250	0	7,026	2,013	5,033	24,157	20	12,078	-	72,577	238,616	278	522	21,919	1,333	40,663	-	12,150	193,800	114,301	20,577	-	644,159	6,075	0	0	340	28,350	4,050	0	0	-	38,815	943,484
115%	1984	97,831	53,649	-	-	151,480	2,533	0	2,801	3,800	99,362	-	108,496	10,003	0	8,116	2,326	5,814	27,907	23	13,954	-	68,144	17,704	1,265	1,917	42,516	0	65,220	-	19,804	17,566	120,846	22,992	-	309,830	9,902	303	909	0	46,210	6,601	0	0	-	63,925	701,875

See Acronyms and Abbreviations list for definitions.

	GSA	Mid Kings River					South Fork Kings							Southwest Kings										El Rico													Tri-County Water Authority										
	Agency	Peoples Ditch Company	Last Chance Water Ditch Co.				Stratford Irrigation District	Empire West Side Irrigation District			Lemoore Canal & Irrigation Company					Dudley Ridge Water District-Monthly Diversions Assumed																															
Kings River Water Years	Diversion	*Peoples Canal- MKRGSA Total*	*Last Chance Canal- MKRGSA Total*	*Lakeside IWD*	Imported Water	Mid Kings	Stratford Canal	Empire West Side ID total from SWP	Empire West Side Canal	Westlake Canal	Lemoore Canal	Imported Water	South Fork Kings River	*Blakeley Canal-Kings River & Lateral A*	TLBWSD Lateral C, T203	Dudley Ridge State Turnout (DR-1), T201	Dudley Ridge State Turnout (DR-1B), T202	Dudley Ridge State Turnout (DR-1A), T204	Dudley Ridge State Turnout (DR-2), T205	Dudley Ridge State Turnout (Paramount), T207	Dudley Ridge State Turnout (DR-3), T208	Imported Water, Angiola/Green Valley Well Fields, City of Lemoore and Westlands RD 761	Southwest Kings	*Empire Weir No. 2 (over #2 weir to river extension, River Water) Modified Total-(Empire Weir No. 2 minus Tri-County Kings River*	*TLBWSD Lateral A, T200 (State Water)-Modified Total-(SWP Total for Lateral A minus Tri-County Entitlement, Then 20% taken*	*TLBWSD Lateral B, T206 (State Water)-Modified Total-(SWP Total for Lateral B minus Tri-County Entitlement)*	Lakelands Canal-Total	Tulare Lake Canal	*Melga Canal-Diversion of Peoples Canal, El Rico GSA Total*	Kern River	*Deer Creek-30% of Deer Creek Total*	Tule River-El Rico	Kaweah River	*Loan Oak/New Deal- Diversion of Last Chance, El Rico GSA Total*	Imported Water	El Rico	Poso Creek	*TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A*	*TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B*	Tule River-Tri-County	*Deer Creek-70% of Deer Creek Total*	White River	Kings River-Tri-County	Other Water	Imported Water	Tri-County	Annual Totals
		(acre-feet per year)																																													
73%	1985	105,362	39,583	-	-	144,944	4,869	4,677	5,209	6,827	103,148	-	124,731	34,288	0	7,791	2,232	5,581	26,788	22	13,394	-	90,096	16,118	49,527	84,042	20,108	29,821	70,241	-	0	367	73,859	16,964	-	361,048	0	5,881	17,644	826	0	0	1,586	0	-	25,937	746,756
190%	1986	111,962	62,457	-	-	174,419	7,329	2,070	7,345	16,723	87,761	-	121,227	27,361	0	6,427	1,841	4,604	22,098	18	11,049	-	73,398	28,395	23,163	41,528	50,896	51,205	74,641	-	5,144	43,384	71,918	26,767	-	417,043	2,572	1,269	3,806	1,701	12,004	1,715	11,054	0	-	34,121	820,207
45%	1987	70,406	24,792	-	-	95,198	5,177	3,961	4,959	10,982	90,541	-	115,620	28,582	0	5,816	1,666	4,166	19,996	17	9,998	-	70,242	18,250	35,048	60,441	27,104	57,023	46,938	-	0	0	44,445	10,625	-	299,874	0	3,517	10,550	0	0	0	9,366	0	-	23,432	604,366
48%	1988	60,312	21,844	-	-	82,156	3,953	3,128	4,457	2,949	76,554	-	91,041	21,261	0	6,030	1,728	4,319	20,733	17	10,367	-	64,456	8,209	23,389	40,544	18,863	17,816	40,208	-	0	0	25,873	9,362	-	184,264	0	2,207	6,622	0	0	0	984	0	-	9,814	431,730
53%	1989	60,579	19,935	-	-	80,514	0	2,700	0	-	56,519	-	59,219	13,458	0	7,168	2,054	5,134	24,645	21	12,323	-	64,802	0	44,142	75,859	7,458	0	40,386	-	0	0	24,550	8,544	-	200,939	0	4,605	13,814	150	0	0	0	1,580	-	20,149	425,623
40%	1990	53,292	9,909	-	-	63,201	0	2,979	0	-	34,465	-	37,444	6,485	0	4,606	1,320	3,299	15,836	13	7,918	14,540	54,016	0	21,271	37,168	15,114	0	35,528	-	0	0	39,853	4,247	-	153,181	0	1,810	5,430	0	0	0	0	4,556	-	11,796	319,638
63%	1991	45,654	18,622	-	-	64,276	1,760	199	1,006	964	31,492	-	35,420	5,941	0	1,670	479	1,196	5,743	5	2,871	8,181	26,085	344	1,536	2,855	6,143	2,870	30,436	-	0	0	28,897	7,981	-	81,060	0	16	49	604	0	0	1,604	0	-	2,274	209,115
41%	1992	49,394	9,361	-	-	58,755	1,759	1,219	0	0	37,968	-	40,945	6,003	0	1,696	486	1,215	5,831	5	2,915	6,095	24,245	0	19,688	35,181	0	0	32,930	-	279	0	23,442	4,012	-	115,532	140	1,156	3,469	0	652	93	0	0	-	5,510	244,987
149%	1993	147,363	53,498	-	-	200,860	5,070	2,467	4,314	8,612	91,166	-	111,629	30,546	0	2,917	836	2,090	10,031	8	5,016	6,480	57,925	25,174	31,782	58,745	66,990	44,555	68,050	-	101	0	108,379	22,928	-	426,703	50	565	1,694	1,155	235	34	6,919	2,575	-	13,226	810,344
50%	1994	69,510	30,738	-	-	100,248	2,997	1,499	3,808	6,811	76,550	-	91,666	26,295	0	3,834	1,099	2,747	13,184	11	6,592	11,642	65,404	15,625	15,834	28,204	0	49,718	38,072	-	0	0	28,376	-	-	175,829	0	990	2,970	0	0	0	6,098	0	-	10,058	443,205
202%	1995	143,785	102,300	-	-	246,085	6,123	1,468	6,419	1,410	85,049	-	100,469	34,039	0	5,715	1,637	4,094	19,650	16	9,825	8,131	83,107	51,722	34,276	59,720	52,969	48,240	75,670	-	2,285	13,777	149,232	-	-	487,891	1,142	3,032	9,095	6,040	5,331	762	4,902	0	-	30,303	947,854
122%	1996	166,765	95,338	-	-	262,103	6,774	1,681	5,576	5,778	105,398	-	125,206	41,813	0	6,886	1,973	4,933	23,677	20	11,839	14,505	105,645	33,027	60,026	107,966	61,767	36,006	81,522	-	1,847	236	139,238	-	-	521,635	924	3,055	9,165	1,913	4,311	616	2,219	0	-	22,202	1,036,790
155%	1997	133,158	85,505	20,657	-	239,321	7,460	0	8,239	2,079	89,117	-	106,896	25,259	0	7,895	2,262	5,655	27,146	23	13,573	11,319	93,132	19,089	5,679	2,107	32,557	25,047	65,232	-	9,220	40,122	66,638	-	-	265,690	4,610	1,895	5,684	1,701	21,513	3,073	4,729	0	-	43,206	748,244
181%	1998	141,107	77,863	29,871	-	248,841	5,578	488	4,596	8,447	75,590	-	94,698	17,157	3,528	6,955	1,993	4,982	23,916	20	11,958	11,348	81,857	4,514	5,745	17,487	32,918	16,707	75,570	-	5,590	26,731	58,340	-	-	243,601	2,795	1,057	3,171	2,083	13,042	1,863	50	0	-	24,061	693,058
74%	1999	101,773	62,938	12,119	-	176,830	4,971	2,858	6,135	3,624	95,504	-	113,092	25,132	0	7,958	2,280	5,701	27,363	23	13,681	10,280	92,418	4,359	59,502	140,451	8,184	13,492	49,810	-	0	2,235	51,184	-	-	329,217	0	95	286	274	0	0	167	0	-	822	712,379
90%	2000	108,835	82,526	13,181	-	204,541	4,598	1,619	2,184	4,566	99,074	-	112,041	21,426	0	7,397	2,119	5,299	25,433	21	12,717	10,299	84,711	16,796	39,928	86,346	35,062	33,304	56,416	-	871	2,900	48,050	-	-	319,674	435	3,935	11,804	1,166	2,032	290	0	0	-	19,663	740,630
59%	2001	73,419	31,031	7,017	-	111,467	4,959	1,674	1,993	2,680	58,979	-	70,285	11,377	0	6,030	1,728	4,319	20,732	17	10,366	10,306	64,875	21,146	21,658	39,067	2,122	38,045	38,433	-	0	8	20,131	-	-	180,610	0	1,027	3,082	0	0	0	3,044	3,000	-	10,154	437,390
67%	2002	99,376	52,020	5,354	-	156,751	4,104	1,265	1,364	2,202	74,196	-	83,131	13,083	0	6,930	1,986	4,964	23,828	20	11,914	10,291	73,016	14,150	20,707	33,324	46,842	7,942	45,043	-	0	490	73,770	-	-	242,267	0	2,004	6,011	124	0	0	0	190	-	8,329	563,493
83%	2003	104,545	54,735	13,325	-	172,605	4,356	1,292	752	3,362	63,511	-	73,273	8,256	0	6,657	1,907	4,768	22,888	19	11,444	10,359	66,299	13,153	14,887	44,894	36,750	45,168	48,228	-	0	1,748	49,413	-	-	254,241	0	2,152	6,455	790	0	0	6,652	160	-	16,209	582,626
61%	2004	79,743	27,306	5,667	-	112,717	2,019	3,206	1,650	1,480	58,257	-	66,611	12,382	0	6,383	1,829	4,572	21,946	18	10,973	10,072	68,176	17,145	22,857	42,460	40,917	16,768	40,719	-	0	1,106	59,030	-	-	241,003	0	265	795	559	0	0	0	5,293	-	6,912	495,419

See Acronyms and Abbreviations list for definitions.

	GSA	Mid Kings River					South Fork Kings							Southwest Kings										El Rico													Tri-County Water Authority										
	Agency	Peoples Ditch Company	Last Chance Water Ditch Co.				Stratford Irrigation District	Empire West Side Irrigation District			Lemoore Canal & Irrigation Company					Dudley Ridge Water District-Monthly Diversions Assumed																															
Kings River Water Years	Diversion	Peoples Canal- MKRGSA Total	Last Chance Canal- MKRGSA Total	Lakeside IWD	Imported Water	Mid Kings	Stratford Canal	Empire West Side ID total from SWP	Empire West Side Canal	Westlake Canal	Lemoore Canal	Imported Water	South Fork Kings River	Blakeley Canal-Kings River & Lateral A	TLBWSD Lateral C, T203	Dudley Ridge State Turnout (DR-1), T201	Dudley Ridge State Turnout (DR-1B), T202	Dudley Ridge State Turnout (DR-1A), T204	Dudley Ridge State Turnout (DR-2), T205	Dudley Ridge State Turnout (Paramount), T207	Dudley Ridge State Turnout (DR-3), T208	Imported Water, Angiola/Green Valley Well Fields, City of Lemoore and Westlands RD 761	Southwest Kings	Empire Weir No. 2 (over #2 weir to river extension, River Water) Modified Total-(Empire Weir No. 2 minus Tri-County Kings River	TLBWSD Lateral A, T200 (State Water)-Modified Total-(SWP Total for Lateral A minus Tri-County Entitlement, Then 20% taken	TLBWSD Lateral B, T206 (State Water)-Modified Total-(SWP Total for Lateral B minus Tri-County Entitlement)	Lakelands Canal-Total	Tulare Lake Canal	Melga Canal-Diversion of Peoples Canal, El Rico GSA Total	Kern River	Deer Creek-30% of Deer Creek Total	Tule River-El Rico	Kaweah River	Loan Oak/New Deal- Diversion of Last Chance, El Rico GSA Total	Imported Water	El Rico	Poso Creek	TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A	TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B	Tule River-Tri-County	Deer Creek-70% of Deer Creek Total	White River	Kings River-Tri-County	Other Water	Imported Water	Tri-County	Annual Totals
		(acre-feet per year)																																													
148%	2005	131,193	54,799	24,547	-	210,539	5,619	3,451	2,664	1,946	98,279	-	111,958	24,480	0	7,366	2,111	5,276	25,327	21	12,663	11,115	88,360	73,872	27,755	75,546	42,290	64,243	67,430	-	1,767	2,372	86,750	-	-	442,024	884	116	347	1,680	4,123	589	10,632	1,235	-	19,605	872,486
172%	2006	129,571	65,459	24,718	-	219,748	6,065	2,954	5,417	2,368	96,857	-	113,661	34,147	0	7,766	2,225	5,563	26,702	22	13,351	11,115	100,891	70,800	22,444	52,463	80,614	74,920	69,623	-	2,392	17,135	171,601	-	-	561,992	1,196	126	378	795	5,581	797	14,253	0	-	23,126	1,019,418
40%	2007	84,144	20,918	3,312	-	108,374	4,836	1,876	3,810	4,727	70,288	-	85,536	25,308	0	6,090	1,745	4,363	20,940	17	10,470	9,975	78,909	21,586	20,496	39,927	17,889	31,676	46,218	-	0	153	39,474	-	-	217,420	0	50	149	0	0	0	18,083	63	-	18,345	508,584
72%	2008	81,364	29,000	6,764	-	117,128	2,037	852	1,470	1,081	59,988	-	65,428	10,209	0	5,292	1,516	3,791	18,195	15	9,097	10,016	58,131	9,553	9,155	11,833	8,051	5,282	41,851	-	0	158	37,662	-	-	123,545	0	156	468	828	0	0	4,756	0	-	6,208	370,440
79%	2009	85,743	30,617	5,829	-	122,189	2,047	148	1,811	1,771	49,297	-	55,074	7,997	0	3,982	1,141	2,852	13,691	11	6,846	12,178	48,699	855	8,865	13,750	22,036	99	43,482	-	0	1,383	62,389	-	-	152,859	0	7	21	0	0	0	0	0	-	28	378,849
121%	2010	113,146	42,817	16,103	-	172,066	4,318	2,545	3,644	2,900	90,694	-	104,101	17,655	0	4,144	1,187	2,969	14,249	12	7,125	42,300	89,641	34,789	9,185	32,026	38,210	37,297	55,771	-	0	5,059	102,754	-	-	315,091	0	2	7	1,676	0	0	10,587	282	-	12,555	693,453
180%	2011	163,801	79,589	23,764	-	267,154	4,979	1,364	4,625	4,947	109,605	-	125,519	43,781	0	3,373	966	2,416	11,597	10	5,799	34,012	101,953	89,121	13,902	25,964	88,052	78,409	83,250	-	0	11,316	140,553	-	-	530,567	0	68	205	-	0	0	0	-	-	273	1,025,466
49%	2012	80,025	30,309	4,595	-	114,929	4,203	1,151	4,594	2,289	71,207	-	83,443	22,689	0	2,775	795	1,988	9,543	8	4,771	51,435	94,006	24,964	16,910	43,921	3,483	15,977	39,616	-	0	200	60,683	-	-	205,755	0	57	170	-	0	0	0	-	-	227	498,360
41%	2013	49,246	12,881	110	-	62,236	0	536	0	0	43,206	-	43,741	3,284	0	3,591	1,029	2,572	12,346	10	6,173	19,602	48,606	0	10,771	13,062	58,140	0	27,281	-	-	-	-	-	-	109,253	0	58	174	-	0	0	0	-	-	232	264,069
32%	2014	27,801	8,824	0	-	36,626	0	158	0	0	17,905	-	18,062	567	0	2,136	612	1,530	7,345	6	3,672	23,852	39,720	0	1,858	3,681	41,472	0	12,461	-	-	-	-	-	-	59,473	0	38	115	-	0	0	0	-	-	154	154,035
21%	2015	12,430	-	0	-	12,430	0	326	0	0	14,759	-	15,085	184	0	3,271	937	2,343	11,247	9	5,623	31,718	55,333	0	605	0	21,076	0	2,493	-	-	-	-	-	-	24,175	0	45	0	-	0	0	0	-	-	45	107,068
75%	2016	67,310	20,567	2,986	-	90,863	0	-	0	0	42,532	-	42,532	-	-	-	-	-	-	-	-	34,248	34,248	0	-	-	32,114	0	27,677	-	-	-	-	-	-	59,791	0			-	0	0	0	-	-	0	227,433
204%	2017	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual Averages	93,943	44,985	4,312		143,240	3,669	2,156	4,804	5,315	77,554		93,499	20,737	68	5,535	1,586	3,965	19,033	16	9,516	8,734	69,598	26,210	21,684	40,175	31,229	26,107	54,847	0	1,383	8,586	45,614	10,052		268,189	705	1,816	5,446	666	3,227	470	3,333	364		16,175	590,701

Notes provided on next page.

See Acronyms and Abbreviations list for definitions.

1.) Values highlighted have been modified.
2.) Values with "0" indicate no surface water delivery to the best of our knowledge.
3.) Values with "-" have no verified data.
4.) Total flow from Peoples Canal is split 60% to Mid Kings, 40% to Melga.
5.) Last Chance Diversion is split 50% between Mid Kings and El Rico.
6.) Blakeley has added State Water from Lateral A for Southwest.
7.) Total flow from Deer Creek split 30% to El Rico, 70% to Tri-County.
8.) Tule River for El Rico includes the total of Elk Bayou and TID Spill.
8.) SWP from TLBWSD Split Throughout Tri-County & Southwest Kings.
9.) Kings River water in Tri-County was subtracted from the total in Empire Weir No. 2. 1976 and 2010 are 0 for Empire Weir No. 2 because of negative values.
10.) Lakeside is a portion of Kaweah River, Reduced Total Kaweah River between Mid Kings and El Rico
11.) Additional Tule River flow data added for Tri-County
12.) Empire West Side ID total from SWP reduce annual totals by 10%
13.) Dudley Ridge Water District reduce annual totals by 10%
14.) Lateral A (T200) & Lateral B (T206) reduce annual totals by 18% for El Rico & Tri-County
15.) Modifications to Peoples Canal and Last Chance as a result of discussions with Mid Kings River GSA 02/14/2019

Key	Average Annual
Wet Year	816,660
Dry Year	423,464
Average Precipitation	686,577
GSA Annual Totals	
Kings River Watershed Total	

Reduction in Entitlement	
Empire West Side ID Total from SWP	10%
Dudley Ridge State Turnouts	10%
Lateral A & B for El Rico & Tri-County	18%

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-2a 1990 - 2016 Historical Water Balance Total Subbasin, Tulare Lake Subbasin SGMA Model, Kings County, California

Date	Tulare Lake Drain Net (AF/Y)	Tulare Lake GHB Net (AF/Y)	Tulare Lake Well Net (AF/Y)	Tulare Lake River Net (AF/Y)	Tulare Lake Lake Net (AF/Y)	Tulare Lake Recharge Net (AF/Y)	Tulare Lake Farm Demand (AF/Y)	Tulare Lake Storage Net (AF/Y)	Tulare Lake Net Subsurface Inflow (AF/Y)	Tulare Lake Net Subsurface Outflow (AF/Y)	Tulare Lake Westside Net (AF/Y)	Tulare Lake Kings Net (AF/Y)	Tulare Lake Kaweah Net (AF/Y)	Tulare Lake Tule Net (AF/Y)	Tulare Lake Kern Net (AF/Y)	Tulare Lake Mid-Kings Net (AF/Y)	Tulare Lake El Rico Net (AF/Y)	Tulare Lake South Fork Net (AF/Y)	Tulare Lake Southwest Net (AF/Y)	Tulare Lake TCWA Net (AF/Y)	Tulare Lake Total Net (AF/Y)	Cumulative Delta Storage (AF)
1990	0	0	-618,843	212,023	0	150,920	-1,065,856	-185,926	181,209	-111,280	23,632	4,815	-3,467	-12,024	56,971	298	-6,672	5,316	22,658	-21,601	298	-185,926
1991	0	0	-577,240	164,892	0	135,941	-994,832	-224,464	164,488	-112,589	13,271	9,747	4,376	-14,187	38,693	-1,273	-6,163	2,959	24,852	-20,376	-1,273	-410,391
1992	0	0	-596,994	125,681	0	139,491	-1,012,909	-290,389	160,839	-119,495	11,225	10,812	2,987	-18,583	34,904	-245	-10,703	4,143	26,835	-20,030	-245	-700,780
1993	0	0	-248,824	231,839	0	167,981	-1,008,709	157,279	128,914	-122,683	7,344	-4,219	-20,133	-13,496	36,736	1,631	-6,528	-857	24,396	-18,642	1,631	-543,501
1994	-26	0	-491,956	139,080	0	173,457	-1,047,937	-168,707	135,909	-125,412	7,647	1,210	-8,114	-20,670	30,426	-2,370	-4,557	2,695	23,956	-19,723	-2,370	-712,208
1995	-82	0	-188,622	200,925	0	235,917	-973,503	231,421	113,880	-130,598	5,564	-14,723	-26,071	-14,705	33,217	8,131	-6,163	-10,023	24,809	-16,753	8,131	-480,786
1996	-251	0	-195,586	177,508	0	238,753	-1,067,962	186,481	102,129	-136,119	6,788	-17,826	-32,867	-19,334	29,250	12,774	1,109	-16,866	23,951	-20,968	12,774	-294,305
1997	-1,392	0	-278,726	162,833	0	252,651	-1,123,726	100,786	104,214	-139,610	10,524	-17,146	-36,466	-21,396	29,090	11,582	1,267	-17,016	25,376	-21,209	11,582	-193,519
1998	-1,870	0	-249,086	165,955	0	266,380	-1,059,009	153,536	105,817	-134,203	13,146	-18,649	-31,067	-21,177	29,362	13,428	145	-19,305	26,305	-20,573	13,428	-39,983
1999	-7,376	0	-338,241	159,660	0	201,878	-1,232,448	522	120,686	-141,114	15,099	-12,823	-38,853	-23,234	39,384	8,567	5,298	-17,001	26,326	-23,190	8,567	-39,461
2000	-17,343	0	-260,726	147,624	0	172,534	-1,127,412	43,638	116,391	-130,053	9,202	-14,008	-24,256	-20,878	36,279	12,669	-1,467	-16,122	26,034	-21,114	12,669	4,177
2001	-13,351	0	-467,326	108,934	0	119,202	-1,111,506	-243,059	128,384	-130,759	7,046	-8,208	-10,602	-19,402	28,791	13,602	-4,429	-14,996	27,329	-21,506	13,602	-238,882
2002	-10,253	0	-435,270	150,502	0	128,082	-1,201,455	-178,393	122,597	-142,986	4,116	-14,310	-17,484	-22,160	29,448	17,210	-4,785	-18,209	28,055	-22,272	17,210	-417,275
2003	-8,170	0	-385,602	145,737	0	157,010	-1,198,411	-101,083	124,533	-140,750	7,968	-14,505	-16,849	-23,580	30,749	18,229	-2,895	-22,651	29,364	-22,046	18,229	-518,358
2004	-20,849	0	-494,263	137,236	0	138,732	-1,162,011	-231,122	125,398	-137,076	7,475	-13,320	-9,952	-24,296	28,416	13,215	-6,077	-14,260	29,378	-22,256	13,215	-749,480
2005	-5,413	0	-217,488	150,074	0	227,638	-1,155,548	121,017	101,739	-138,073	4,993	-20,418	-30,344	-20,294	29,728	13,527	-585	-19,200	27,026	-20,768	13,527	-628,463
2006	-9,651	0	-205,429	138,230	0	339,860	-1,129,741	220,649	94,159	-142,864	4,446	-22,451	-40,403	-20,192	29,895	14,152	1,839	-20,925	24,221	-19,288	14,152	-407,814
2007	-14,999	0	-474,153	137,542	0	123,827	-1,183,096	-248,490	109,552	-142,905	7,330	-14,948	-17,451	-25,274	16,990	13,841	2,341	-15,691	26,046	-26,536	13,841	-656,305
2008	-13,795	0	-515,546	126,421	0	117,419	-1,083,093	-296,277	119,872	-143,019	1,856	-12,181	-14,428	-21,584	23,191	15,124	1,866	-14,493	28,346	-30,843	15,124	-952,581
2009	-4,295	0	-456,641	133,032	0	135,636	-1,091,697	-213,010	118,378	-142,215	-1,793	-15,575	-2,407	-18,590	14,527	18,226	6,659	-21,735	28,060	-31,210	18,226	-1,165,591
2010	-2,440	0	-249,776	129,805	0	171,969	-1,016,725	13,129	101,421	-138,727	-5,091	-25,818	-13,379	-16,097	23,078	17,294	7,760	-18,014	26,354	-33,394	17,294	-1,152,462
2011	-4,486	0	-77,680	147,432	0	355,590	-791,090	361,228	83,220	-144,621	-6,641	-38,331	-35,573	-11,696	30,840	15,170	-5,654	-15,516	22,355	-16,355	15,170	-791,234
2012	-3,226	0	-357,301	111,314	0	120,601	-776,133	-169,947	99,000	-141,994	-6,733	-25,065	-25,720	-10,775	25,299	16,520	-4,782	-14,082	22,062	-19,718	16,520	-961,181
2013	-8,381	0	-455,726	99,564	0	90,038	-826,405	-305,607	105,083	-143,219	-9,909	-18,283	-18,315	-13,933	22,304	14,998	-4,112	-12,022	24,044	-22,907	14,998	-1,266,788
2014	-3,579	0	-508,253	82,742	0	107,427	-757,265	-360,352	110,508	-151,969	-11,151	-13,313	-18,684	-18,842	20,529	15,626	2,274	-17,973	26,111	-26,037	15,626	-1,627,140
2015	-829	0	-524,338	60,439	0	99,444	-624,647	-392,279	114,003	-141,493	-10,951	-10,641	-15,502	-15,383	24,986	13,276	-5,612	-12,806	26,751	-21,609	13,276	-2,019,419
2016	-2,497	0	-428,423	69,718	0	123,037	-677,936	-294,325	102,102	-160,350	-9,455	-33,115	-23,497	-14,438	22,257	16,359	-11,753	-11,101	26,620	-20,125	-2,088	-2,313,744
1990-2016 Average	-5,724	0	-381,410	141,361	0	173,756	-1,018,558	-85,694	83,220	-111,280	3,961	-13,826	-19,427	-18,379	29,457	11,539	-2,310	-12,806	25,838	-22,261	10,856	-720,867
1998-2010 Average	-9,985	0	-365,350	140,827	0	176,936	-1,134,781	-73,765	181,209	-160,350	5,830	-15,939	-20,575	-21,289	27,680	14,545	436	-17,893	27,142	-24,230	14,545	-535,575

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-2b 1990 - 2016 Historical Water Balance Upper Aquifer, Tulare Lake Subbasin SGMA Model, Kings County, California

Date	Tulare Lake Drain Net (AF/Y)	Tulare Lake GHB Net (AF/Y)	Tulare Lake Well Net (AF/Y)	Tulare Lake River Net (AF/Y)	Tulare Lake Lake Net (AF/Y)	Tulare Lake Recharge Net (AF/Y)	Tulare Lake ET Net (AF/Y)	Tulare Lake Storage Net (AF/Y)	Tulare Lake Net Subsurface Inflow (AF/Y)	Tulare Lake Net Subsurface Outflow (AF/Y)	Tulare Lake Westside Net (AF/Y)	Tulare Lake Kings Net (AF/Y)	Tulare Lake Kaweah Net (AF/Y)	Tulare Lake Tule Net (AF/Y)	Tulare Lake Kern Net (AF/Y)	Tulare Lake Mid-Kings Net (AF/Y)	Tulare Lake El Rico Net (AF/Y)	Tulare Lake South Fork Net (AF/Y)	Tulare Lake Southwest Net (AF/Y)	Tulare Lake TCWA Net (AF/Y)	Tulare Lake Total Net (AF/Y)	Cumulative Delta Storage (AF)
1990	0	0	-363,970	212,023	0	150,920	0	-392,438	60,944	-52,493	10,293	-6,068	2,356	-2,438	4,309	-8,770	7,916	7,068	3,123	-9,337	-8,770	-392,438
1991	0	0	-351,785	164,892	0	135,941	0	-379,415	59,832	-44,466	9,849	-337	6,851	-3,950	2,953	-8,028	6,401	5,211	3,601	-7,185	-8,028	-771,853
1992	0	0	-345,307	125,681	0	139,491	0	-379,874	58,304	-43,733	9,211	1,619	7,092	-5,396	2,045	-6,955	5,529	3,812	3,711	-6,097	-6,955	-1,151,727
1993	0	0	-239,755	231,839	0	167,981	0	-117,785	51,892	-42,526	7,943	-136	4,801	-4,918	1,676	-4,786	5,130	2,368	3,440	-6,153	-4,786	-1,269,512
1994	-26	0	-310,055	139,080	0	173,457	0	-255,820	52,755	-44,438	7,097	625	5,581	-6,383	1,398	-4,950	4,717	2,121	3,471	-5,360	-4,950	-1,525,332
1995	-82	0	-205,637	200,925	0	235,917	0	-23,977	45,868	-50,708	5,953	-9,550	3,591	-6,120	1,286	-2,716	3,395	746	3,431	-4,856	-2,716	-1,549,309
1996	-251	0	-184,321	177,508	0	238,753	0	-4,023	42,064	-47,154	5,561	-7,356	979	-5,613	1,340	-1,526	3,881	-427	3,567	-5,495	-1,526	-1,553,331
1997	-1,392	0	-204,969	162,833	0	252,651	0	-15,247	40,618	-50,417	5,470	-9,442	-1,210	-5,876	1,259	-791	3,397	-1,403	3,400	-4,603	-791	-1,568,578
1998	-1,870	0	-191,289	165,955	0	266,380	0	17,175	38,754	-55,626	5,112	-14,784	-2,171	-6,255	1,226	-228	3,124	-2,136	3,467	-4,226	-228	-1,551,403
1999	-7,376	0	-227,049	159,660	0	201,878	0	-71,374	41,389	-47,970	5,311	-6,241	-1,422	-5,855	1,627	44	3,916	-2,399	3,599	-5,159	44	-1,622,778
2000	-17,343	0	-201,799	147,624	0	172,534	0	-76,900	41,391	-44,741	5,135	-5,270	889	-6,253	2,149	713	3,385	-2,978	3,773	-4,892	713	-1,699,678
2001	-13,351	0	-264,888	108,934	0	119,202	0	-222,719	44,167	-45,556	5,150	-3,924	1,956	-6,748	2,177	215	3,431	-2,996	3,872	-4,521	215	-1,922,397
2002	-10,253	0	-272,312	150,502	0	128,082	0	-174,685	46,006	-45,147	4,999	-2,792	3,355	-6,755	2,052	-373	3,874	-2,666	3,785	-4,620	-373	-2,097,082
2003	-8,170	0	-255,270	145,737	0	157,010	0	-133,547	45,798	-46,552	4,757	-3,317	2,678	-6,922	2,049	-308	4,005	-2,944	3,826	-4,578	-308	-2,230,628
2004	-20,849	0	-279,593	137,236	0	138,732	0	-181,729	46,099	-46,854	4,686	-2,691	2,602	-7,402	2,050	-688	3,857	-2,647	3,846	-4,368	-688	-2,412,358
2005	-5,413	0	-194,492	150,074	0	227,638	0	516	41,121	-48,908	4,301	-5,838	-1,307	-7,087	2,145	212	3,616	-3,177	3,796	-4,447	212	-2,411,841
2006	-9,651	0	-174,179	138,230	0	339,860	0	117,742	37,534	-56,025	3,971	-11,267	-6,576	-6,948	2,329	1,405	2,956	-3,767	3,678	-4,271	1,405	-2,294,099
2007	-14,999	0	-264,654	137,542	0	123,827	0	-177,972	42,192	-52,530	4,404	-5,195	-3,761	-7,669	1,883	385	3,549	-3,225	3,501	-4,210	385	-2,472,071
2008	-13,795	0	-283,431	126,421	0	117,419	0	-210,701	43,266	-49,766	4,321	-3,743	-38	-8,161	1,122	-622	4,068	-2,880	3,259	-3,825	-622	-2,682,773
2009	-4,295	0	-268,843	133,032	0	135,636	0	-170,773	43,877	-49,818	4,722	-3,492	961	-8,469	338	-626	4,176	-3,145	3,179	-3,584	-626	-2,853,545
2010	-2,440	0	-187,770	129,805	0	171,969	0	-56,332	37,974	-47,711	3,677	-4,768	-334	-8,179	-134	400	3,717	-3,559	3,094	-3,653	400	-2,909,877
2011	-4,486	0	-126,313	147,432	0	355,590	0	197,345	32,182	-58,840	2,822	-16,373	-6,573	-6,907	374	2,222	2,629	-4,345	3,147	-3,652	2,222	-2,712,533
2012	-3,226	0	-205,013	111,314	0	120,601	0	-137,135	34,819	-52,627	2,733	-7,480	-6,645	-7,386	969	1,491	2,935	-4,085	3,111	-3,452	1,491	-2,849,668
2013	-8,381	0	-252,639	99,564	0	90,038	0	-222,003	38,673	-50,934	3,106	-4,297	-4,573	-7,569	1,071	520	3,719	-3,772	3,013	-3,481	520	-3,071,671
2014	-3,579	0	-276,394	82,742	0	107,427	0	-247,305	41,277	-51,497	3,633	-2,586	-3,508	-8,263	503	-96	3,951	-3,688	2,996	-3,163	-96	-3,318,976
2015	-829	0	-283,699	60,439	0	99,444	0	-286,779	41,875	-50,653	3,580	-1,050	-3,164	-8,423	279	-674	3,899	-3,598	3,107	-2,734	-674	-3,605,754
2016	-2,497	0	-248,557	69,718	0	123,037	0	-234,011	36,829	-60,070	3,401	-14,540	-4,136	-8,370	403	-321	3,744	-3,738	3,005	-2,691	-2,088	-3,839,765
1990-2016 Average	-5,724	0	-246,814	141,361	0	173,756	0	-142,214	32,182	-42,526	5,230	-5,566	-64	-6,678	1,514	-1,291	4,034	-1,565	3,437	-4,615	-1,356	-2,160,777
1998-2010 Average	-9,985	0	-235,813	140,827	0	176,936	0	-103,177	60,944	-60,070	4,658	-5,640	-244	-7,131	1,616	41	3,667	-2,963	3,590	-4,335	41	-2,243,118

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-2c 1990 - 2016 Historical Water Balance Lower Aquifer, Tulare Lake Subbasin SGMA Model, Kings County, California

Date	Tulare Lake Drain Net (AF/Y)	Tulare Lake GHB Net (AF/Y)	Tulare Lake Well Net (AF/Y)	Tulare Lake River Net (AF/Y)	Tulare Lake Lake Net (AF/Y)	Tulare Lake Recharge Net (AF/Y)	Tulare Lake ET Net (AF/Y)	Tulare Lake Storage Net (AF/Y)	Tulare Lake Net Subsurface Inflow (AF/Y)	Tulare Lake Net Subsurface Outflow (AF/Y)	Tulare Lake Westside Net (AF/Y)	Tulare Lake Kings Net (AF/Y)	Tulare Lake Kaweah Net (AF/Y)	Tulare Lake Tule Net (AF/Y)	Tulare Lake Kern Net (AF/Y)	Tulare Lake Mid-Kings Net (AF/Y)	Tulare Lake El Rico Net (AF/Y)	Tulare Lake South Fork Net (AF/Y)	Tulare Lake Southwest Net (AF/Y)	Tulare Lake TCWA Net (AF/Y)	Tulare Lake Total Net (AF/Y)	Cumulative Delta Storage (AF)
1990	0	0	-254,873	0	0	0	0	206,511	120,265	-58,787	13,339	10,884	-5,823	-9,586	52,663	9,068	-14,587	-1,752	19,535	-12,264	9,068	206,511
1991	0	0	-225,455	0	0	0	0	154,951	104,657	-68,123	3,422	10,084	-2,475	-10,237	35,740	6,755	-12,564	-2,252	21,251	-13,191	6,755	361,463
1992	0	0	-251,686	0	0	0	0	89,485	102,535	-75,762	2,013	9,193	-4,106	-13,187	32,859	6,710	-16,232	331	23,124	-13,932	6,710	450,947
1993	0	0	-9,069	0	0	0	0	275,064	77,023	-80,157	-600	-4,082	-24,934	-8,578	35,060	6,416	-11,659	-3,226	20,957	-12,489	6,416	726,011
1994	0	0	-181,901	0	0	0	0	87,113	83,154	-80,974	550	585	-13,695	-14,288	29,028	2,579	-9,275	573	20,484	-14,362	2,579	813,124
1995	0	0	17,015	0	0	0	0	255,398	68,012	-79,891	-388	-5,174	-29,662	-8,585	31,931	10,847	-9,559	-10,769	21,378	-11,896	10,847	1,068,522
1996	0	0	-11,265	0	0	0	0	190,504	60,065	-88,966	1,227	-10,470	-33,846	-13,721	27,910	14,300	-2,772	-16,439	20,385	-15,474	14,300	1,259,026
1997	0	0	-73,758	0	0	0	0	116,032	63,597	-89,192	5,054	-7,705	-35,256	-15,520	27,831	12,373	-2,130	-15,613	21,976	-16,606	12,373	1,375,059
1998	0	0	-57,797	0	0	0	0	136,362	67,063	-78,577	8,034	-3,865	-28,896	-14,922	28,136	13,656	-2,978	-17,169	22,838	-16,347	13,656	1,511,420
1999	0	0	-111,192	0	0	0	0	71,897	79,296	-93,144	9,788	-6,582	-37,432	-17,379	37,757	8,524	1,382	-14,601	22,726	-18,031	8,524	1,583,317
2000	0	0	-58,927	0	0	0	0	120,539	75,001	-85,312	4,067	-8,738	-25,145	-14,625	34,130	11,957	-4,852	-13,144	22,261	-16,221	11,957	1,703,855
2001	0	0	-202,438	0	0	0	0	-20,340	84,217	-85,202	1,896	-4,283	-12,559	-12,654	26,614	13,388	-7,861	-12,000	23,458	-16,985	13,388	1,683,515
2002	0	0	-162,957	0	0	0	0	-3,708	76,591	-97,839	-883	-11,518	-20,839	-15,405	27,396	17,582	-8,658	-15,543	24,270	-17,652	17,582	1,679,807
2003	0	0	-130,332	0	0	0	0	32,464	78,735	-94,198	3,210	-11,188	-19,527	-16,659	28,700	18,537	-6,900	-19,706	25,538	-17,468	18,537	1,712,271
2004	0	0	-214,670	0	0	0	0	-49,393	79,299	-90,221	2,789	-10,629	-12,554	-16,894	26,366	13,904	-9,935	-11,614	25,533	-17,888	13,904	1,662,878
2005	0	0	-22,996	0	0	0	0	120,500	60,617	-89,165	692	-14,580	-29,037	-13,207	27,583	13,315	-4,201	-16,023	23,231	-16,321	13,315	1,783,378
2006	0	0	-31,250	0	0	0	0	102,907	56,625	-86,840	475	-11,184	-33,827	-13,243	27,566	12,747	-1,116	-17,157	20,543	-15,017	12,747	1,886,285
2007	0	0	-209,499	0	0	0	0	-70,518	67,360	-90,375	2,925	-9,752	-13,691	-17,605	15,108	13,455	-1,207	-12,467	22,545	-22,326	13,455	1,815,767
2008	0	0	-232,114	0	0	0	0	-85,575	76,606	-93,253	-2,465	-8,438	-14,390	-13,423	22,069	15,746	-2,202	-11,613	25,088	-27,018	15,746	1,730,191
2009	0	0	-187,798	0	0	0	0	-42,237	74,501	-92,397	-6,514	-12,082	-3,368	-10,120	14,189	18,852	2,483	-18,590	24,881	-27,626	18,852	1,687,954
2010	0	0	-62,006	0	0	0	0	69,461	63,446	-91,016	-8,768	-21,050	-13,046	-7,919	23,212	16,894	4,043	-14,456	23,260	-29,741	16,894	1,757,415
2011	0	0	48,633	0	0	0	0	163,884	51,038	-85,781	-9,463	-21,958	-28,999	-4,789	30,466	12,948	-8,283	-11,171	19,208	-12,702	12,948	1,921,299
2012	0	0	-152,288	0	0	0	0	-32,812	64,180	-89,367	-9,466	-17,585	-19,076	-3,389	24,330	15,029	-7,718	-9,997	18,951	-16,266	15,029	1,888,486
2013	0	0	-203,087	0	0	0	0	-83,604	66,410	-92,285	-13,015	-13,986	-13,742	-6,364	21,233	14,477	-7,831	-8,251	21,031	-19,426	14,477	1,804,883
2014	0	0	-231,859	0	0	0	0	-113,047	69,232	-100,472	-14,784	-10,727	-15,176	-10,580	20,026	15,722	-1,678	-14,285	23,115	-22,875	15,722	1,691,836
2015	0	0	-240,639	0	0	0	0	-105,501	72,128	-90,840	-14,531	-9,591	-12,338	-6,960	24,707	13,951	-9,511	-9,208	23,645	-18,876	13,951	1,586,335
2016	0	0	-179,866	0	0	0	0	-60,314	65,273	-100,280	-12,856	-18,575	-19,362	-6,068	21,854	16,680	-15,498	-7,363	23,614	-17,433	0	1,526,021
1990-2016 Average	0	0	-134,595	0	0	0	0	56,519	51,038	-58,787	-1,269	-8,259	-19,363	-11,700	27,943	12,830	-6,344	-11,241	22,401	-17,646	12,212	1,439,910
1998-2010 Average	0	0	-129,537	0	0	0	0	29,412	120,265	-100,472	1,173	-10,299	-20,331	-14,158	26,063	14,504	-3,231	-14,929	23,552	-19,895	14,504	1,707,542

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-3 Historical and Current Water Balance, Tulare Lake Subbasin SGMA Model, Kings County, California

Land Surface Water Budget														
			Inflows						Outflows					
Year	Kings River Flows	Year Type	Effective Precipitation (AF)	Applied Surface Water (AF)	Applied Pond Water (AF)	Imported Groundwater (AF)	Applied Groundwater (AF)	Total Inflows (AF)	Drain Outflow (AF)	Farm Demand Evapotranspiration (AF)	Deep Percolation (AF)	Total Outflows (AF)	Net Inflow-Outflow (AF)
1990	40%	D	19,958	319,870	10,310	48,885	609,474	1,008,496	0	1,065,856	132,933	1,198,789	-190,293
1991	63%	D	78,722	209,568	3,793	52,225	568,130	912,439	0	994,832	125,674	1,120,507	-208,068
1992	41%	D	64,818	245,345	8,619	46,926	587,328	953,036	0	1,012,909	126,365	1,139,274	-186,238
1993	149%	W	67,191	811,312	31,153	7,533	238,616	1,155,805	0	1,008,709	124,472	1,133,181	22,624
1994	50%	D	34,514	443,731	4,237	27,612	481,028	991,122	26	1,047,937	129,432	1,177,394	-186,272
1995	202%	W	95,479	948,773	42,079	905	177,847	1,265,083	82	973,503	116,897	1,090,481	174,601
1996	122%	N	100,745	1,038,046	26,566	0	182,868	1,348,225	251	1,067,962	127,604	1,195,817	152,408
1997	155%	W	58,885	749,117	54,380	0	265,952	1,128,333	1,392	1,123,726	143,342	1,268,459	-140,126
1998	181%	W	116,167	693,908	49,104	0	237,530	1,096,709	1,870	1,059,009	128,533	1,189,412	-92,703
1999	74%	D	34,039	713,206	39,371	0	325,154	1,111,771	7,376	1,232,448	151,647	1,391,471	-279,701
2000	90%	N	70,413	741,494	35,618	6,833	247,306	1,101,664	17,343	1,127,412	95,624	1,240,379	-138,714
2001	59%	D	94,963	437,871	8,911	54,771	453,432	1,049,949	13,351	1,111,506	90,933	1,215,791	-165,841
2002	67%	D	26,034	564,134	21,817	51,428	408,568	1,071,981	10,253	1,201,455	85,417	1,297,125	-225,143
2003	83%	N	40,108	583,124	4,687	24,029	366,253	1,018,201	8,170	1,198,411	95,332	1,301,914	-283,713
2004	61%	D	74,858	495,764	25,863	63,254	475,486	1,135,226	20,849	1,162,011	86,876	1,269,736	-134,510
2005	148%	W	80,390	873,425	36,085	857	200,953	1,191,709	5,413	1,155,548	101,553	1,262,513	-70,804
2006	172%	W	104,703	1,020,922	37,530	154	189,607	1,352,916	9,651	1,129,741	108,496	1,247,887	105,029
2007	40%	D	14,800	508,886	4,613	60,608	456,931	1,045,839	14,999	1,183,096	97,935	1,296,030	-250,191
2008	72%	D	35,836	371,231	9,331	72,842	497,113	986,354	13,795	1,083,093	89,622	1,186,511	-200,157
2009	79%	N	32,367	379,590	16,632	68,391	440,286	937,266	4,295	1,091,697	94,173	1,190,165	-252,899
2010	121%	N	88,203	694,592	51,406	31,531	234,505	1,100,238	2,440	1,016,725	78,915	1,098,080	2,158
2011	180%	W	52,937	1,026,568	21,035	7,241	60,638	1,168,420	4,486	791,090	83,959	879,535	288,885
2012	49%	D	45,317	498,937	20,785	64,173	339,834	969,046	3,226	776,133	62,058	841,417	127,629
2013	41%	D	2,800	264,515	1,725	84,661	437,315	791,017	8,381	826,405	65,687	900,473	-109,456
2014	32%	D	30,586	154,346	0	85,650	491,323	761,906	3,579	757,265	62,755	823,599	-61,693
2015	21%	D	15,085	107,212	0	79,517	508,193	710,008	829	624,647	49,756	675,231	34,777
2016	75%	D	41,890	227,755	0	70,864	413,868	754,377	2,497	677,936	53,544	733,977	20,400
1990-2016 Avg	91%		56,363	560,120	20,950	37,440	366,501	1,041,375	5,724	1,018,558	100,353	1,124,635	-83,260
1998-2010 Avg	96%		62,529	621,396	26,228	33,438	348,702	1,092,294	9,985	1,134,781	100,389	1,245,155	-152,861

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-3 Historical and Current Water Balance, Tulare Lake Subbasin SGMA Model, Kings County, California (Continued)

Subsurface Water Budget																	
			Inflows							Outflows							
			Deep Percolation				Interbasin Inflow			Groundwater Pumping		Interbasin Outflow			Annual Change in Storage		
Year	Kings River Flows	Year Type	Precipitation Infiltration (AF)	Applied Water Infiltration (AF)	Stream Leakage (AF)	Intentional Recharge (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Total Inflows (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Total Outflows (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Total Aquifer (AF)
1990	40%	D	17,012	132,933	222,466	1,021	60,944	120,265	554,640	363,970	254,873	52,493	58,787	730,124	-392,438	206,512	-185,926
1991	63%	D	10,310	125,674	149,106	0	59,832	104,657	449,578	351,785	225,455	44,466	68,123	689,829	-379,415	154,951	-224,464
1992	41%	D	13,215	126,365	122,515	0	58,304	102,535	422,934	345,307	251,686	43,733	75,762	716,488	-379,874	89,485	-290,389
1993	149%	W	43,499	124,472	178,243	61	51,892	77,023	475,190	239,755	9,069	42,526	80,157	371,507	-117,785	275,064	157,279
1994	50%	D	20,701	129,432	121,447	23,540	52,755	83,154	431,028	310,055	181,901	44,438	80,974	617,368	-255,820	87,113	-168,707
1995	202%	W	58,569	116,897	160,315	60,372	45,868	68,012	510,032	205,637	17,015	50,708	79,891	353,250	-23,977	255,398	231,421
1996	122%	N	78,864	127,604	161,750	32,081	42,064	60,065	502,429	184,321	11,265	47,154	88,966	331,705	-4,023	190,504	186,481
1997	155%	W	65,946	143,342	153,373	42,787	40,618	63,597	509,662	204,969	73,758	50,417	89,192	418,336	-15,247	116,032	100,786
1998	181%	W	75,095	128,533	152,395	61,425	38,754	67,063	523,264	191,289	57,797	55,626	78,577	383,288	17,175	136,362	153,536
1999	74%	D	47,885	151,647	180,710	0	41,389	79,296	500,928	227,049	111,192	47,970	93,144	479,355	-71,374	71,897	522
2000	90%	N	51,238	95,624	159,781	23,540	41,391	75,001	446,574	201,799	58,927	44,741	85,312	390,779	-76,900	120,539	43,638
2001	59%	D	26,775	90,933	124,376	0	44,167	84,217	370,468	264,888	202,438	45,556	85,202	598,085	-222,719	-20,340	-243,059
2002	67%	D	41,347	85,417	164,069	0	46,006	76,591	413,429	272,312	162,957	45,147	97,839	578,256	-174,685	-3,708	-178,393
2003	83%	N	36,128	95,332	174,955	23,540	45,798	78,735	454,487	255,270	130,332	46,552	94,198	526,352	-133,547	32,464	-101,083
2004	61%	D	40,008	86,876	148,458	10,700	46,099	79,299	411,440	279,593	214,670	46,854	90,221	631,339	-181,729	-49,393	-231,122
2005	148%	W	64,268	101,553	185,872	58,945	41,121	60,617	512,376	194,492	22,996	48,908	89,165	355,562	516	120,500	121,017
2006	172%	W	57,791	108,496	169,501	170,266	37,534	56,625	600,213	174,179	31,250	56,025	86,840	348,293	117,742	102,907	220,649
2007	40%	D	23,538	97,935	174,019	0	42,192	67,360	405,044	264,654	209,499	52,530	90,375	617,057	-177,972	-70,518	-248,490
2008	72%	D	26,373	89,622	137,369	0	43,266	76,606	373,236	283,431	232,114	49,766	93,253	658,564	-210,701	-85,575	-296,277
2009	79%	N	29,563	94,173	167,126	10,700	43,877	74,501	419,939	268,843	187,798	49,818	92,397	598,856	-170,773	-42,237	-213,010
2010	121%	N	67,953	78,915	145,364	23,540	37,974	63,446	417,193	187,770	62,006	47,711	91,016	388,504	-56,332	69,461	13,129
2011	180%	W	88,853	83,959	180,036	180,066	32,182	51,038	616,133	126,313	48,633	58,840	85,781	319,567	197,345	163,884	361,228
2012	49%	D	46,276	62,058	126,057	10,700	34,819	64,180	344,090	205,013	152,288	52,627	89,367	499,295	-137,135	-32,812	-169,947
2013	41%	D	23,005	65,687	123,434	0	38,673	66,410	317,209	252,639	203,087	50,934	92,285	598,945	-222,003	-83,604	-305,607
2014	32%	D	20,546	62,755	92,469	23,320	41,277	69,232	309,598	276,394	231,859	51,497	100,472	660,223	-247,305	-113,047	-360,352
2015	21%	D	25,814	49,756	74,156	23,540	41,875	72,128	287,269	283,699	240,639	50,653	90,840	665,831	-286,779	-105,501	-392,279
2016	75%	D	26,426	53,544	32,070	42,659	36,829	65,273	256,801	248,557	179,866	60,070	100,280	588,773	-234,011	-60,314	-294,325
1990-2016 Avg	91%		41,740	100,353	147,460	30,474	43,981	74,331	438,340	246,814	139,458	49,547	86,978	522,797	-142,214	56,519	-85,694
1998-2010 Avg	96%		45,228	100,389	160,307	29,435	42,274	72,258	449,892	235,813	129,537	49,016	89,811	504,176	-103,177	29,412	-73,765

See Acronyms and Abbreviations list for definitions.

Table 3.3.1-4 Historical Evapotranspiration Demand, Tulare Lake Subbasin SGMA Model, Kings County, California

Tulare Lake Subbasin	1990-1995 (AF/Y)	1996-1998 (AF/Y)	1999-2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)	Average (AF/Y)
Tulare Lake Subbasin														
Alfalfa Hay and Clover	172,519	135,032	225,167	300,041	333,752	296,086	288,555	160,621	174,457	204,219	148,325	122,839	100,395	190,580
Almonds (Adolescent)			8,113			11,218	19,864	8,127	10,631	18,529	16,937	15,155	13,714	6,332
Almonds (Mature)	26,791	18,278	15,869	47,030	43,122	35,832	30,537	36,976	39,450	41,720	46,956	54,869	55,084	28,083
Almonds (Young)		2,287	6,480	12,062	26,125	15,445	17,964	13,431	14,580	18,458	17,621	15,779	20,206	8,292
Berries	47								2	6		1		11
Carrot Single Crop								37	16	41	7	6	56	6
Citrus (no ground cover)			91		42	46	14	405	99	335	300	74	32	74
Corn and Grain Sorghum	36,877	100,450	75,793	101,418	82,027	89,467	59,478	87,236	75,344	71,190	58,462	48,619	44,935	65,605
Cotton	463,179	525,386	362,232	320,870	258,511	212,071	287,383	308,970	260,527	261,476	185,559	130,368	215,815	345,645
Dairy Single Crop*	14,290	15,268	16,421											9,129
Fallow Land*														-
Forest*														-
Grain and Grain Hay	50,167	84,811	110,025	33,572	48,563	47,755	45,271	13,518	17,369	19,505	21,282	36,934	33,228	60,837
Melons	413	92	468				21	3	16	10	1,182	27	128	275
Misc. field crops	40,450	30,296	121,265		5			1			4			43,795
Onions and Garlic	807	846	1,359			12	2,417	731	538	167	893	266	1,146	854
Open Water*														-
Pasture and Misc. Grasses	10,799	21,726	24,256	218,974	191,082	289,198	229,306	63,417	57,751	66,333	144,942	68,014	59,370	62,524
Pistachio (Adolescent)								213	315	559	1,290	4,713	5,704	474
Pistachio (Mature)	15,229	12,354	12,341	17,831	5,680	2,825	1,236	1,283	1,237	1,135	1,075	1,412	1,374	9,256
Pistachio (Young)		394	2,265	1,091	1,370	2,454	2,395	3,729	5,770	7,498	8,281	8,231	9,024	2,477
Pomegranates (Adolescent)											5	23	41	3
Pomegranates (Young)				11	303	99	52	901	210	376	537	567	746	141
Potatoes, Sugar beets, Turnip etc..	18,604	4	676	19		10		29		127		7	7	4,317
Riparian*														-
Small Vegetables	2,835	1,147	8,009	33	3	20	340	227	212	390	264	126	317	2,905
Stone Fruit (Adolescent)			4,238			28	138	232	291	171	106	414	425	1,166
Stone Fruit (Mature)	25,350	17,875	13,818	4,560	1,886	584	64	11	80	141	79	95	136	11,485
Stone Fruit (Young)		1,310	3,001	466	1,234	1,217	1,879	1,010	547	1,250	1,186	913	667	1,308
Tomatoes and Peppers	12,971	3,747	33,791	261	5	246	26	47,851	52,725	15,847	26,555	42,793	52,168	20,892
Urban, Industrial*														-
Wine Grapes with 80% canopy	7,586	8,301	14,872	14,203	8,893	5,692	6,980	13,625	23,455	11,832	16,450	11,874	27,920	11,683
Winter Wheat*														-
Tulare Lake Subbasin Irrigated ET Demand	884,626	964,336	1,044,130	1,072,442	1,002,603	1,010,305	993,918	762,584	735,624	741,315	698,299	564,117	642,636	879,019
Tulare Lake Subbasin GSA Total ET Demand	898,916	979,604	1,060,551	1,072,442	1,002,603	1,010,305	993,918	762,584	735,624	741,315	698,299	564,117	642,636	888,148

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year.

See Acronyms and Abbreviations list for definitions.

Table 4.3.1-1a Representative Monitoring Areas - A-Zone

RMA	RMS Well ID	MO Elevation	MT Elevation	Total Well Count	Domestic Wells Impacted at the MT	Agriculture Wells Impacted at the MT	Water Supply Wells Impacted at the MT
A-1	192132J1	197	187	11	0	0	0
A-2	192120R1	209	199	32	0	0	0
A-3	192118R1	202	192	64	0	1	0
A-4	19S20E29E002M	170	160	41	1	2	0
A-5		181	171	22	4	3	0
A-6		192	182	50	1	5	0
A-7		189	179	35	4	5	0
A-8	192012A1	197	187	38	0	1	0
A-9		191	181	45	2	2	1
A-10	AG-1	194	184	14	0	0	0
A-11	182036M1	204	194	41	1	0	0
A-12		195	185	35	1	4	0
A-13	KRCDAC1S	196	186	27	1	0	0
A-14	192117B1	208	198	66	0	0	0
A-15	192115R1	210	200	46	1	0	0
A-16	182130D1	216	206	56	0	0	0
A-17	182128B1	209	199	54	0	0	0
A-18	182117N1	216	206	33	0	0	0
A-19	18S21E07R003M	211	201	8	0	0	0
A-20	20S19E25A003M	187	177	28	3	11	0
A-21		190	180	1	0	0	0
A-22		192	182	1	0	0	0
A-23		196	186	1	0	0	0
A-24		203	193	1	0	0	0
A-25		211	201	3	0	0	0
A-26		219	209	3	0	0	0
A-27		216	206	1	0	0	0
A-28		210	200	1	0	0	0
A-29	192131Q1	207	197	22	0	0	0
A-30		200	190	14	2	1	0
			Total Well Counts:	794	21	35	1

Table 4.3.1-1b Representative Monitoring Areas - B-Zone

RMA	RMS Well ID	MO Elevation	MT Elevation	Total Well Count	Domestic Wells Impacted at the MT	Agricultural Wells Impacted at the MT	Water Supply Wells Impacted at the MT
B-1		38	8	2	0	0	0
B-2	Becky Pease Well	95	65	13	0	0	0
B-3		55	25	2	0	0	0
B-4		53	23	1	0	0	0
B-5		52	22	1	0	0	0
B-6		54	24	3	0	0	0
B-7	SL-1	60	30	12	0	0	0
B-8	KRCDAC5M	53	23	47	1	0	0
B-9	192134D1	-3	-33	29	0	0	0
B-10		58	28	30	0	0	0
B-11		57	27	2	0	0	0
B-12	CID-071	63	33	10	0	0	0
B-13		67	37	11	0	0	0
B-14	192127F2	-20	-50	44	1	0	0
B-15	192103B1	132	102	59	0	0	0
B-16	18S22E34R001M	119	89	38	0	0	0
B-17	192207K1	98	68	107	3	0	1
B-18	192103J1	63	33	32	11	0	0
B-19	182134B2	60	30	86	26	0	0
B-20		65	35	54	9	1	0
B-21	18S21E31B001M	89	59	53	2	0	0
B-22	18S20E34N001M	110	80	27	1	1	0
B-23	182132A1	60	30	120	38	1	0
B-24		79	49	28	2	0	0
B-25	1610005-009	43	13	36	8	0	1
B-26	182108J1	90	60	71	3	0	0
B-27	KRCDKCWD08	105	75	30	1	0	0
B-28	KRCDKCWD05	110	80	57	1	0	0
B-29	182217Q1	94	64	61	2	0	1
B-30	182112N1	115	85	69	2	0	0
B-31	18S22E03B001M	140	110	16	0	0	0
B-32	172135C1	145	115	90	1	0	0
B-33	172127L1	142	112	67	0	0	1
B-34	172232C1	150	120	74	3	1	1
B-35	MW-C	205	175	17	0	0	0
B-36	MW-A	238	208	16	0	0	0
B-37	ER_CID_05	130	100	44	0	2	0
B-38	MWD INT	201	171	16	0	0	0
B-39	MWG INT	190	160	3	0	0	0
B-40	18S22E24D001M	134	104	3	0	0	0
B-41	MWH INT	105	75	29	0	0	0
B-42	LR-4	62	32	47	3	1	1
B-43	192119D2	-10	-40	70	7	2	0
B-44	KRCDKCWD01	170	140	25	1	1	0
			Total Well Counts:	1652	126	10	6

Table 4.3.1-1c Representative Monitoring Areas - C-Zone

RMA	RMS Well ID	MT Elevation	Total Well Count
C-03	--	-250	0
C-04	Well 16-8	-379	5
C-05	ER_S-225	-309	45
C-05	20S20E28E003M	-262	45
C-06	KRCDAC5D	-249	34
C-07	20S20E07H001M	-267	70
C-07	KRCDAC3D	-350	70
C-08	19S20E06D005M	-188	21
C-09	KRCDKCWD06	-178	111
C-10	1610005-011	-184	56
C-10	1610005-020	-171	56
C-14	--	-350	0
C-15	--	-300	0
C-16	--	-350	0
C-18	--	-250	21
C-19	19S22E08D002M	-44	85
C-19	MWH DEEP	-55	85
C-20	--	-250	173
C-21	--	-285	70
C-22	MWG DEEP	52	196
C-22	MWD DEEP	58	196
C-23	ZE 33-4	-250	33
C-23	FB 35-2	-150	33
CC1	ER_S-173	-223	26
DS1	--	-400	0
GTLN1	KRCDTL002	-198	42
GTLN1	KRCDTL003	-227	42
GTLN2	ER_CID-081	-175	40
GTLN2	ER_CID-01	-150	40
GTLS1	--	-300	1
TL01	--	-200	18
TL02	--	-250	0
TL03	--	-250	11
TL04	--	-300	34
TL05	ER_S-205	-348	23
TL05	21S22E07J001M	-308	23
TL06	--	-300	0
TL07	--	-350	0
TL08	--	-300	0
TL09	--	-300	14
TL10	--	-350	9
TL11	--	-400	0
TL12	--	-400	0
TL13	--	-400	0
TL14	--	-350	2

Table 5.1.0-2. Monitoring Networks for Each Sustainability Indicator

		Site Code	Local Monitoring Station Name	State Well ID	Aquifer Zone	Latitude	Longitude	Facility Type	Status	SGMA Monitoring Frequency	Sustainability Indicators	Aquifer Monitored
Mid Kings River GSA	Water Levels	363722N1197282W001	18S21E07R003M	18S21E07R003M	A Zone	36.3722	-119.7282	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	above A-clay
		363722N1197282W001	18S21E07R003M	18S21E07R003M	A Zone	36.3722	-119.7282	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	above A-clay
			182036M1		A Zone	36.319332	-119.761382	Monitoring	new	Semiannual	WL,WQ	above A-clay
			182117N1		A Zone	36.360408	-119.726826	Monitoring	new	Semiannual	WL,WQ	above A-clay
			182128B1		A Zone	36.342461	-119.697906	Monitoring	new	Semiannual	WL,WQ	above A-clay
			182130D1		A Zone	36.33885	-119.743766	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192012A1		A Zone	36.297352	-119.748385	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192115R1		A Zone	36.271989	-119.673202	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192117B1		A Zone	36.283557	-119.717056	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192118R1		A Zone	36.270332	-119.728408	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192120R1		A Zone	36.256001	-119.709786	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192131Q1		A Zone	36.227505	-119.731277	Monitoring	new	Semiannual	WL,WQ	above A-clay
			192132J1		A Zone	36.23055	-119.710963	Monitoring	new	Semiannual	WL,WQ	above A-clay
		363142N1195685W001	18S22E34R001M	18S22E34R001M	B Zone	36.3142	-119.5685	Domestic	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		363274N1195809W001	MWH INT	MWH INT	B Zone	36.32743	-119.58086	Monitoring	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		363274N1197327W001	18S21E31B001M	18S21E31B001M	B Zone	36.3274	-119.7327	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		363393N1195832W001	KRCDKCWD08	18S22E28A001M	B Zone	36.34	-119.58	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		363419N1196799W001	KRCDKCWD05	18S21E27B001M	B Zone	36.34	-119.68	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		363572N1195468W001	18S22E24D001M	18S22E24D001M	B Zone	36.3572	-119.5468	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		363992N1195716W001	18S22E03B001M	18S22E03B001M	B Zone	36.3992	-119.5716	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		364303N1195841W001	KRCDKCWD01	17S22E28A001M	B Zone	36.4303	-119.5841	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		364304N1195373W001	MWG INT	MWG INT	B Zone	36.43036	-119.5373	Monitoring	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		364436N1195641W001	MWD INT	MWD INT	B Zone	36.44364	-119.56407	Monitoring	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		364452N1195550W001	MW-C	MW-C	B Zone	36.44522	-119.55496	Monitoring	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		364834N1195404W001	MW-A	MW-A	B Zone	36.48337	-119.54036	Monitoring	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
			172127L1		B Zone	36.422863	-119.680151	Monitoring	new	Semiannual	WL	above E-clay
			172135C1		B Zone	36.41555	-119.663765	Monitoring	new	Semiannual	WL	above E-clay
			172232C1		B Zone	36.415695	-119.613347	Monitoring	new	Semiannual	WL	above E-clay
			182108J1		B Zone	36.37587	-119.709595	Monitoring	new	Semiannual	WL	above E-clay
			182112N1		B Zone	36.372222	-119.65352	Monitoring	new	Semiannual	WL	above E-clay
			182132A1		B Zone	36.32685	-119.711264	Monitoring	new	Semiannual	WL	above E-clay
			182134B2		B Zone	36.327841	-119.688702	Monitoring	new	Semiannual	WL	above E-clay
			182217Q1		B Zone	36.357683	-119.607783	Monitoring	new	Semiannual	WL	above E-clay
			192103B1		B Zone	36.312444	-119.681904	Monitoring	new	Semiannual	WL	above E-clay
			192103J1		B Zone	36.303292	-119.673185	Monitoring	new	Semiannual	WL	above E-clay
			192119D2		B Zone	36.267818	-119.742429	Monitoring	new	Semiannual	WL	above E-clay
			192127F2		B Zone	36.249217	-119.68483	Monitoring	new	Semiannual	WL	above E-clay
			192134D1		B Zone	36.240214	-119.690038	Monitoring	new	Semiannual	WL	above E-clay
			192207K1		B Zone	36.292948	-119.623363	Monitoring	new	Semiannual	WL	above E-clay
		362258N1198699W001	20S19E02A001M	20S19E02A001M	C Zone	36.225861	-119.869972	Irrigation	Published in 2020 GSP	Semiannual	WL	below E-clay
		362618N1197496W001	KRCDKCWD06	19S21E30A001M	C Zone	36.25	-119.73	Unknown	Published in 2020 GSP	Semiannual	WL	below E-clay
		362981N1196189W001	19S22E08D002M	19S22E08D002M	C Zone	36.29808	-119.61892	Monitoring	Published in 2020 GSP	Semiannual	WL	below E-clay
		363277N1195806W001	MWH DEEP	MWH DEEP	C Zone	36.32769	-119.58055	Monitoring	Published in 2020 GSP	Semiannual	WL	below E-clay
		364306N1195370W001	MWG DEEP	MWG DEEP	C Zone	36.43061	-119.53699	Monitoring	Published in 2020 GSP	Semiannual	WL	below E-clay
		364436N1195648W001	MWD DEEP	MWD DEEP	C Zone	36.44364	-119.56475	Monitoring	Published in 2020 GSP	Semiannual	WL	below E-clay
	Water Quality		1610003-044		B Zone	36.313147	-119.619225	MUNICIPAL	Published in 2020 GSP	Annual	WQ	above E-clay
			1610001-001		C Zone	36.307684	-119.705564	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610001-007		C Zone	36.318727	-119.715948	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-026		C Zone	36.315854	-119.637836	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-028		C Zone	36.343256	-119.650264	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-031		C Zone	36.351449	-119.659114	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-033		C Zone	36.357985	-119.659973	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-034		C Zone	36.342878	-119.671615	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-036		C Zone	36.343483	-119.683438	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-037		C Zone	36.338642	-119.682356	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-039		C Zone	36.328943	-119.631167	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-040		C Zone	36.34118	-119.643019	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-041		C Zone	36.351782	-119.633135	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-042		C Zone	36.361419	-119.641004	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
			1610003-043		C Zone	36.345708	-119.623917	MUNICIPAL	Published in 2020 GSP	Annual	WQ	below E-clay
	Subsidence		SUB111			36.313418	-119.736111	Benchmark	Published in 2020 GSP	Annual	LS	
			SUB068			36.313611	-119.735556	Benchmark	Published in 2020 GSP	Annual	LS	
			N 460 RESET			36.313889	-119.722222	Benchmark	Published in 2020 GSP	Annual	LS	
			X 931			36.323182	-119.709159	Benchmark	Published in 2020 GSP	Annual	LS	
			SUB091			36.327222	-119.645833	Benchmark	Published in 2020 GSP	Annual	LS	
			SUB032			36.3275	-119.647222	Benchmark	Published in 2020 GSP	Annual	LS	
			S224P2			36.327939	-119.595252	Benchmark	Published in 2020 GSP	Annual	LS	
			U 808			36.328056	-119.609167	Benchmark	Published in 2020 GSP	Annual	LS	
			U 511			36.328094	-119.625146	Benchmark	Published in 2020 GSP	Annual	LS	
			X 511			36.342778	-119.645833	Benchmark	Published in 2020 GSP	Annual	LS	
			S222R			36.357226	-119.583544	Benchmark	Published in 2020 GSP	Annual	LS	
			K021			36.401405	-119.580471	Benchmark	Published in 2020 GSP	Annual	LS	

Table 5.1.0-2. Monitoring Networks for Each Sustainability Indicator - Continued

		Site Code	Local Monitoring Station Name	StatewellID	AquiferZone	Latitude	Longitude	Facility Type	Status	SGMA Monitoring Frequency	Sustainability Indicators	Aquifer Monitored
South Fork Kings GSA	Water Level	361700N1198510W001	20S19E25A003M	20S19E25A003M	A Zone	36.16492	-119.852	Piezometer	Published in 2020 GSP	Semiannual	WL, WQ	above A-clay
		362500N1198310W001	19S20E29E002M	19S20E29E002M	A Zone	36.25103	-119.834	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above A-clay
		363305N1198258W001	AG-1	AG-1	A Zone	36.33043	-119.826	Agricultural	Newly Added	Semiannual	WL, WQ	above A-clay
		363500N1197800W003	KRCDAC1S	18S20E23E003M	A Zone	36.34604	-119.781	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above A-clay
		361600N1197800W001	KRCDAC5M	20S20E26L001M	B Zone	36.15983	-119.776	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		361893N1198706W001	SL-1	SL-1	B Zone	36.18931	-119.871	Monitoring	Newly Added	Semiannual	WL, WQ	above E-clay
		363144N1197968W001	18S20E34N001M	18S20E34N001M	B Zone	36.3144	-119.797	Domestic	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		363349N1198129W001	LR-4	LR-4	B Zone	36.33483	-119.813	Agricultural	Newly Added	Semiannual	WL, WQ	above E-clay
		363863N1197745W001	1610005-009	1610005-009	B Zone	36.38628	-119.774	Public	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		362400N1198300W002	KRCDAC3M		B Zone	36.24053	-119.835	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		363133N1198512W001	19S20E06D004M	19S20E06D004M	B Zone	36.31333	-119.851	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		363500N1197800W002	KRCDAC1M		B Zone	36.34609	-119.781	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		362400N1198300W001	KRCDAC3D	19S20E32D003M	B Zone	36.24045	-119.835	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	above E-clay
		361429N1198259W001	ER_S-225	ER_S-225	C Zone	36.14294	-119.826	Unknown	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		361429N1198259W001	ER_S-225	ER_S-225	C Zone	36.14294	-119.826	Unknown	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		361600N1197700W001	KRCDAC5D	20S20E26L002M	C Zone	36.15977	-119.776	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		361617N1198124W001	20S20E28E003M	20S20E28E003M	C Zone	36.16145	-119.812	Irrigation	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		361617N1198124W001	20S20E28E003M	20S20E28E003M	C Zone	36.16145	-119.812	Irrigation	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		362061N1198388W001	20S20E07H001M	20S20E07H001M	C Zone	36.20557	-119.839	Domestic	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		362944N1198055W001	1610005-011	1610005-011	C Zone	36.29443	-119.805	Public	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		363133N1198477W002	19S20E06D005M	19S20E06D005M	C Zone	36.31327	-119.848	Irrigation	Replaced Former RMS	Semiannual	WL, WQ	Below E-clay
		363840N1197762W002	1610005-020	1610005-020	C Zone	36.38403	-119.776	Public	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		363500N1197800W001	KRCDAC1D		C Zone	36.34607	-119.781	Monitoring	Published in 2020 GSP	Semiannual	WL, WQ	Below E-clay
		362410N1197802W001	CU ELEMENTARY SCHOOL	19S20E26N002M	C Zone	36.2438	-119.78	Water Supply	Published in 2020 GSP	Semiannual	WL	Below E-clay
	Water Quality		1610005-003		B Zone	36.38491	-119.776	municipal	Published in 2020 GSP	Annual	WQ	above E-clay
			1610005-009		B Zone	36.38628	-119.774	municipal	Published in 2020 GSP	Annual	WQ	above E-clay
			1610005-018		B Zone	36.29588	-119.826	municipal	Published in 2020 GSP	Annual	WQ	above E-clay
			1610006-001		B Zone	36.19289	-119.82	municipal	Published in 2020 GSP	Annual	WQ	above E-clay
			1610006-002		B Zone	36.18544	-119.824	municipal	Published in 2020 GSP	Annual	WQ	above E-clay
			1610005-005		C Zone	36.38597	-119.77	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-006		C Zone	36.30497	-119.795	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-007		C Zone	36.2805	-119.799	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-008		C Zone	36.27913	-119.799	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-010		C Zone	36.32214	-119.78	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-011		C Zone	36.29443	-119.805	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-020		C Zone	36.38405	-119.776	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-021		C Zone	36.29145	-119.821	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610005-022		C Zone	36.28891	-119.829	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
			1610006-007		C Zone	36.19657	-119.82	municipal	Published in 2020 GSP	Annual	WQ	Below E-clay
	Subsidence		SUB061			36.17226	-119.816	benchmark	Published in 2020 GSP	Annual	LS	
			SUB102			36.1895	-119.845	benchmark	Published in 2020 GSP	Annual	LS	
			SUB028			36.25564	-119.86	benchmark	Published in 2020 GSP	Annual	LS	
			LEMA (RMS)			36.29194	-119.783	benchmark	Published in 2020 GSP	Monthly	LS	
			SUB086			36.36259	-119.809	benchmark	Published in 2020 GSP	Annual	LS	
El Rico GSA	Water Levels	360702N1195369W001	CID-071	CID-071	B Zone	36.07025	-119.537	Unknown	Newly Added	Semiannual	WL,WQ	Above E-clay
		361381N1195558W001	ER_CID_05	ER_CID_05	B Zone	36.13809	-119.556	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	Above E-clay
		360462N1196418W001	ER_S-205	ER_S-205	C Zone	36.04618	-119.642	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	Below E-clay
		360757N1195438W001	ER_S-173	ER_S-173	C Zone	36.07568	-119.544	Unknown	Published in 2020 GSP	Semiannual	WL,WQ	Below E-clay
		361158N1196258W001	21S22E07J001M	21S22E07J001M	C Zone	36.11581	-119.626	Monitoring	Published in 2020 GSP	Semiannual	WL,WQ	Below E-clay
		361338N1195366W001	ER_CID-081	ER_CID-081	C Zone	36.13381	-119.537	Unknown	Newly Added	Semiannual	WL,WQ	Below E-clay
		361700N1196900W001	KRCDTL003	KRCDTL003	C Zone	36.17	-119.69	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	Below E-clay
		361890N1195650W001	ER_CID-01	ER_CID-01	C Zone	36.18896	-119.565	Unknown	Newly Added	Semiannual	WL,WQ	Below E-clay
		362000N1196700W001	KRCDTL002	KRCDTL002	C Zone	36.18896	-119.67	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	Below E-clay
	Water Quality		1610004-019		B Zone	36.13765	-119.552	MUNICIPAL	Published in 2020 GSP	Annual	WQ	Above E-clay
	Subsidence		SUB093			35.88787	-119.525	benchmark	Published in 2020 GSP	Annual	LS	
			SUB083			36.03621	-119.572	benchmark	Published in 2020 GSP	Annual	LS	
			CRCN (RMS)			36.11389	-119.568	benchmark	Published in 2020 GSP	Monthly	LS	
			S238			36.12335	-119.574	benchmark	Published in 2020 GSP	Annual	LS	
			SUB110			36.07961	-119.771	benchmark	Published in 2020 GSP	Annual	LS	
			SUB109			36.12338	-119.698	benchmark	Published in 2020 GSP	Annual	LS	
			S234P2			36.18215	-119.6	benchmark	Published in 2020 GSP	Annual	LS	
Southwest Kings GSA	Water Levels	360074N1199605W001	Becky Pease Well	1610009-003	B Zone	36.0074	-119.96	Municipal	Published in 2020 GSP	Semiannual	WL,WQ	above E-clay
		360879N1199263W001	Well 16-8	Well 16-8	C Zone	36.08787	-119.926	Irrigation	Published in 2020 GSP	Semiannual	WL,WQ	Below E-clay
	Water Quality		1610009-003		B Zone	36.00741	-119.96	Municipal	Published in 2020 GSP	Annual	WQ	above E-clay
	Subsidence		SUB076			35.78993	-119.869	benchmark	Published in 2020 GSP	Annual	LS	
			SUB030			35.85706	-119.892	benchmark	Published in 2020 GSP	Annual	LS	
			U 1097			35.97889	-119.951	benchmark	Published in 2020 GSP	Annual	LS	
			SUB027			35.99261	-119.959	benchmark	Published in 2020 GSP	Annual	LS	
Tri-County Water Authority GSA	Water Levels	357906N1195913W001	ZE 33-4	ZE 33-4	C Zone	35.79062	-119.591	Irrigation	Replaced Former RMS	Semiannual	WL, WQ	Below E-clay
		358036N1195732W001	FB 35-2	FB 35-2	C Zone	35.80363	-119.573	Irrigation	Replaced Former RMS	Semiannual	WL, WQ	Below E-clay
	Subsidence		SUB107			35.93405	-119.754	benchmark	Published in 2020 GSP	Annual	LS	

Table 5.9.0-1. Annual Reporting Requirements

SGMA Section	Annual Reporting Requirement	Input to DMS (or link)
356.2(b)(1)(B)	Hydrographs including water year type from Jan 2015(?) to current	Generated in DMS from water level data input by GSAs
356.2(b)(1)(A)	GW Elevation Contours (spring & fall)	Generated outside DMS using data from DMS then contour maps created and a linked PDF maps from the
356.2(b)(2)	GW extraction by water use sector including method of determination and map	Determined outside DMS. Total use by sector input by each GSA then summarized for subbasin in DMS as a
356.2(b)(3)	Surface Water use by source	Total by GSA for input to DMS and summarized for subbasin in DMS as a summary table
356.2(b)(4)	Total Water use by sector	DMS summary table of water supplies by sector per GSA
356.2(b)(5)(A)	Change in GW Storage maps	Calculated outside DMS from contour data using basin-wide method then total per GSA input into DMS
356.2(b)(5)(B)	Graph with Water Year type, est. GW use, annual & cumulative GW Storage change	DMS generated basin total graph using data in DMS.

Table 5.10.0-1 Reporting Standards

Category of Information	Reporting Units
Water Volumes	AF
Surface Water Flows Groundwater Flows	AF/Y or CFS AF/Y
Field Measurements of Elevations Groundwater Surface Water Land Surface	to nearest 0.1 ft relative to NAVD 88
Reference Point Elevations	To within 0.5 feet, or best available information relative to NAVD 88
Geographic Locations	GPS coordinates by latitude and longitude in decimal degrees to five decimal places, to a minimum accurate of 30 feet, relative to NAD 83

Table 6-1. Project and Management Actions

§354.44 Projects and Management Actions

(a) Each Plan shall include a description of the projects and management actions the Agency has determined may achieve the sustainability goal for the Subbasin, including projects and management actions to respond to changing conditions in the Subbasin.

(b) Each Plan shall include a description of the projects and management actions that include the following 1-9:

(c) Projects and management actions shall be supported by best available information and best available science.

(d) An Agency shall take into account the level of uncertainty associated with the Subbasin setting when developing projects or management actions.

#	Management Action (b)(1) *	Description (b)(1)	Measurable Objective (b)(1)	Circumstances of Implementation (b)(1)(A)	Quantification of Demand Reduction (b)(2)	Permitting & Regulatory Process (b)(3)	Status, Start, End, and Accrual of Benefits (b)(4)	Explanation of Benefits and Method of Evaluation (b)(5)	Explanation of Water Source and Reliability (b)(6)	Cost and Funding Options (b)(8)	Management of Groundwater Extraction and Recharge (b)(9)	Level of Uncertainty Associated with the Basin Setting, 1=uncertain 5=certain (d)
Mid-King River GSA												
1	Well Registry	Registration of all groundwater wells, including domestic wells, within the GSA boundaries.	The goal is to categorize all of the wells to better quantify the amount of pumping that is occurring and from what which zone. In addition the program would help identify potential wells at risk.	The GSA has already began implementation of the well registration program and expects to be substantially complete by December 2024	Demand reduction will occur as this data is utilized to identify individual exactors who are over drafting	The GSA adopted this policy in November 2022. No permits or regulatory action is required for the GSA to adopt this policy.	The GSA adopted the policy November 2022 and is currently gathering data. The program is expected to be substantially completed by December 2024.	The expected benefits is provide the GSA with a understanding of where pumping is occurring and from which aquifer. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	Estimated cost of $25,000 to implement the policy. These costs are included in the agency budget	Well registry program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
2	Well Meter Policy	Require that all active wells have meters installed	The goal of this policy is to develop an understanding of the amount of groundwater extracted in the GSA	The GSA has already began implementation of the well registration program and expects to be substantially complete by December 2025	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	The GSA adopted this policy in November 2022. No permits or regulatory action is required for the GSA to adopt this policy.	The GSA adopted the policy November 2022 and is currently gathering data. The program is expected to be substantially completed by December 2025.	The expected benefits is provide the GSA with a understanding of the amount of pumping that is occurring. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The cost of the meter is the responsibility of each well owner. The estimated GSA administrative cost are $25,000 to implement the policy. These costs are included in the agency budget	Well meter program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
3	Groundwater Allocation	Establish an initial groundwater allocation for each acre of agricultural land within its boundary.	The goal is to ensure a groundwater allocation which defines the acceptable groundwater extraction volume per year. The policy is intended to reduce the amount of groundwater extracted to recuse the number of dry wells and the amount of subsidence	The GSA approved an initial groundwater allocation policy in March 2024 with specified pumping values for each aquifer zone	This policy will be a direct reduction in demand as extractors will operate within the allocated amounts. Groundwater levels and pumped volumes will be used to evaluate demand reduction	The GSA adopted this policy in March 2024. No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater pumping as outlined in SGMA	The GSA adopted the policy March 2024 and is currently performing outreach to landowners. The program will be revised and updated as needed.	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of sustainable change in groundwater allocation	The level of uncertainty is 5 and GSA has already begun implementation.
4	GSA Funding	The GSA approach to funding the proposed projects	The goal is ensure that the GSA has adequate funds for the proposed projects, including mitigation plans	The GSA is currently going through a Proposition 218 process	Demand reduction will occur as projects are funded	The GSA has the authority to conduct a Proposition 218 election under SGMA	The Proposition 218 election is expected to occur in late April	The expected benefits are the funding of projects including mitigation efforts	The management action is accomplished by Proposition 218 election. No external water source is used.	The estimated GSA administrative costs are $40,000 to implement the Proposition 218 election	The project will fund demand reduction and recharge projects	The level of uncertainty is 3 as there is a possibility that the Proposition 218 election may not pass.
5	Well Mitigation	Policy to address the impact of falling water levels on shallow domestic wells.	The goal of the policy is support domestic well owners by providing appropriate mitigation, including up to the installation of a new well	The GSA approved an initial well mitigation policy in November 2022	While not directly reducing demand, the policy will assist those impacted by decreasing water levels	The GSA adopted this policy in November 2022. No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater pumping as outlined in SGMA	The Policy will be implemented once funding is secured through the successful completion of the Proposition 218 election	The policy will greatly benefit rural domestic well owners who have been impacted by decreasing water levels. The policy is also in line with Human Right to Water	The management action is accomplished by policy adoption. No external water source is used.	The GSA is anticipating as much as $6 million may be need through 2040 to fund the program	The project will replace shallow wells with deeper to ensure adequate supply for domestic users	The level of uncertainty is 3 as there is a possibility that the Proposition 218 election may not pass.
6	Additional Dedicated Monitor Wells	Installation of Monitoring Wells to assist with evaluating compliance with SMCs and to fill data gaps	The goal of the wells is to provide additional monitoring locations and depths to evaluate the effectiveness of the groundwater management activities and identify areas where changes need to occur	Well installation has been included in the GSA Annual budget and installation will occur over the next few years	While not directly reducing demand, the policy will assist identifying areas of concern	Each well will require obtaining a well construction permit from Kings County	The well installation is expected to begin in 2025 and continue for several years	The additional wells will help monitor groundwater levels in the different aquifers across the GSA	The management action is accomplished by policy adoption. No external water source is used.	The cost of the program is expected to be $300,000 annually	This project will fill data gaps necessary to actively manage groundwater	The level of uncertainty is 3 as there is a possibility that the Proposition 218 election may not pass.
7	Expanded Monitoring Program	Expansion of the monitoring programs for water levels, water quality, and subsidence	The goal is to increase the amount and frequency of monitoring water levels and water quality across the GSA	The additional monitoring has been included in the GSA Annual budget and installation will occur over the next few years	While not directly reducing demand, the policy will assist identifying areas of concern	The GSA adopted this policy in March 2024. No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater monitoring in the area	The additional monitoring is expected to begin in 2025 and continue the implementation time period	The additional monitoring will help to evaluate trends across the GSA and assist in identifying changes to groundwater management	The management action is accomplished by policy adoption. No external water source is used.	The cost of the program is expected to be $150,000 annually	This project will fill data gaps necessary to actively manage groundwater	The level of uncertainty is 3 as there is a possibility that the Proposition 218 election may not pass.
8	Esajian Basin	Construction of 80-acre recharge basin to infiltrate flood waters	The goal is capture flood waters for groundwater recharge	This project was completed in January 2023 in time to receive floodwaters for that year.	Groundwater demand will be offset be groundwater recharge	Grading permits were obtained from Kings County	Project was completed in January 2023 and is operational	The estimated recharge volume was calculated based on the basin size, infiltration rate, and number of days water would be available for recharge	Kings River flood waters available through People Ditch	Project was funded by the Kings County Water District	The project will result in direct groundwater recharge	The level of uncertainty is 5 as the project is complete
9	Griswold Basin	Creation of an approximate 35-acre recharge area between the Old River Channel and the Riverbank Ditch.	The goal is capture flood waters for groundwater recharge	The project is currently in design with construction expected to start by mid 2024	Groundwater demand will be offset be groundwater recharge	Grading permits will need to be obtained from Kings County	Project is expected to start construction mid 2024	The estimated recharge volume was calculated based on the basin size, infiltration rate, and number of days water would be available for recharge	Kings River flood waters	The cost of the basin is estimated at $3M	The project will result in direct groundwater recharge	The level of uncertainty is 5 as the project is fully funded through the SGM Round I grant
10	New Basin Development	Development of serval recharge basins: Last Chance Basin, Cody Slough, Railsback Basin, and Lopez Basin	The goal is capture flood waters for groundwater recharge	Various project sites are being considered and will be dependent upon land acquisition	Groundwater demand will be offset be groundwater recharge	Grading permits will need to be obtained from Kings County	Projects will occur over time as land acquisition is completed	The estimated recharge volume was calculated based on the basin size, infiltration rate, and number of days water would be available for recharge	Kings River flood waters	The cost is expected to vary between $2 to $6M	The project will result in direct groundwater recharge	The level of uncertainty is 3 as there is a possibility that the Proposition 218 election may not pass.
11	Initial Groundwater Recharge Policy	Policy to encourage landowners to recharge groundwater	The goal is to encourage landowners to construct recharge facilities to maximize capture of floodwaters	The GSA is currently in discussions with stakeholders to develop an effective policy	Groundwater demand will be offset be groundwater recharge	No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater pumping as outlined in SGMA	The GSA is currently preparing a policy and is currently performing outreach to landowners. The program will be revised and updated as needed.	The expected benefits is to encourage additional groundwater recharge across the GSA	Kings River flood waters and other landowner specific sources	Estimated cost of $25,000 to implement the policy. These costs are included in the agency budget	The project will result in direct groundwater recharge	The level of uncertainty is 3 as the policy and projects are dependent on landowner participation
12	System Improvements	Improvement of current recharge basins such as Everett Recharge Basin and Independent Ditch	System improvement will allow the effective movement and utilization of water	Various project sites are being considered and will be dependent upon funding opportunities	While not directly reducing demand, the projects will assist in encourage effective water use	The actual permits required will be based on the projects selected	The GSA is currently reviewing a number of proposed projects to identify those with highest beneficial use	The expected benefits is to improve the movement of water and allow for the most effective use	Kings River flood waters and other landowner specific sources	The cost is expected to vary between $2 to $6M	The project will improve the effective use of surface water across the GSA to reduce groundwater pumping	The level of uncertainty is 2 as funding has not been secured and there is a possibility that the Proposition 218 election may not pass.
13	Land Fallowing Program	Program to encourage fallowing or repurposing of land from agricultural production to other uses	The goal is to reduce irrigated acreage. Success will be measured by the amount of acreage of fallowed land and off-set groundwater pumping	The GSA is currently in discussions with stakeholders to develop an effective policy	Demand reduction will be based on acreage removed from active production and offset groundwater pumping	No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater pumping as outlined in SGMA	The GSA is currently preparing a policy and is currently performing outreach to landowners. The program will be revised and updated as needed.	A direct benefit to the groundwater levels will be accomplished through this policy based on demand reduction.	The management action is accomplished by policy adoption. No external water source is used.	Estimated cost of $50,000 to implement the policy. These costs are included in the agency budget	Chronic lowering of groundwater levels and depletion of supply during periods of drought will be partially offset by fallowing	The level of uncertainty is 2 as the policy and projects are dependent on landowner participation

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South Fork Kings GSA												
1	King River Sedimentation Removal	Restoration of 100-year flood capacity of the King River between Jackson Avenue bridge and Empire Weir 1	The goal was to remove accumulated sediment to reclaim capacity for flood flows and to allow that water to be used in lieu of groundwater pumping	This project was completed in January 2023 in time to receive floodwaters for that year.	Demand reduction will be based the amount of flood flows	CEQA clearance had already been obtained for the project	Project was completed in January 2023	The expected benefits included expanded channel capacity to minimize impacts to flood levees and maximize available surface water use in lieu of groundwater pumping. Effectiveness would be evaluated by reduction in groundwater pumping	Kings River flood waters	The cost of the project was funded by the SGM Round I implementation Grant	The project will improve the effective use of surface water across the GSA to reduce groundwater pumping	The level of uncertainty is 5 and GSA has already begun implementation.
2	Well Registry	Registration of all groundwater wells, including domestic wells, within the GSA boundaries.	The goal is to categorize all of the wells to better quantify the amount of pumping that is occurring and from what which zone. In addition the program would help identify potential wells at risk.	The GSA is currently in discussions with stakeholders to develop an effective policy. The policy is expected to be completed by September 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits is provide the GSA with a understanding of where pumping is occurring and from which aquifer. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well registry program is a key component necessary to manage groundwater extractions	The level of uncertainty is 3 as funding needs to be secured.
3	Well Mitigation	Policy to address the impact of falling water levels on shallow domestic wells.	The goal of the policy is support domestic well owners by providing appropriate mitigation, including up to the installation of a new well	The GSA is currently in discussions with stakeholders to develop an effective policy. the policy is expected to be completed by September 2024	While not directly reducing demand, the policy will assist those impacted by decreasing water levels	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	Estimated cost of $25,000 to implement the policy. These costs are included in the agency budget	The project will replace shallow wells with deeper to ensure adequate supply for domestic users	The level of uncertainty is 3 as funding needs to be secured.
4	Groundwater Allocations	Establish an initial groundwater allocation for each acre of agricultural land within its boundary.	The goal is to ensure a groundwater allocation which defines the acceptable groundwater extraction volume per year. The policy is intended to reduce the amount of groundwater extracted to recuse the number of dry wells and the amount of subsidence	The GSA is currently working with landowners to prepare an initial groundwater allocation policy by September 2024 with specified pumping values for each aquifer zone	This policy will be a direct reduction in demand as extractors will operate within the allocated amounts. Groundwater levels and pumped volumes will be used to evaluate demand reduction	The GSA expect to adopted this policy by September 2024. No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater pumping as outlined in SGMA	The GSA expects to adopt the policy by September 2024	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	Estimated cost of $25,000 to implement the policy. These costs are included in the agency budget	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of sustainable change in groundwater allocation	The level of uncertainty is 3 as funding needs to be secured.
5	Aquifer Storage and Recovery Program	Evaluation of the use of ASR for groundwater recharge.	The goal is allow for direct injection and storage of surplus water into retrofitted production wells	The GSA will be preparing a Report of Waste Discharge for the CRWQCB and CA DDW along with a programmatic CEQA document	Demand reduction will be dependent upon amount of water injected and landowner participation	Permits and/or approval will be required by the CRWQCB and CA DDW. In addition CEQA documentation will need to be prepared	Program will begin upon receipt of regulatory approvals	The expected benefits will be immediate and commensurate with the amount of water injected and the level of landowner participation	Kings River flood waters and other landowner specific sources	Estimated cost of $400,000 to implement the policy and prepare the supporting documentation	Chronic lowering of groundwater levels and depletion of supply during periods of drought will be partially offset by direct injection in flood years	The level of uncertainty is 2 as funding needs to be secured.

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Southwest Kings GSA												
1	Well Registry	Registration of all groundwater wells, including domestic wells, within the GSA boundaries.	The goal is to categorize all of the wells to better quantify the amount of pumping that is occurring and from what which zone. In addition the program would help identify potential wells at risk.	The GSA has already began implementation of the well registration program and expects to be substantially complete by December 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits is provide the GSA with a understanding of where pumping is occurring and from which aquifer. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well registry program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
2	Well Mitigation	Policy to address the impact of falling water levels on shallow domestic wells.	The goal of the policy is support domestic well owners by providing appropriate mitigation, including up to the installation of a new well	The GSA is currently in discussions with stakeholders to develop an effective policy. the policy is expected to be completed by September 2024	While not directly reducing demand, the policy will assist those impacted by decreasing water levels	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of sustainable change in groundwater allocation	The level of uncertainty is 5 and GSA has already begun implementation.
3	Meter Policy	Require that all active wells have meters installed	The goal of this policy is to develop an understanding of the amount of groundwater extracted in the GSA	The GSA has already began implementation of the well registration program and expects to be substantially complete by September 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by May 2024	The expected benefit is provide the GSA with a understanding of the amount of pumping that is occurring. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well meter program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
4	Well Permitting Policy	Any new wells drilled in the GSA will be required to conduct a subsidence study to prove no impacts to the SWP	The goal of the policy is to limit the installation of new wells that have the potential to cause subsidence along the SWP	The GSA will work with Kings County to inform any well applicants that a subsidence study will be required before the installation of any new wells in the GSA	This policy will help to avoid subsidence impacts to the SWP	No permits or regulatory action is required for the GSA to adopt this policy. The GSA is already coordinating with Kings County	The GSA expects to adopt the policy by May 2024	The expected benefit is to avoid impacts to the SWP	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	The policy is a key component to limit subsidence by limiting groundwater extraction in the area of the SWP	The level of uncertainty is 5 and GSA has already begun implementation.

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El Rico GSA												
1	Well Registry	Registration of all groundwater wells, including domestic wells, within the GSA boundaries.	The goal is to categorize all of the wells to better quantify the amount of pumping that is occurring and from what which zone. In addition the program would help identify potential wells at risk.	The GSA has already began implementation of the well registration program and expects to be substantially complete by September 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits is provide the GSA with a understanding of where pumping is occurring and from which aquifer. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well registry program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
2	Well Meter Program	GSA's policy of requiring all active production wells to have meters installed.	The goal of this policy is to develop an understanding of the amount of groundwater extracted in the GSA	The GSA has already began implementation of the well registration program and expects to be substantially complete by September 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA adopted the policy March 2024 and is currently performing outreach to landowners. The program will be revised and updated as needed.	The expected benefit is provide the GSA with a understanding of the amount of pumping that is occurring. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well meter program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
3	Well Mitigation	Policy to address the impact of falling water levels on shallow domestic wells.	The goal of the policy is support domestic well owners by providing appropriate mitigation, including up to the installation of a new well	The GSA is currently in discussions with stakeholders to develop an effective policy. the policy is expected to be completed by September 2024	While not directly reducing demand, the policy will assist those impacted by decreasing water levels	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	The project will replace shallow wells with deeper to ensure adequate supply for domestic users	The level of uncertainty is 5 as the GSA is committed to implementation
4	Initial Groundwater Allocations	Establish an initial groundwater allocation for each acre of agricultural land within its boundary.	The goal is to ensure a groundwater allocation which defines the acceptable groundwater extraction volume per year. The policy is intended to reduce the amount of groundwater extracted to recuse the number of dry wells and the amount of subsidence	The GSA approved an initial groundwater allocation policy in January 2024 with specified pumping values for each aquifer zone	This policy will be a direct reduction in demand as extractors will operate within the allocated amounts. Groundwater levels and pumped volumes will be used to evaluate demand reduction	The GSA adopted this policy in January 2024. No permits or regulatory action is required for the GSA to adopt this policy. The GSA has the authority to regulate groundwater pumping as outlined in SGMA	The GSA adopted the policy in January 2024 and is currently performing outreach to landowners. The program will be revised and updated as needed.	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of sustainable change in groundwater allocation	The level of uncertainty is 5 and GSA has already begun implementation.
5	Salyer Basin	Excavation of Salyer Reservoir to increase storage and groundwater recharge.	The goal is capture flood waters for groundwater recharge	The project is currently in design with construction expected to start by late 2024	Groundwater demand will be offset be groundwater recharge	Grading permits will need to be obtained from Kings County	Project is expected to start construction late 2024	The estimated recharge volume was calculated based on the basin size, infiltration rate, and number of days water would be available for recharge	Kings River and Tule River flood flows via Cross Creek	The cost of the basin is estimated at $2.5M	The project will result in direct groundwater recharge	The level of uncertainty is 5 and GSA has already begun implementation.
6	Improvements to Conveyance Systems	Replacement of inefficient canal systems with an enclosed conveyance system.	System improvement will allow the effective movement and utilization of water	Various project are being considered and will be dependent upon funding opportunities	While not directly reducing demand, the projects will assist in encourage effective water use	The actual permits required will be based on the projects selected	The GSA is currently reviewing a number of proposed projects to identify those with highest beneficial use	The expected benefits is to improve the movement of water and allow for the most effective use	Kings River and Tule River flood flows via Cross Creek	The cost is expected to vary between $2 to $14M	The project(s) will improve the effective use of surface water across the GSA to reduce groundwater pumping	The level of uncertainty is 2 as funding needs to be secured.
7	Flood MAR	Modify existing conveyance system to incorporate scheduled and flood water to allow for recharge on existing agricultural lands	System improvements and policies to encourage the use of agricultural land in production for recharge	Various project are being considered and will be dependent upon funding opportunities	Groundwater demand will be offset be groundwater recharge	The actual permits required will be based on the projects selected	The GSA is currently reviewing a number of proposed projects to identify those with highest beneficial use	The expected benefits is to encourage additional groundwater recharge across the GSA	Kings River and Tule River flood flows via Cross Creek. Plus other landowner specific water sources	The cost is expected to vary between $2 to $10M	The project(s) will result in direct groundwater recharge	The level of uncertainty is 2 as funding needs to be secured.
8	Land Fallowing Program	GSA's use of flexible cropping patterns to adjust available water supply, as opposed to overplanting permanent crops.	Continue the use of the flexible cropping patterns and expand the fallowing program was needed	The land fallowing program has been in place for decades and is adjusted annually depending upon surface water availability	Demand reduction occurs as land is fallowed	No permits or regulatory action is required for the GSA to adopt this policy.	The land fallowing program has been in place for decades and is adjusted annually depending upon surface water availability	The expected benefits occurs as land is fallowed based on landowner participation	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of land fallowing	The level of uncertainty is 5 and GSA is already implementing the program
9	Subsidence Mitigation Plan	Prepare a subsidence study to evaluate the cause of subsidence and alternatives to minimize it	The goal is to better understand the cause of subsidence and the amount residual subsidence that can be expected	The subsidence study is expected to begin in 20025 and be completed by 2027	While not directly reducing demand, the projects will assist in reducing subsidence	No permits or regulatory action is required for the GSA to conduct this study	The subsidence study is expected to begin in 20025 and be completed by 2027	The expected benefit is to reduce the rate of subsidence	The management action is accomplished by policy adoption. No external water source is used.	The cost is expected to be approximately $400,000	The project will assist in reducing the rate of subsidence	The level of uncertainty is 5 as the GSA is committed to implementing the study

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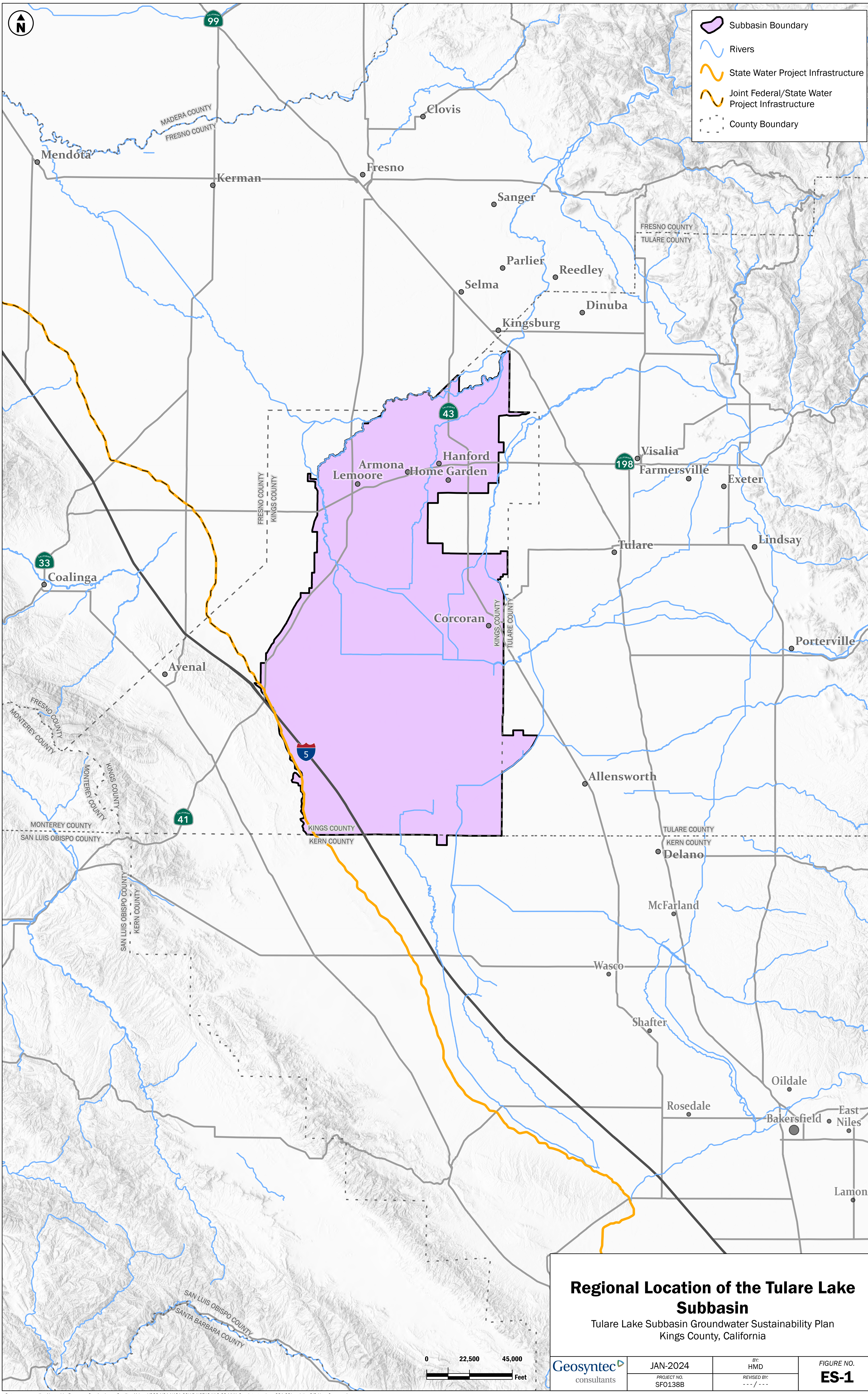
Tri-County Water Authority												
1	Groundwater Allocation	Establish an initial groundwater allocation for each acre of agricultural land within its boundary.	The goal is to ensure a groundwater allocation which defines the acceptable groundwater extraction volume per year. The policy is intended to reduce the amount of groundwater extracted to recuse the number of dry wells and the amount of subsidence	The GSA approved an initial groundwater allocation policy in 2021 and has been implementing for last three years. Changes to policy are expected by end of 2024	Demand reduction will occur as this data is utilized to identify individual exactors who are over drafting	No permits or regulatory action is required for the GSA to adopt this policy.	Policy has been in place since 2021	The expected benefits is provide the GSA with a understanding of where pumping is occurring and from which aquifer. This will allow the GSA to actively manage the groundwater.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of sustainable change in groundwater allocation	The level of uncertainty is 5 and GSA has already begun implementation.
2	Well Registration Program	Registration of all groundwater wells, including domestic wells, within the GSA boundaries.	The goal is to categorize all of the wells to better quantify the amount of pumping that is occurring and from what which zone. In addition the program would help identify potential wells at risk.	The GSA has already began implementation of the well registration program and expects to be substantially complete by December 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well registry program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA is already implementing the program
3	Well Mitigation	Policy to address the impact of falling water levels on shallow domestic wells.	The goal of the policy is support domestic well owners by providing appropriate mitigation, including up to the installation of a new well	The GSA approved an initial well mitigation policy in June 2022	While not directly reducing demand, the policy will assist those impacted by decreasing water levels	No permits or regulatory action is required for the GSA to adopt this policy.	Poilicy has been in place since 2023	The policy will greatly benefit rural domestic well owners who have been impacted by decreasing water levels. The policy is also in line with Human Right to Water	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	The project will replace shallow wells with deeper to ensure adequate supply for domestic users	The level of uncertainty is 5 and GSA has already begun implementation.
4	Well Meter Program	GSA's policy of requiring all active production wells to have meters installed.	The goal of this policy is to develop an understanding of the amount of groundwater extracted in the GSA	The GSA is currently in discussions with stakeholders to develop an effective policy. the policy is expected to be completed by September 2024	This policy will help fill data gaps and provide a better understanding of groundwater extractions in the GSA	No permits or regulatory action is required for the GSA to adopt this policy.	The GSA expects to adopt the policy by September 2024	The expected benefits are to mitigate overdraft by ensuring groundwater supplies are withdrawn in a sustainable manner by monitoring extractions.	The management action is accomplished by policy adoption. No external water source is used.	The estimated GSA administrative costs are $25,000 to implement the policy	Well meter program is a key component necessary to manage groundwater extractions	The level of uncertainty is 5 and GSA has already begun implementation.
5	Land Repurposing	Prepare a land repurposing program for land taken out of production	The goal of this program is identify potential alternative land uses for fallowed land	The GSA is currently preparing a similar study in the Tule Subbasin and expects to incorporate much of those findings to the Tulare Lake	Demand reduction occurs as land is fallowed	No permits or regulatory action is required for the GSA to adopt this policy.	The study is expected to be completed by mid-2025	The expected benefits occurs as land is fallowed based on landowner participation	The management action is accomplished by policy adoption. No external water source is used.	The estimated cost is expected to be $100,000	Chronic lowering of groundwater levels and depletion of supply during periods of drought may be eliminated by implementation of land fallowing	The level of uncertainty is 5 and GSA has already begun implementation.

Table 7.1.1-1 Tulare Lake Subbasin Plan Implementation Cost Estimate

	2020-2025			2025-2030			2030-2035			2035-2040			2020-2040
1. Regular/Ongoing SGMA Compliance Activities	**Capital Cost**	**Average annual O&M Cost**	**5-year O&M Cost**	**Capital Cost**	**Average annual O&M Cost**	**5-year O&M Cost**	**Capital Cost**	**Average annual O&M Cost**	**5-year O&M Cost**	**Capital Cost**	**Average annual O&M Cost**	**5-year O&M Cost**	**Total Est. Capital and O&M Costs**
Administration	$ -	$ 1,250	$ 6,250	$ -	$ 1,250	$ 6,250	$ -	$ 1,250	$ 6,250	$ -	$ 1,250	$ 6,250	$ 25,000
Internal/External Basin Coordination	$ -	$ 75	$ 375	$ -	$ 60	$ 300	$ -	$ 50	$ 250	$ -	$ 40	$ 200	$ 1,125
Correspondance and Outreach Materials	$ -	$ 50	$ 250	$ -	$ 50	$ 250	$ -	$ 30	$ 150	$ -	$ 30	$ 150	$ 800
Monitoring Data Collection & Management	$ 150	$ 375	$ 1,875	$ -	$ 375	$ 1,875	$ -	$ 300	$ 1,500	$ -	$ 300	$ 1,500	$ 6,900
Fill Data Gaps	$ -	$ 50	$ 250	$ -	$ 50	$ 250	$ -	$ 20	$ 100	$ -	$ 20	$ 100	$ 700
Engineering Consultants	$ -	$ 750	$ 3,750	$ -	$ 750	$ 3,750	$ -	$ 750	$ 3,750	$ -	$ 750	$ 3,750	$ 15,000
Annual Reporting	$ -	$ 75	$ 375	$ -	$ 60	$ 300	$ -	$ 60	$ 300	$ -	$ 60	$ 300	$ 1,275
Legal Counsel	$ -	$ 250	$ 1,250	$ -	$ 250	$ 1,250	$ -	$ 250	$ 1,250	$ -	$ 250	$ 1,250	$ 5,000
Enforcement	$ -	$ 25	$ 125	$ -	$ 25	$ 125	$ -	$ 25	$ 125	$ -	$ 25	$ 125	$ 500
Subtotal Cost	$ 150	$ 2,900	$ 14,500	$ -	$ 2,870	$ 14,350	$ -	$ 383	$ 13,675	$ -	$ 2,725	$ 13,625	$ 56,300
2. GSP Five-Year Update													
Engineering Consultant	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 5,000
Subtotal Cost	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 1,250	$ -	$ -	$ 5,000
3. Plans to Fill Data Gaps													
Coordination and Implementation	$ 1,250	$ 250	$ 1,250	$ 1,250	$ 250	$ 1,250	$ 1,250	$ 150	$ -	$ -	$ 150	$ -	$ 2,500
Subtotal Cost	$ 1,250	$ 250	$ 1,250	$ 1,250	$ 250	$ 1,250	$ 1,250	$ 150	$ -	$ -	$ 150	$ -	$ 2,500
4. Projects													
MKR - Well Registry		$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ 100
MKR - Well Meter Policy	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50
MKR - Pumping 'Cap' Policy	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50
MKR - GSA Funding	$ -	$ 20	$ 100	$ -		$ -	$ -		$ -	$ -		$ -	$ 100
MKR - Shallow Well Mitigation Policy	$ -	$ 500	$ 2,500	$ -	$ 300	$ 1,500	$ -	$ 200	$ 1,000	$ -	$ 100	$ 500	$ 5,500
MKR - Additional Dedicated Monitoring Wells	$ -	$ 150	$ 750	$ -	$ 150	$ 750	$ -		$ -	$ -		$ -	$ 1,500
MKR - Expanded Monitoring Network	$ -	$ 50	$ 250	$ -	$ 50	$ 250	$ -	$ 20	$ 100	$ -		$ -	$ 600
MKR - Esajian Basin	$ 3,000	$ 50	$ 250	$ -	$ 50	$ 250	$ -	$ 50	$ 250	$ 50	$ -	$ -	$ 3,750
MKR - Griswold Basin	$ -	$ -	$ -	$ 3,000	$ 50	$ 250	$ -	$ 50	$ 250	$ 50	$ 50	$ 250	$ 3,750
MKR - New Basin Development	$ -		$ -	$ 1,500	$ 50	$ 250	$ 1,500	$ 50	$ 250	$ 1,500	$ 50	$ 250	$ 5,250
MKR - Groundwater Recharge Policy	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ 100
MKR - System Improvements		$ 10	$ 50	$ 350	$ 10	$ 50	$ 250	$ 10	$ 50	$ -	$ 10	$ 50	$ 800
MKR - Land Fallowing	$ -	$ 10	$ 50		$ 70	$ 350	$ -	$ 70	$ 350		$ 70	$ 350	$ 1,100
MKR - Subsidence Mitigation	$ -	$ 250	$ 1,250	$ -	$ 500	$ 2,500	$ -	$ 500	$ 2,500	$ -	$ 500	$ 2,500	$ 8,750
SFK - Kings River Sedimentation Removal	$ 1,250		$ -			$ -			$ -			$ -	$ 1,250
SFK - Well Registry		$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ -	$ -	$ 150
SFK - Well Mitigation	$ -	$ 200	$ 1,000		$ 300	$ 1,500		$ 150	$ 750		$ 100	$ 500	$ 3,750
SFK - Groundwater Allocations	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50
SFK - Aquifer Storage and Recovery Program	$ -		$ -	$ -	$ 50	$ 250	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 350
SFK - Expanded Monitoring Network	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 200
SWK - Well Registry		$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 200
SWK - Well Mitigation	$ -	$ 40	$ 200	$ -	$ 10	$ 50	$ -	$ 5	$ 25	$ -	$ 5	$ 25	$ 300
SWK - Meter Policy	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50
SWK - Well Permitting Policy	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 200
ER - Well Registry	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ 100
ER - Installation of Flowmeters	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -		$ -	$ -		$ -	$ 100
ER - Well Mitigation	$ -	$ 200	$ 1,000	$ -	$ 200	$ 1,000	$ -	$ 50	$ 250	$ -	$ 50	$ 250	$ 2,500
ER - Groundwater Allocations	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50
ER - CID Flood Capture and Basin Recharge Storage Project	$ 2,500	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 2,700
ER - CID Flood Capture and On Farm Recharge		$ 100	$ 500	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 650
ER - CID Aquifer Storage and Recovery		$ -	$ -	$ -	$ 50	$ 250	$ -	$ 200	$ 1,000	$ -	$ 200	$ 1,000	$ 2,250
ER - CID District-Modifications to Conveyance System		$ -	$ -	$ 2,000	$ -	$ -	$ 2,000	$ -	$ -	$ -	$ -	$ -	$ 4,000
ER - CID Reservoir Construction		$ -	$ -	$ 3,000	$ 50	$ 250	$ 3,000	$ 50	$ 250	$ -	$ 50	$ 250	$ 6,750
ER- CID Pipeline Conveyance		$ -	$ -	$ 2,000	$ 50	$ 250	$ 3,000	$ 50	$ 250	$ -	$ 50	$ 250	$ 5,750
ER - Salyer Basin	$ 2,300	$ 10	$ 50	$ -	$ 50	$ 250	$ -	$ 50	$ 250	$ -	$ -	$ -	$ 2,850
ER - Flood MAR	$ -	$ 50	$ 250	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 250
ER - Land Fallowing Program	$ -	$ 10	$ 50			$ -	$ -		$ -	$ -	$ -	$ -	$ 50
ER - Subsidence Mitigation Plan	$ -	$ 1,000	$ 5,000	$ -	$ 3,000	$ 15,000	$ -	$ 1,000	$ 5,000	$ -	$ 1,000	$ 5,000	$ 30,000
TCWA - Groundwater Allocations	$ -	$ 20	$ 100	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 100
TCWA - Well Registration Program	$ -	$ 10	$ 50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50
TCWA - Well Mitigation Program	$ -	$ 20	$ 100	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 250
TCWA - Well Meter Program	$ -	$ 20	$ 100	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ -	$ 10	$ 50	$ 250
TCWA - Land Repurposing Program	$ -	$ 40	$ 200	$ -	$ 100	$ 500	$ -	$ 100	$ 500	$ -	$ 100	$ 500	$ 1,700
												Subtotal	$ 98,250

2024 Tulare Lake GSP
Figures

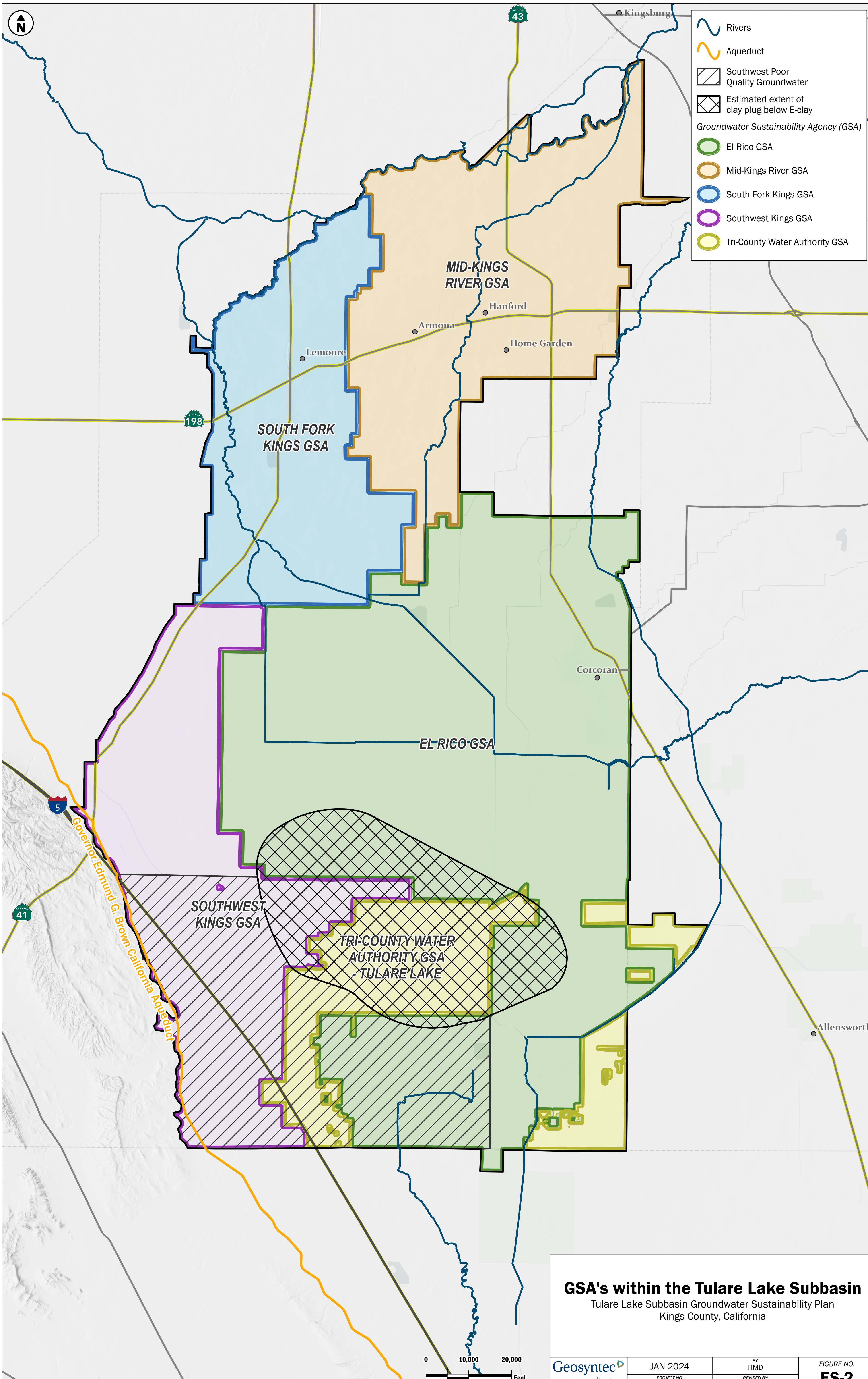


Regional Location of the Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants | JAN-2024 | BY: HMD | FIGURE NO. ES-1
PROJECT NO. SF0138B | REVISED BY: ---/---

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



GSA's within the Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO. ES-2
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	

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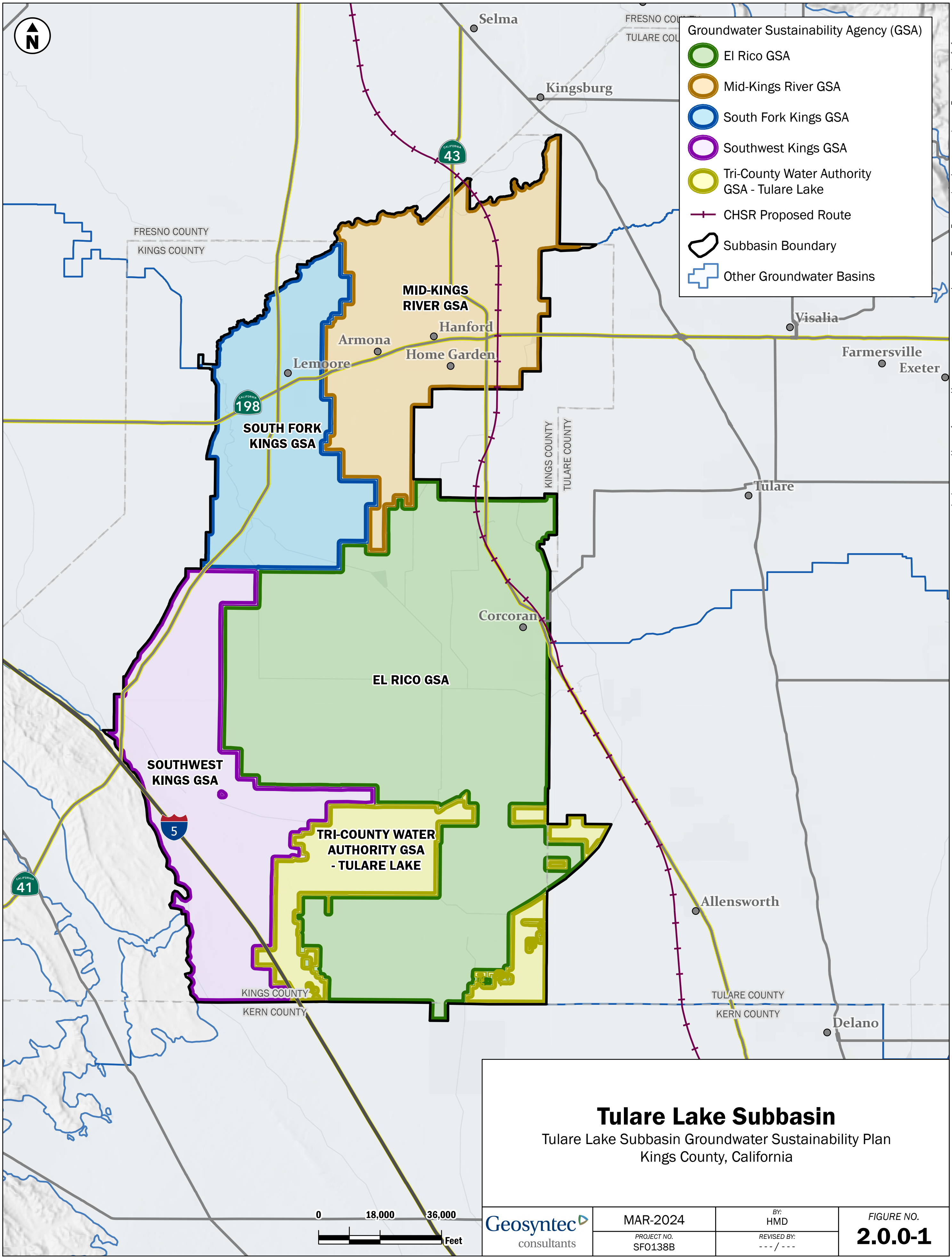


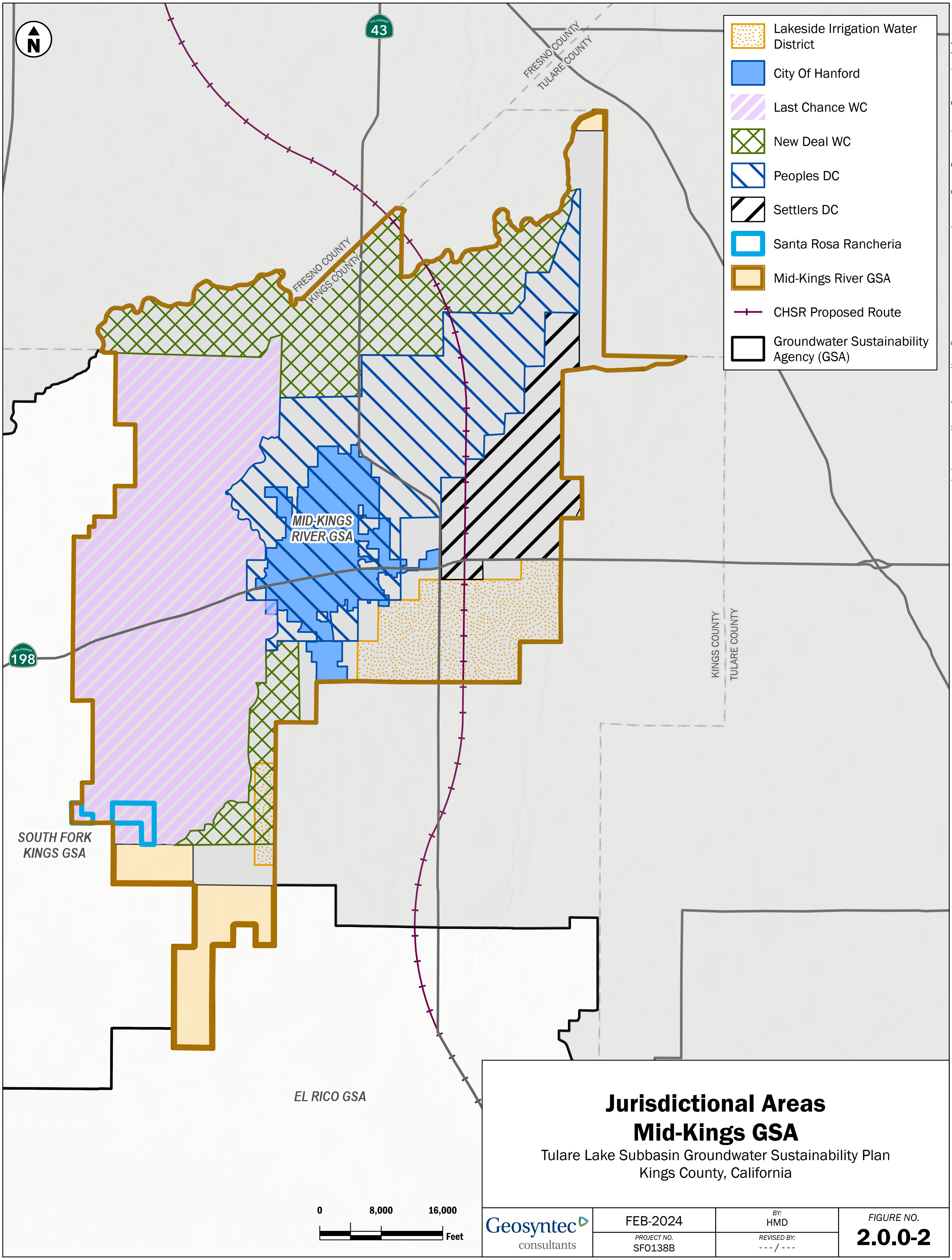
Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-1

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter2\TulareLake_230301_SF0138B.aprx: 2.0.0-1 Tulare Lake Subbasin || User: haley.duran || Print Date: 3/13/2024

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



Jurisdictional Areas
Mid-Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**2.0.0-2**

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

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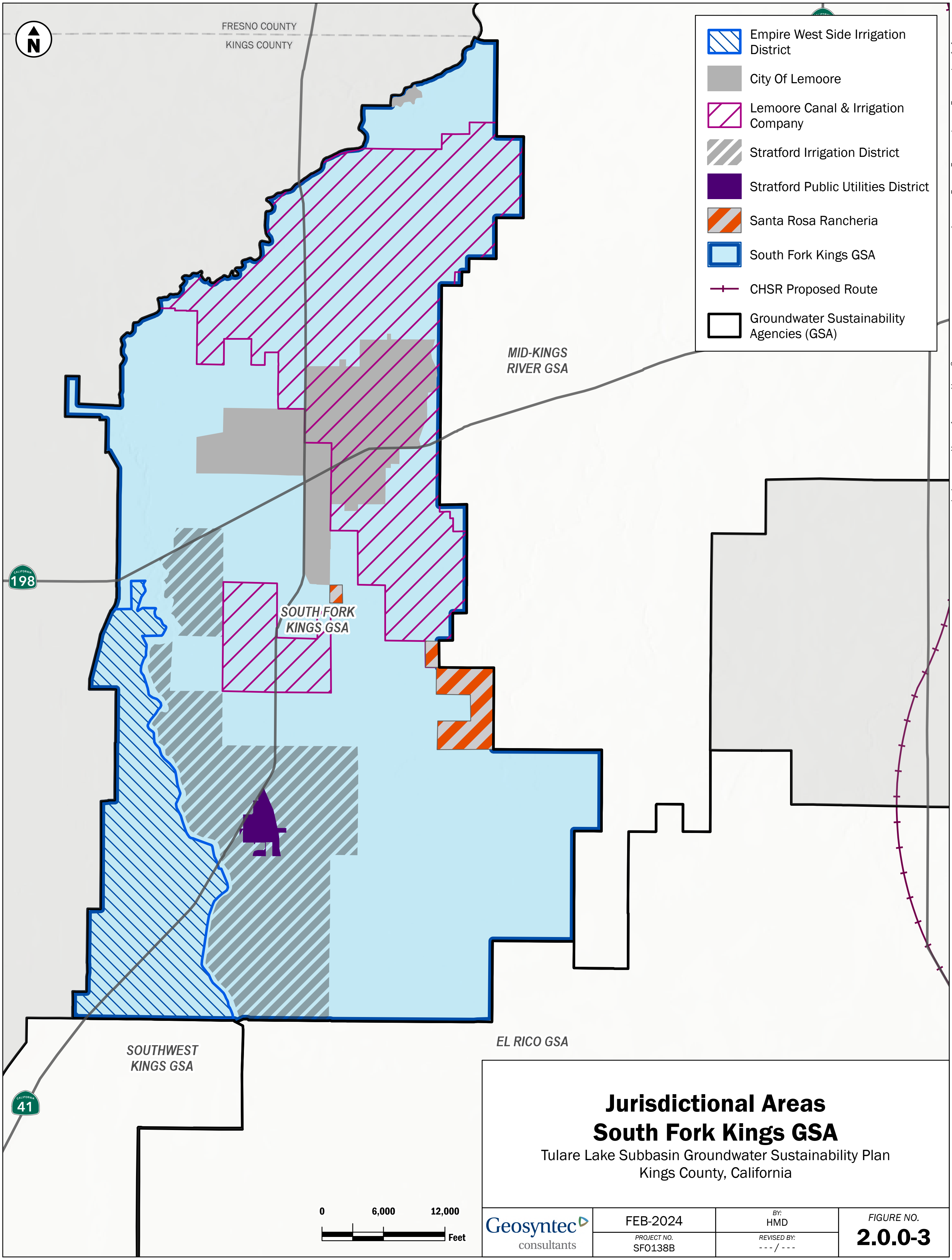

Jurisdictional Areas
South Fork Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-3

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-3 Jurisdictional Areas South Fork Kings GSA | | User: haley.duran || Print Date: 2/14/2024

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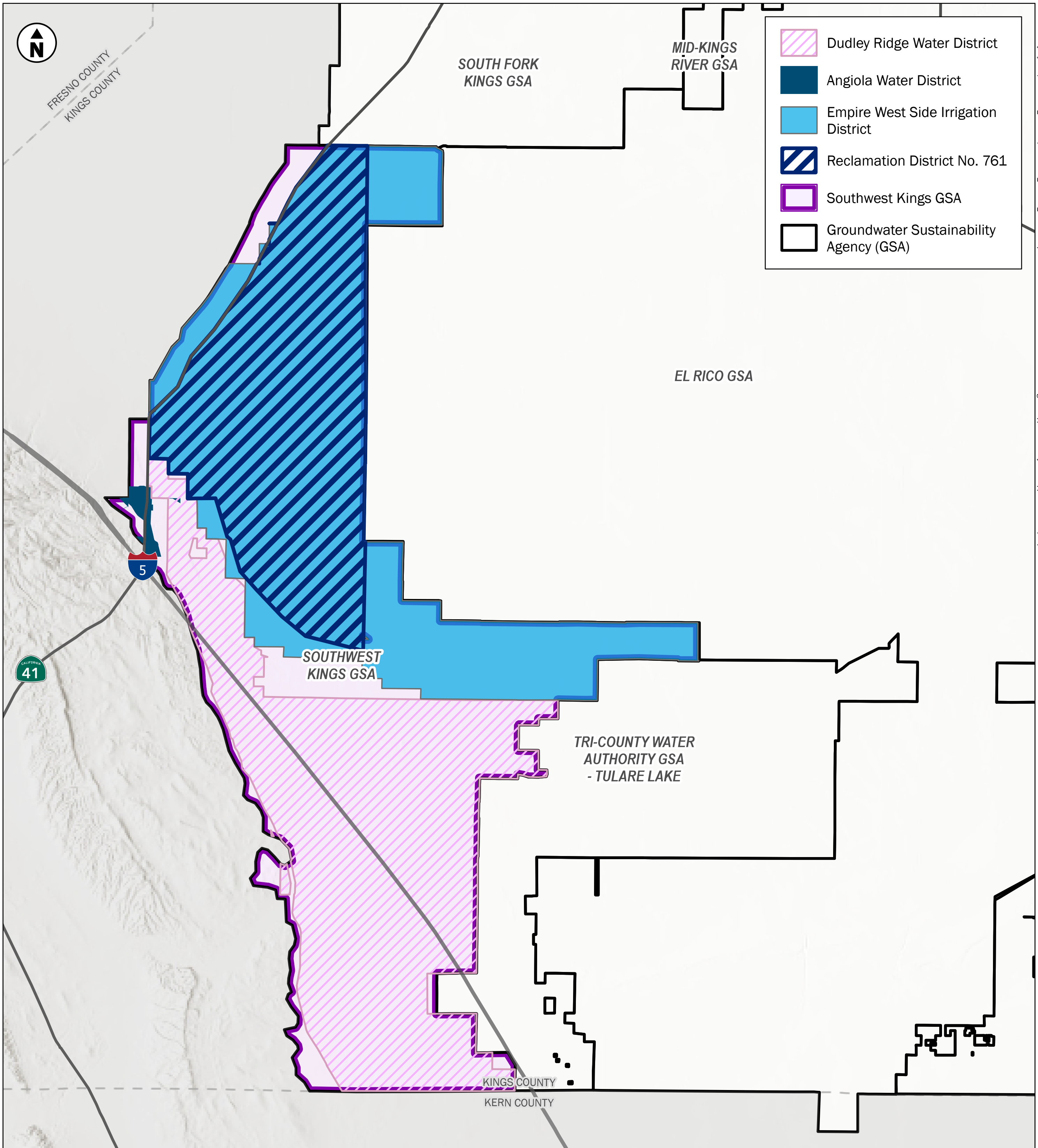

Jurisdictional Areas Southwest Kings GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-4

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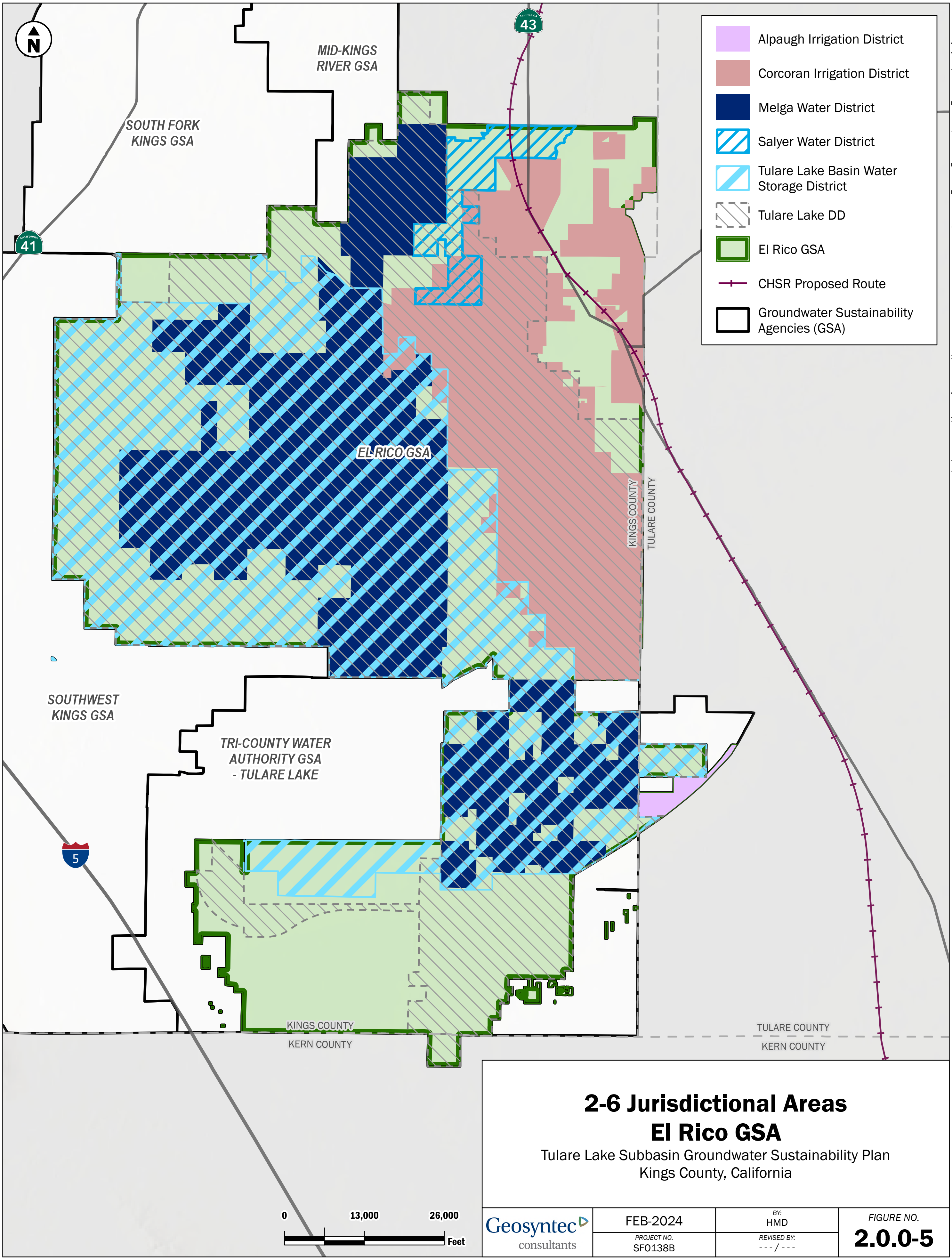
GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-4 Jurisdictional Areas Southwest Kings GSA | | User: haley.duran | | Print Date: 2/14/2024



2-6 Jurisdictional Areas
El Rico GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-5

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-5 Jurisdictional Areas El Rico GSA | | User: haley.duran | | Print Date: 2/14/2024

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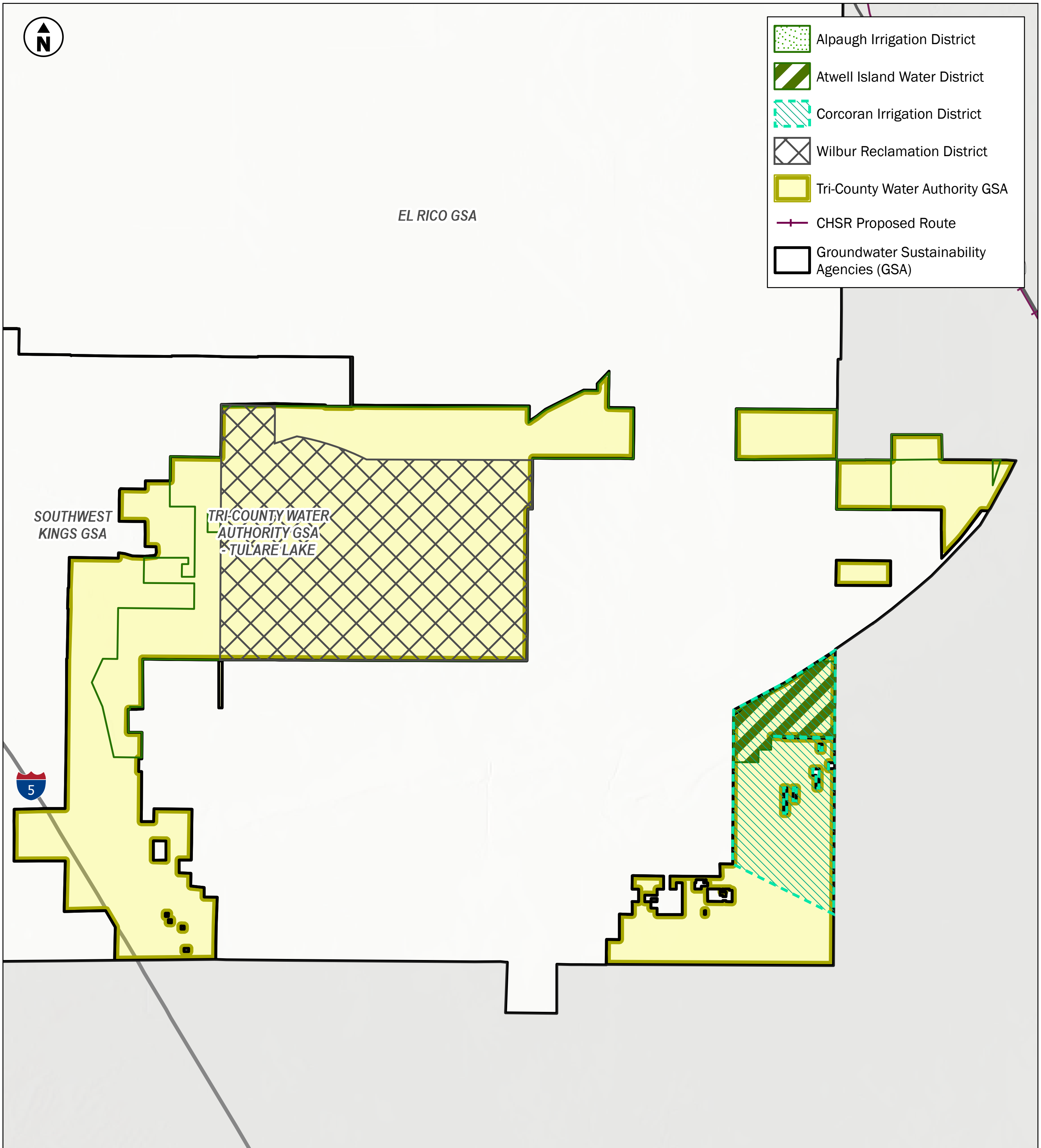

Jurisdictional Areas
Tri-County Water Authority GSA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**2.0.0-6**

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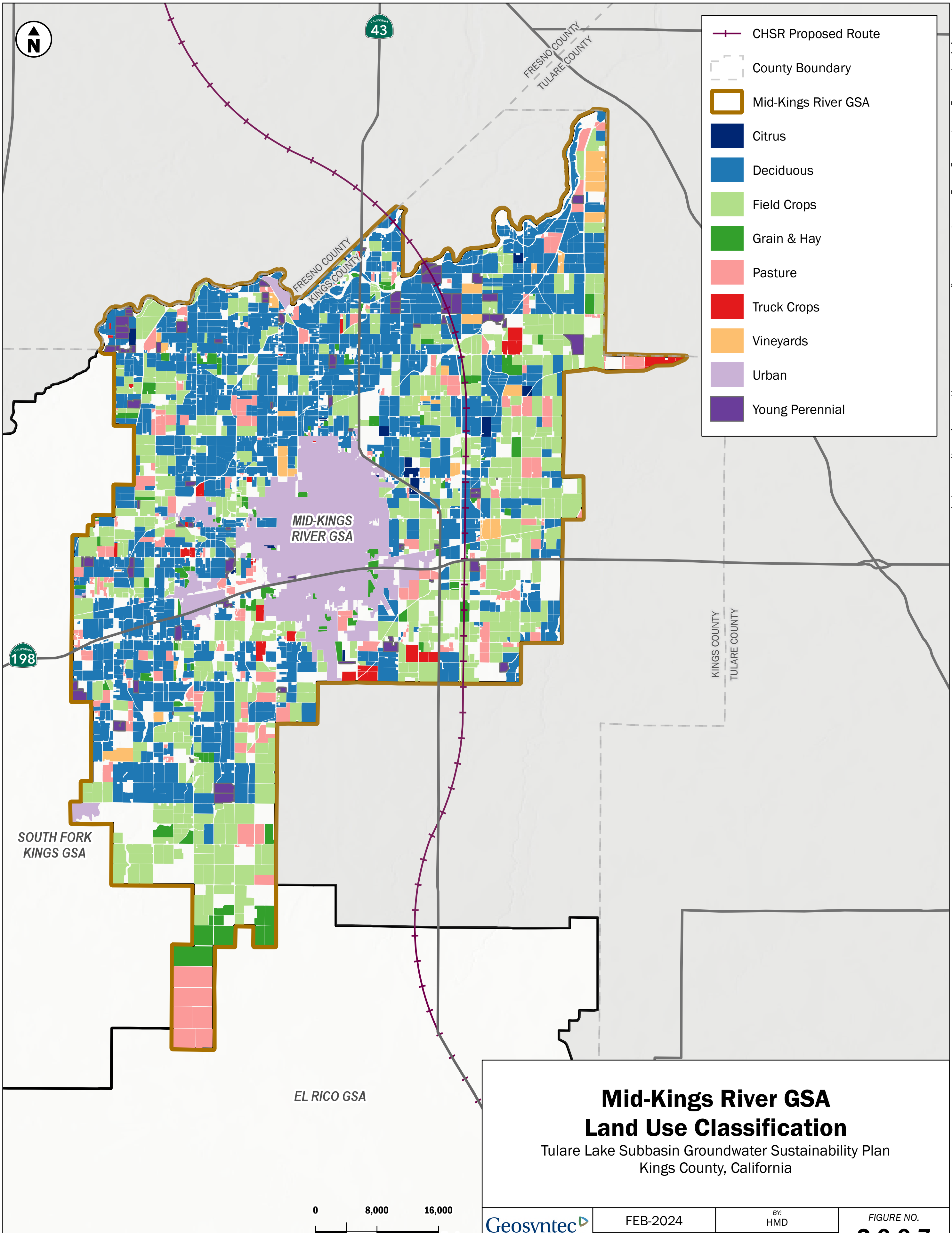
GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-6 Jurisdictional Areas Tri-County Water Authority GSA || User: haley.duran || Print Date: 2/14/2024



Mid-Kings River GSA
Land Use Classification

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**2.0.0-7**

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-7 Mid-Kings River GSA Land Use Classification | | User: haley.duran | | Print Date: 2/14/2024

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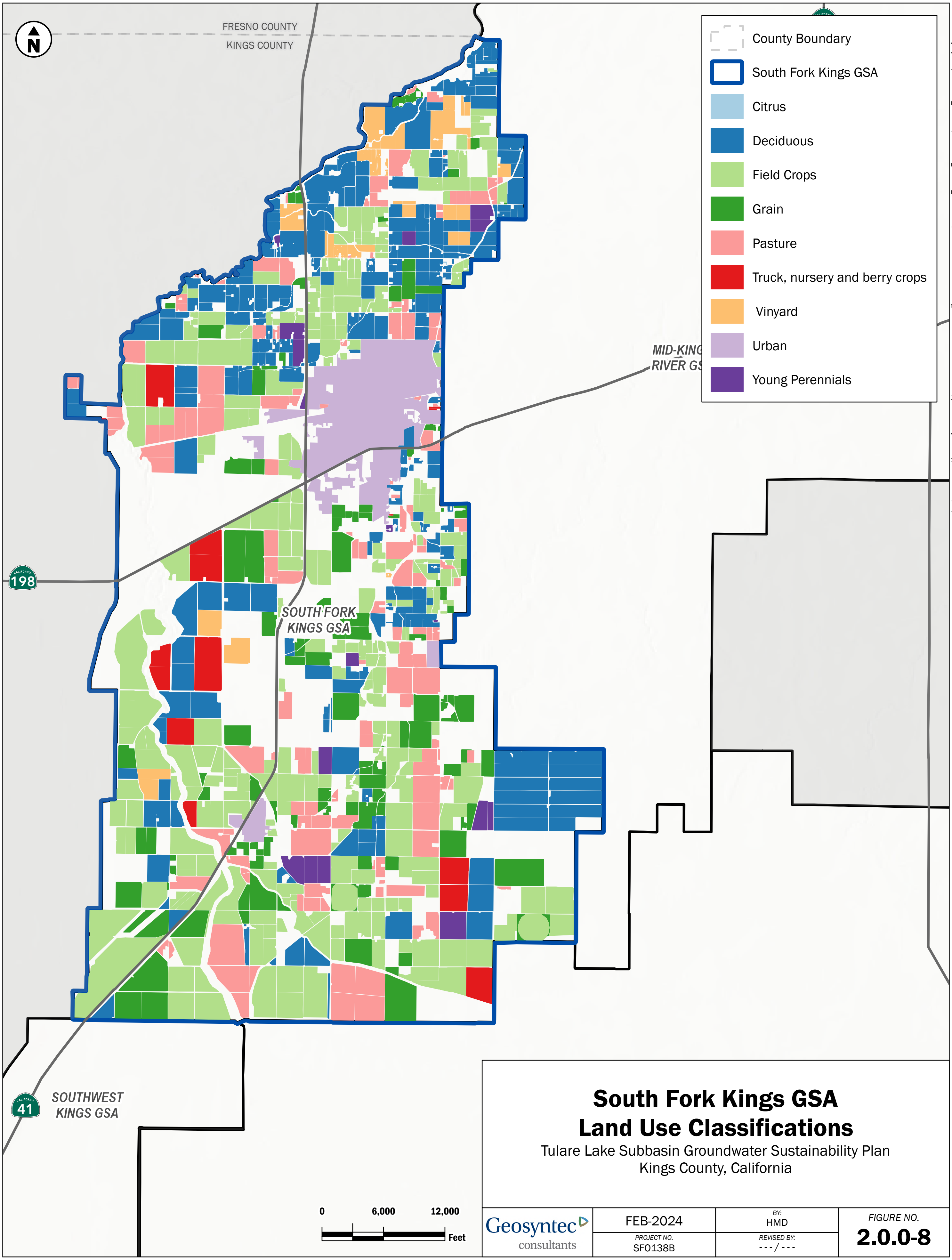

South Fork Kings GSA
Land Use Classifications

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-8

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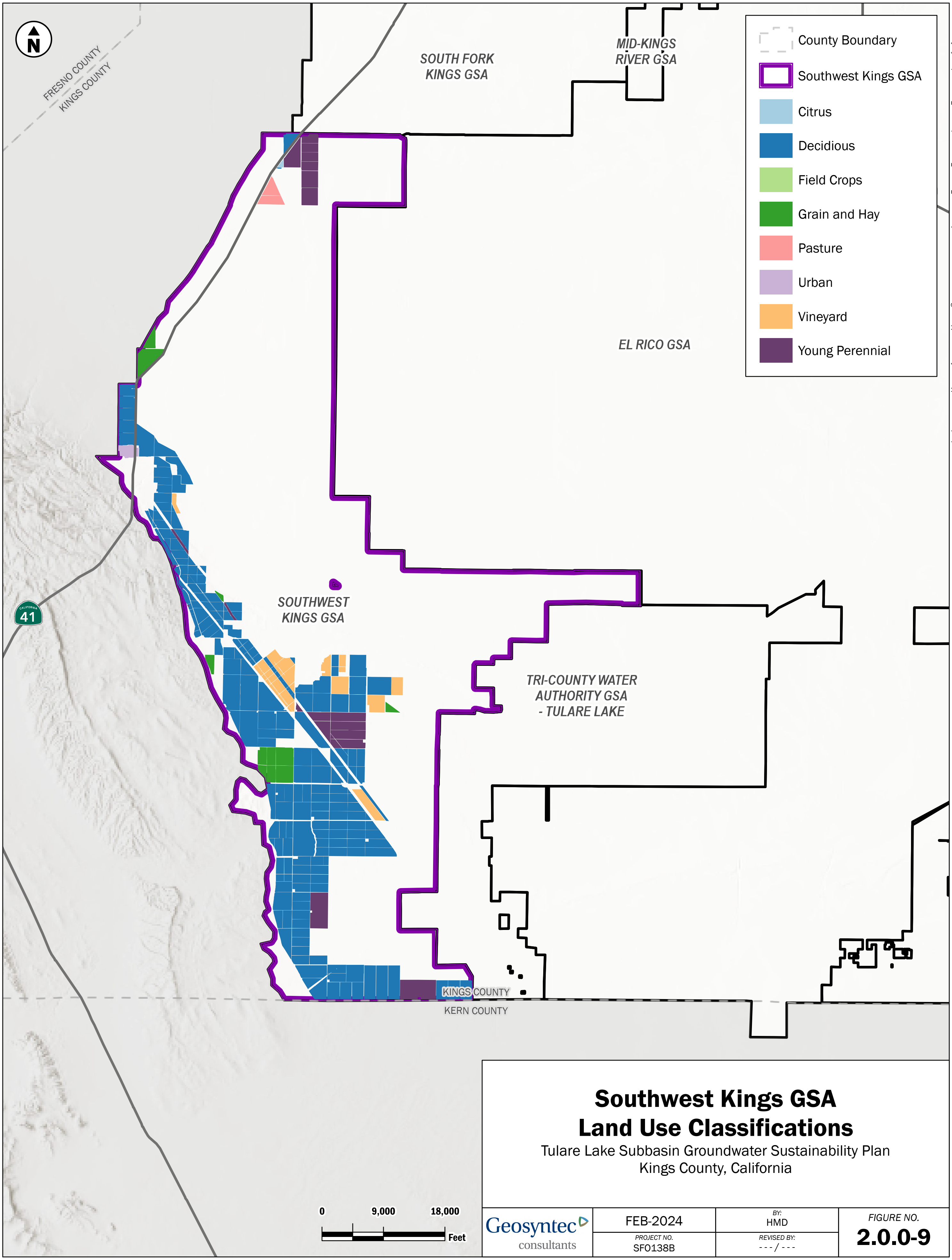
GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-8 South Fork Kings GSA Land Use Classification || User: haley.duran || Print Date: 2/14/2024



Southwest Kings GSA
Land Use Classifications

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-9

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

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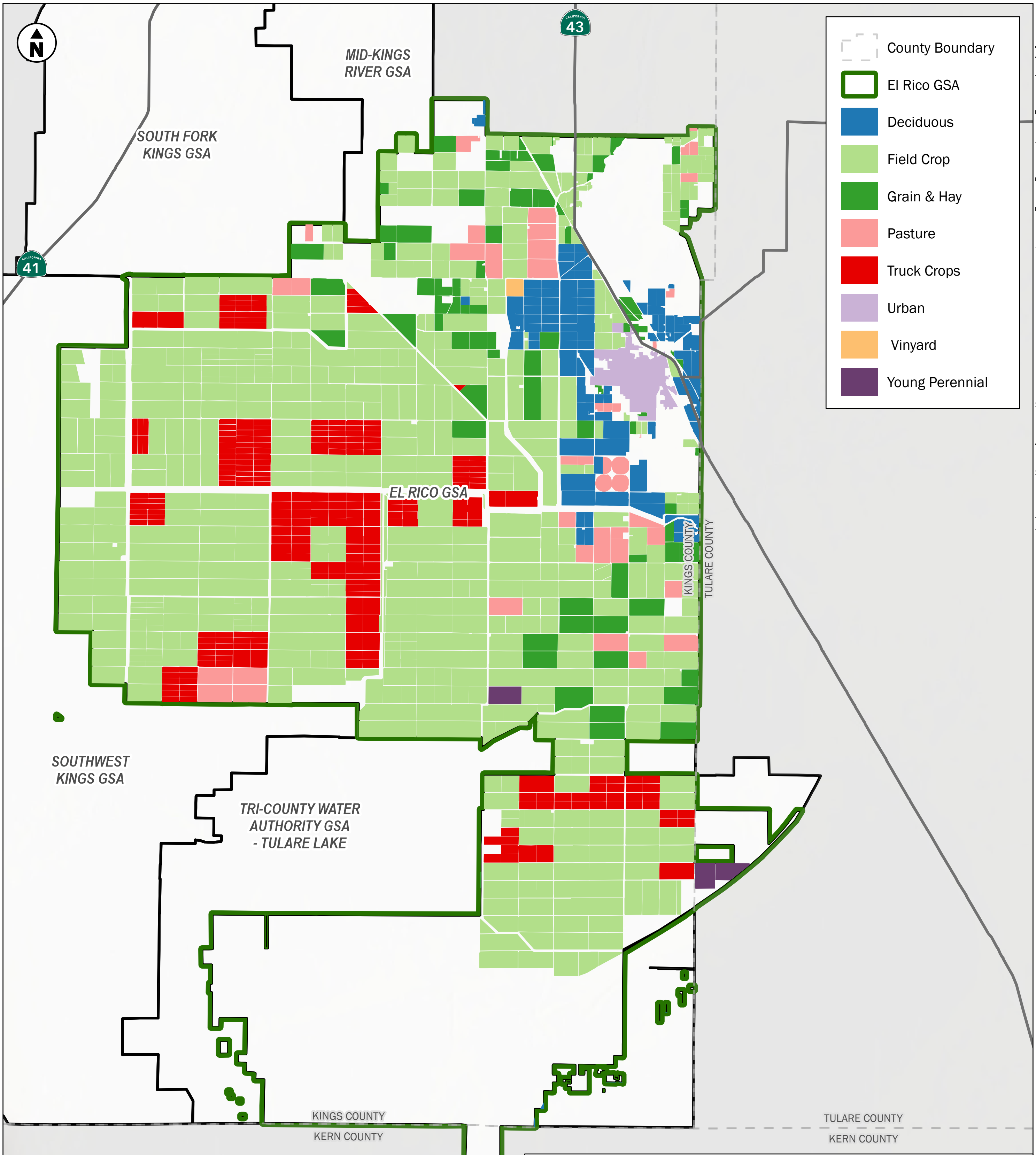


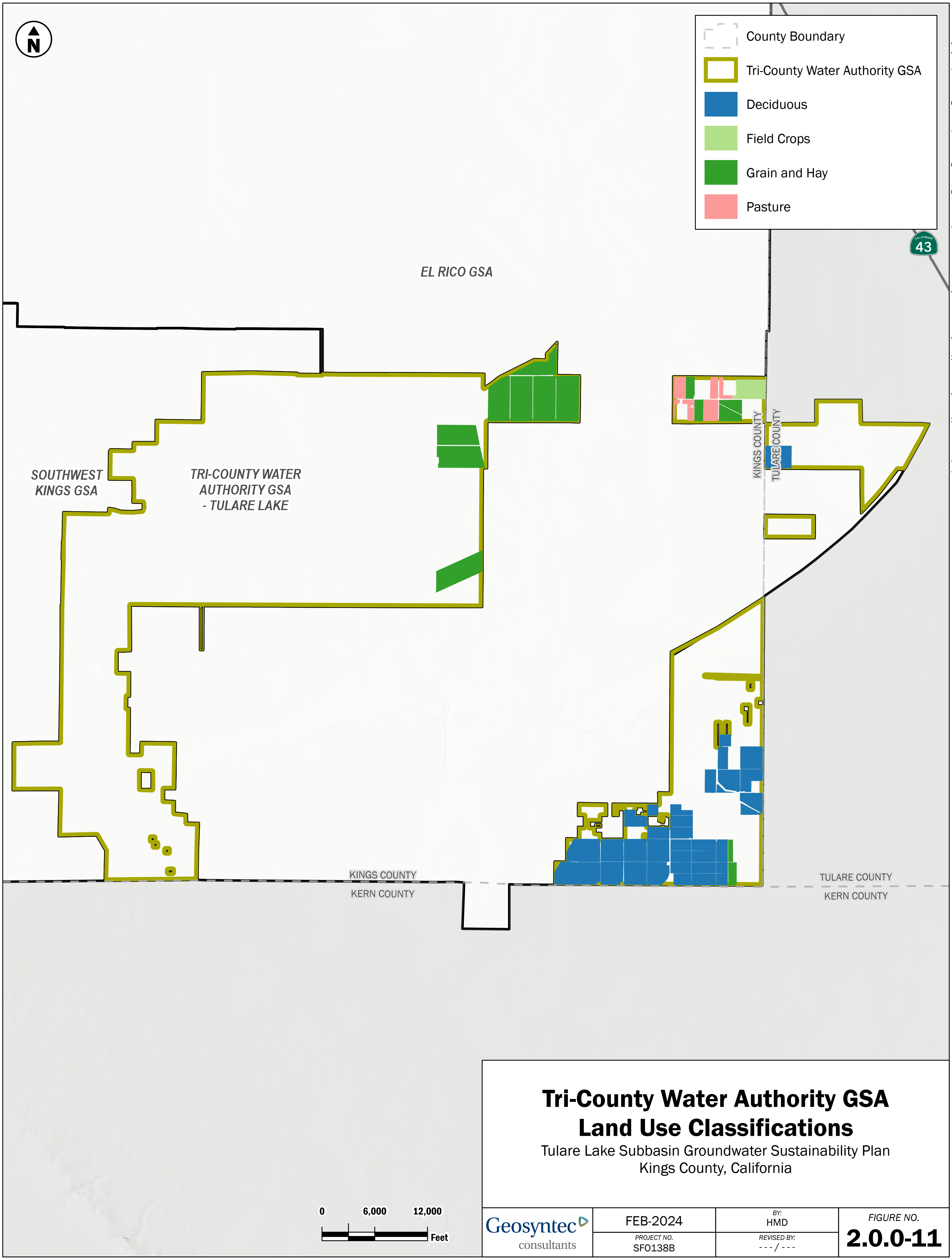
El Rico GSA Land Use Classification

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-10

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-10 El Rico GSA Land Use Classification || User: haley.duran || Print Date: 2/14/2024



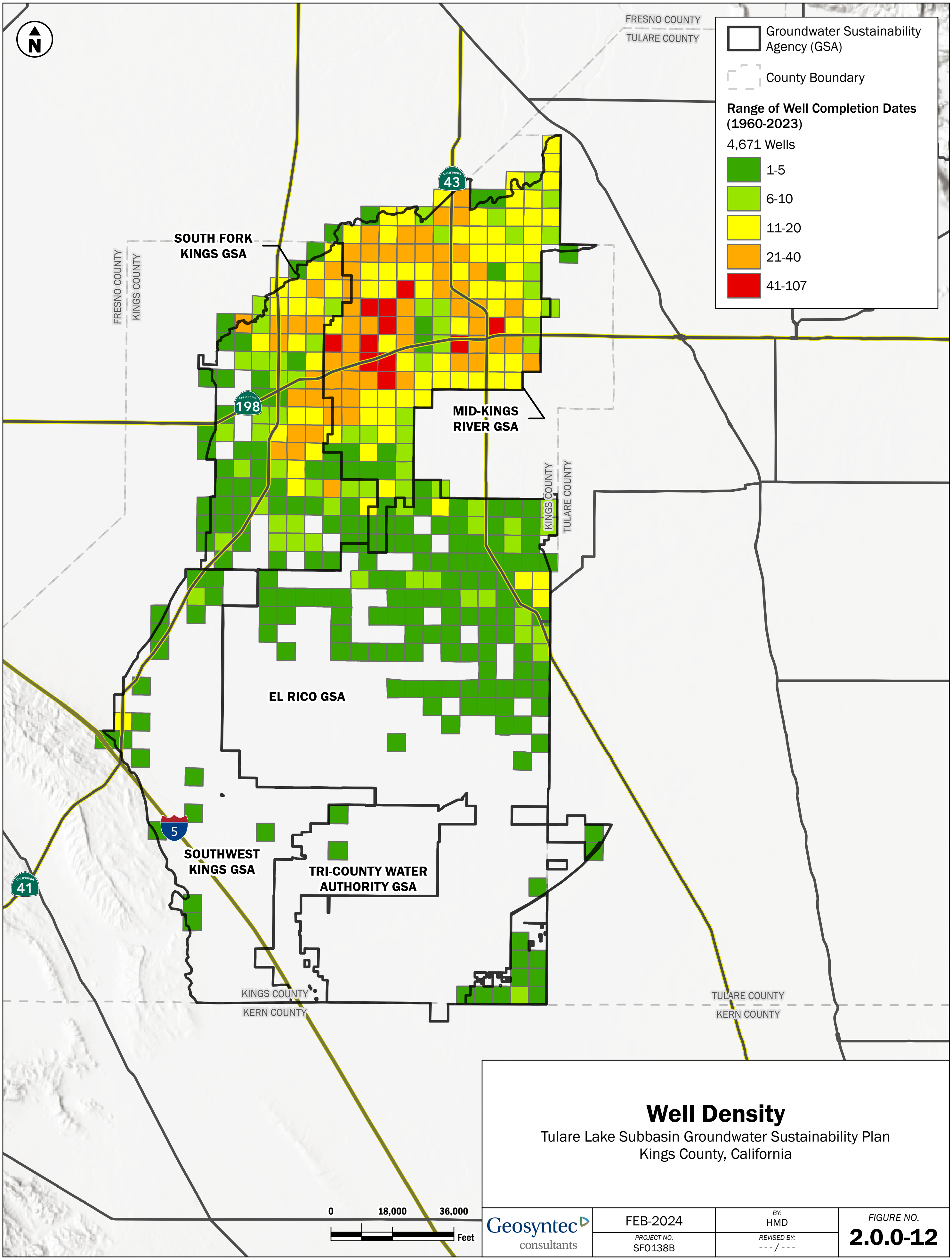
Tri-County Water Authority GSA Land Use Classifications

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	2.0.0-11

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-11 Tri-County Water Authority GSA | | User: haley.duran | | Print Date: 2/14/2024

Data source credits: None | | Basemap Service Layer Credits: Esri, NASA, NGA, USGS, FEMA, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



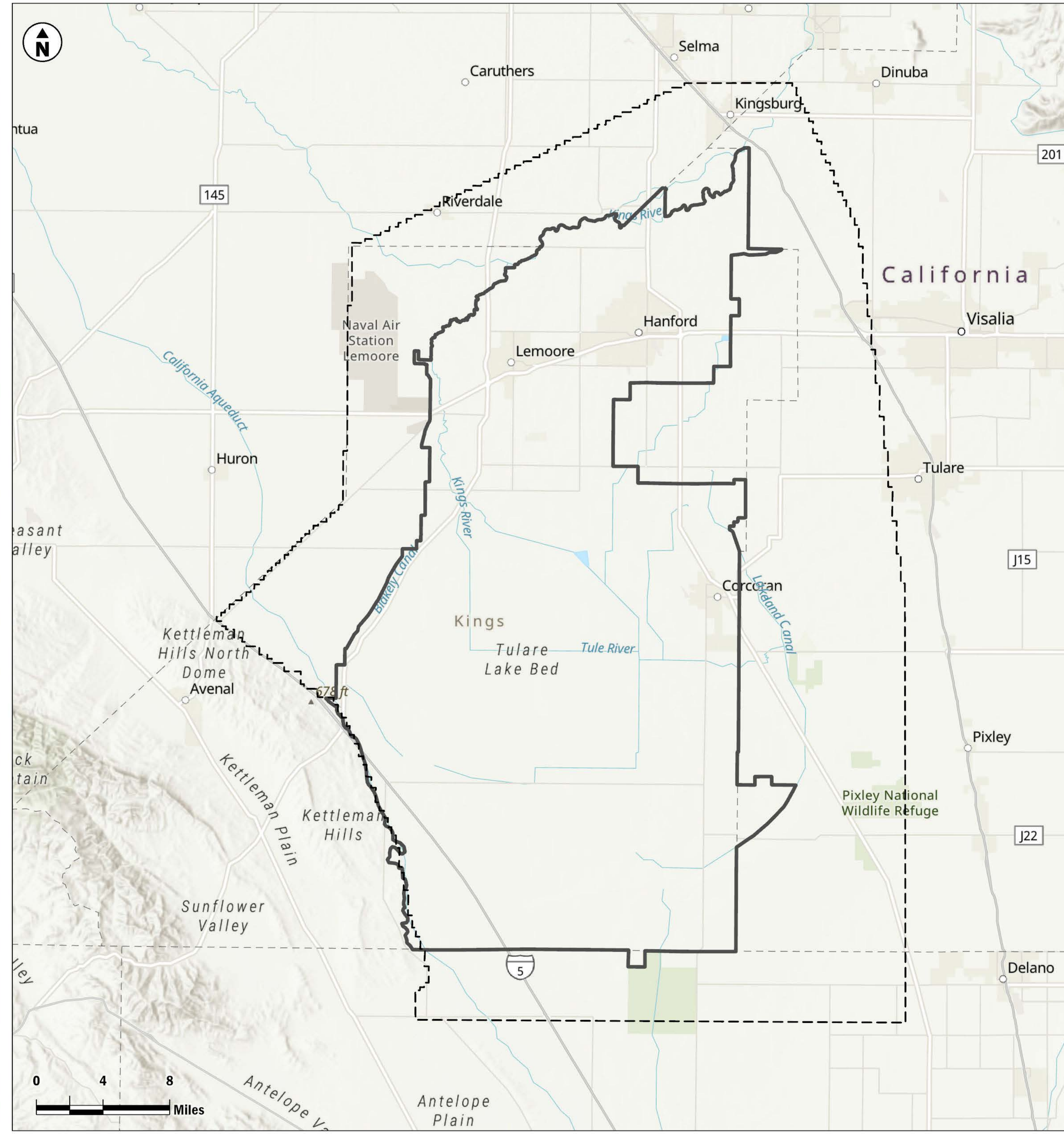
Well Density

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**2.0.0-12**

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 2.0.0-12 Well Density Map| || User: haley.duran || Print Date: 3/1/2024

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



Study Area

Tulare Lake Subbasin Boundary

Tulare Lake Hydrologic Region

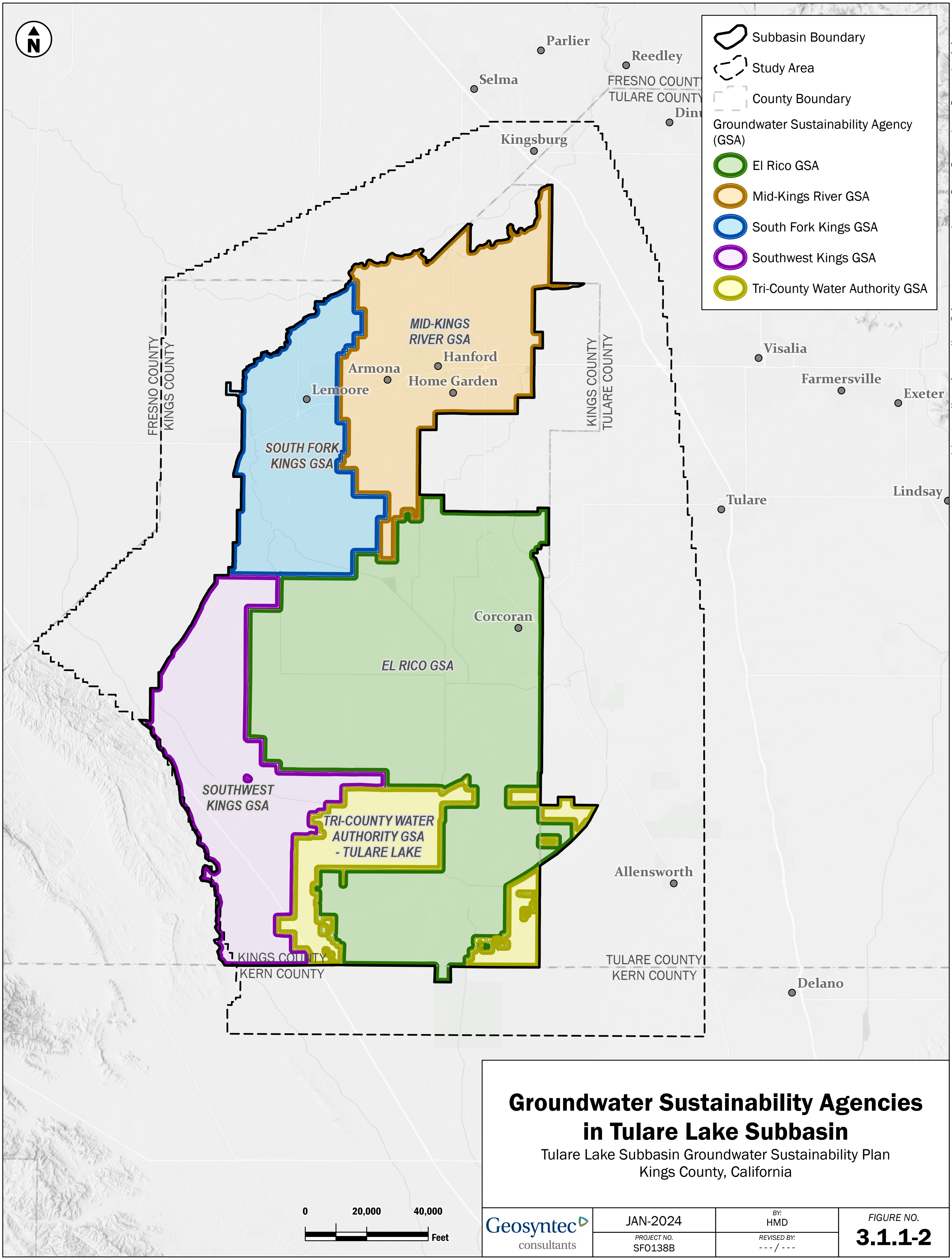
California Hydrologic Regions

Note:
- Hydrologic region dataset obtained from California Department of Water Resources (CA DWR), October 12, 2023.
https://data.ca.gov/dataset/hydrologic-regions

Site Location Map

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024 PROJECT NO. SF0138B	BY HMD REVISED BY: ---/---	FIGURE NO. 3.1.1-1



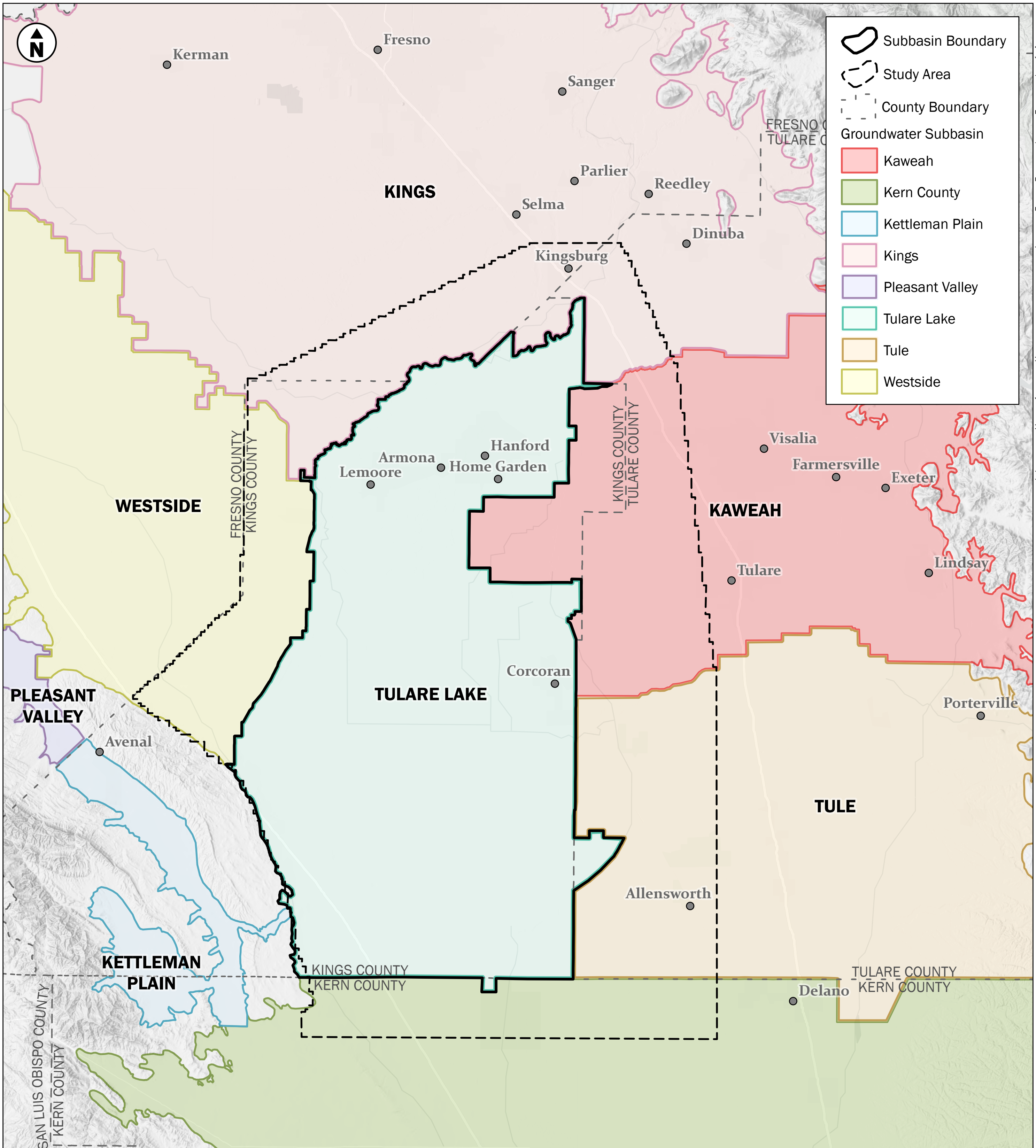
Groundwater Sustainability Agencies in Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.1-2

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.1-2 GW Sustainability Agencies || User: haley.duran || Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



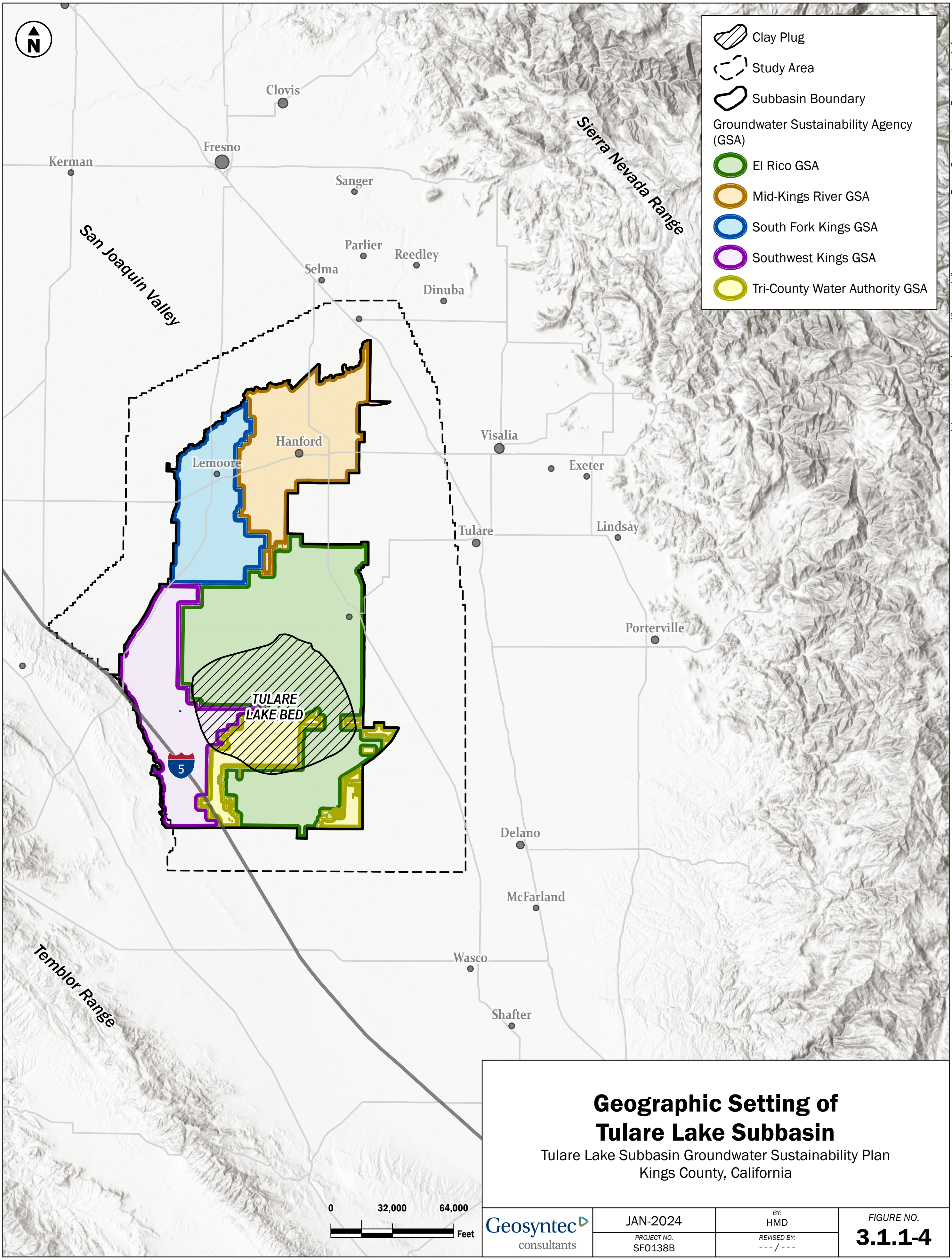
Subbasins Bounding The Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.1-3

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.1-3 Subbasins Boundaries || User: haley.duran || Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



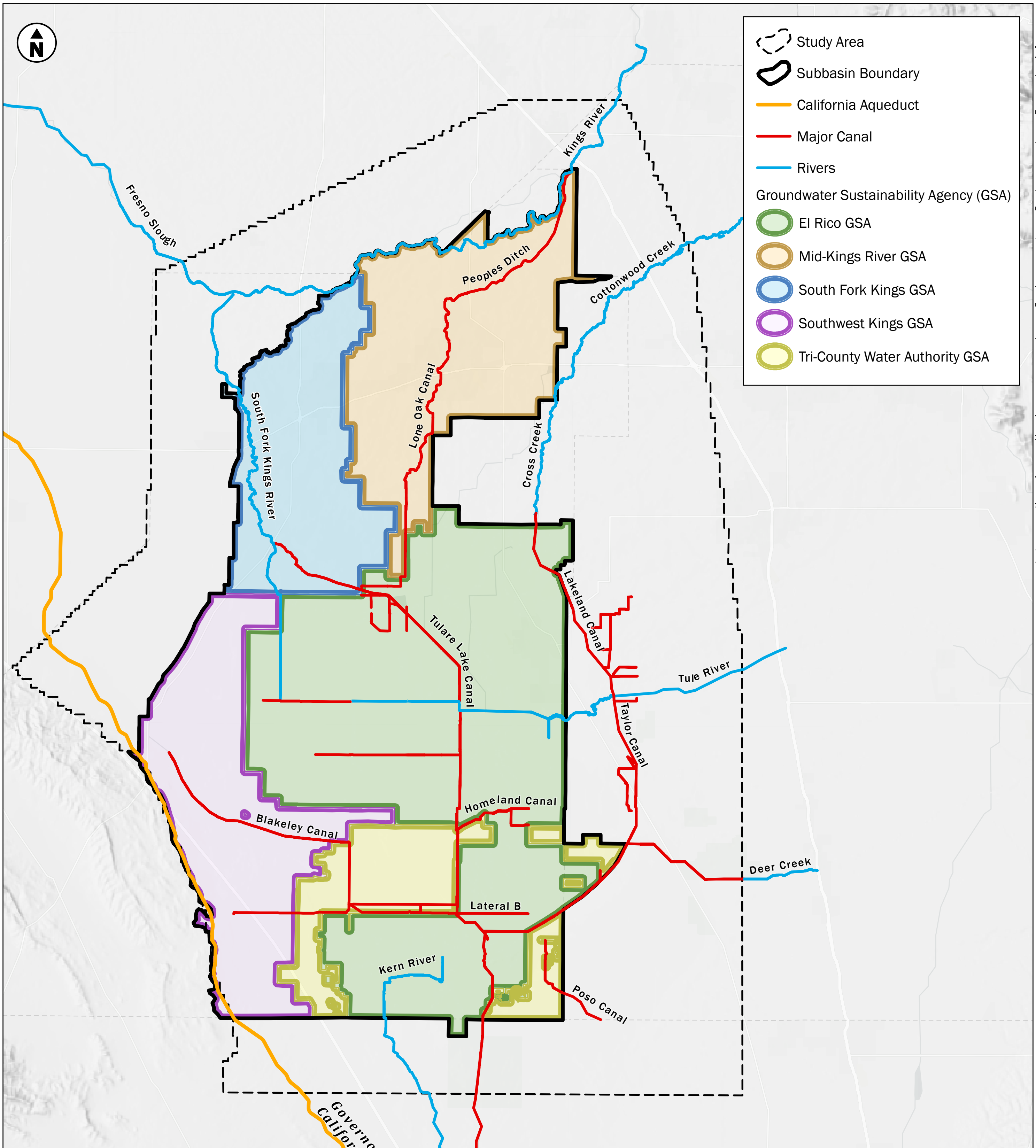
Geographic Setting of Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**3.1.1-4**

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.1-4 Geographic Setting || User: haley.duran || Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Esri, CGIAR, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

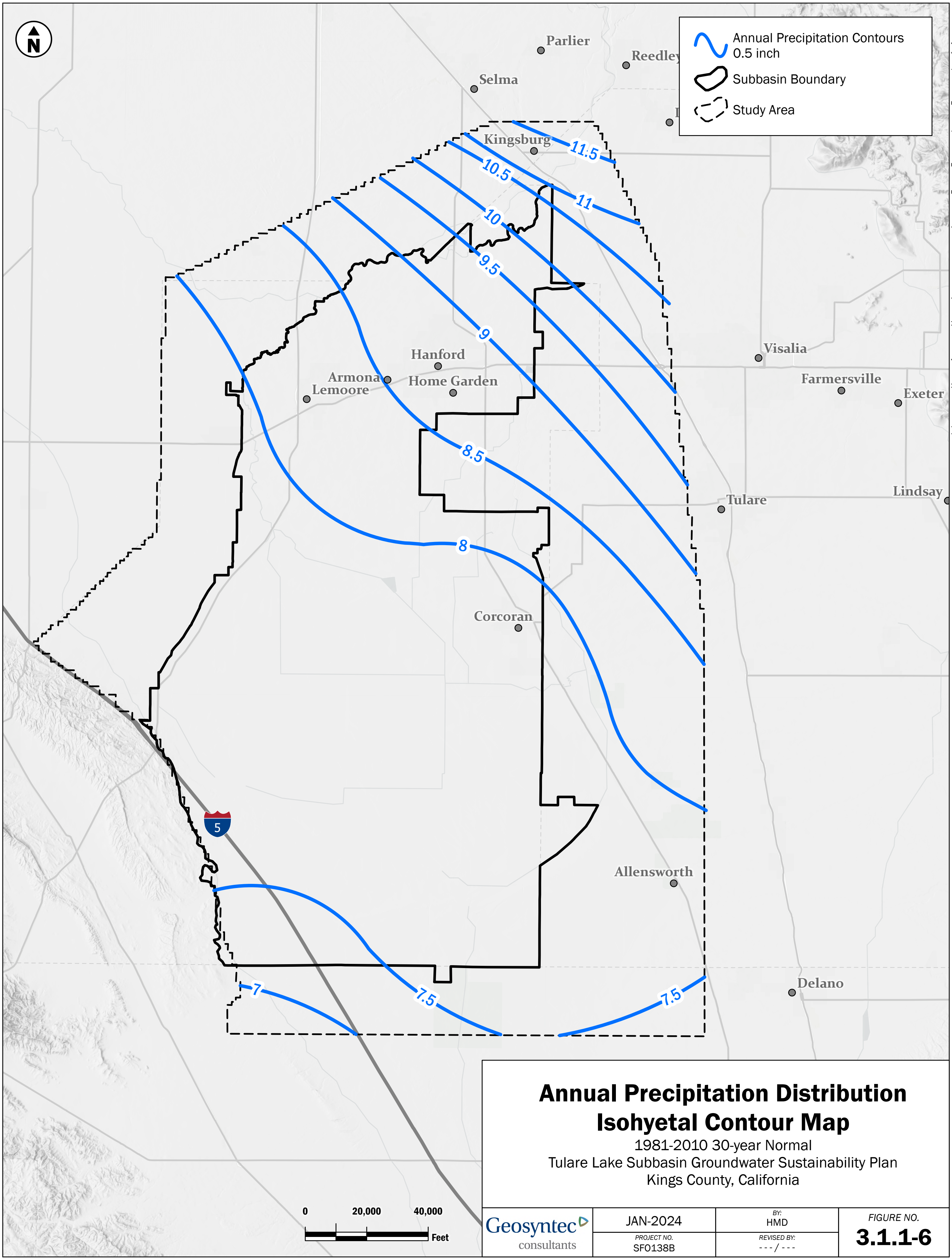


Surface Water System

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: RAP / HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.1-5

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



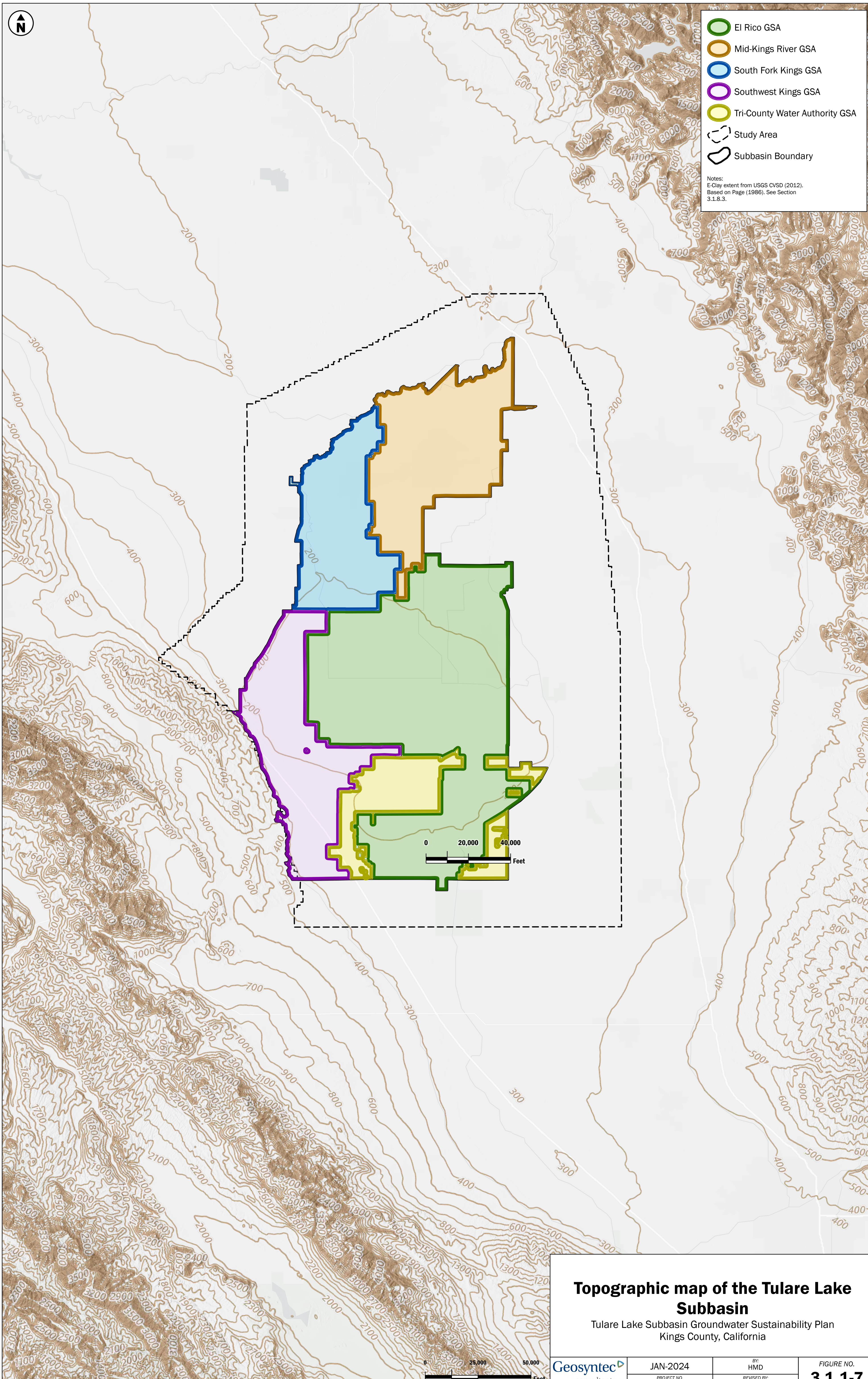
Annual Precipitation Distribution Isohyetal Contour Map

1981-2010 30-year Normal
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.1-6

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.1-6 Annual Precipitation || User: haley.duran || Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS

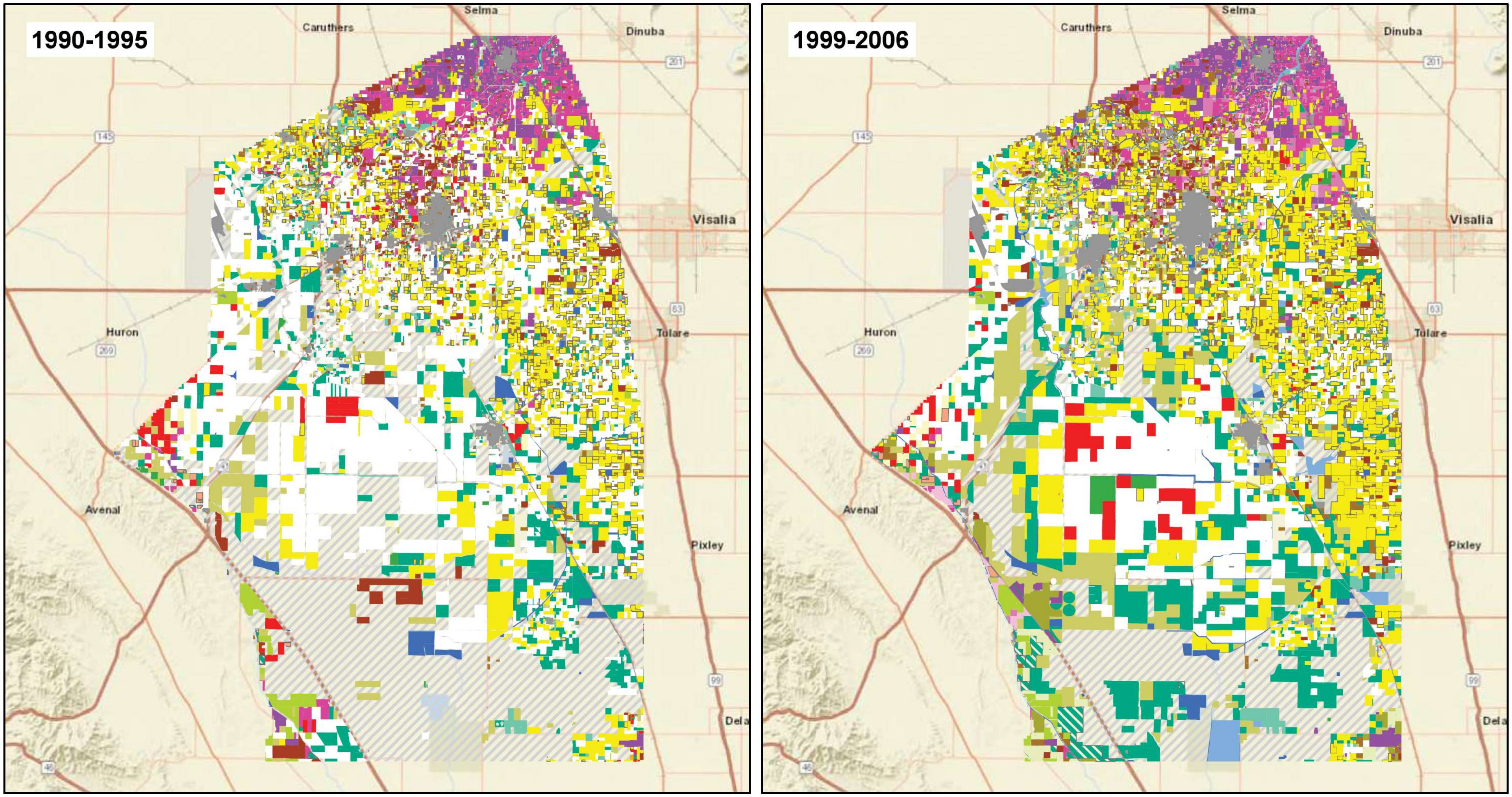


Topographic map of the Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3.1.1-7

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, USGS The National Map: 3D Elevation Program. Data Refreshed January, 2024., Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

N

0 20,000 40,000

APPROXIMATE SCALE IN FEET

Crop Distributions

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp | Date: 3/26/2019 | Project No.: FR18161220

Geosyntec consultants

Figure **3.1.1-8a**

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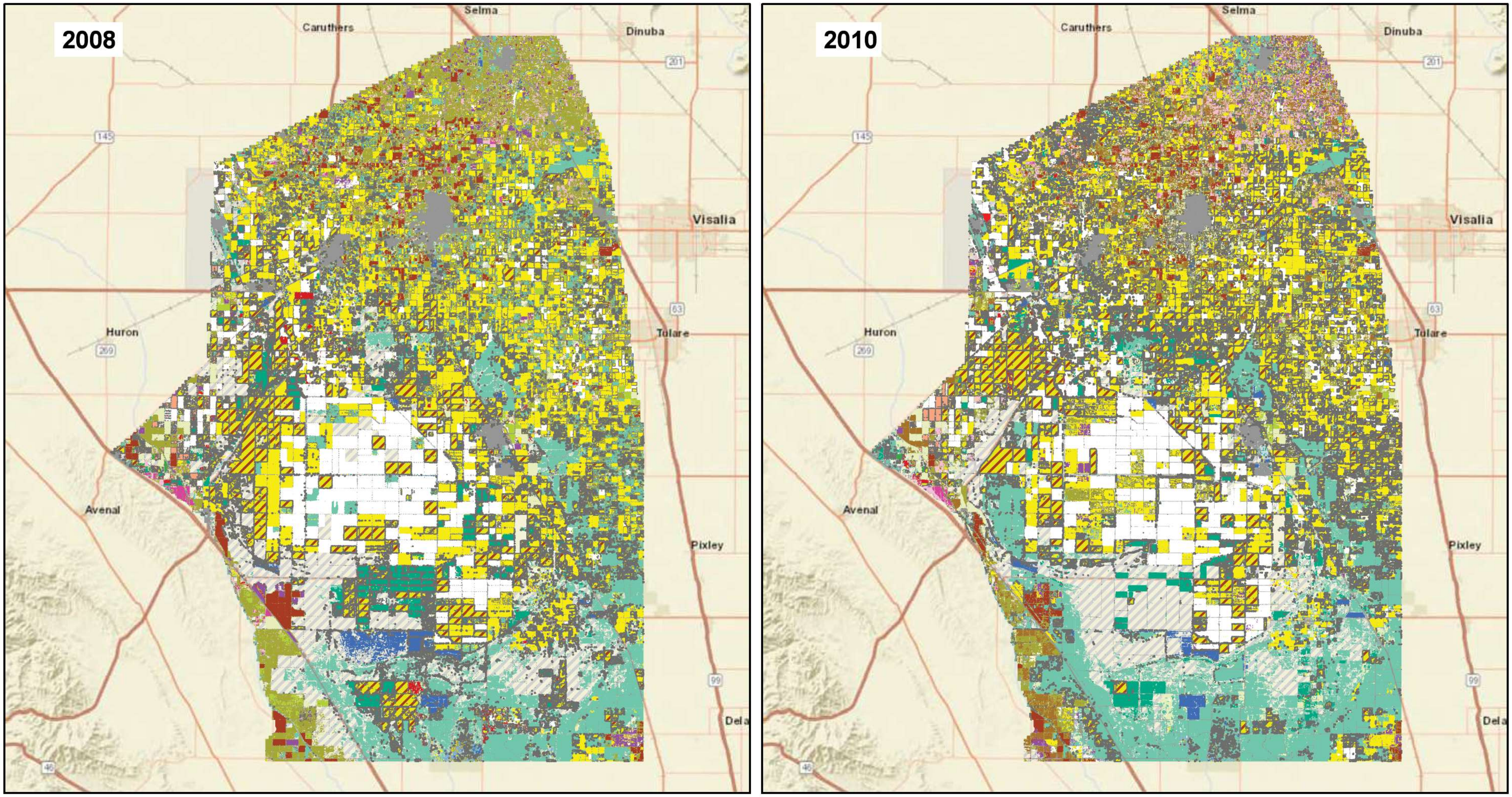

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

Crop Distributions
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp | Date: 3/26/2019 | Project No.: FR18161220

Geosyntec consultants

Figure **3.1.1-8b**

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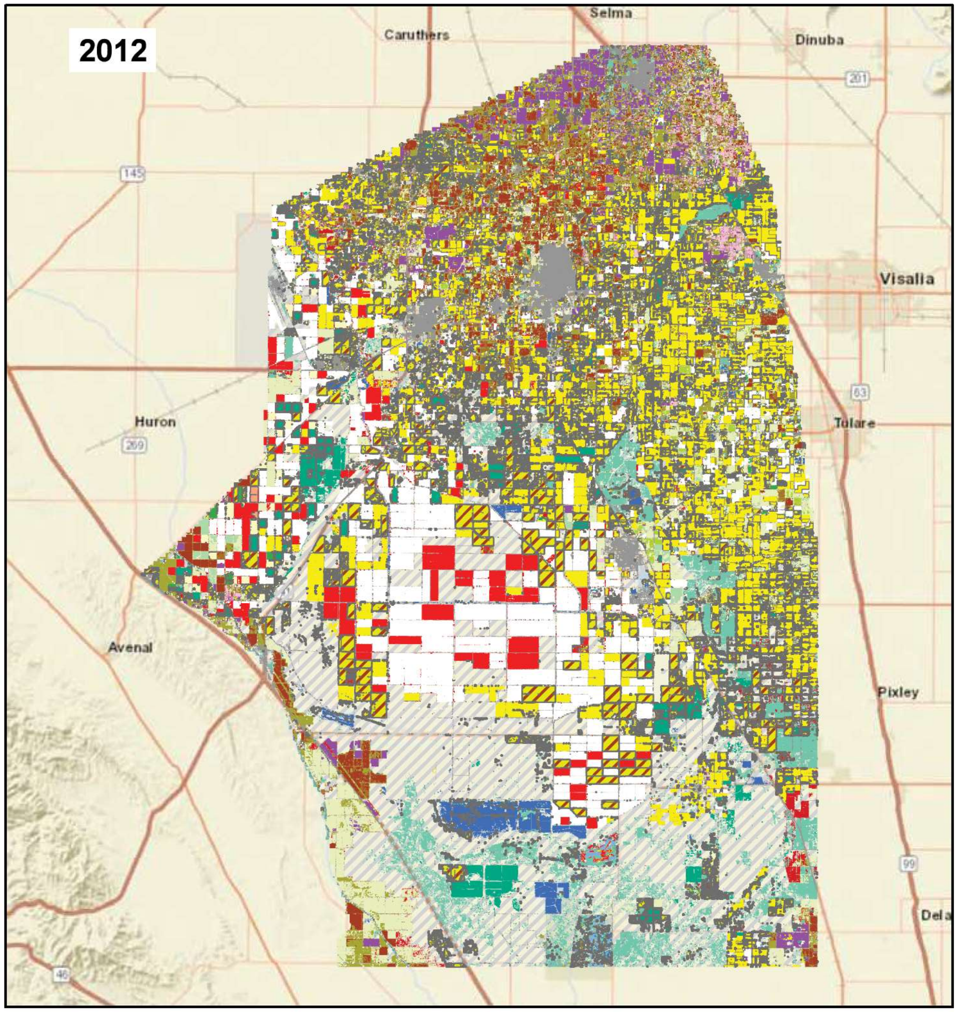

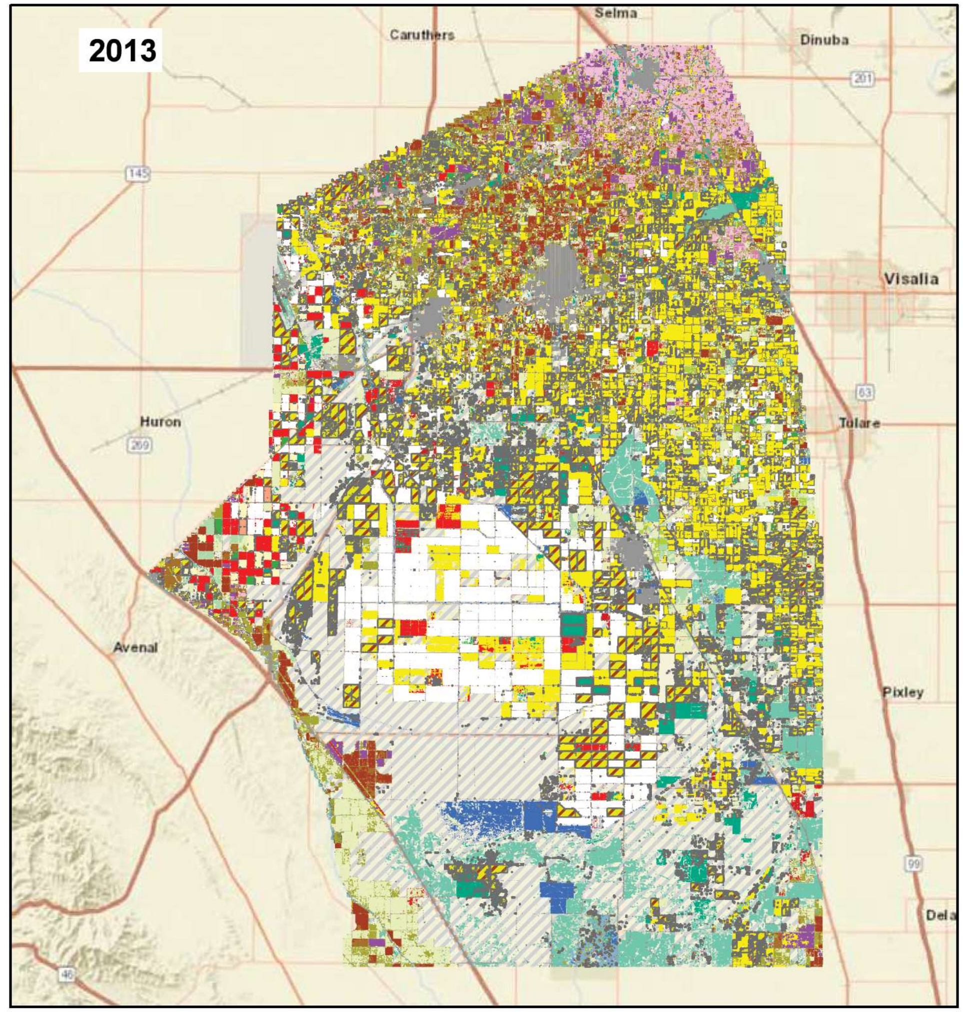

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
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- Onions and Garlic
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- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

N

0 20,000 40,000

APPROXIMATE SCALE IN FEET

Crop Distributions

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: jmp	Date: 3/26/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.1.1-8c**

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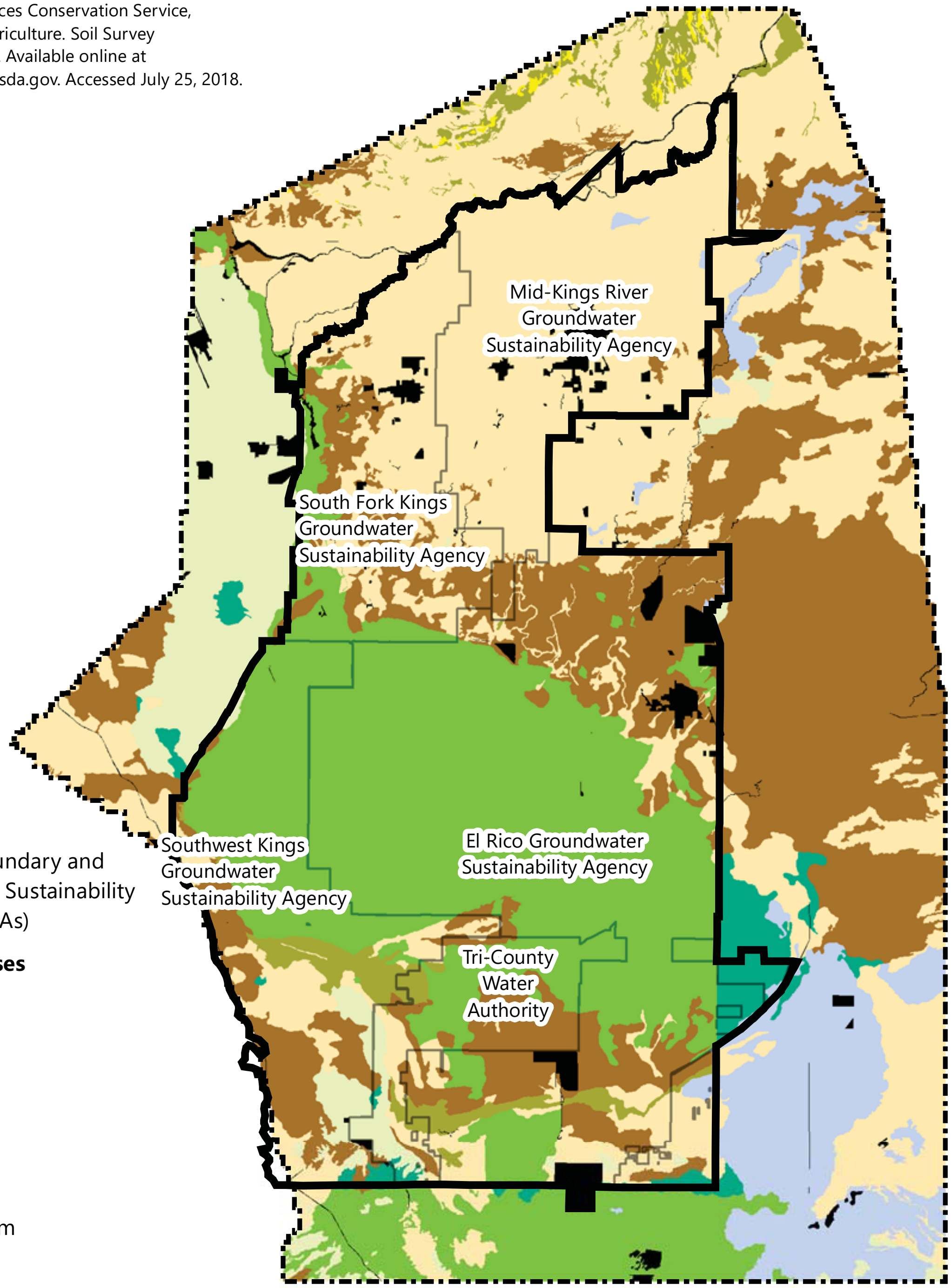
Soil texture data adapted from:
Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) database. Available online at https://sdmdataaccess.sc.egov.usda.gov. Accessed July 25, 2018.



Explanation

Study area

Subbasin boundary and Groundwater Sustainability Agencies (GSAs)

USDA soil textural classes

- Clay
- Silty clay
- Clay loam
- Silty clay loam
- Silt loam
- Loam
- Sandy loam
- Loamy sand
- Sand
- Unweathered bedrock
- Soil data unavailable

Miles: 0 2 4 8

Kilometers: 0 2.5 5 10

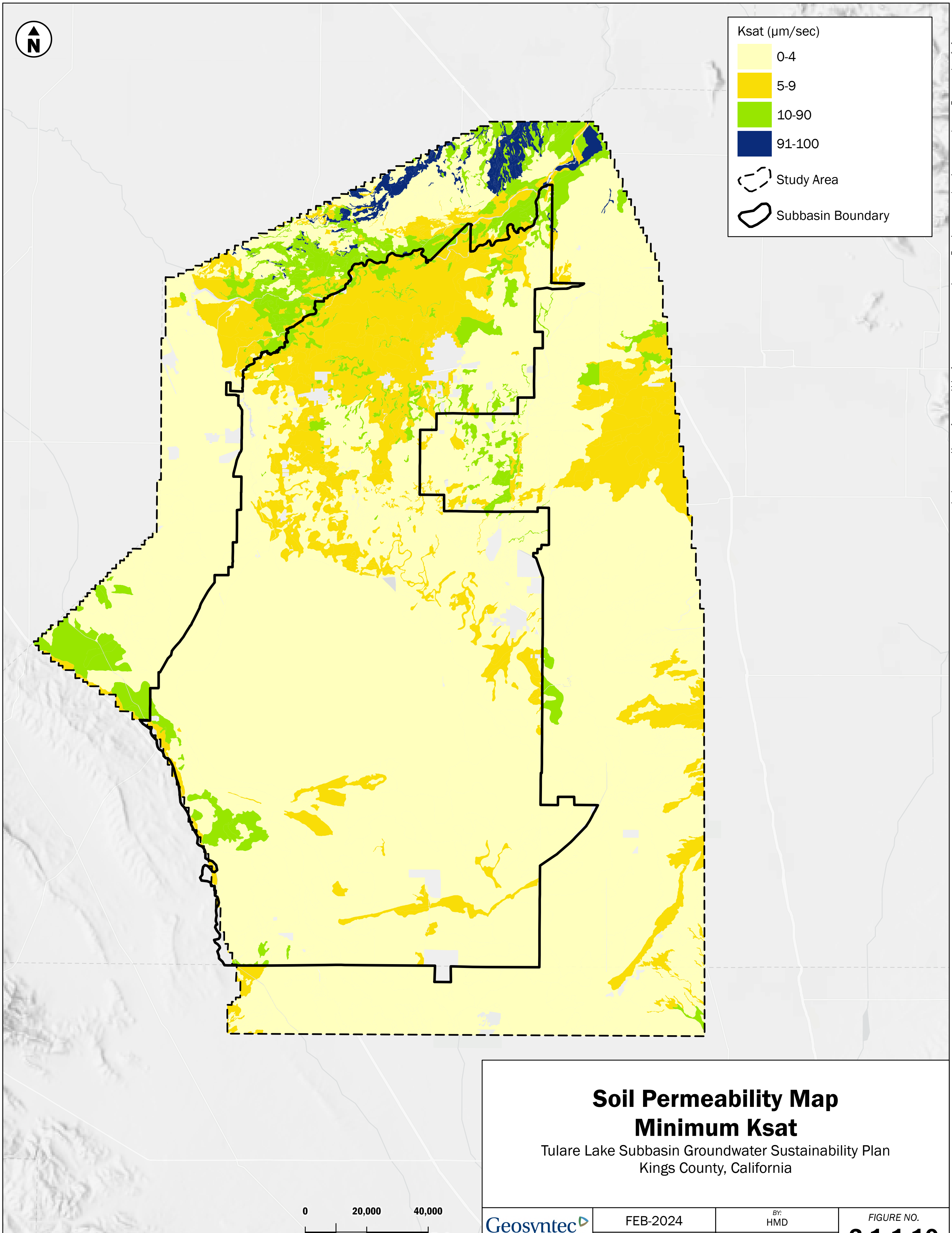
N

Soil Texture Map

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.1.1-9**

Date: 11/15/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting\8.5x11_fig3-9_SoilTexture.mxd



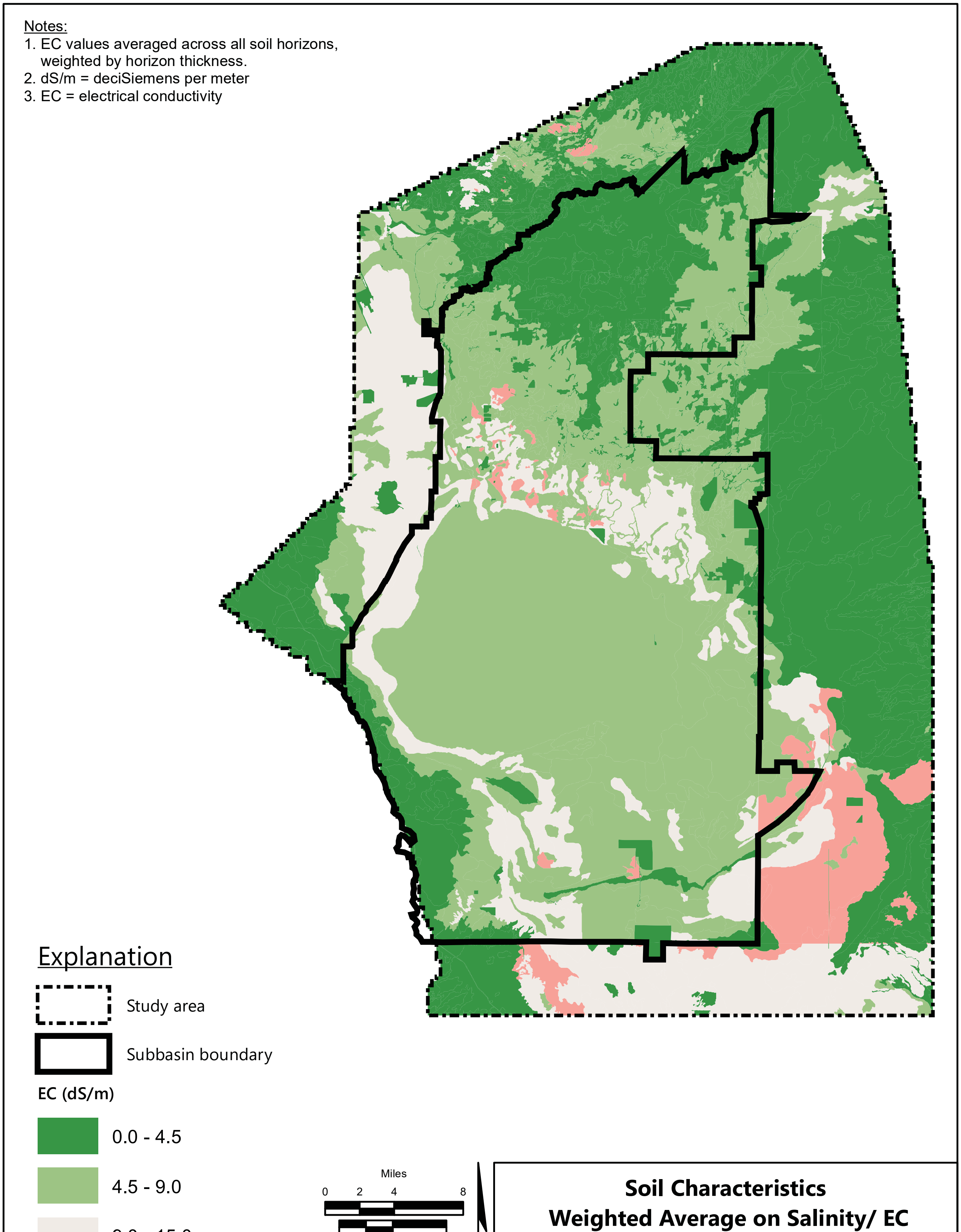
Soil Permeability Map
Minimum Ksat

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**3.1.1-10**

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx: 3.1.1-10 Soil Permeability Map| | User: haley.duran | | Print Date: 2/20/2024

Data source credits: None | | Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



Date: 11/15/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting\8.5x11_fig3-11_SoilSalinity.mxd

Soil Characteristics
Weighted Average on Salinity/ EC
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.1.1-11**

Date: 1/9/2020 Printed by: elizabeth.chapman
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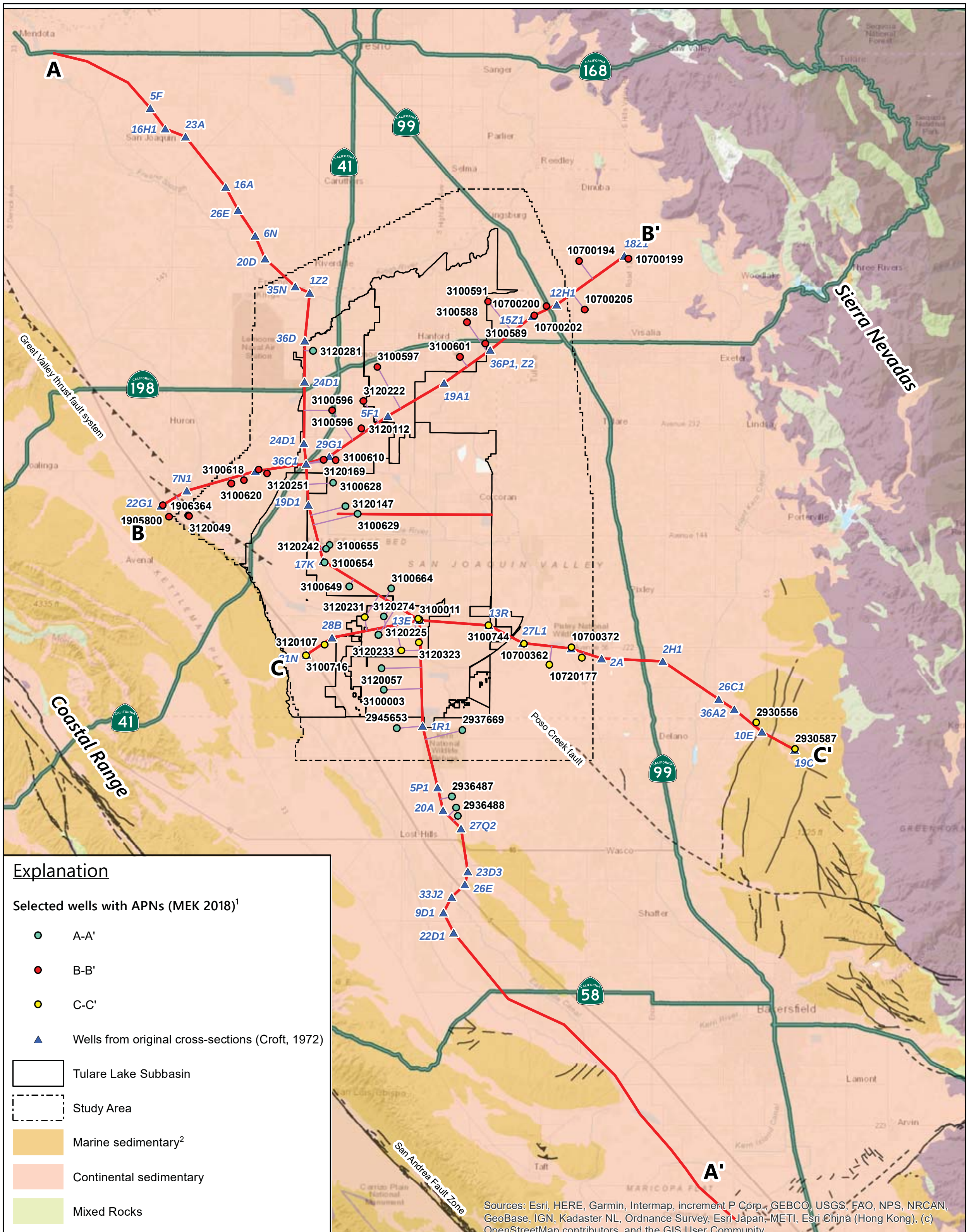


Explanation

Selected wells with APNs (MEK 2018)[1]

- A-A'
- B-B'
- C-C'
- Wells from original cross-sections (Croft, 1972)
- Tulare Lake Subbasin
- Study Area
- Marine sedimentary[2]
- Continental sedimentary
- Mixed Rocks
- Igneous
- Metamorphic
- Wells projected onto cross-section lines
- Cross-section lines (Croft, 1972)
- Highways (TIGER/Line 2016)
- Constrained fault line[3]
- Inferred fault
- Inferred thrust fault

N

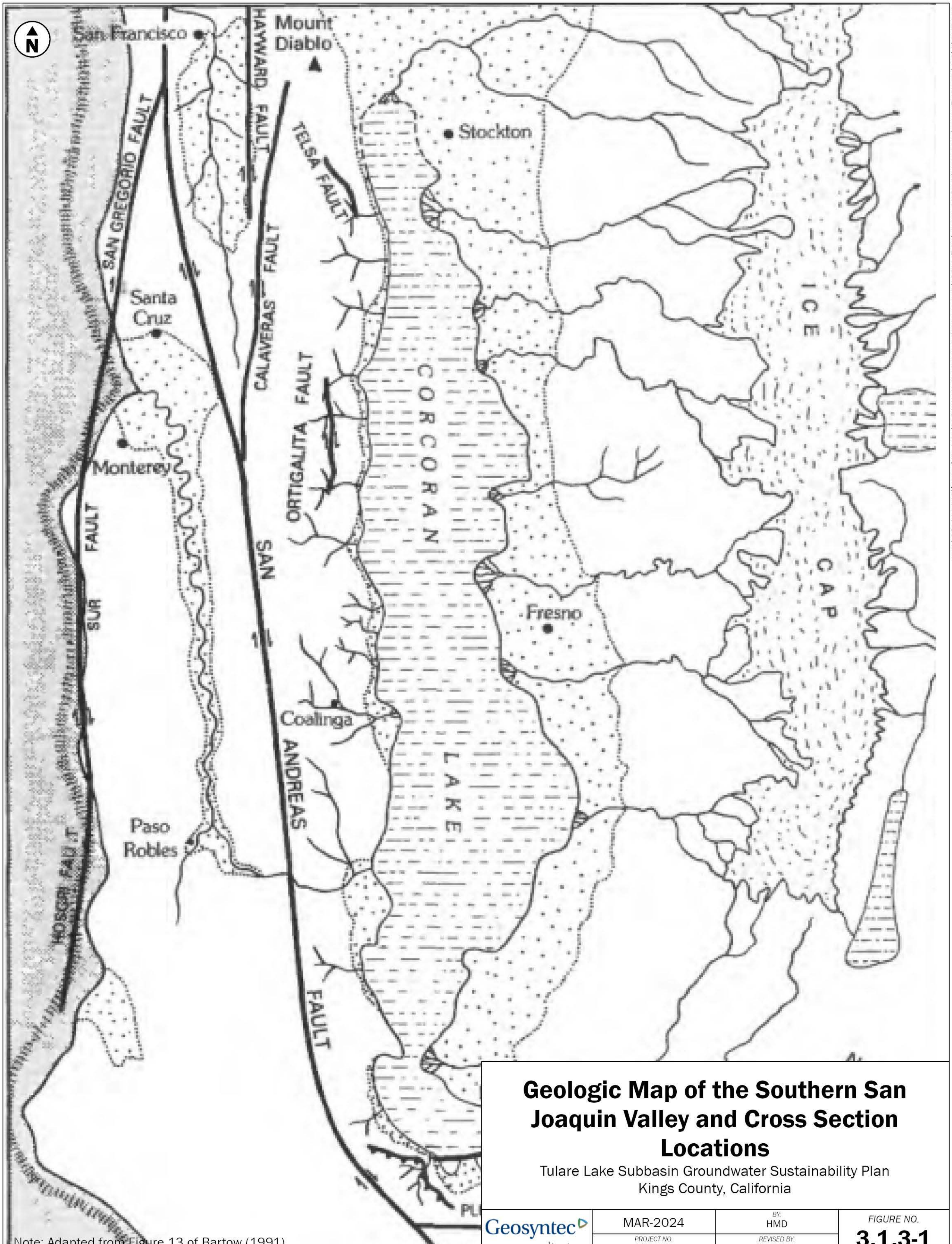
Approximate Scale in Miles
0 5 10 20

0 5 10 20
Approximate Scale in Kilometers

Notes:
1) Well records obtained from DOGGR well search. 2018. https://secure.conservation.ca.gov/WellSearch
2) Geologic Units derived from Geologic Map of California, 1977. USGS. https://mrdata.usgs.gov/geology/state
3) Fault data adapted from Quaternary Fault and Fold Database of the US. 2018 https://earthquake.usgs.gov/hazards/qfaults/

Geologic Map of the Southern San Joaquin Valley and Cross Section Locations
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220
Geosyntec consultants		Figure **3.1.2-1**



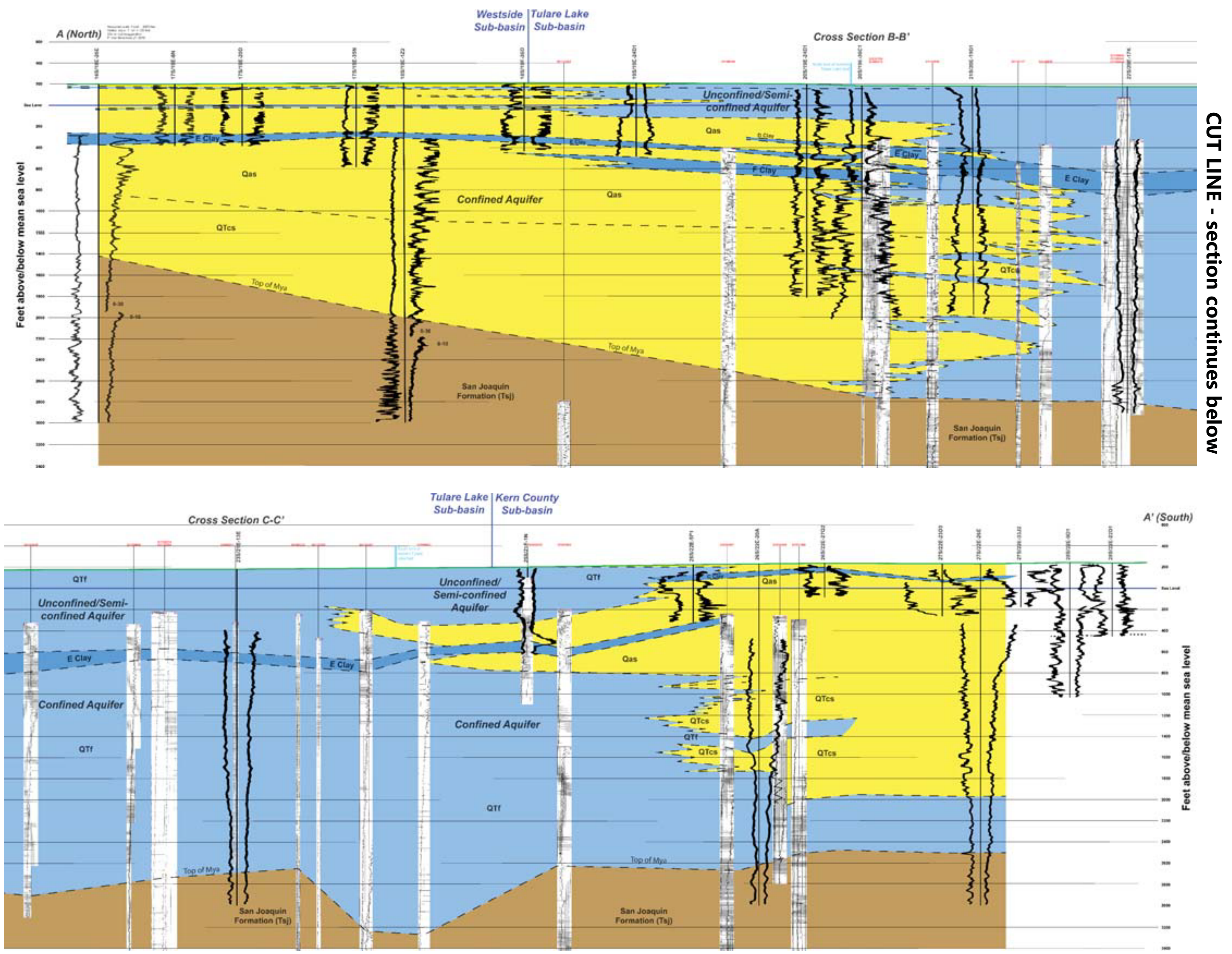
Geologic Map of the Southern San Joaquin Valley and Cross Section Locations

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	**3.1.3-1**

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx: 3.1.3-1 Pleistocene Extent of Corcoran Lake || User: haley.duran || Print Date: 3/12/2024

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



Explanation

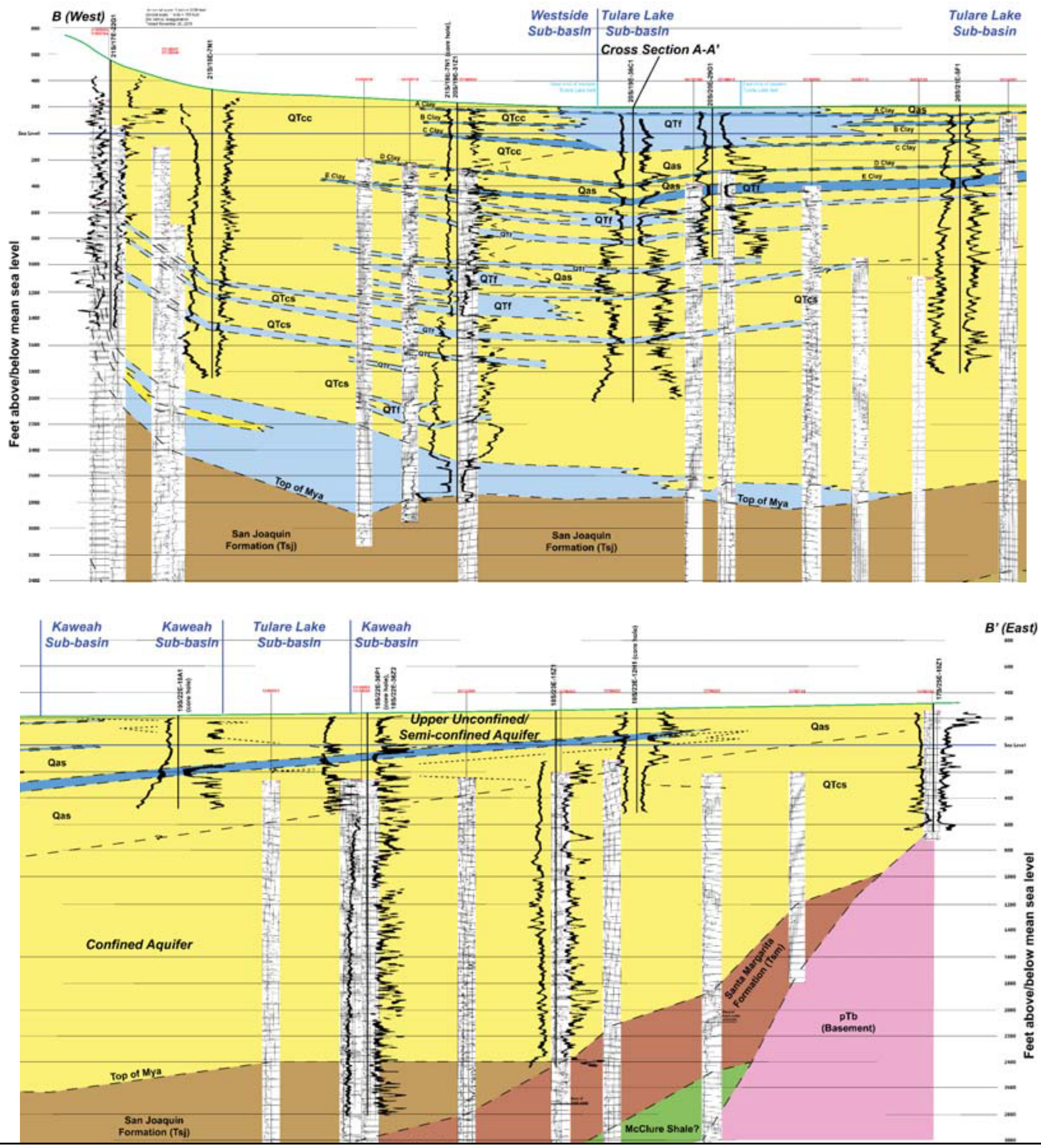
- Coarse-grained alluvium / Tulare Formation
- San Joaquin Formation
- Alluvium / Tulare Formation lacustrine sediments
- Regional clay marker beds as defined by Croft (1972)
- **25S/21E-1N** CA DWR well name
- **03120281** CA DOGGR well APN
- 0 30 Electric log resistivity scale (ohmmeters)

Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

Cross Section A-A'

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings county, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220
Geosyntec consultants		Figure **3.1.4-1a**



Explanation

Coarse-grained alluvium / Tulare Formation

San Joaquin Formation

Etchegoin Formation

Santa Margarita Formation

Alluvium / Tulare Formation lacustrine sediments

Regional clay marker beds as defined by Croft (1972)

Crystalline basement

25S/21E-1N CA DWR well name

03120281 CA DOGGR well APN

0 30 Electric log resistivity scale (ohmmeters)

Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

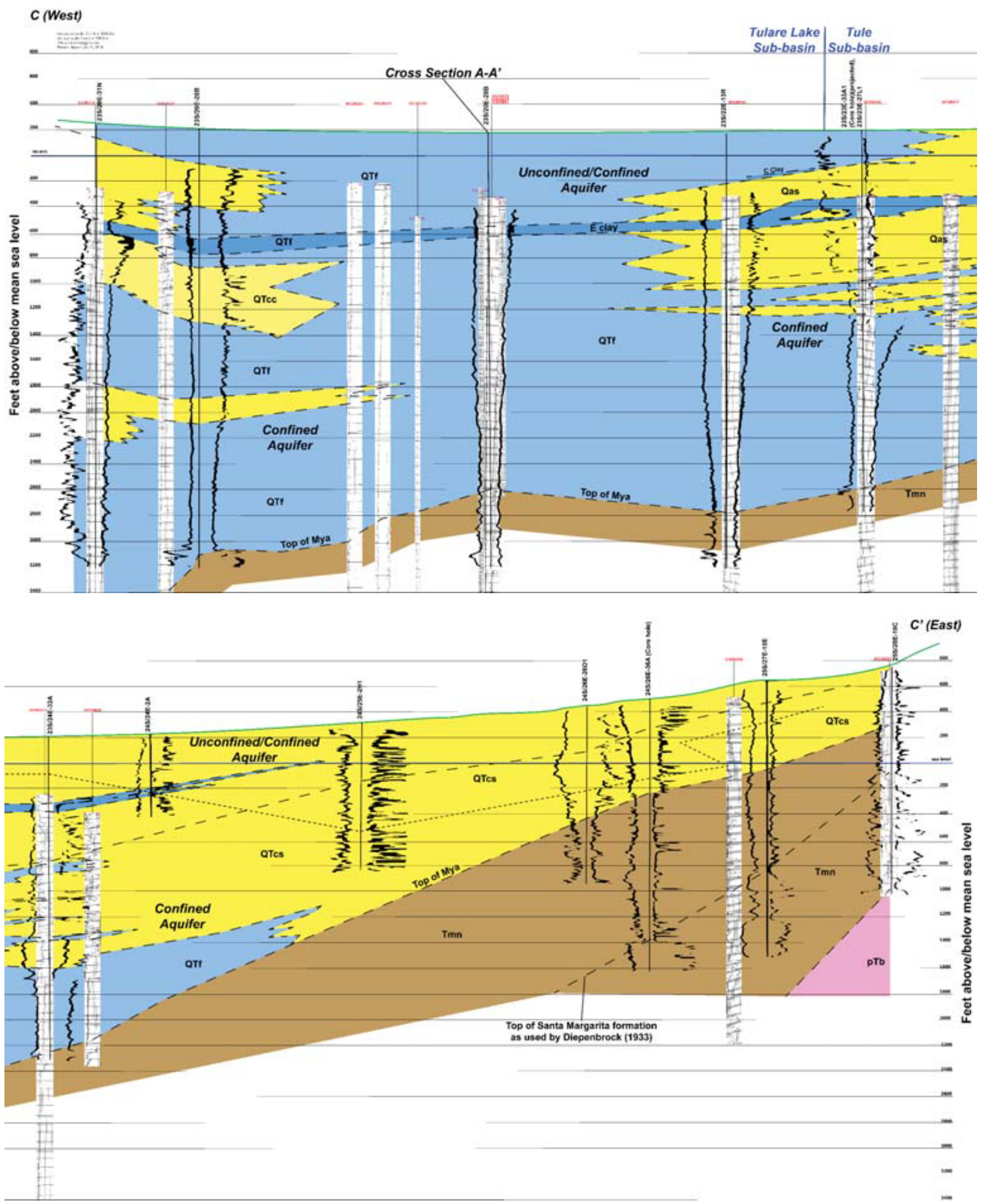
Cross Section B-B'
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220

Geosyntec consultants

Figure **3.1.4-1b**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-14b_xsecB-B'.mxd



Explanation

Coarse-grained alluvium / Tulare Formation

San Joaquin Formation

Alluvium / Tulare Formation lacustrine sediments

Regional clay marker beds as defined by Croft (1972)

Crystalline basement

25S/21E-1N CA DWR well name

03120281 CA DOGGR well APN

0 30 Electric log resistivity scale (ohmmeters)

Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
3) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

Cross Section C-C'
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220

Geosyntec consultants

Figure **3.1.4-1c**

Date: 1/9/2020 Printed by: elizabeth.chapman
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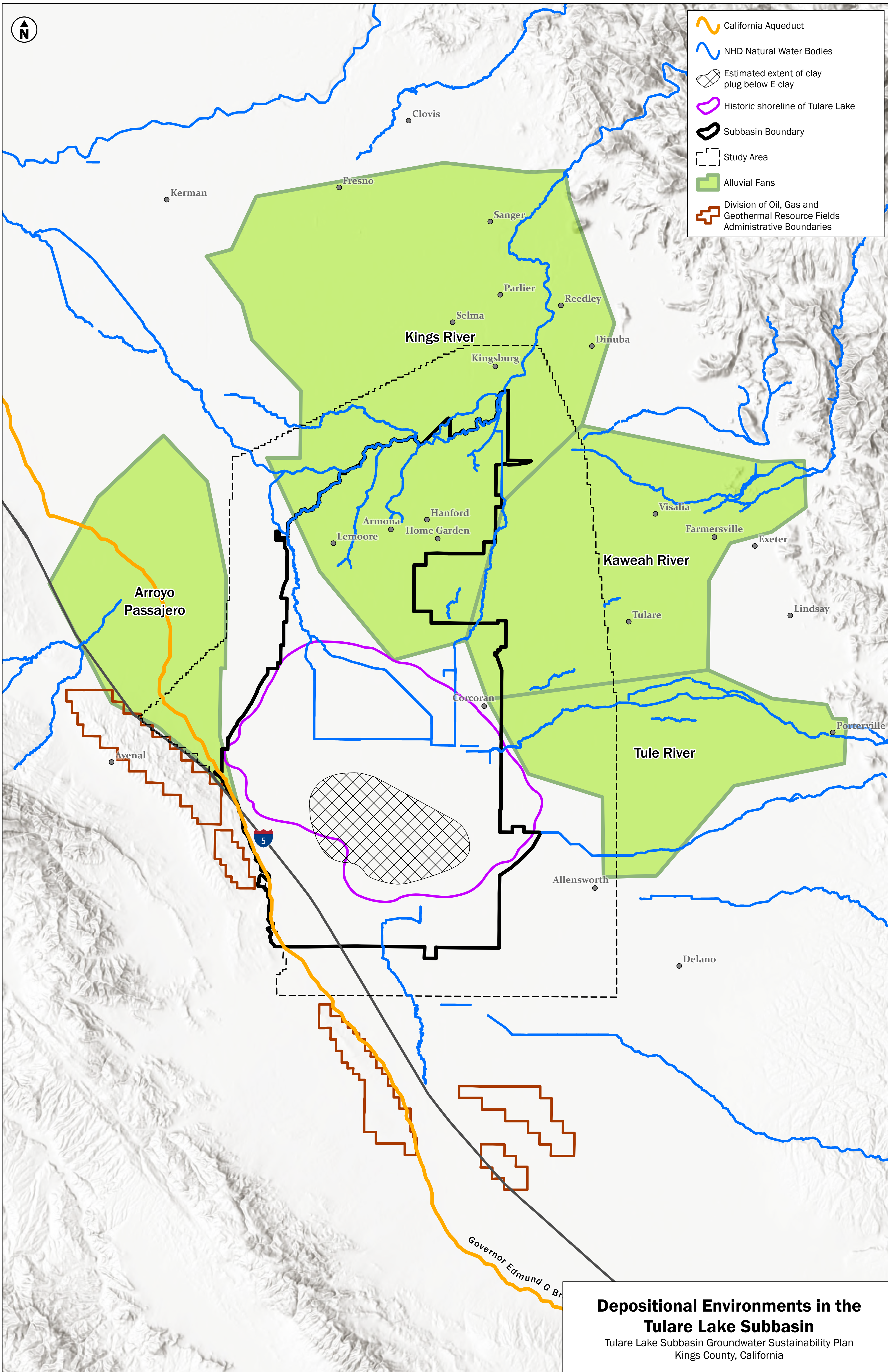


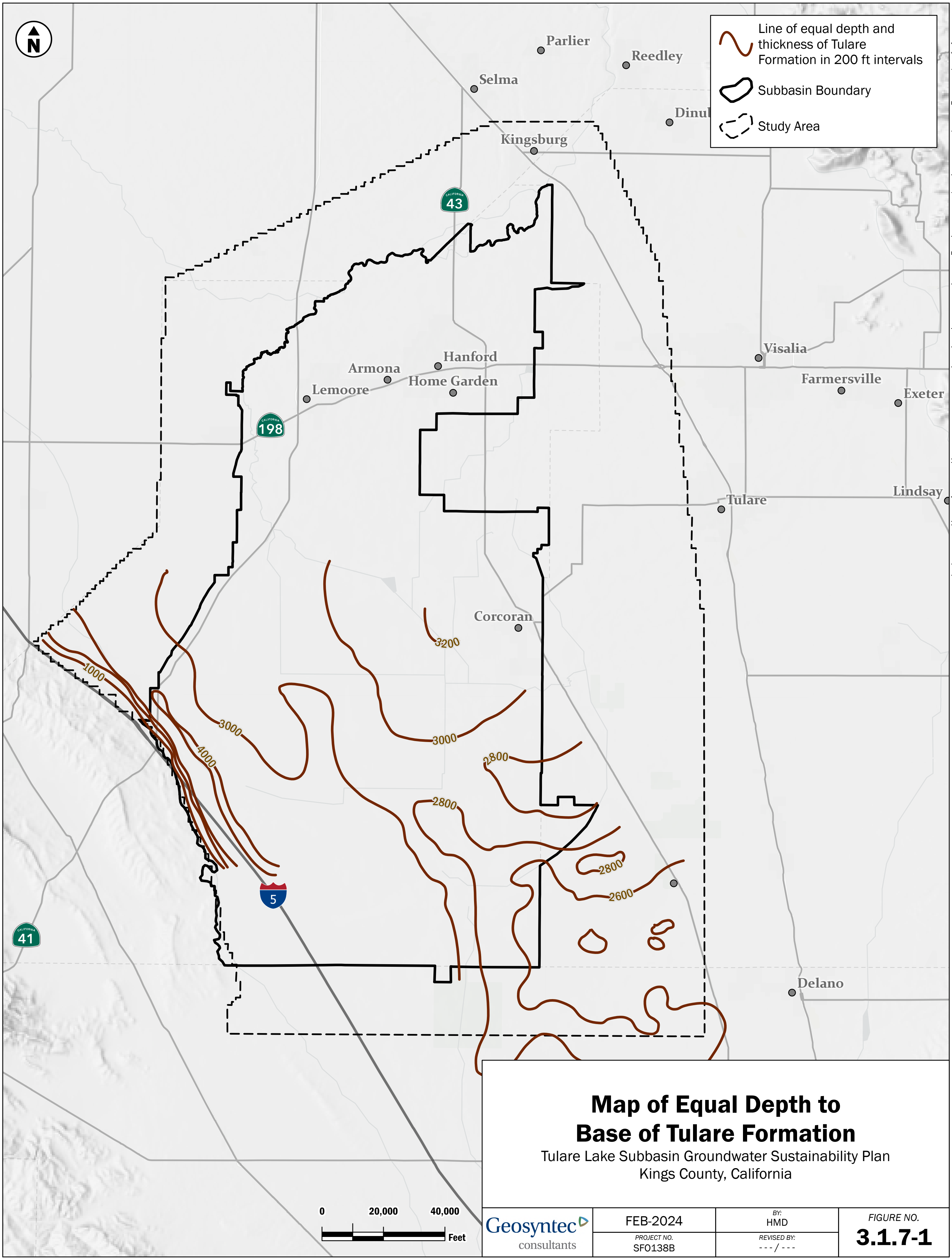
Depositional Environments in the Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3.1.6-1

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx: 3.1.6-1 Depositional Environments in the Tulare Lake Subbasin || User: haley.duran || Print Date: 3/1/2024



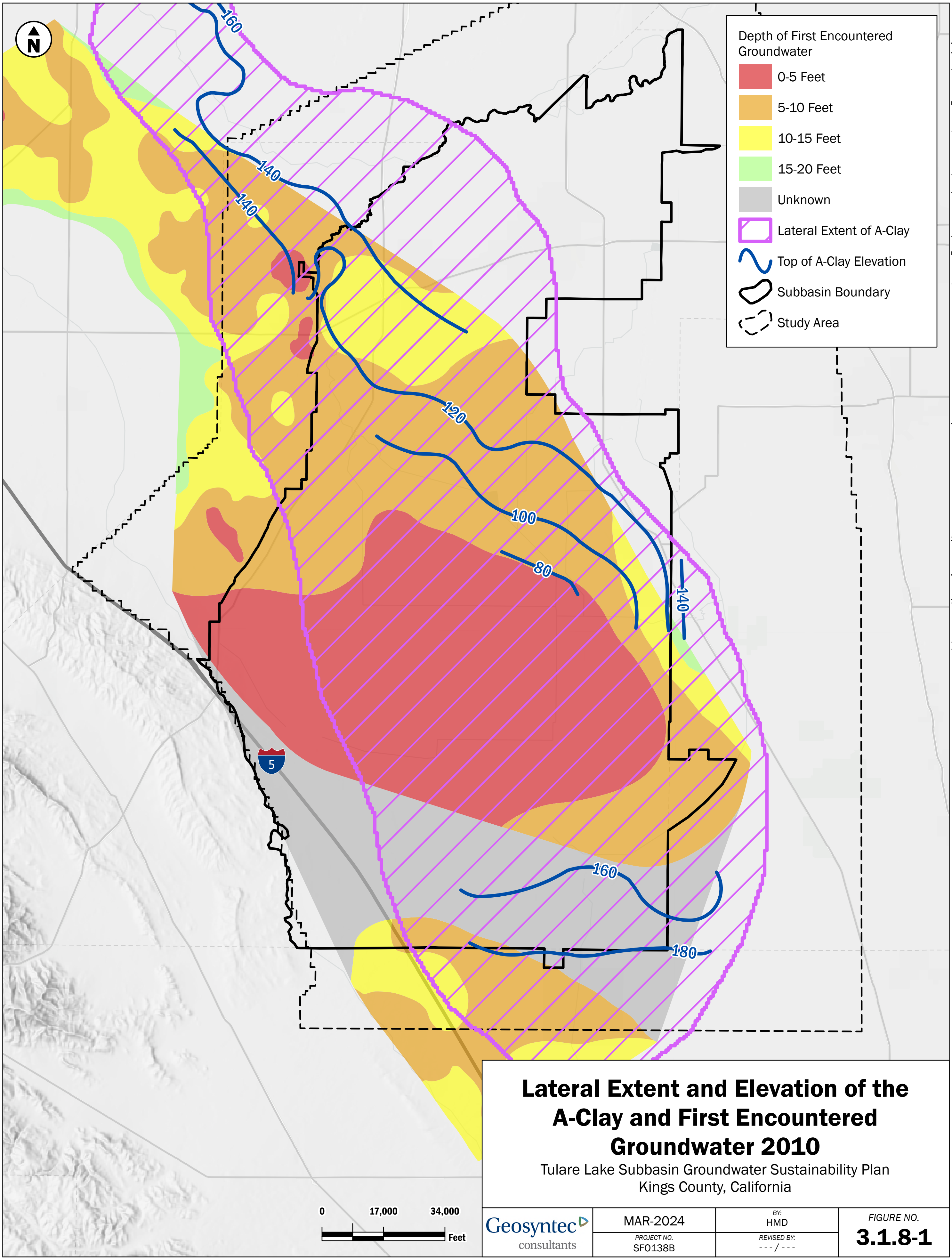
Map of Equal Depth to Base of Tulare Formation

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.7-1

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx: 3.1.7-1 Map of Equal Depth to Base of Tulare Formation || User: haley.duran || Print Date: 2/20/2024

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



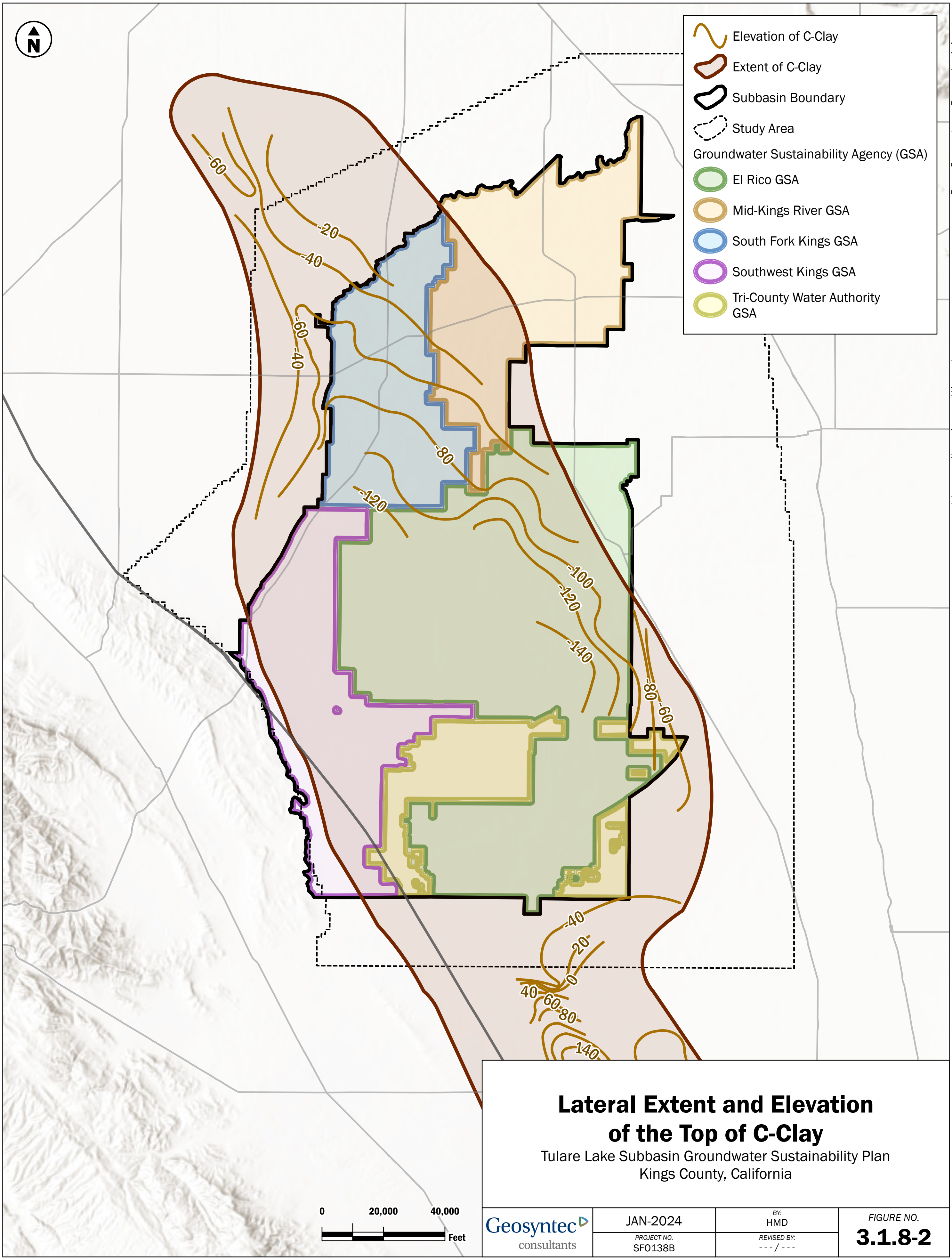
Lateral Extent and Elevation of the A-Clay and First Encountered Groundwater 2010

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO. 3.1.8-1
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx: 3.1.8-1 Lateral Extent and Elevation of A-Clay First Encountered Groundwater 2010 || User: haley.duran || Print Date: 3/1/2024

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS

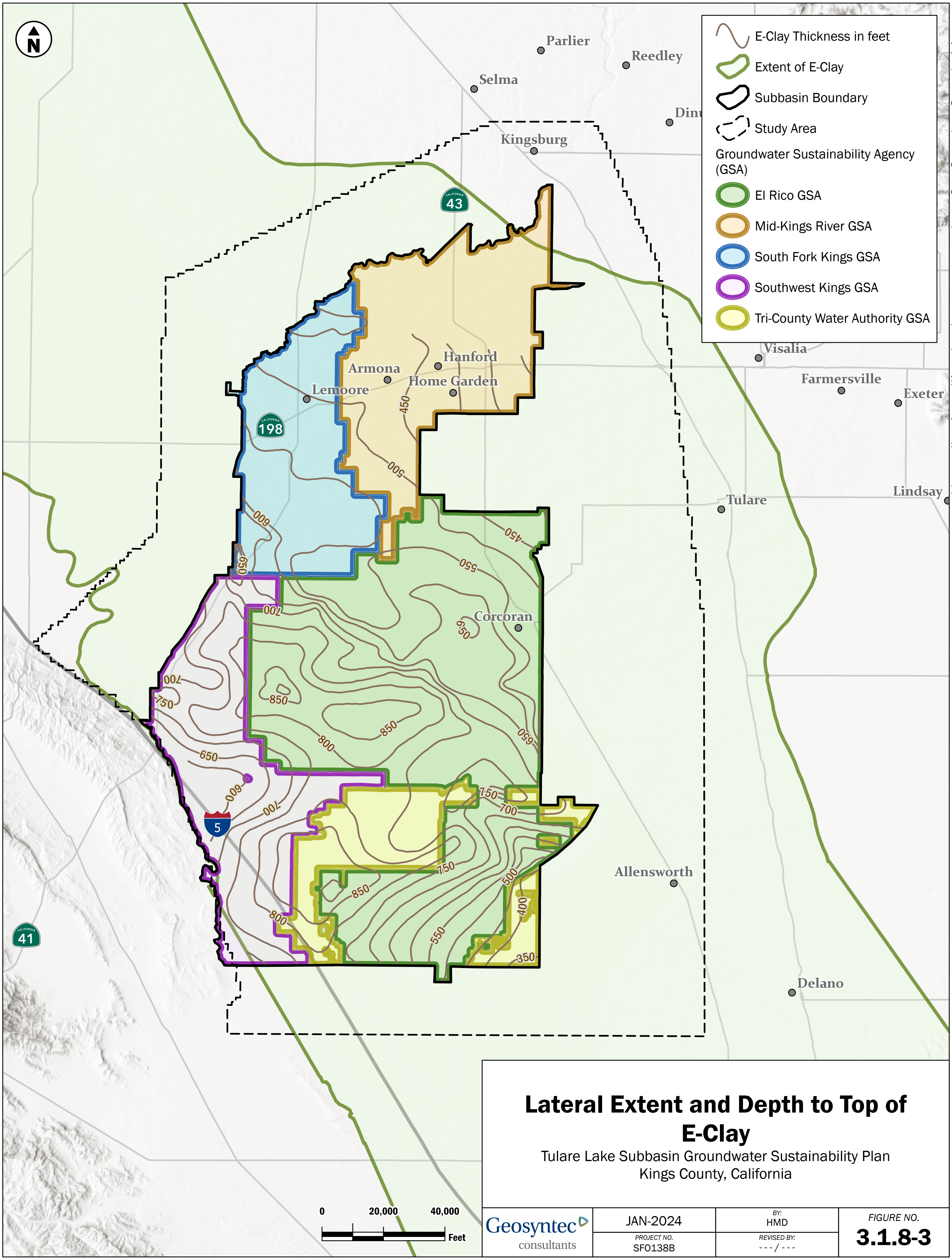


Lateral Extent and Elevation of the Top of C-Clay

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.8-2

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



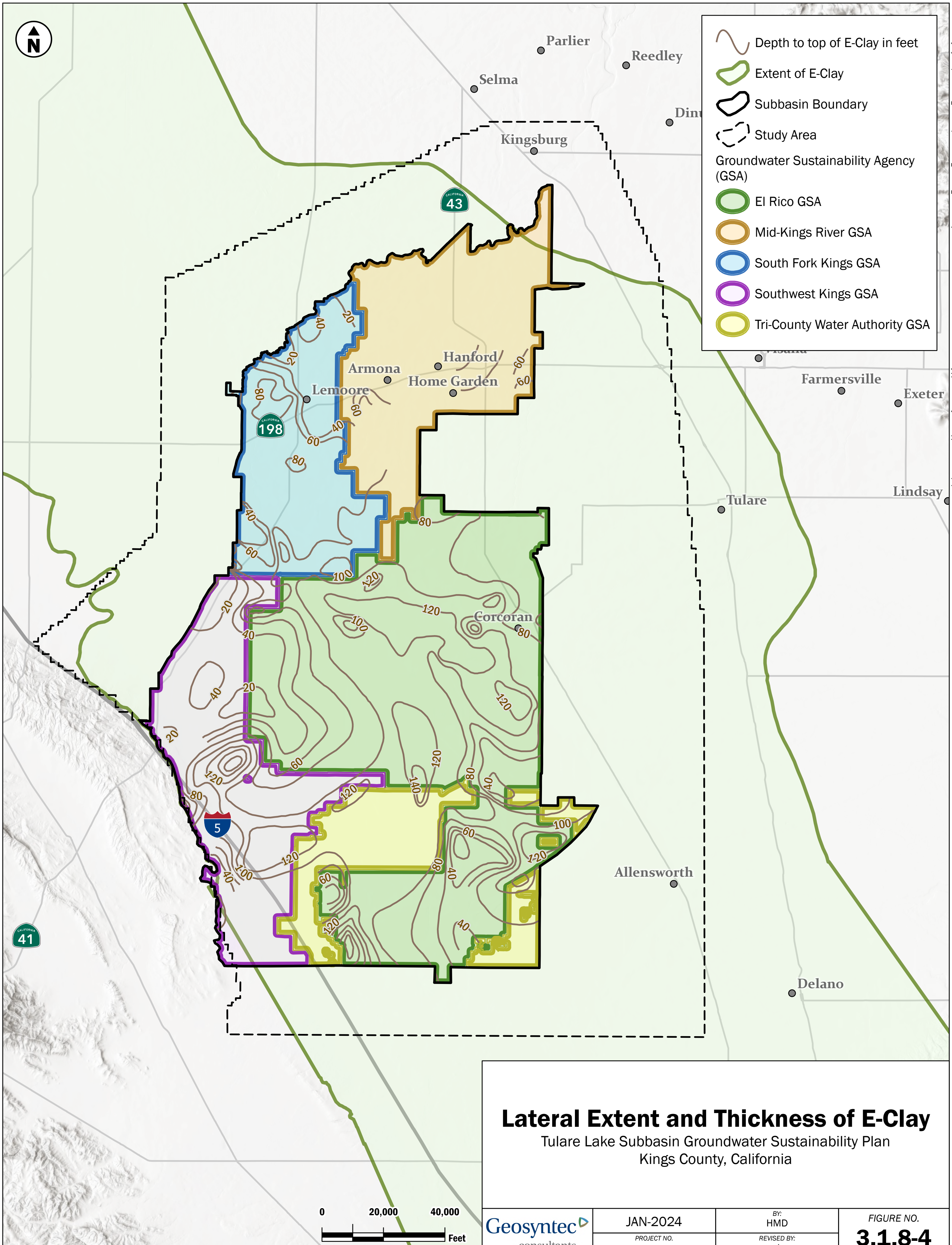
Lateral Extent and Depth to Top of E-Clay

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.8-3

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.8-3 Lateral Extent and Depth to Top of E-Clay || User: haley.duran || Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



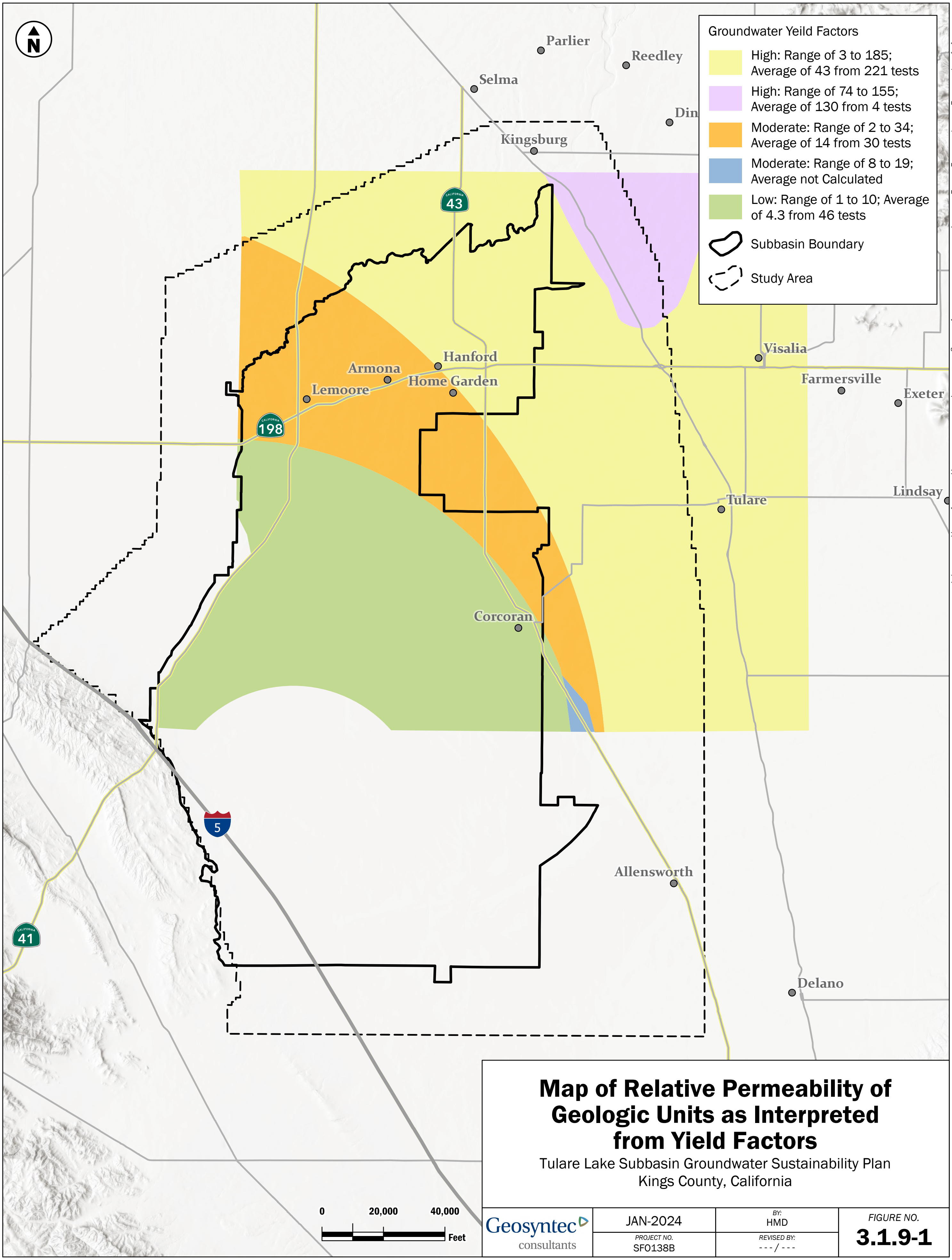
Lateral Extent and Thickness of E-Clay

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3.1.8-4

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.8-4 Lateral Extent and Thickness of E-Clay | User: haley.duran | Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



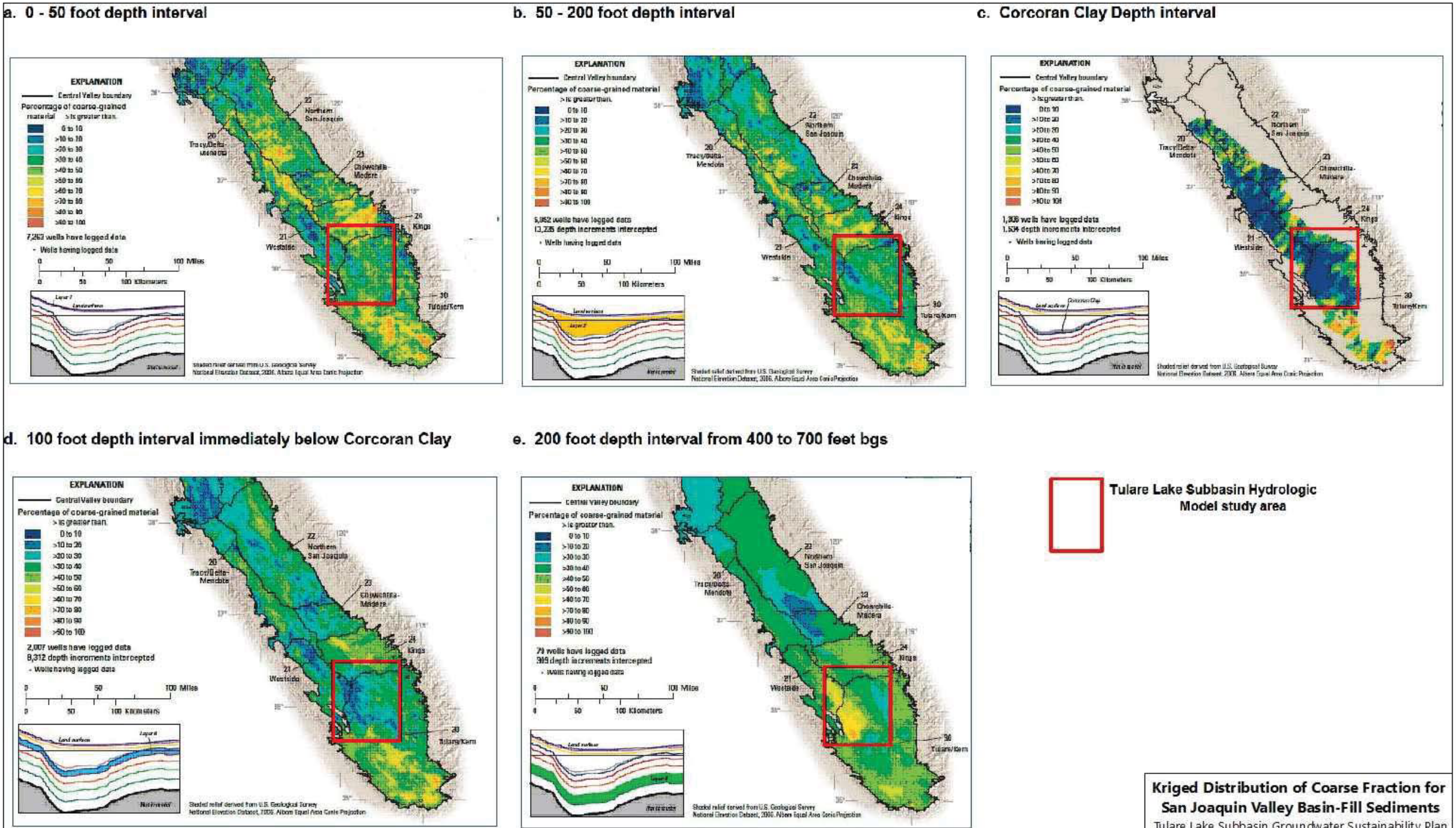
Map of Relative Permeability of Geologic Units as Interpreted from Yield Factors

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.1.9-1

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.1.9-1 Relative Permeability of Geologic Units as Interpreted from Yield Factors | | User: haley.duran | | Print Date: 1/8/2024

Data source credits: None || Basemap Service Layer Credits: Esri, CGIAR, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community



Kriged Distribution of Coarse Fraction for San Joaquin Valley Basin-Fill Sediments

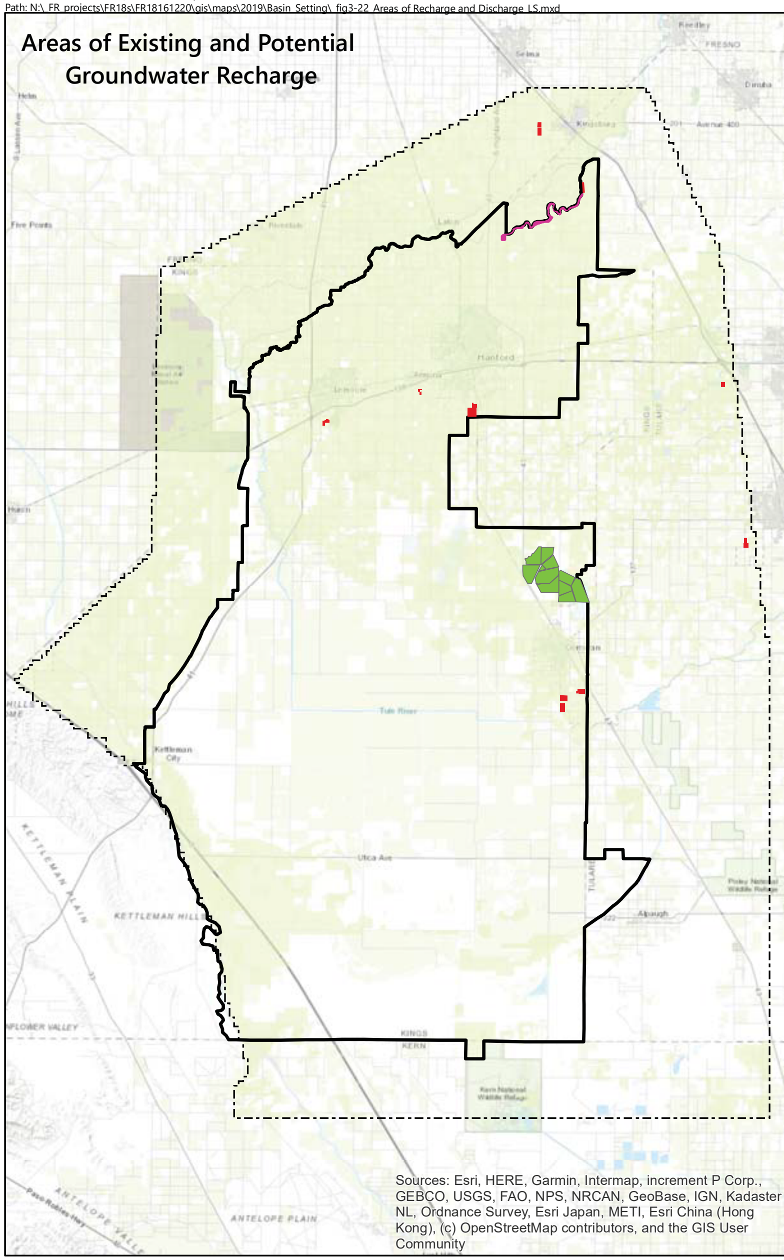
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

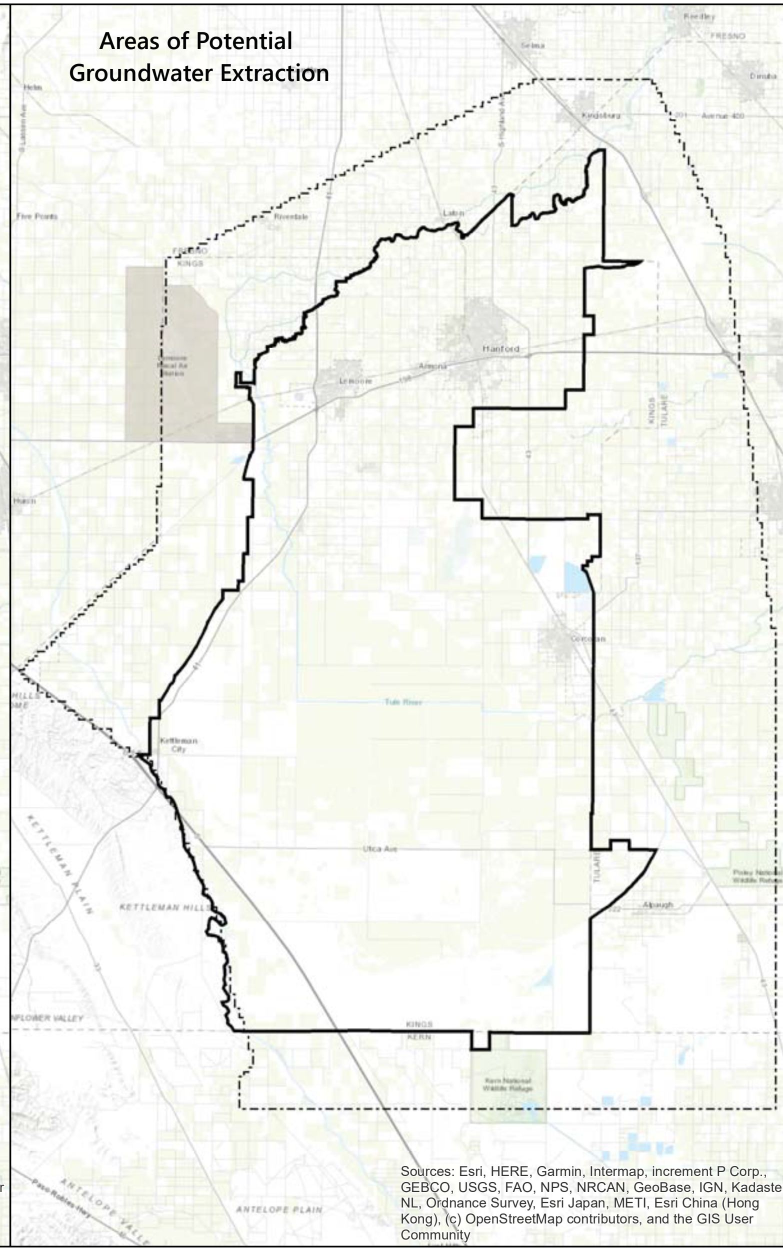
By: EMC	Date: 1/9/2020	Project No.: FR16181220

Geosyntec consultants

Figure **3.1.9-2**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-22_Areas of Recharge and Discharge_LS.mxd





Explanation

- Study area
- Subbasin boundary
- Subsurface (tile) drained areas
- Area of potential groundwater extraction
- Stream and canal recharge
- Potential recharge area

Existing areas of intentional recharge

- Waste Water Treatment Ponds
- Corcoran Irrigation District ponds
- Old river/ APEX Ranch

Approximate Scale in Feet: 0 17,500 35,000 70,000

Approximate Scale in Meters: 0 4,000 8,000 16,000

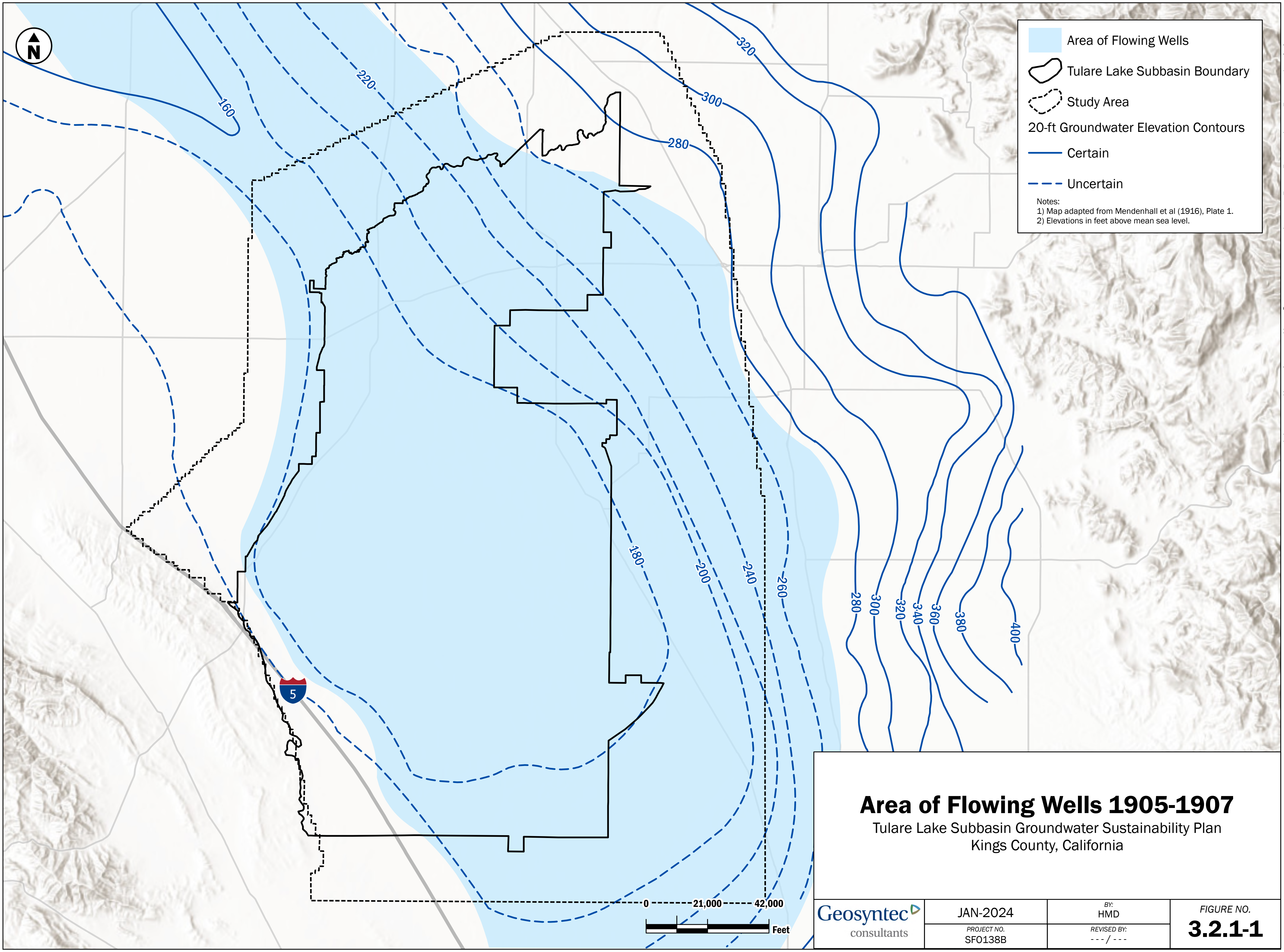
Areas of Existing and Potential Recharge and Extraction

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220

Geosyntec consultants

Figure **3.1.10-1**



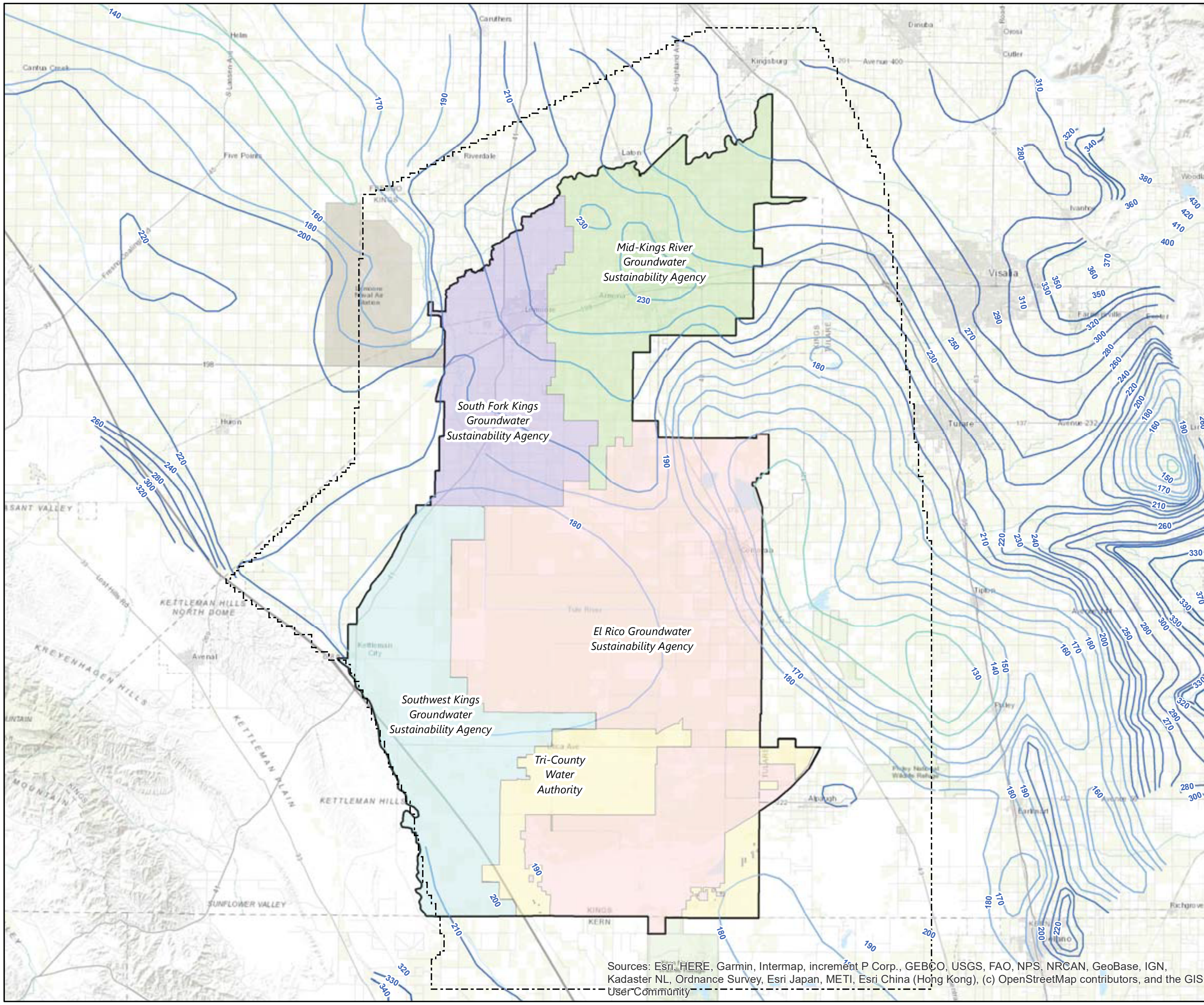
Area of Flowing Wells 1905-1907

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.2.1-1

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.2.1-1 Areas of Flowing Wells || User: haley.duran || Print Date: 1/9/2024



Explanation

- Study Area
- Subbasin boundary

10-ft groundwater elevation contours

- 100 - 150ft
- 150 - 200ft
- 210 - 250ft
- 260 - 300ft
- 310-450ft
- 460 - 500ft
- 510-580ft

Groundwater Sustainability Agencies (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Approximate Scale in Miles: 0, 2½, 5, 10

Approximate Scale in Kilometers: 0, 2½, 5, 10

Notes:
1) Map adapted from Davis (1959), Plate 15.
2) Elevations in feet above mean sea level.

Map of Unconfined Groundwater Conditions1952

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/9/2020	Project No.: FR18161220
Geosyntec consultants		Figure 3.2.1-2

Date: 1/9/2020 Printed by: elizabeth.chapman
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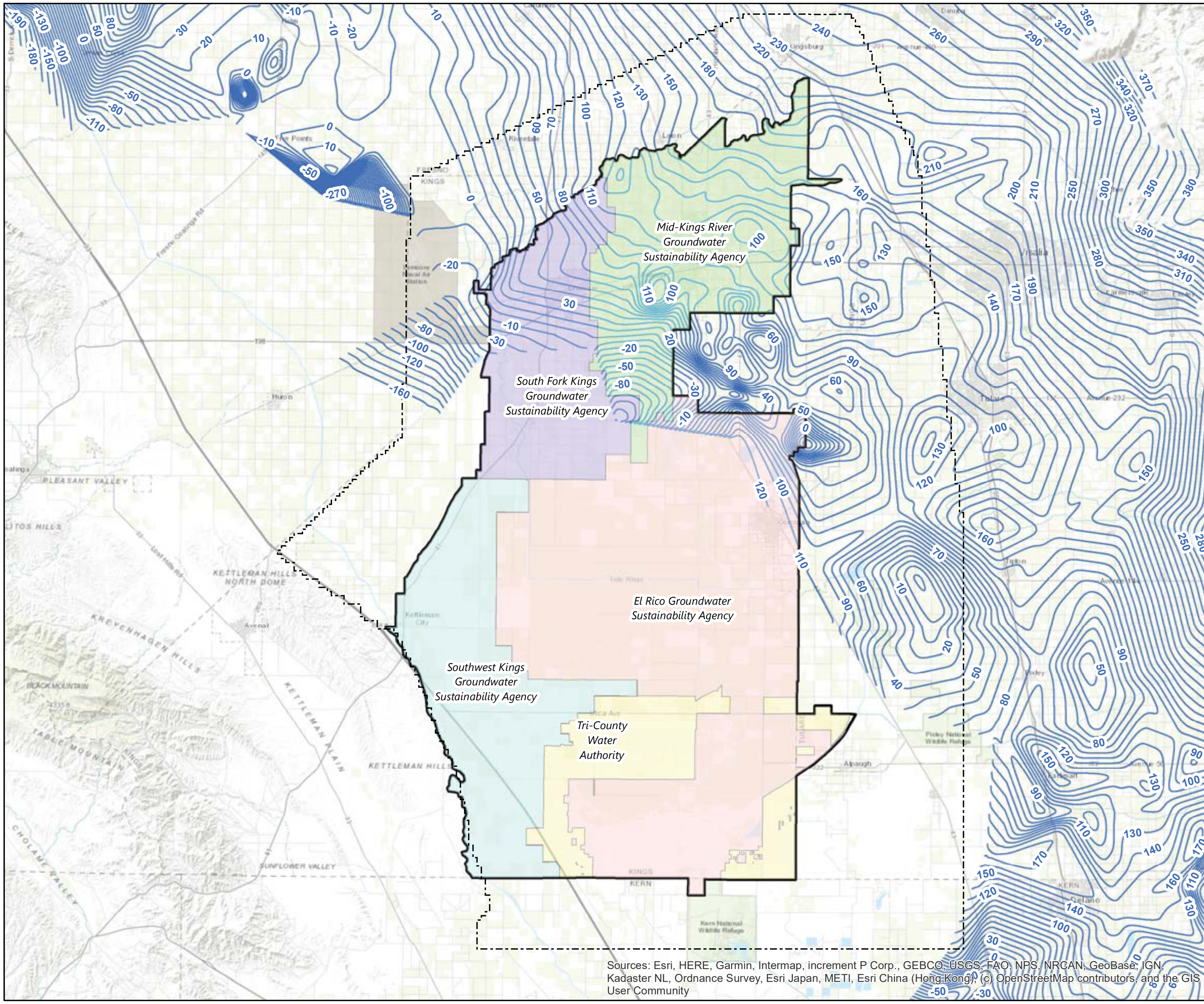


Explanation

- 10-ft lines of equal groundwater elevation
- Study area
- Subbasin boundary

Groundwater Sustainability Areas (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Approximate Scale in Miles: 0, 2½, 5, 10

Approximate Scale in Kilometers: 0, 2½, 5, 10

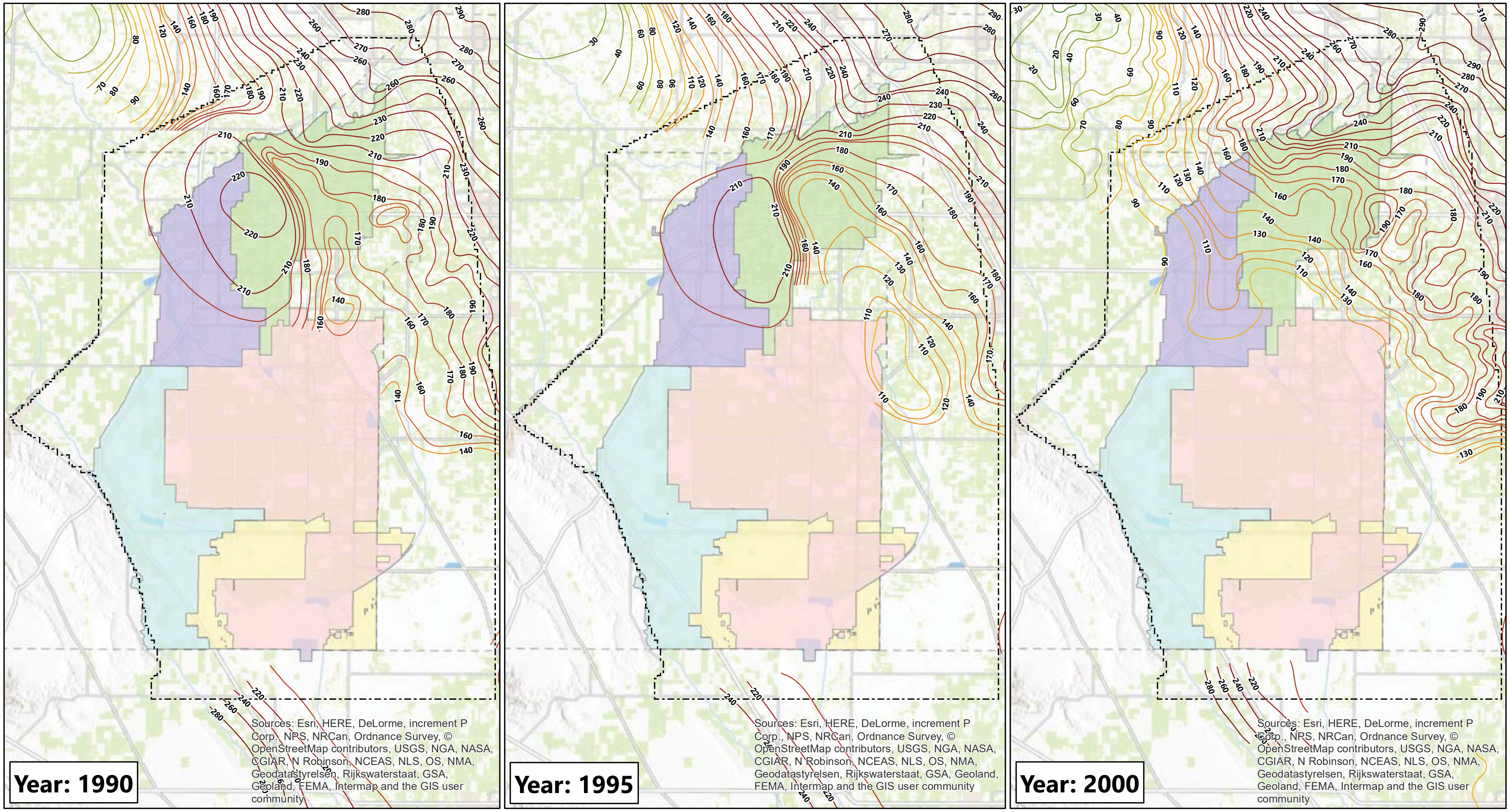
Notes:
1) Map adapted from DWR, June 2018.
2) Elevations in feet above mean sea level.

Map of Unconfined Groundwater Elevations 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.2.1-3**

Date: 11/15/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-25_GroundwaterConditions_2016.mxd



Explanation

- Study area
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Groundwater elevation (FMSL)
-700
-350

APPROXIMATE SCALE IN MILES
0 5 10 20

0 5 10 20
APPROXIMATE SCALE IN KILOMETERS

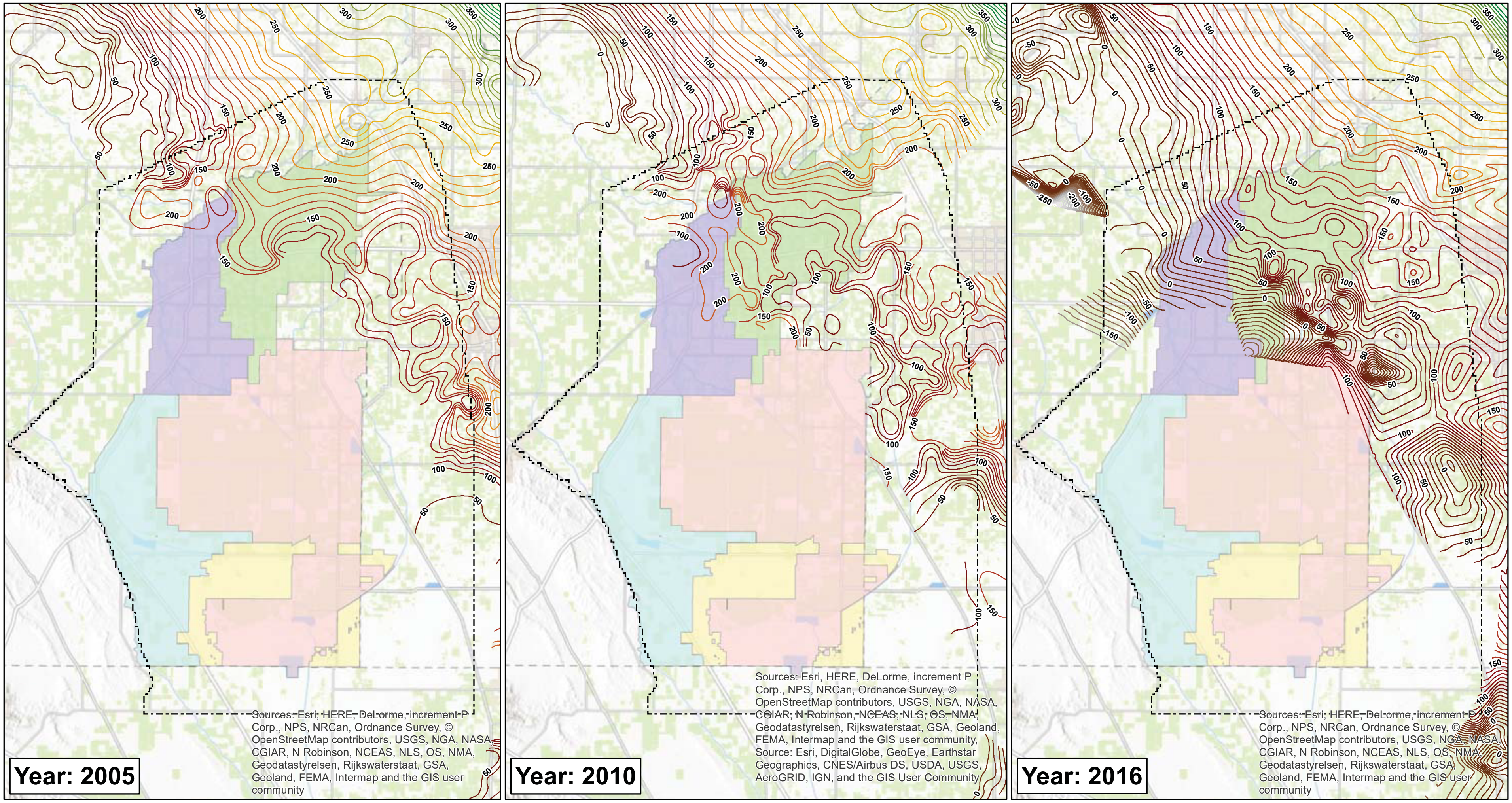
N

Historical DWR Groundwater Elevation Maps Unconfined Aquifer

Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.2.2-1**

Date: 11/15/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-26_RecentGroundwaterConditions_1990_1995_2000.mxd



Explanation

- Study area
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Groundwater elevation (FMSL)
-700
-350

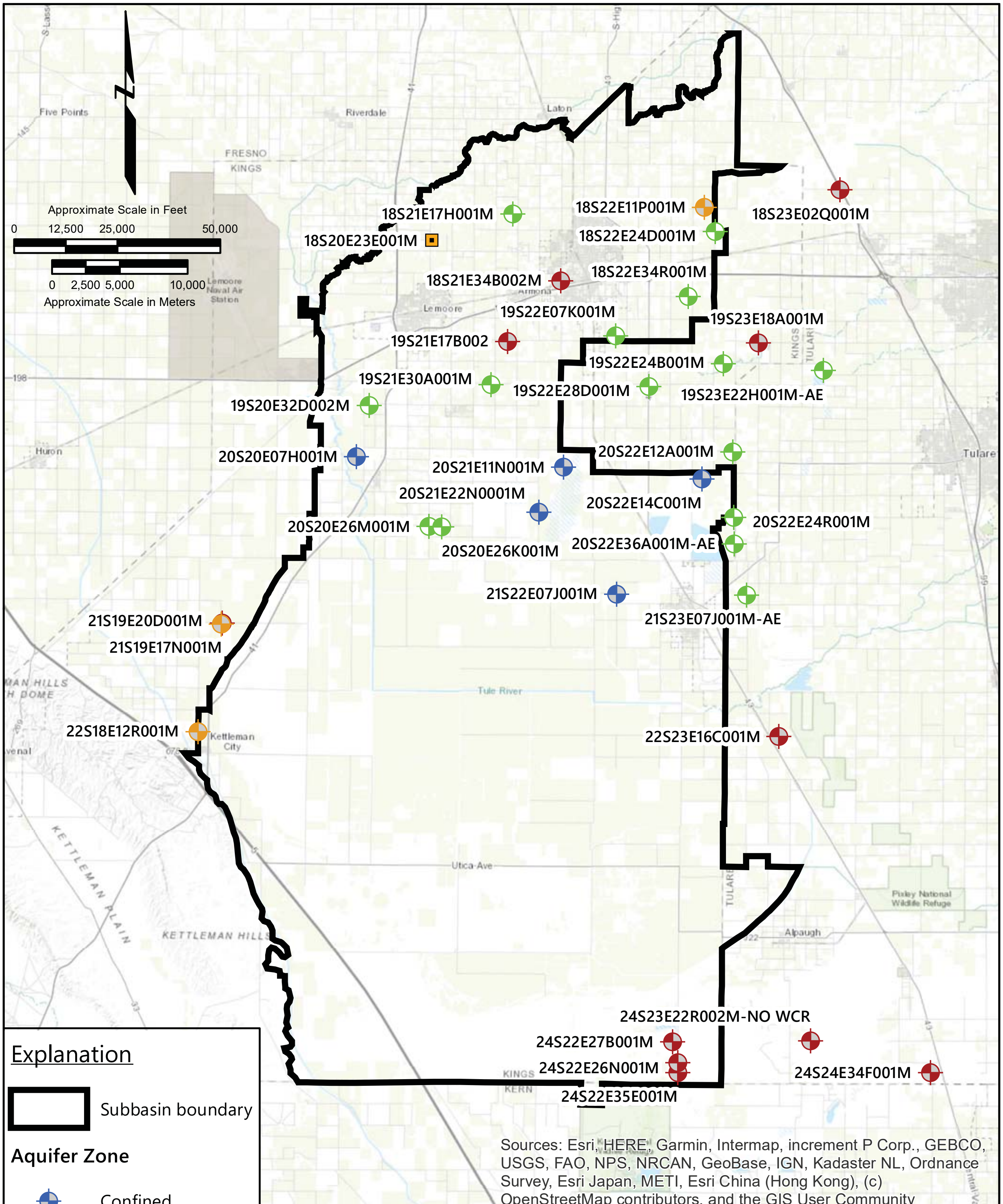
APPROXIMATE SCALE IN MILES
0 5 10 20
0 5 10 20
APPROXIMATE SCALE IN KILOMETERS

NOTE:
1) Groundwater elevation data obtained from California Department of Water Resources (CA DWR), June 2018: https://databasin.org/datasets/b05820cda86b4921a515065fa1deffcc
2) FMSL = Feet above mean sea level.

Historical DWR Groundwater Elevation Maps, Unconfined Aquifer
Tulare Lake Subbasin Hydrologic Model
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.2.2-2**

Date: 11/15/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-27_RecentGroundwaterConditions_2005_2010_2016.mxd



Explanation

Subbasin boundary

Aquifer Zone

- Confined
- MultiZone
- Nested
- Unconfined
- Unknown

Wells with Long term Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan

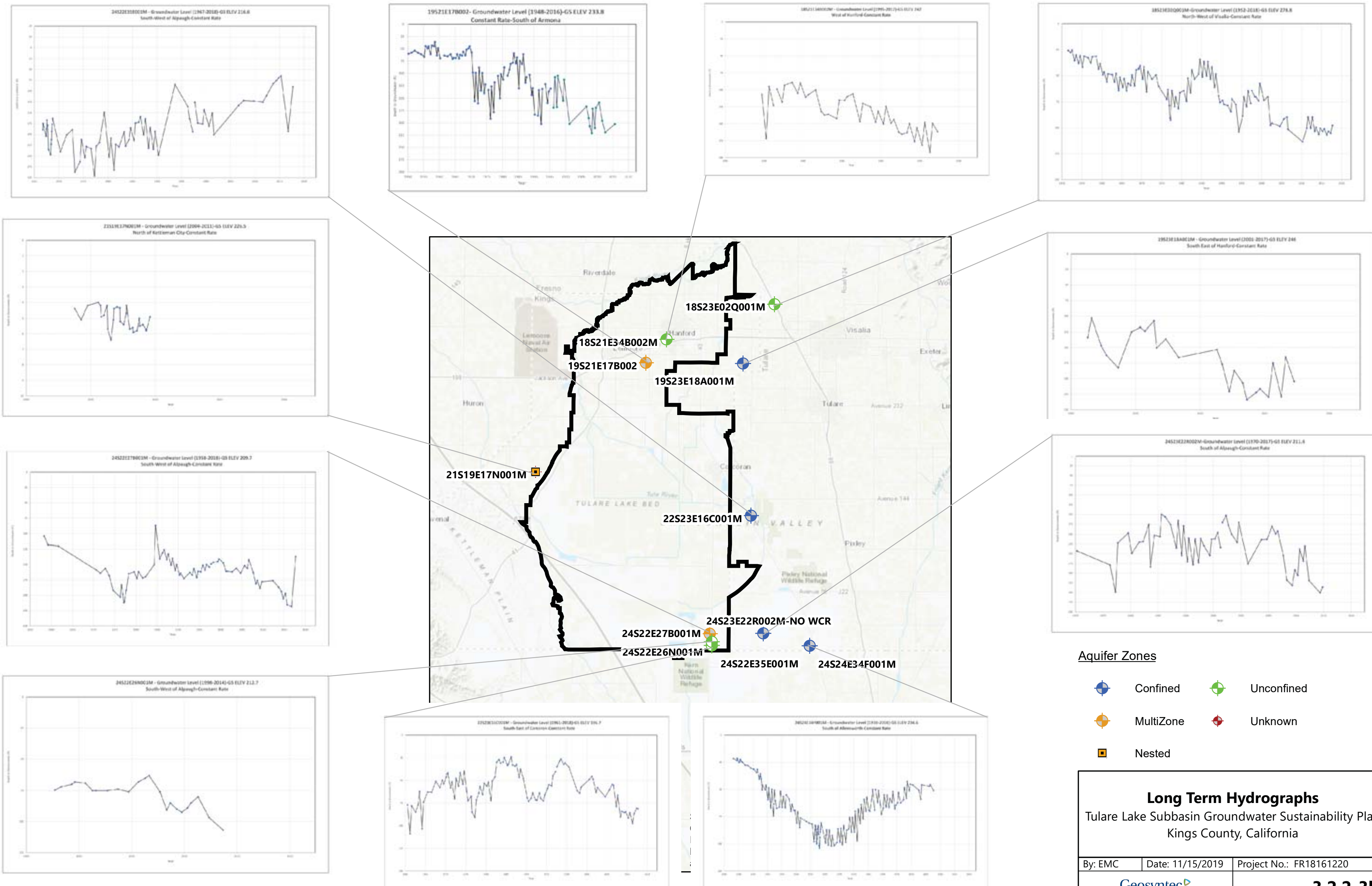
Kings County, California

By: EMC	Date: 11/26/2019	Project No.: FR18161220

Geosyntec consultants

Figure **3.2.2-3a**

Date: 11/26/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting\8.5x11_fig3-28a_WellswithLongtermHydrographs.mxd



Long Term Hydrographs
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.2.2-3b**

Date: 11/15/2019 Printed by: shaina.price
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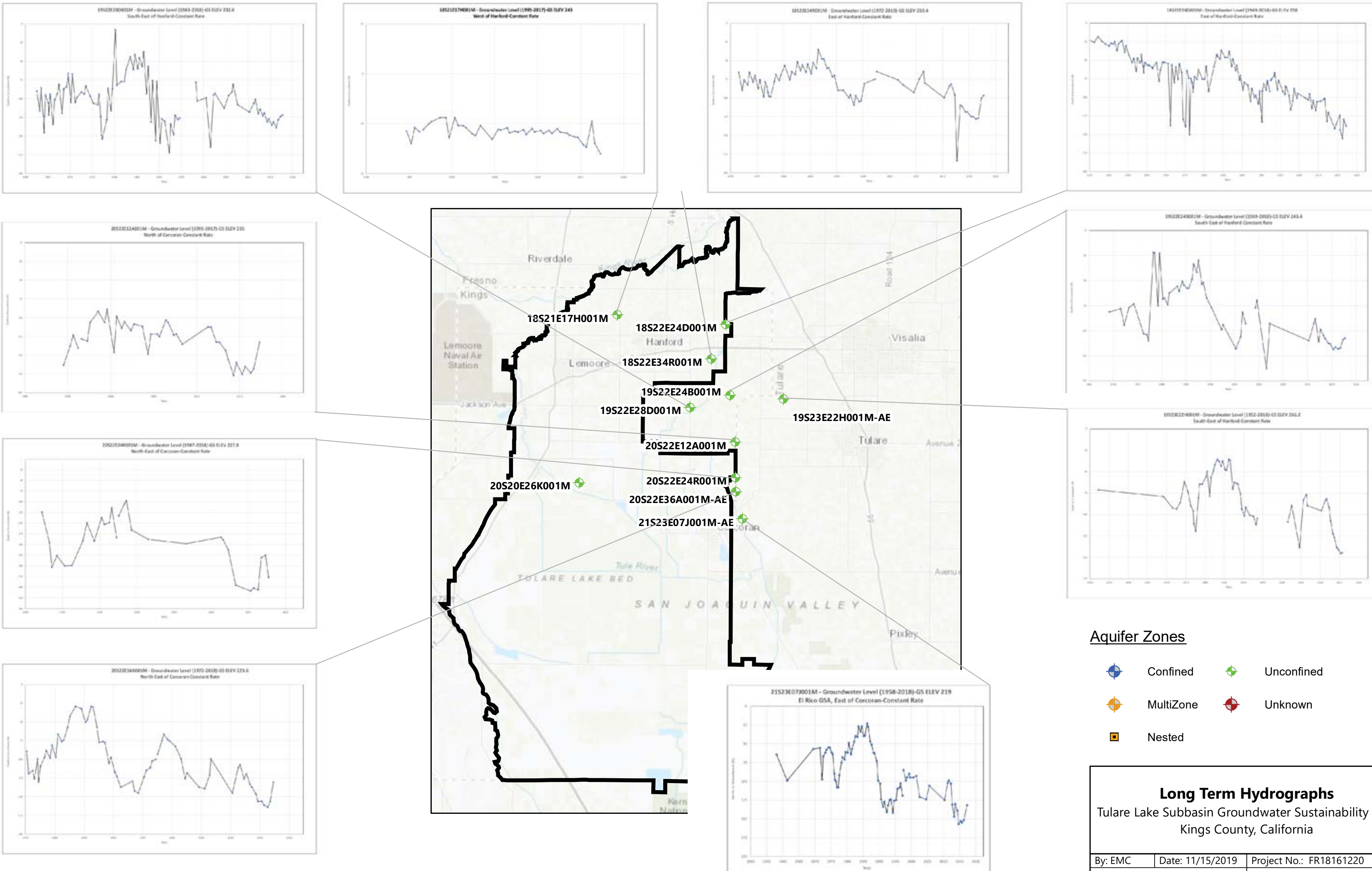


Aquifer Zones

Confined   Unconfined

MultiZone   Unknown

Nested

Long Term Hydrographs

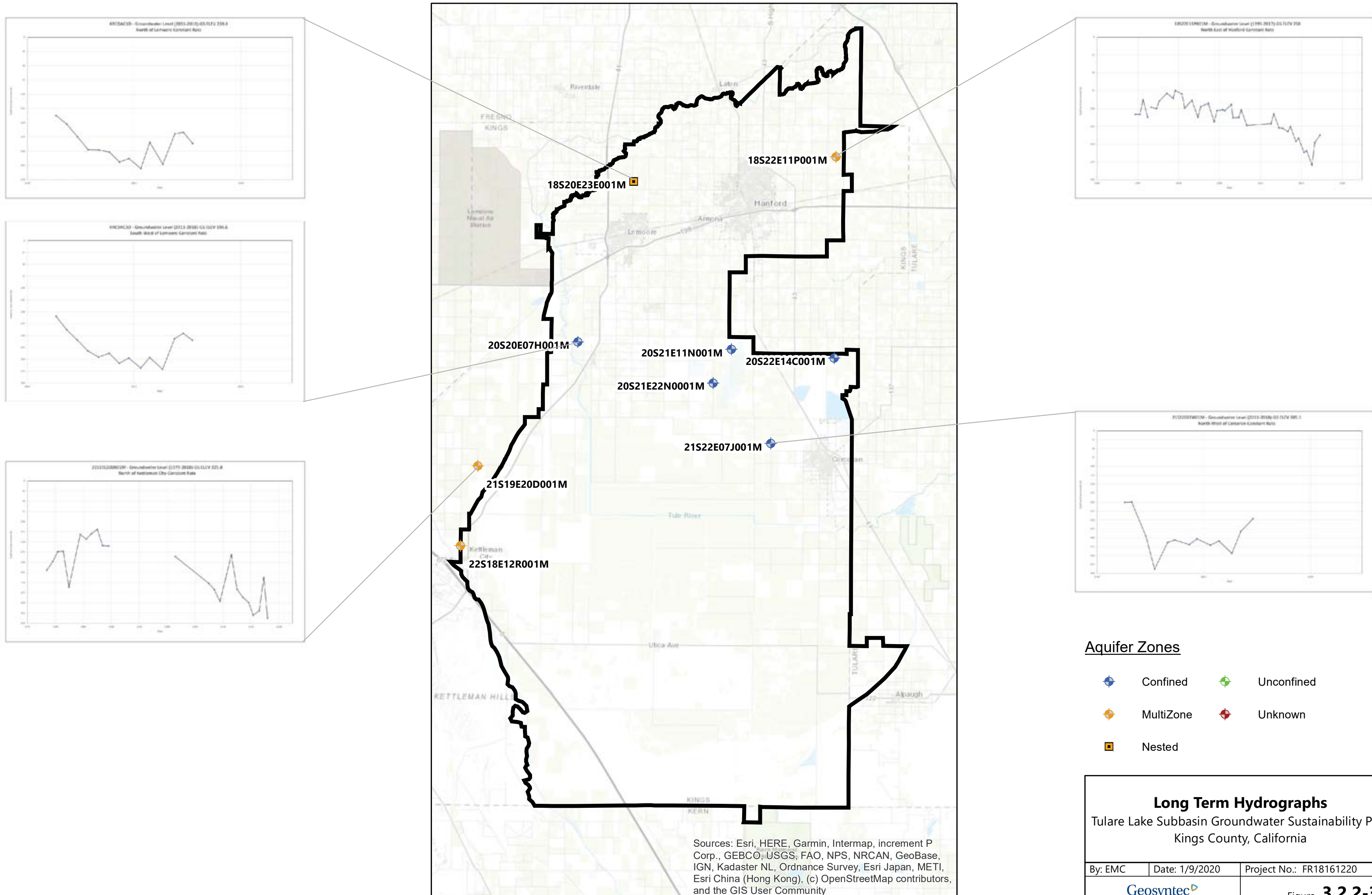
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/15/2019	Project No.: FR18161220

Geosyntec consultants

Figure **3.2.2-3c**

Date: 11/15/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-28C_UnconfinedAquiferZoneHydrograph.mxd



Long Term Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

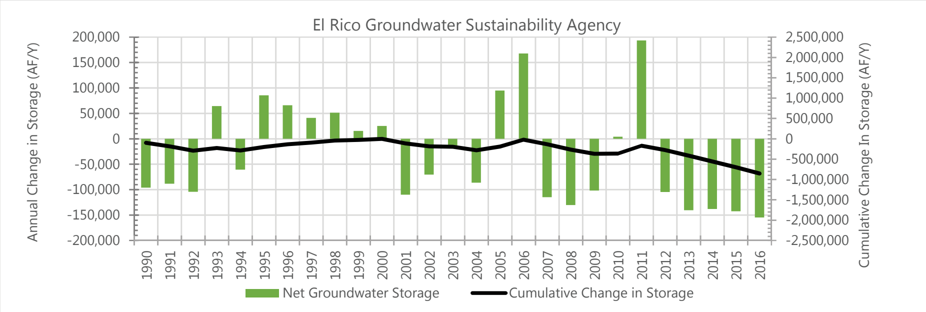
By: EMC | Date: 1/9/2020 | Project No.: FR18161220

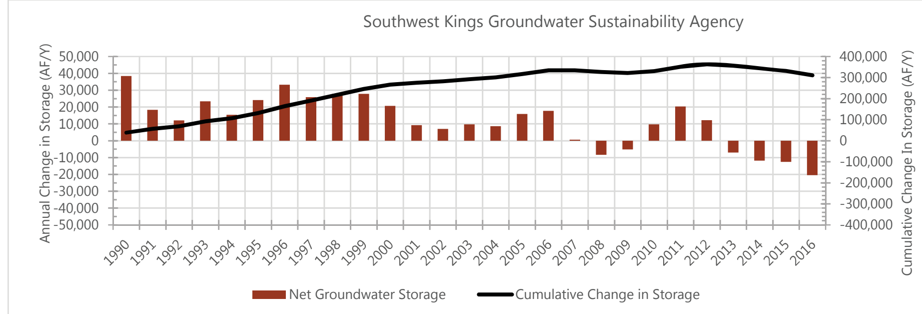
Geosyntec consultants

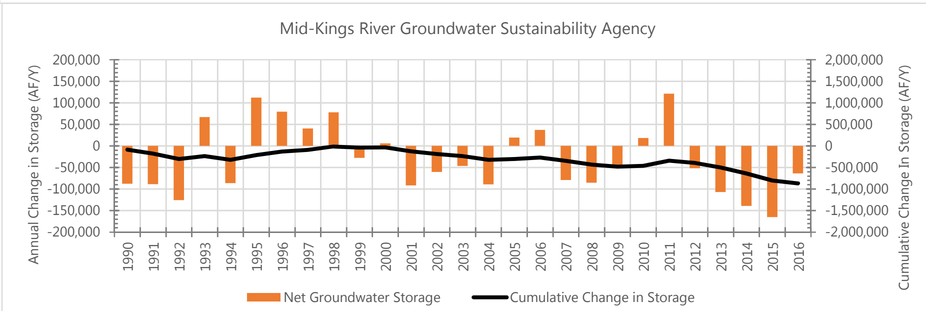
Figure **3.2.2-3d**

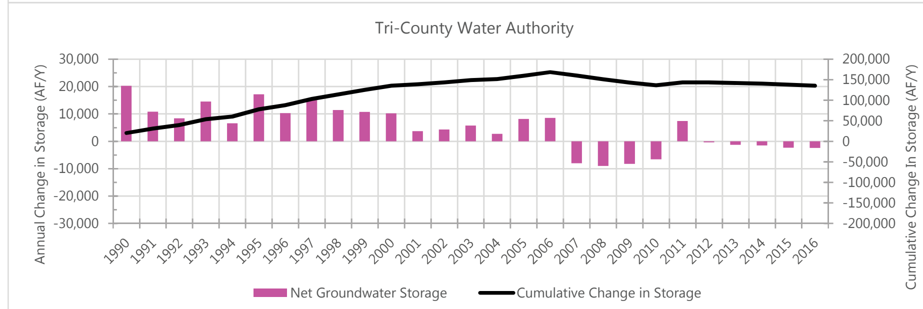
Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-28D_ConfinedAquiferZoneHydrograph.mxd

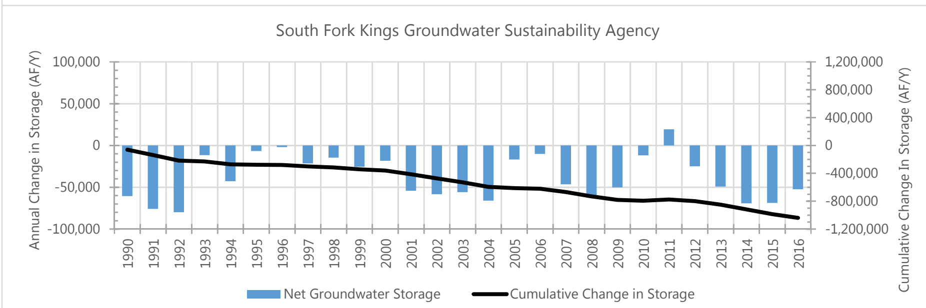
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-29_3-53_120619.xlsmFigure 3-29a 1/8/2020

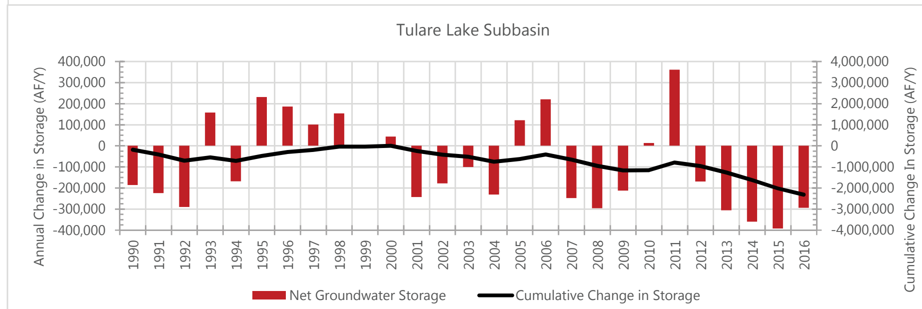










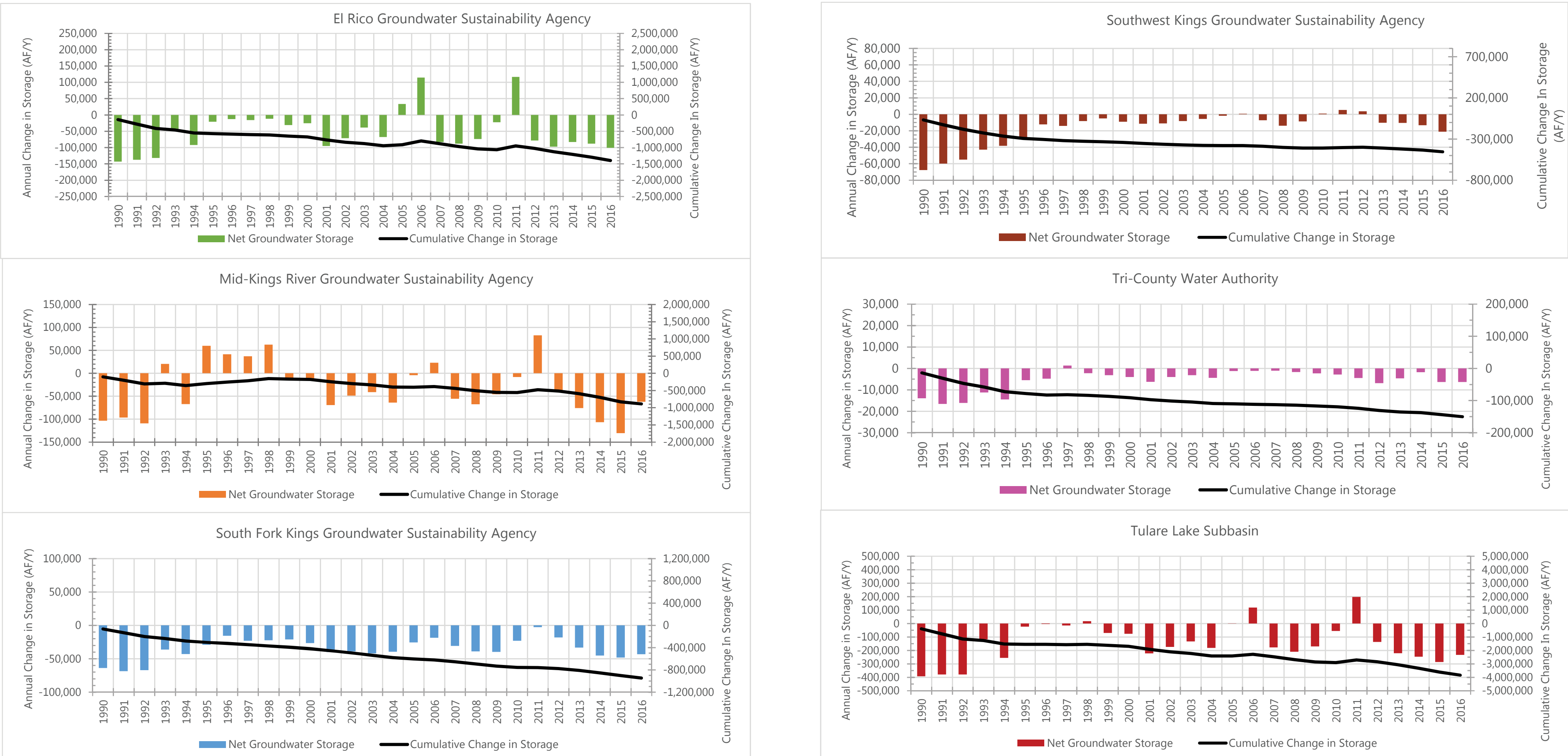


Notes:
1. AF/Y = acre-feet per year

Change in Groundwater Storage
All Aquifer Zones 1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.2.4-1a**

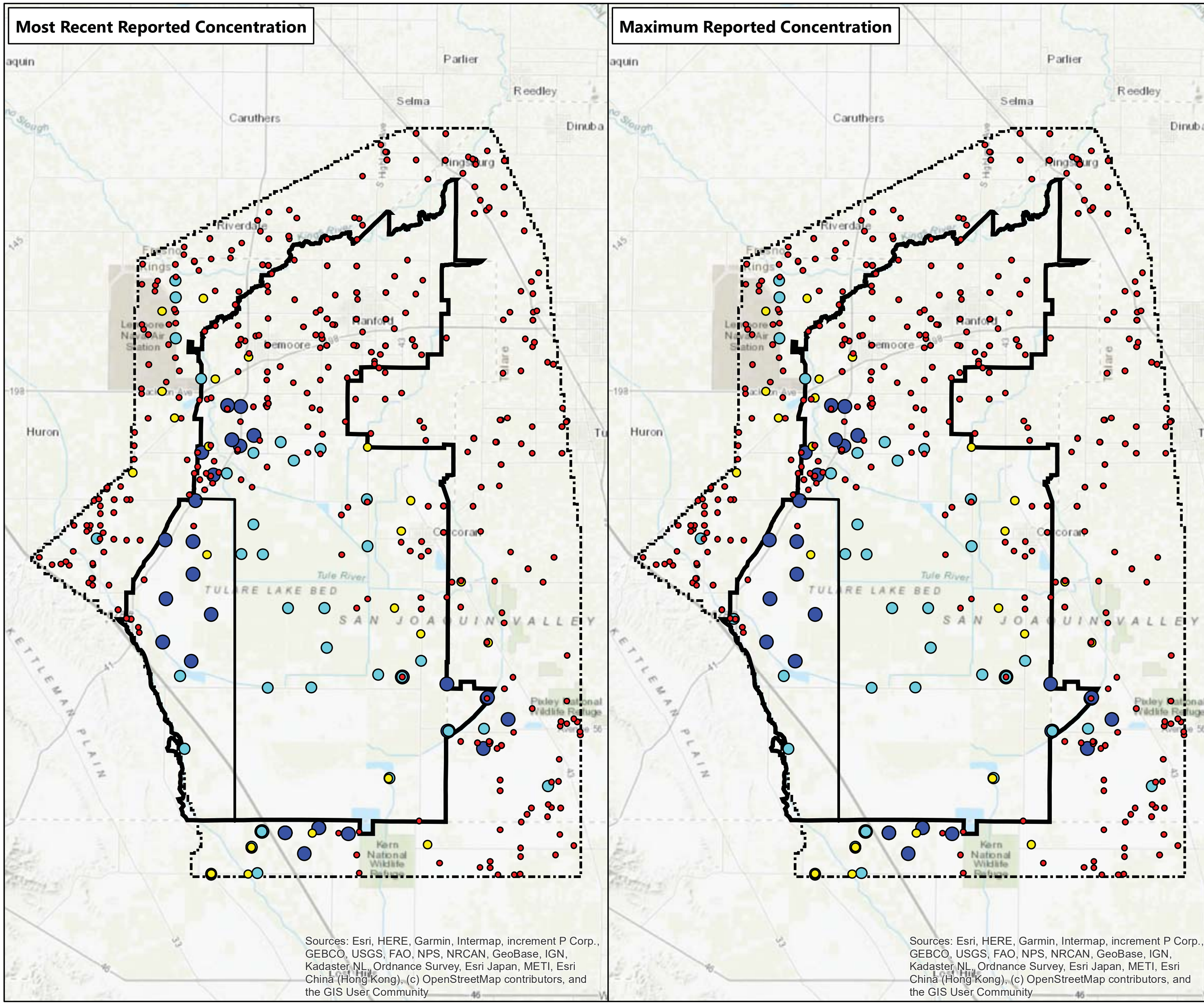
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-29_3-53_120619.xlsmFigure 3-29b 1/8/2020



Notes:
1. AF/Y = acre-feet per year

Change in Groundwater Storage
Upper Aquifer Zone 1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.2.4-1b**



Explanation

- <1,500 mg/L
- 1,500 - 3,000 mg/L
- 3,000 - 10,000 mg/L
- >10,000 mg/L
- Study Area
- Subbasin boundary

Notes:
1) Data compiled from California Water Boards Geotracker. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

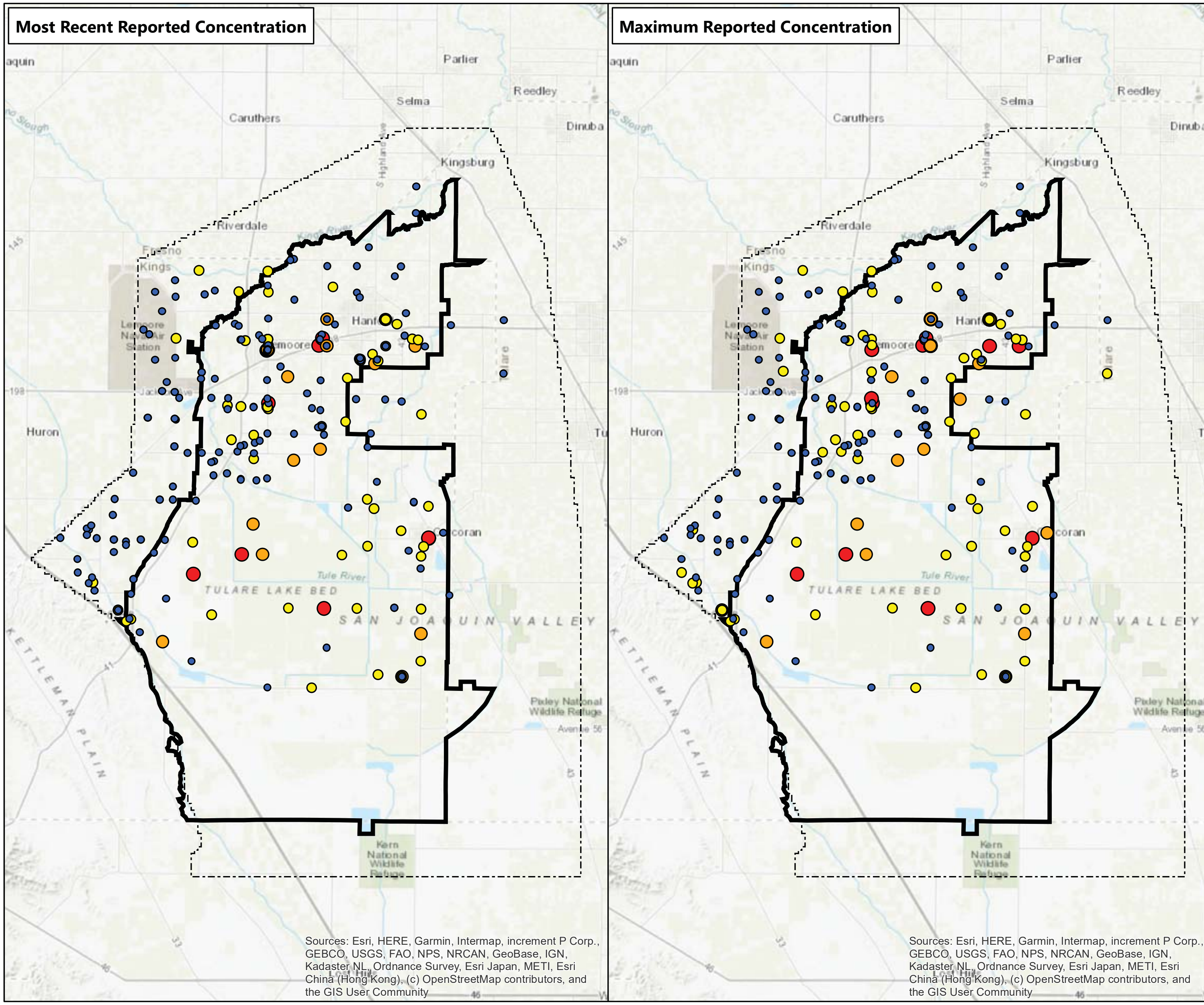
Approximate Scale in Miles: 0 5 10 20

Approximate Scale in Kilometers: 0 5 10 20

Total Dissolved Solids in Groundwater
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 1/9/2020	Project No.: FR16181220
Geosyntec consultants		Figure **3.2.5-1**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-30_Total_Dissolved_Solids_NEW.mxd



Explanation

- <10 µg/L
- 10.01 - 50.0 µg/L
- 50.1 - 100.0 µg/L
- >100 µg/L
- Study Area
- Subbasin boundary

Notes:
1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

N

Approximate Scale in Miles: 0, 5, 10, 20

Approximate Scale in Kilometers: 0, 5, 10, 20

Arsenic in Groundwater

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 1/9/2020	Project No.: FR16181220

Geosyntec consultants

Figure **3.2.5-2**

Date: 1/9/2020 Printed by: elizabeth.chapman
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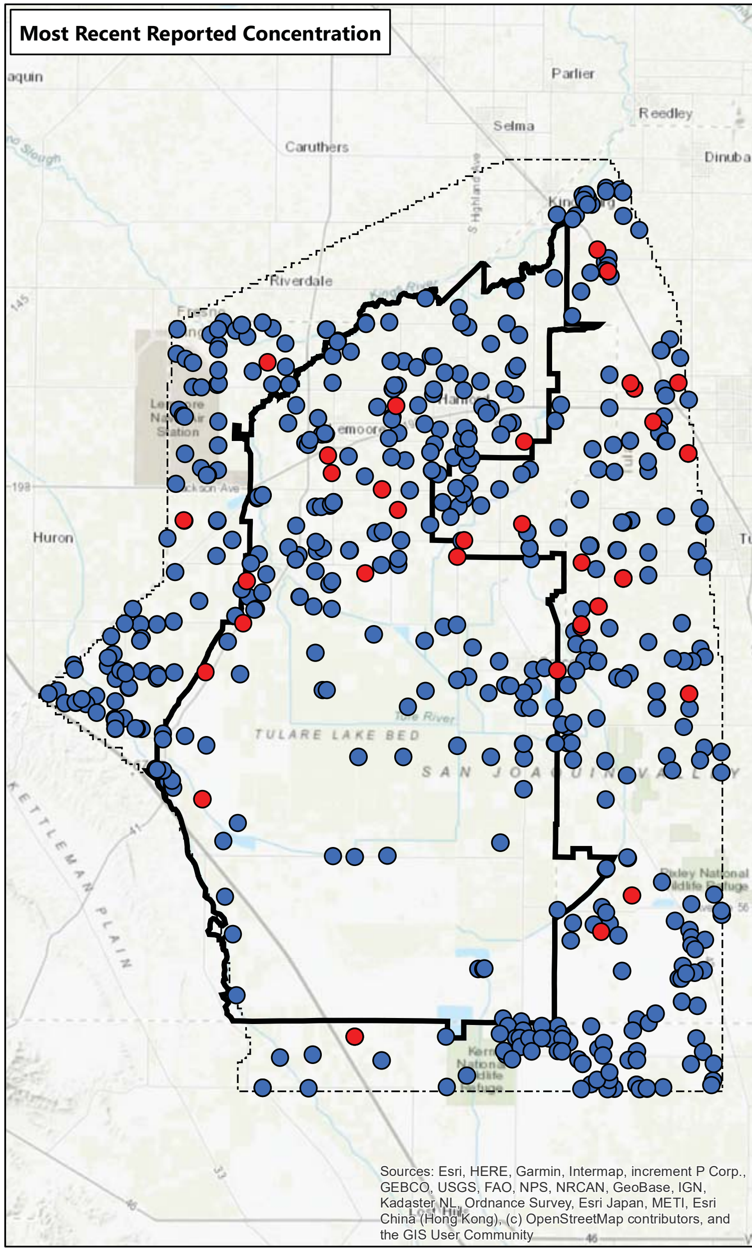

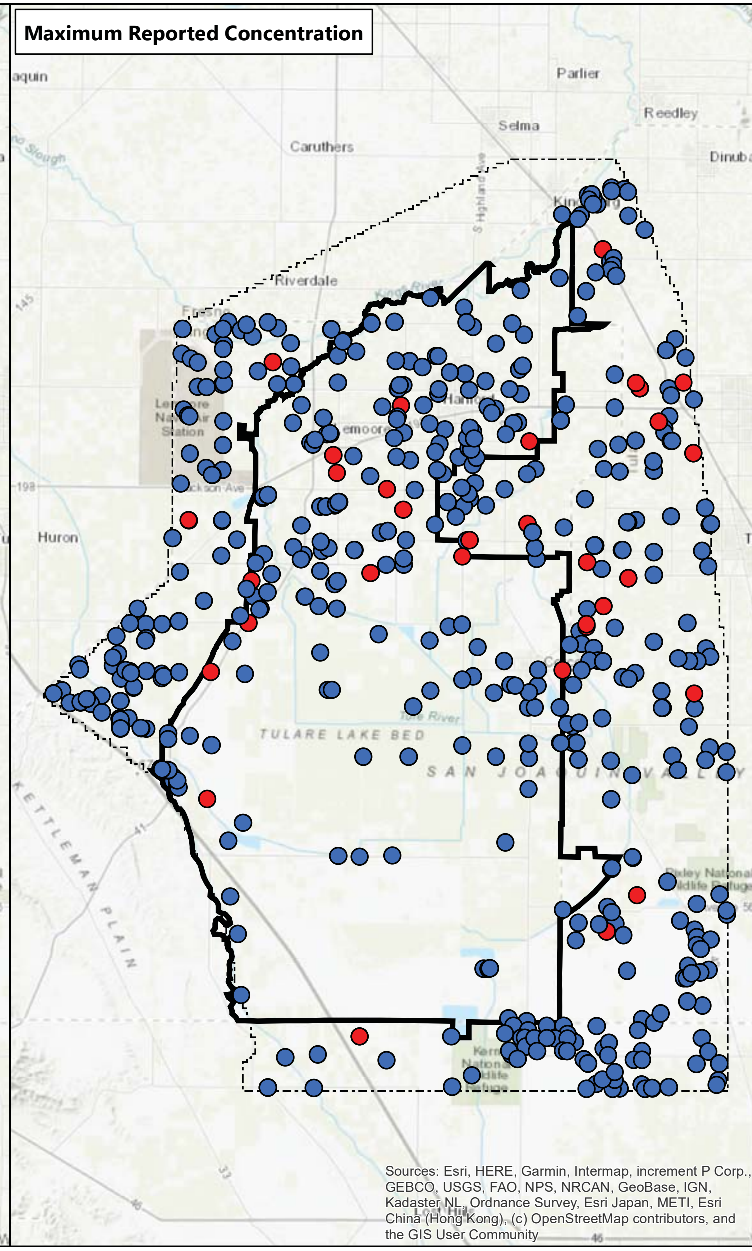

Explanation

- <10 mg/L
- >10 mg/L
- Study Area
- Subbasin boundary

Notes:

1) Data compiled from California Water Boards. November 2018: https://gamagroundwater. waterboards.ca.gov/gama/gamamap/public/Default.asp

Approximate Scale in Miles: 0, 5, 10, 20

Approximate Scale in Kilometers: 0, 5, 10, 20

Nitrate in Groundwater

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 1/9/2020	Project No.: FR16181220
Geosyntec consultants		Figure **3.2.5-3**

Date: 1/9/2020 Printed by: elizabeth.chapman
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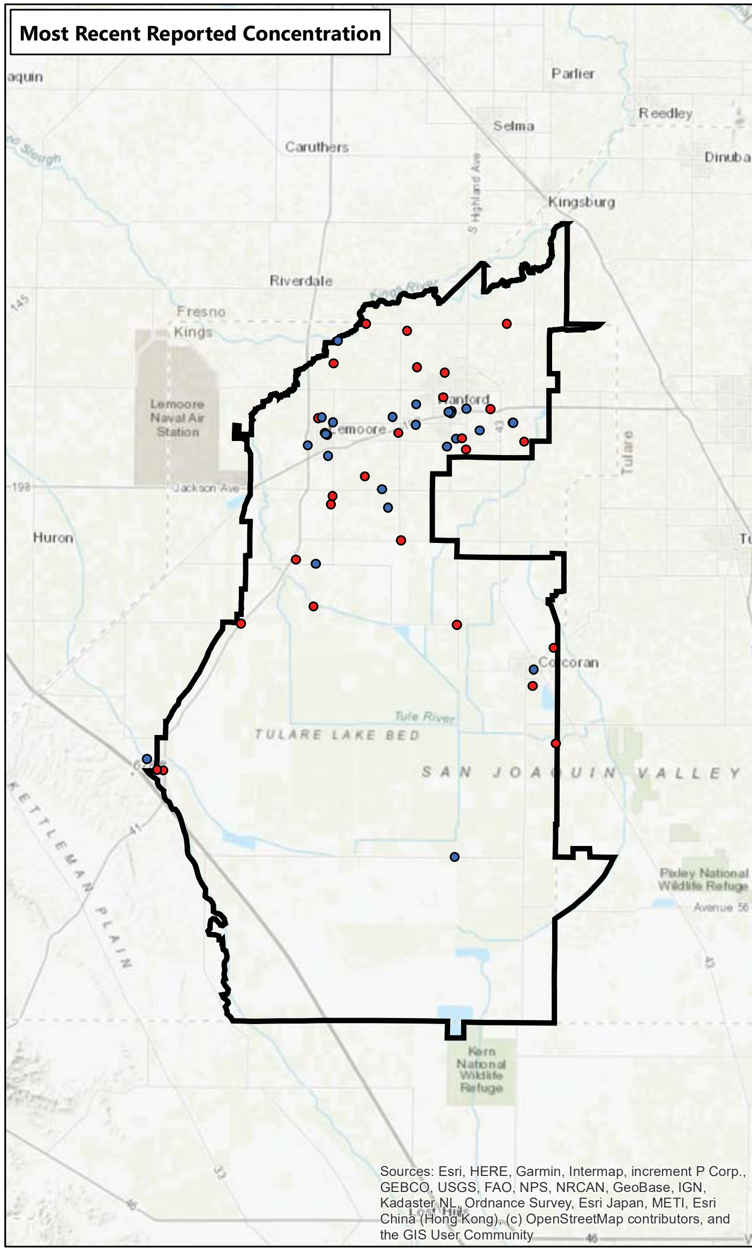
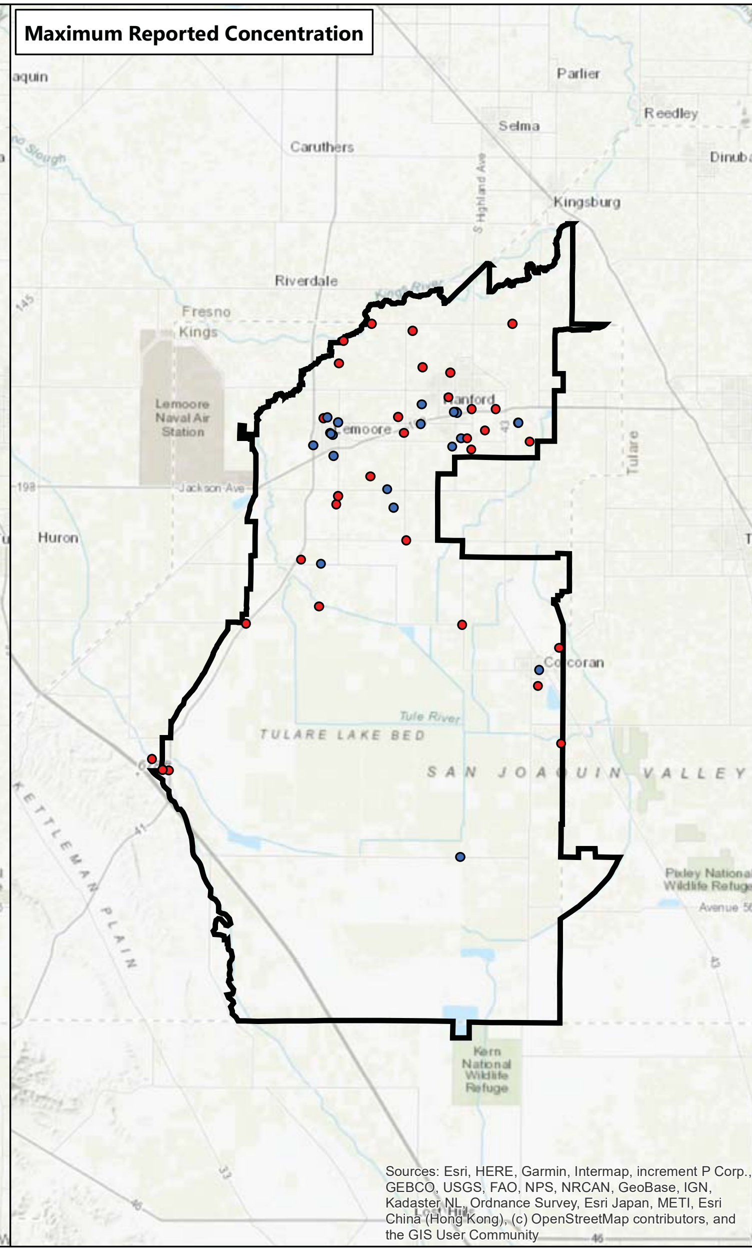




Explanation

1,2,3-TCP

<0.005

>0.005

Subbasin boundary

Notes:
1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

Approximate Scale in Miles: 0, 5, 10, 20

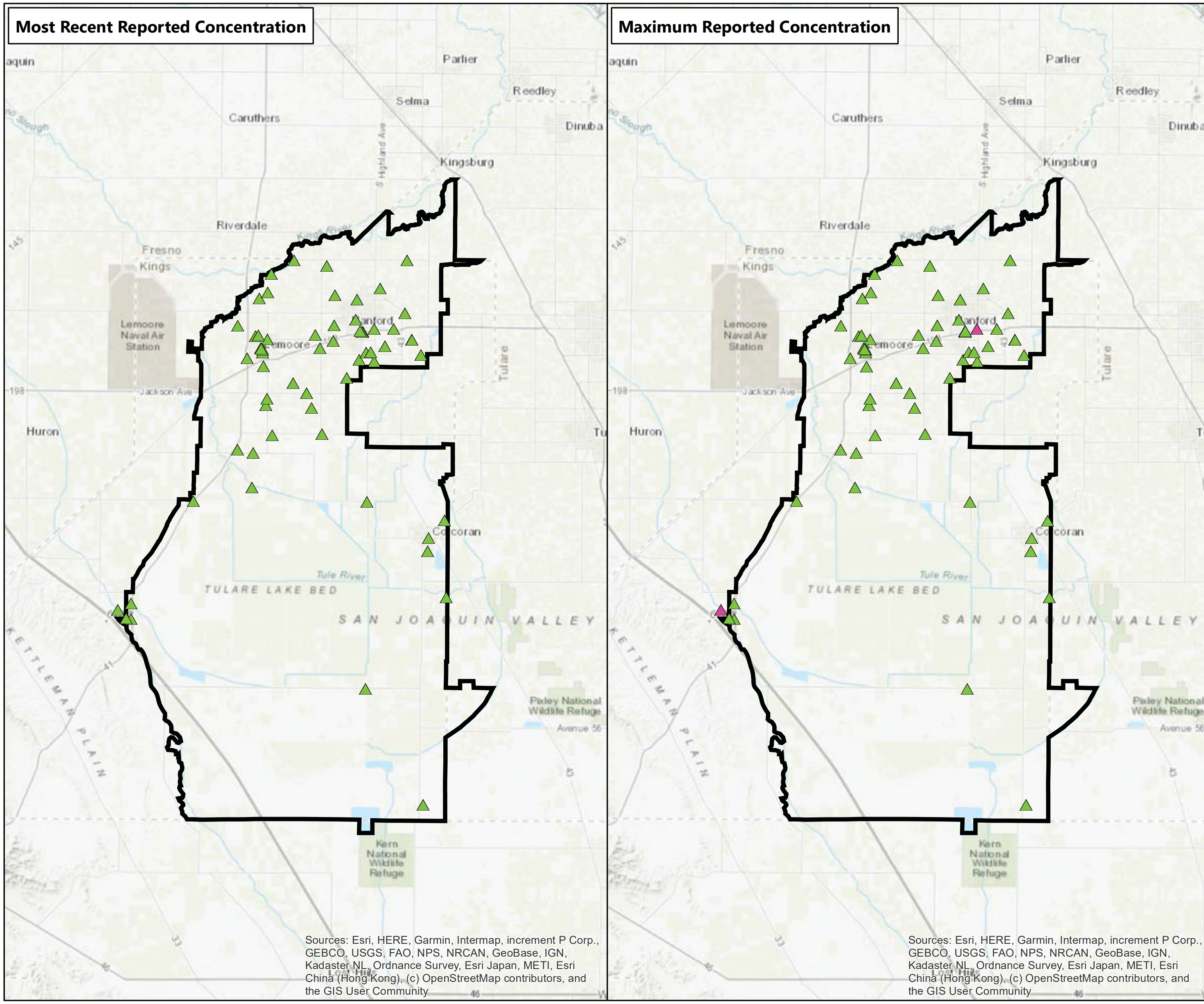
Approximate Scale in Kilometers: 0, 5, 10, 20

Volatile Organic Compounds in Groundwater

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 1/9/2020	Project No.: FR16181220
Geosyntec consultants		Figure **3.2.5-4a**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-33_VOCs_in_Groundwater_NEW.mxd



Explanation

DBCP

- <0.20 µg/L
- >0.21 µg/L
- Subbasin boundary

Notes:

1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

Approximate Scale in Miles: 0, 5, 10, 20

Approximate Scale in Kilometers: 0, 5, 10, 20

Volatile Organic Compounds in Groundwater

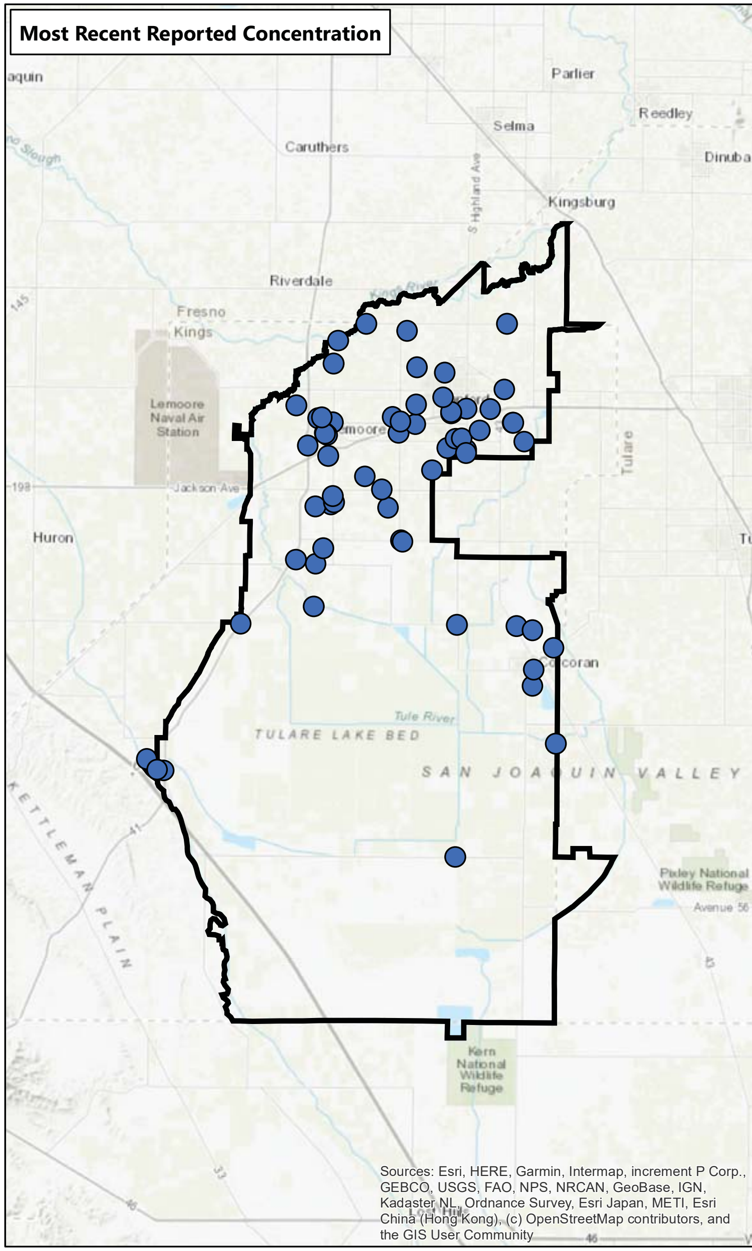
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

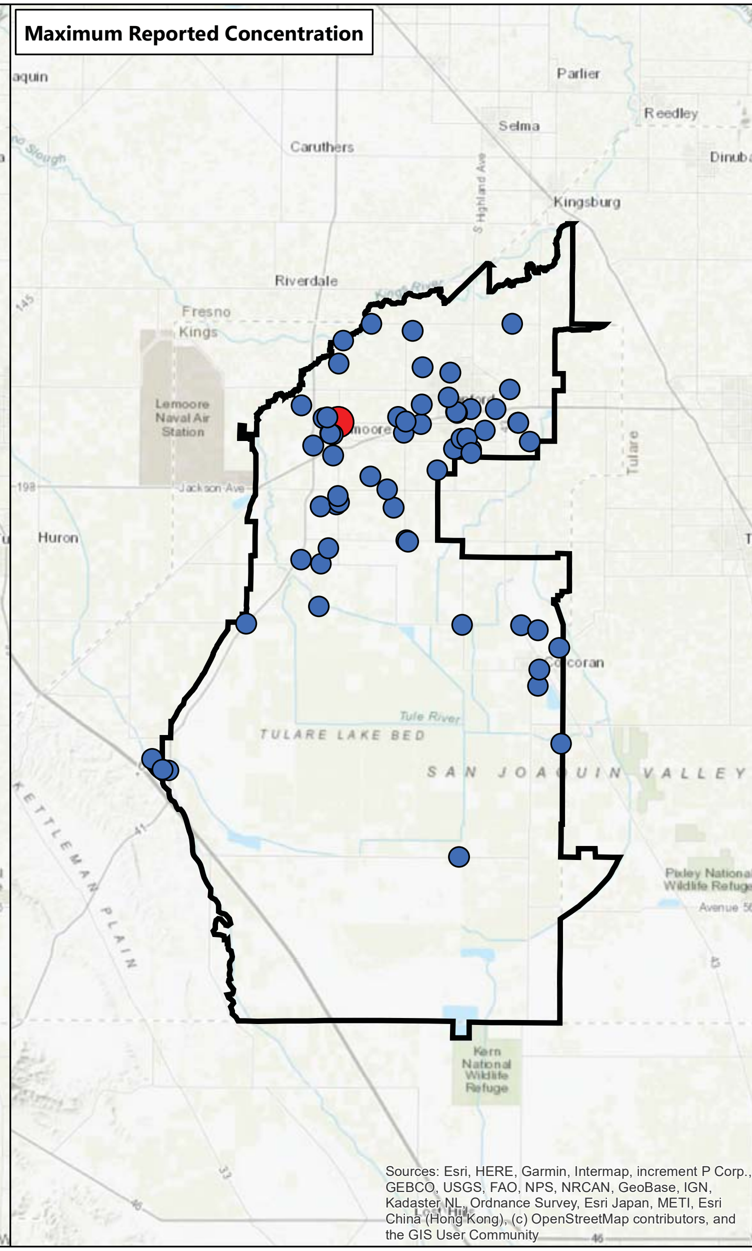
By: SCM	Date: 1/9/2020	Project No.: FR16181220

Geosyntec consultants

Figure **3.2.5-4b**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-33b_VOCs_in_Groundwater_DBCP.mxd





Explanation

TCE

<5.00 µg/L

>5.01 µg/L

Subbasin boundary

Notes:
1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

Approximate Scale in Miles: 0, 5, 10, 20
Approximate Scale in Kilometers: 0, 5, 10, 20

Volatile Organic Compounds in Groundwater

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM | Date: 1/9/2020 | Project No.: FR16181220

Geosyntec consultants

Figure **3.2.5-4c**

Date: 1/9/2020 Printed by: elizabeth.chapman
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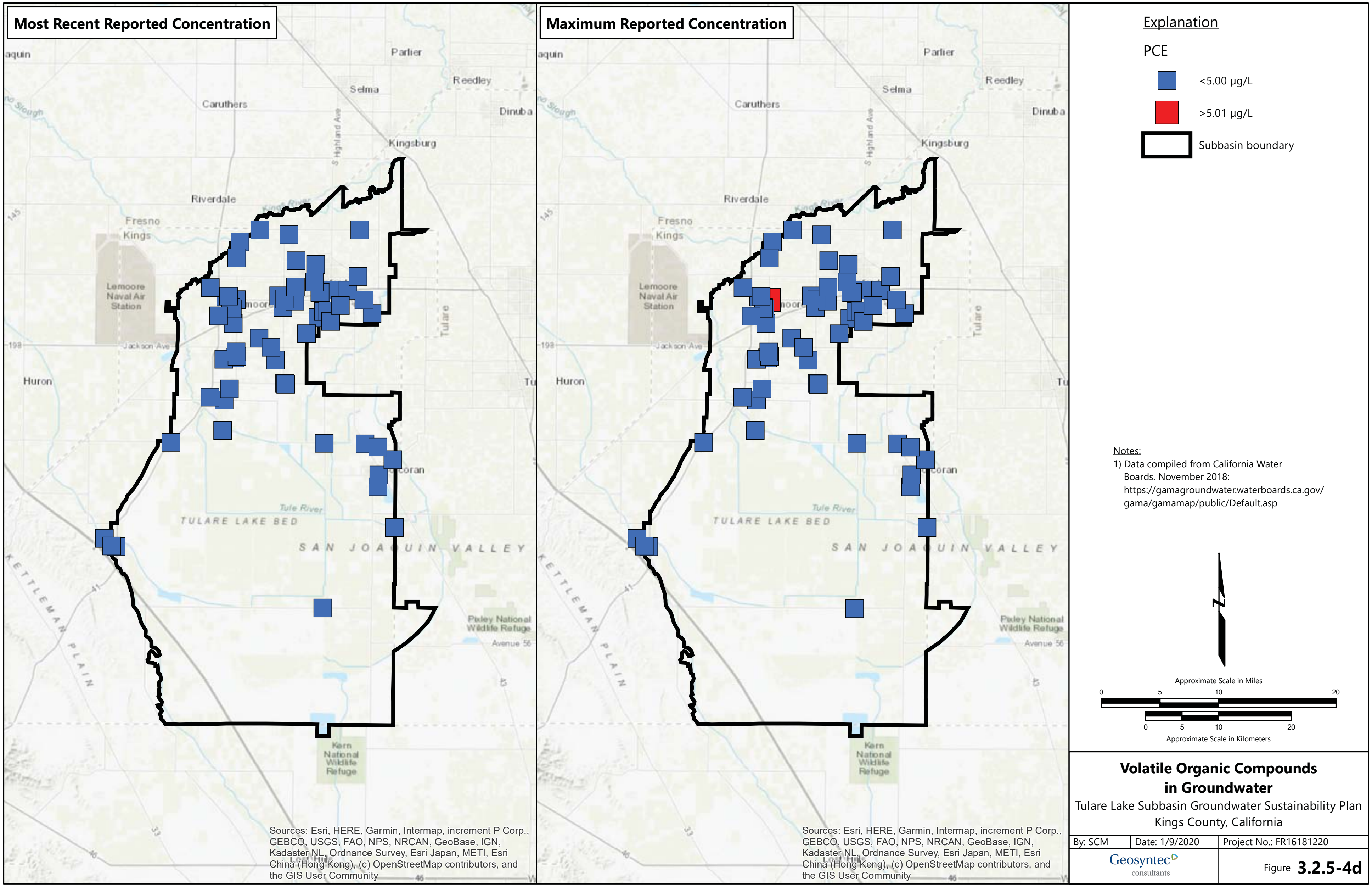


Notes:
1) Data compiled from California Water Boards. November 2018: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp

Volatile Organic Compounds in Groundwater

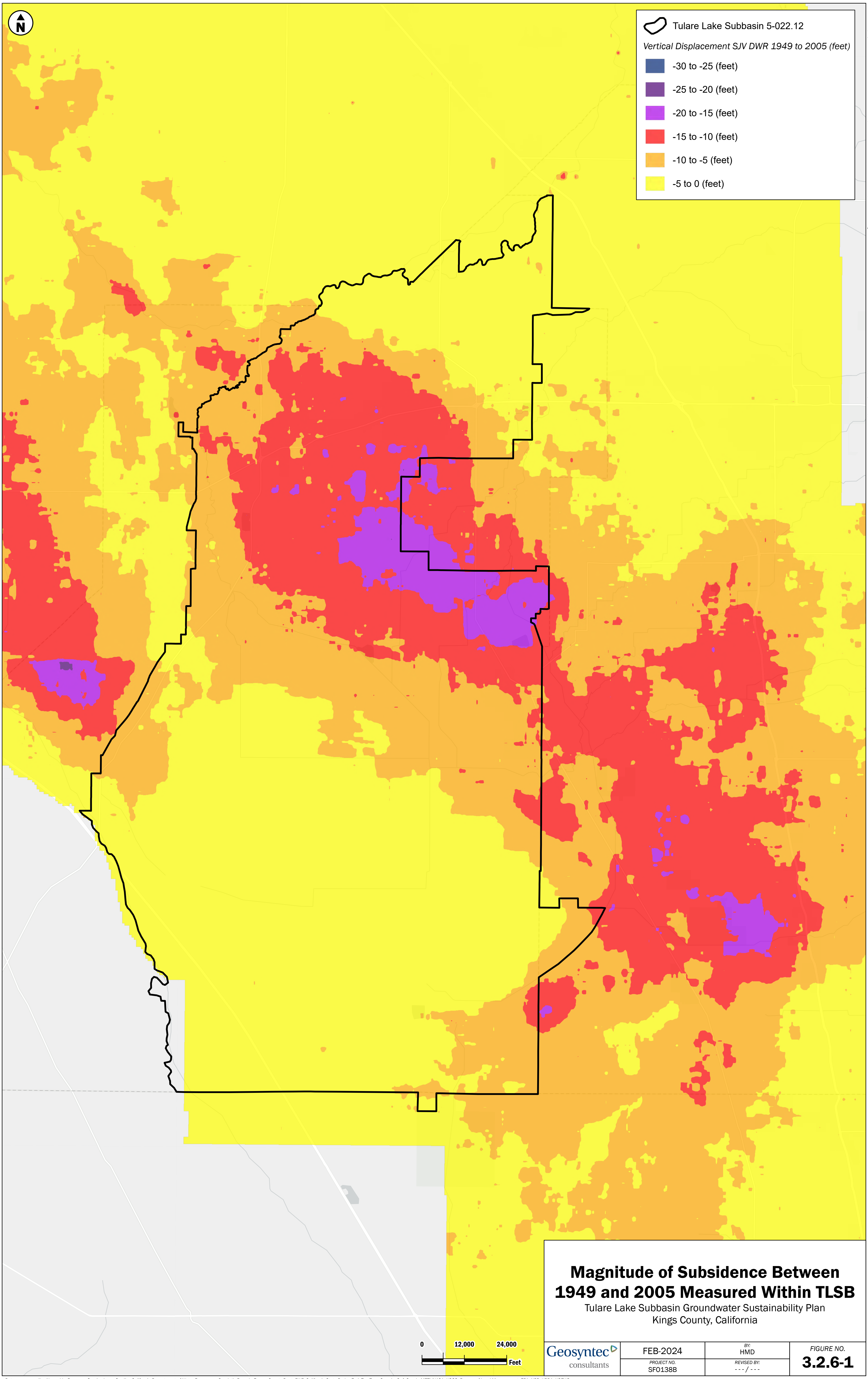
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: SCM	Date: 1/9/2020	Project No.: FR16181220

Geosyntec consultants

Figure **3.2.5-4d**

Date: 1/9/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-33d_VOCs_in_Groundwater_PCE.mxd



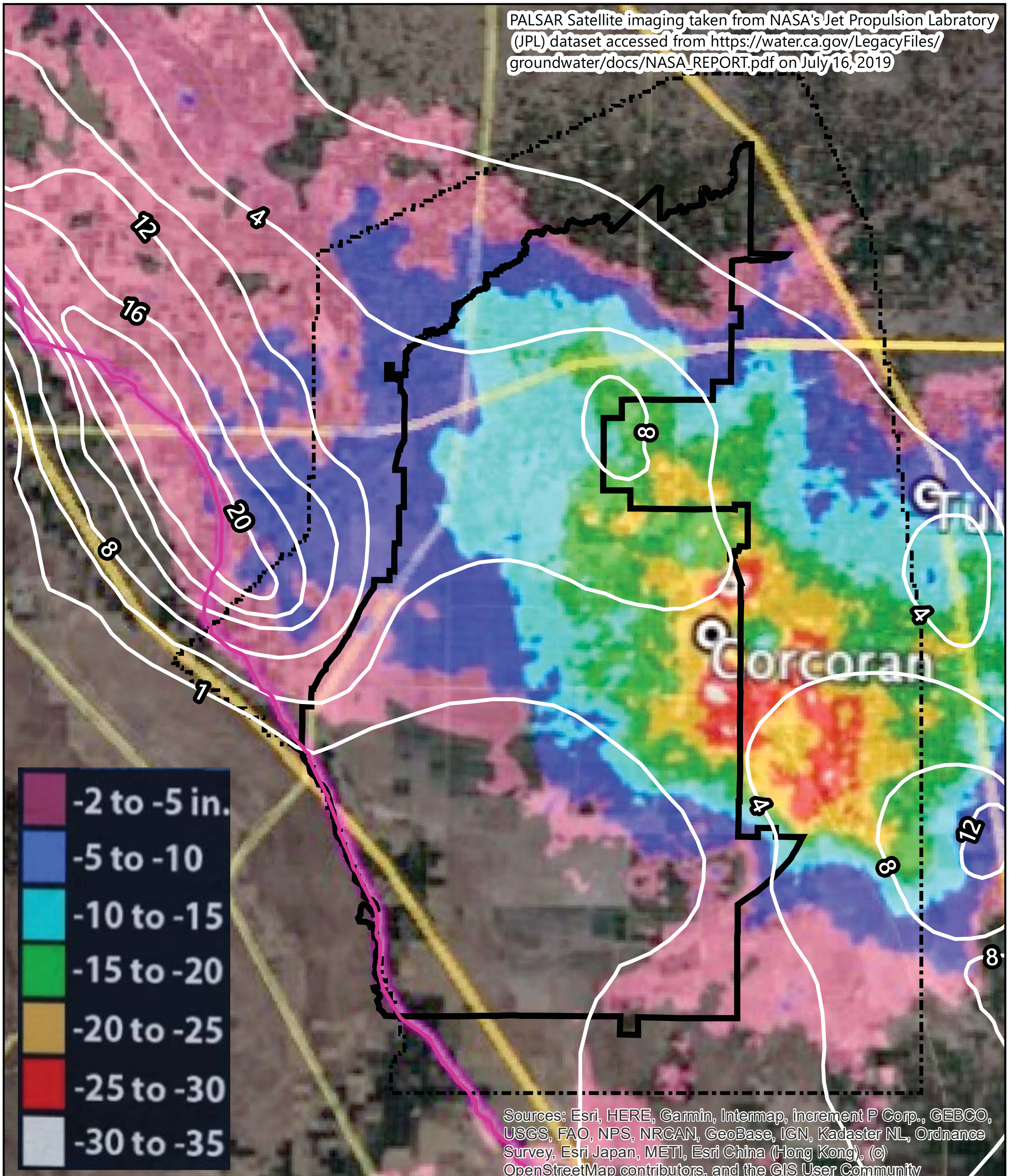
Magnitude of Subsidence Between 1949 and 2005 Measured Within TLSB

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO. 3.2.6-1
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	

Data source credits: None || Basemap Service Layer Credits: California Department of Water Resources, Geodetic Branch, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



Explanation

Study Area

Subbasin boundary

Edmund G. Brown California Aqueduct

White line shows historical subsidence data from 1926-1970 (ft.)

Miles: 0 2 4 8

Kilometers: 0 2.5 5 10

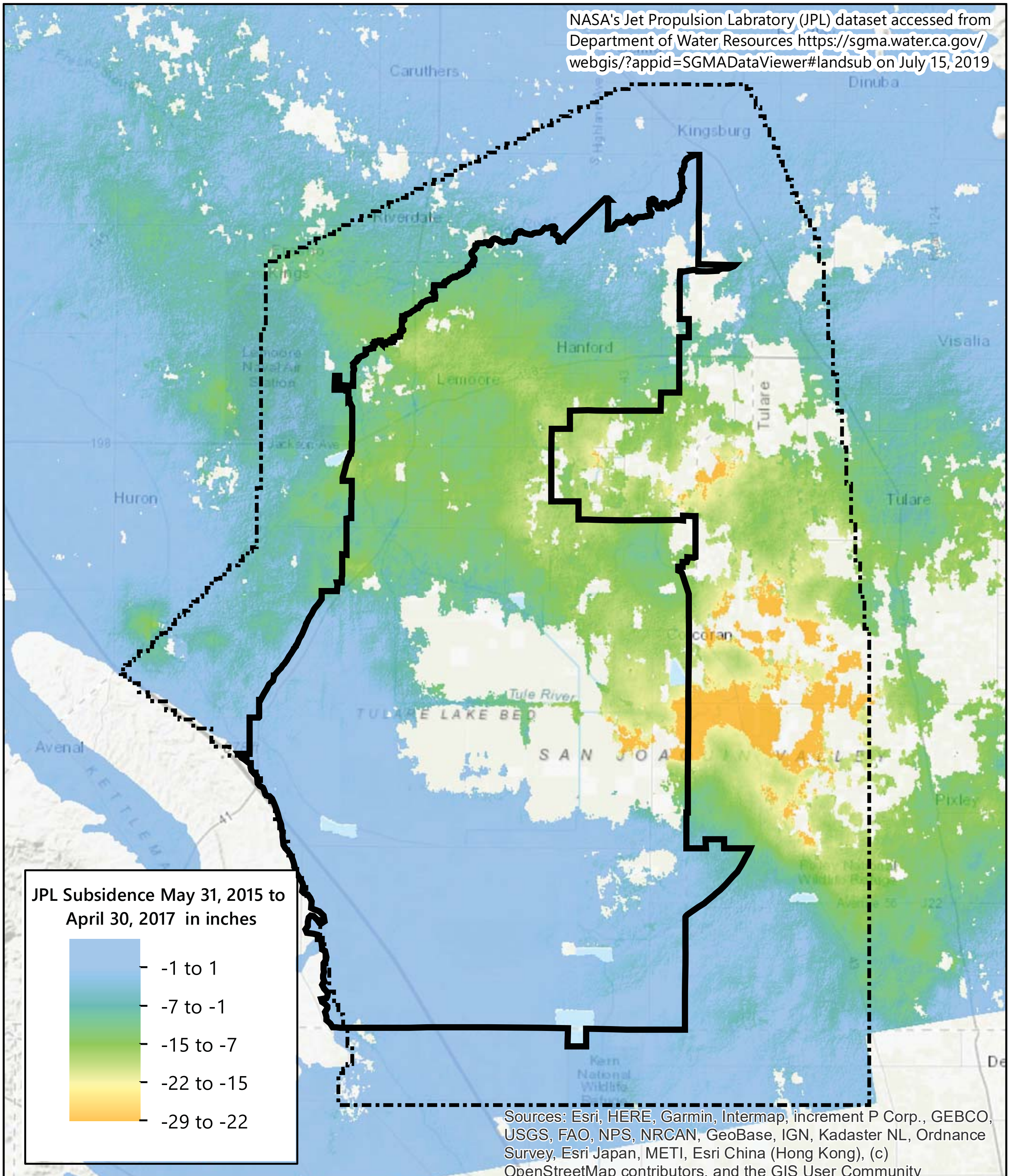
N

Subsidence in the Tulare Lake Subbasin 2007 to 2010

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/7/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.2.6-2a**

Date: 11/7/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting\8.5x11_fig3-35a_Subsidence2007-2010_8x11.mxd



Explanation

Study Area

Subbasin boundary

Miles
0 2 4 8
0 2.5 5 10
Kilometers

N

Subsidence in the Tulare Lake Subbasin 2015 to 2017

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/7/2019	Project No.: FR18161220
Geosyntec consultants		Figure **3.2.6-2b**

Date: 11/7/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting\8.5x11_fig3-35b_Subsidence2015-2017_8x11.mxd

Note:
Adapted from "map of the San Joaquin, Sacramento and Tulare Valleys State of California. Prepared under the direction of the board of commissioners on irrigation 1873"

0 42,000 84,000 Feet

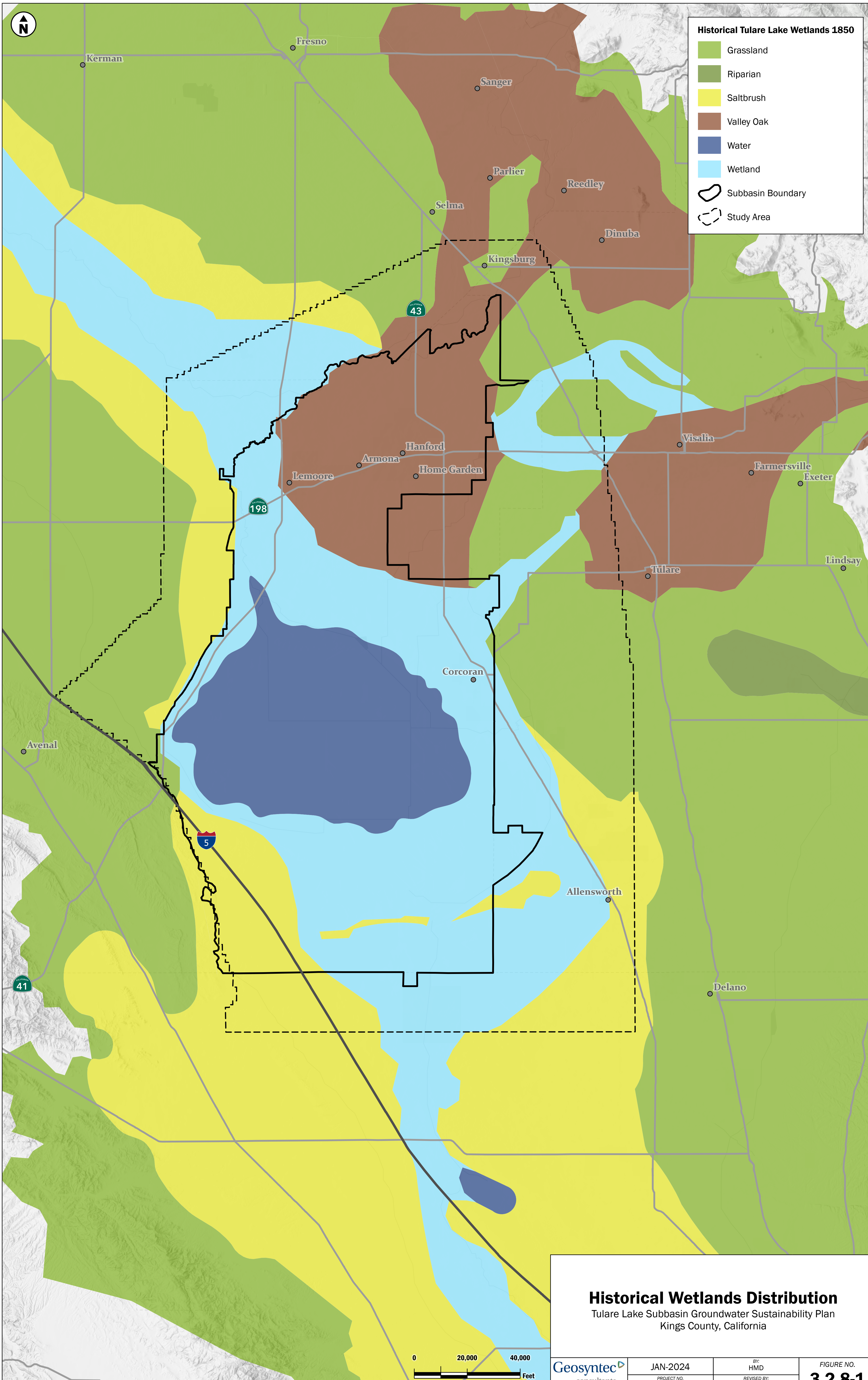
Historic Drainage System Tulare Lake Basin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.2.7-1

Data source credits: None || Basemap Service Layer Credits: NA

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx 3.2.7-1 Historical Drainage System || User: haley.duran || Print Date: 3/12/2024

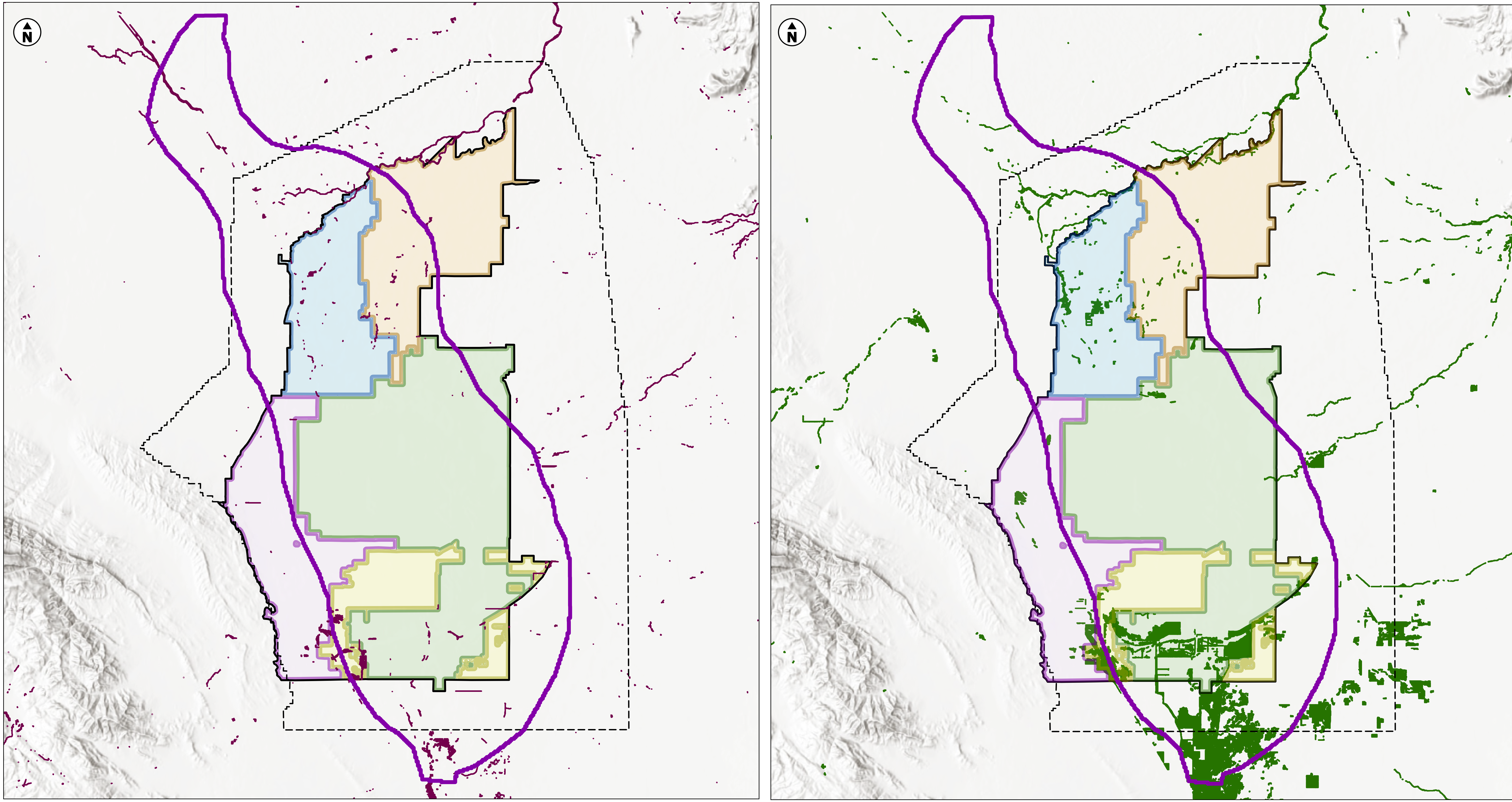


Historical Wetlands Distribution

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3.2.8-1

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



California Natural Resources Agency phreatophyte vegetation

California Natural Resources Agency Wetlands

Extent of A-Clay

Subbasin Boundary

Study Area

Groundwater Sustainability Agency (GSA)

El Rico GSA

Mid-Kings River GSA

South Fork Kings GSA

Southwest Kings GSA

Tri-County Water Authority GSA - Tulare Lake

0 26,000 52,000 Feet

Note:
- Hydrologic region dataset obtained from California Department of Water Resources (CA DWR), October 12, 2023. https://data.ca.gov/dataset/hydrologic-regions

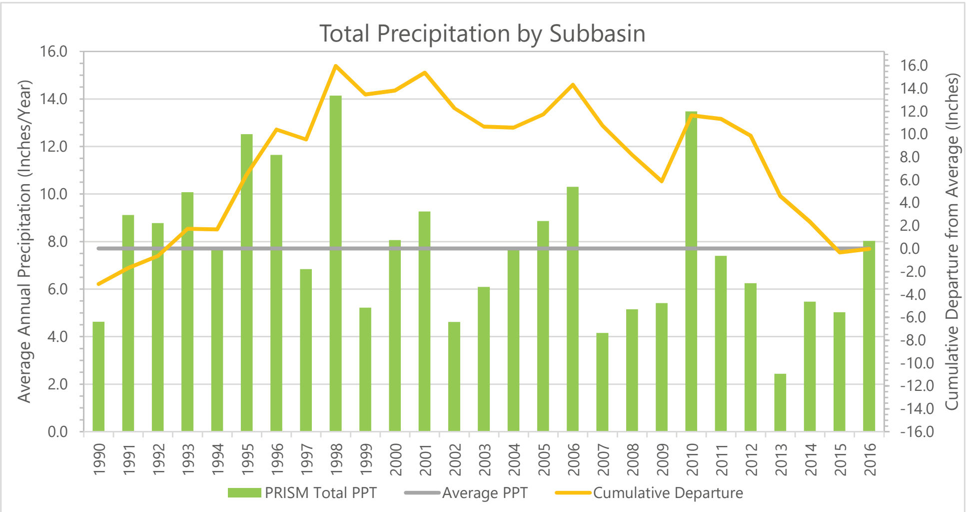
Distribution of Wetlands and Phreatophyte Vegetation

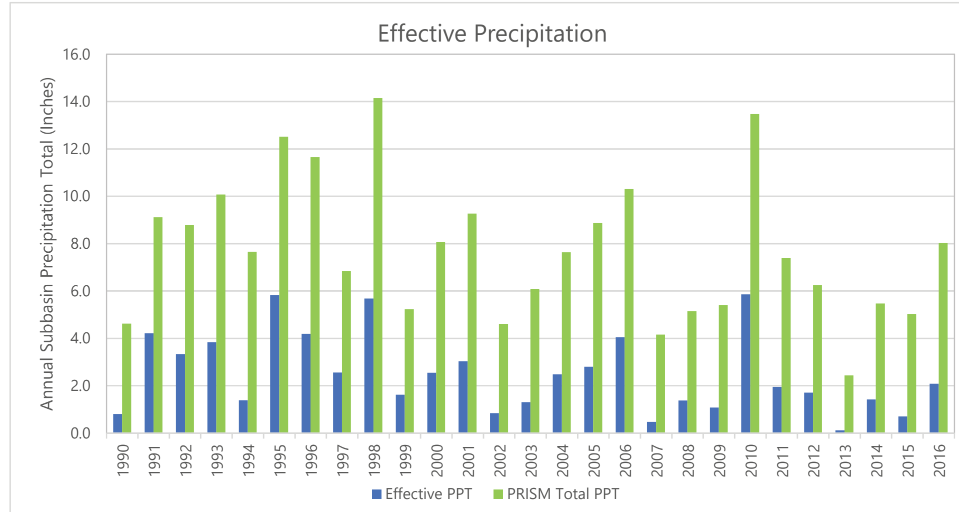
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

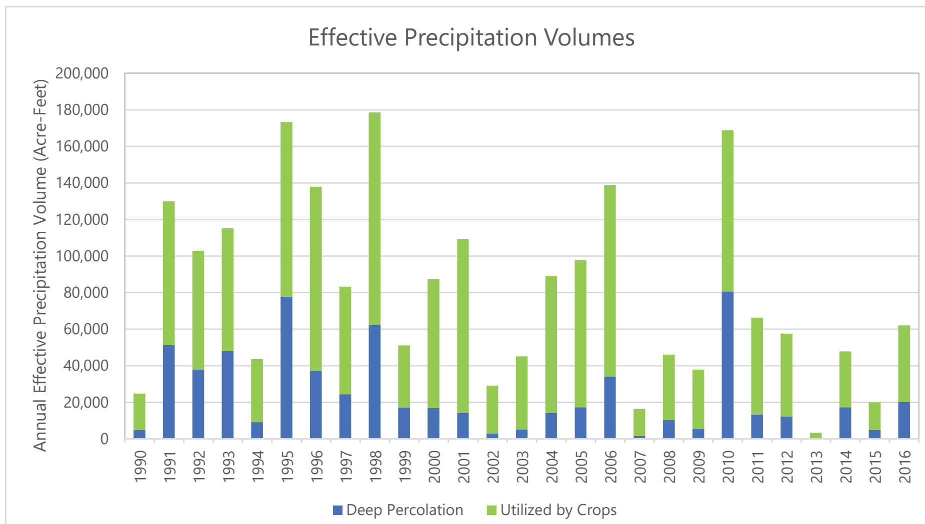
Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.2.8-2

Data source credits: None || Basemap Service Layer Credits: Esri, CGIAR, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-39_3-40_120619.xlsmFigure 3-39 12/9/2019







Notes:
1. PPT = precipitation
2. Climate data accessed from Parameter-elevation Regressions on Independent Slopes Model (PRISM) Climate group.. http://www.prism.oregonstate.edu/ Accessed November 2018

Annual Precipitation, Effective Precipitation, and Effective Precipitation Volumes
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.3.1-1**

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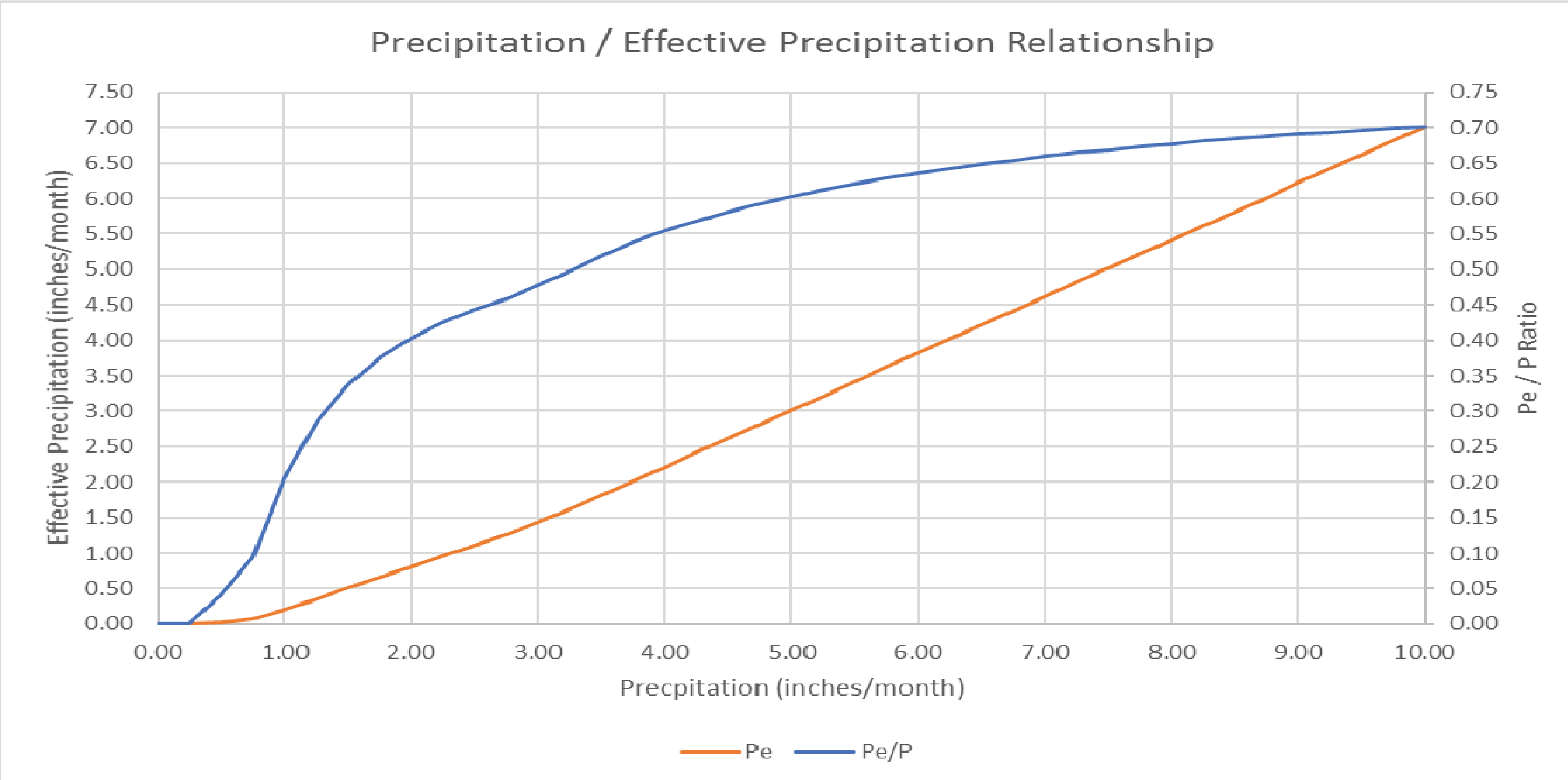
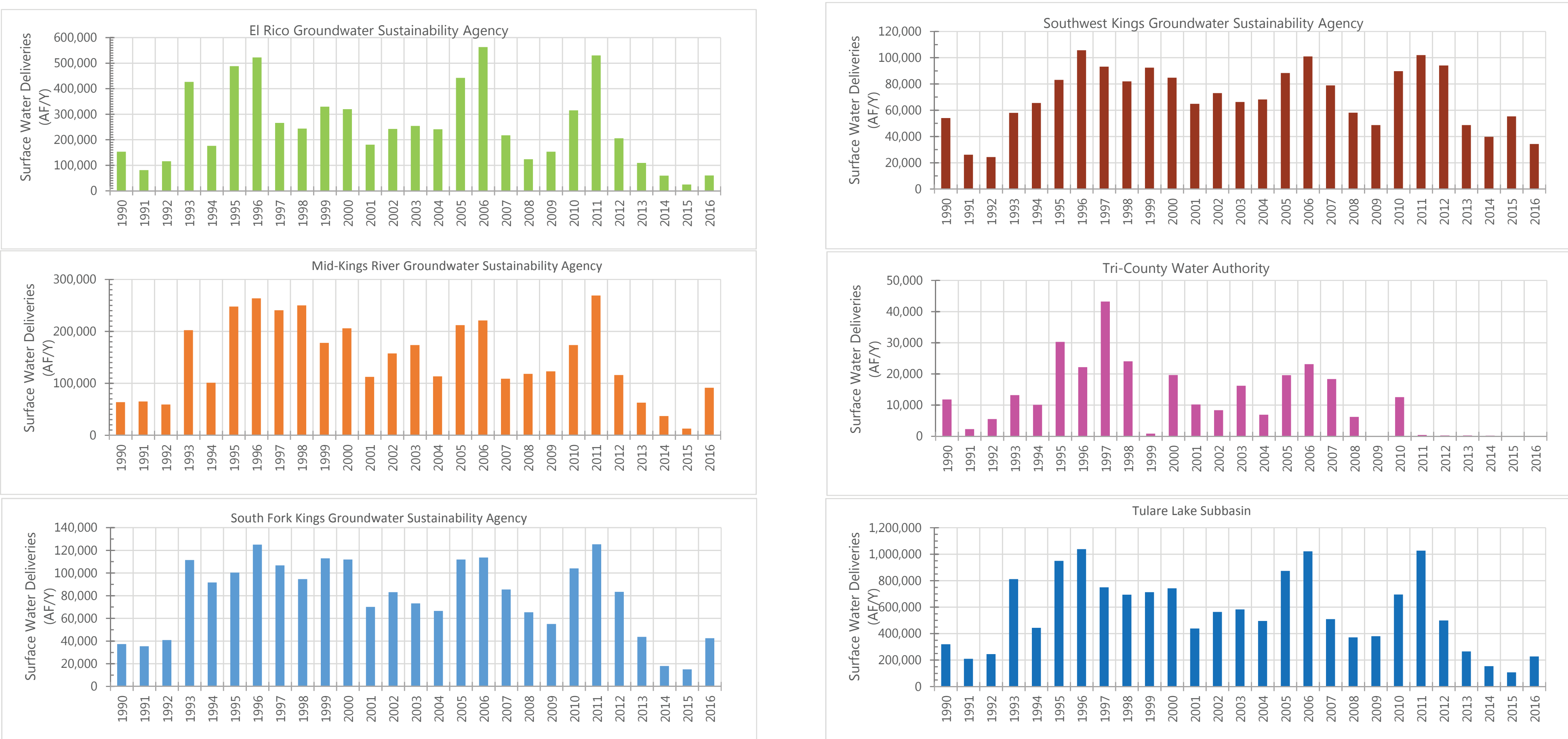


Notes:

Modified from:
United Nations Food and Agriculture Organization (FAO)
FAO 56,Chapter 3 Table 6
Precipitation (P) and Effective Precipitation (Pe) in inches/month

Precipitation Versus
Effective Precipitation
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220
Geosyntec consultants		**Figure 3.3.1-2**



Notes:
1. AF/Y = acre-feet per year

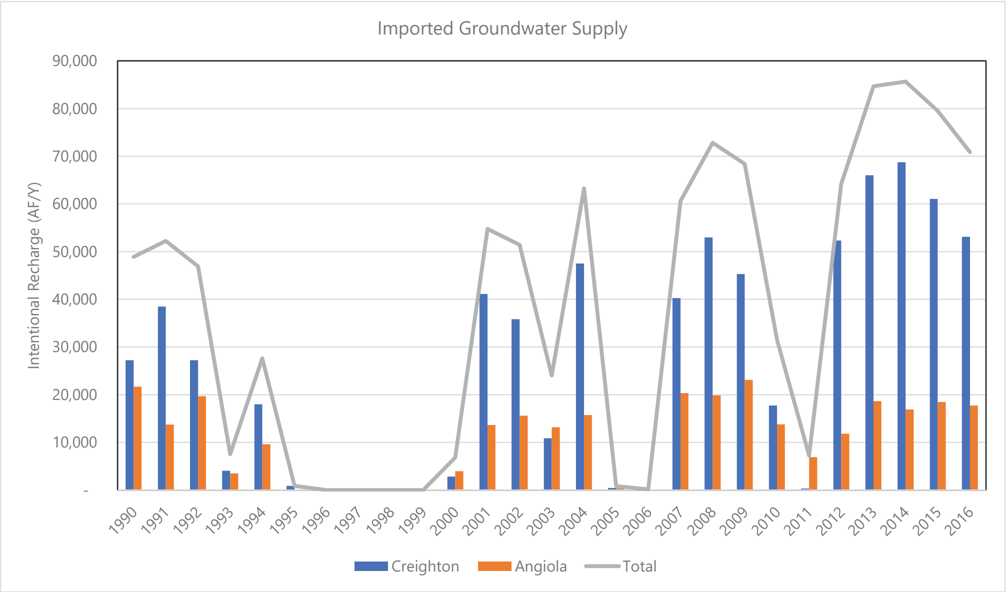
Surface Water Diversions
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

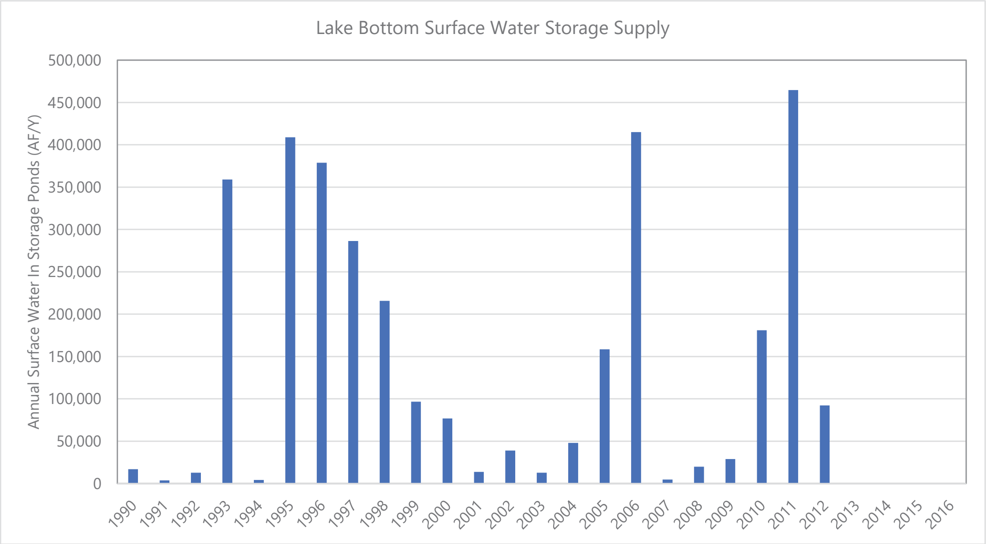
By: dmb | Date: 11/20/2018 | Project No.: FR18161220

Geosyntec consultants

Figure: 3.3.1-3

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-29_3-53_120619.xlsmFigure 3-42 1/9/2020



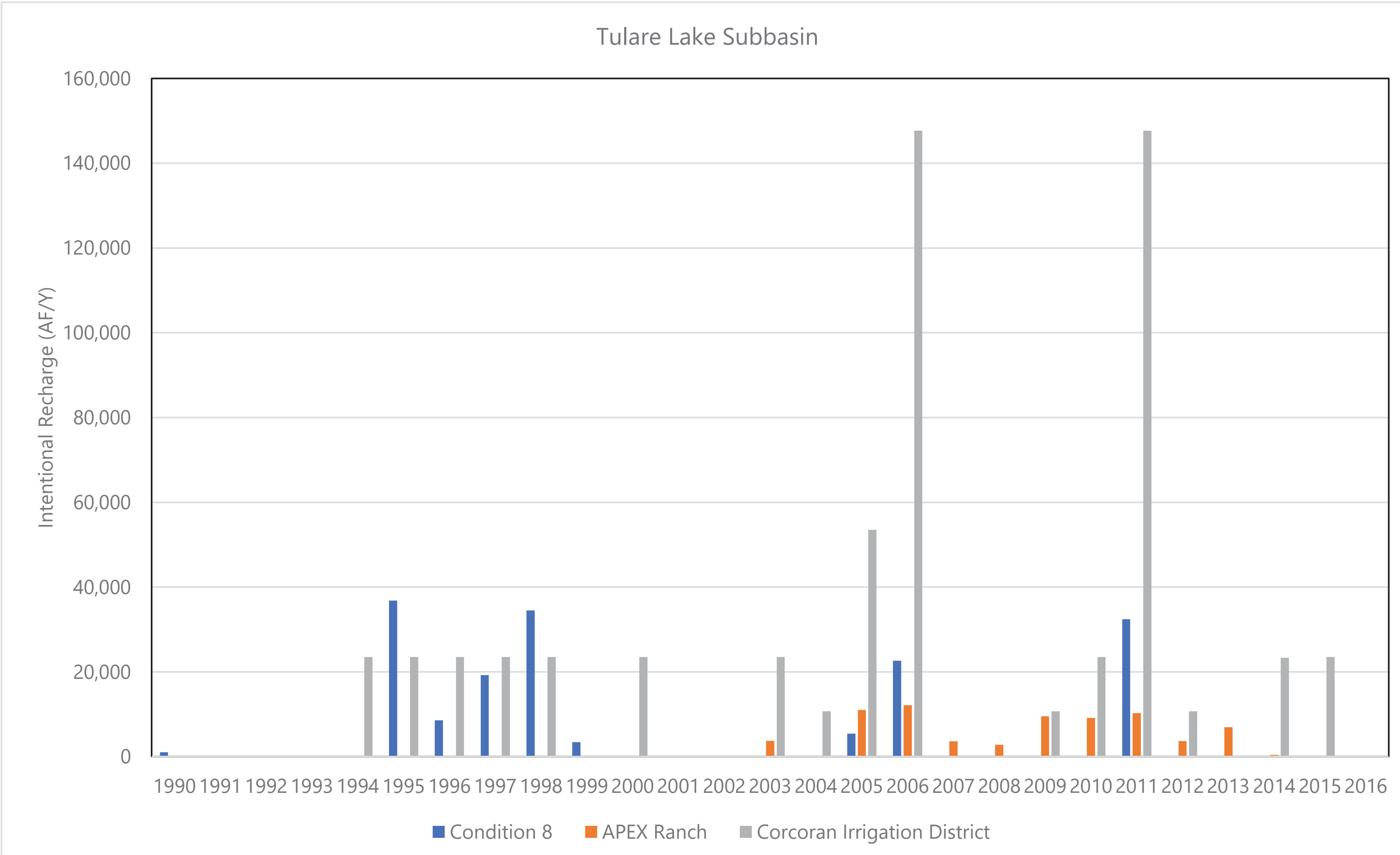


Notes:
1. Only EL Rico and TCWA GSAs import groundwater into the Tulare Lake Subbasin.
2. Only EL Rico and TCWA GSAs have significant surface water storage facilities.
3. Mid-Kings River GSA, South Fork Kings GSA, and Southwest Kings GSA do not have significant surface water storage facilities.
4. AF/Y = acre-feet per year

Lake Bottom Surface Water Storage and Imported Groundwater Supplies 1990-2016

Tulare Lake Subbasin Groundwater sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
Geosyntec consultants	Figure	3.3.1-4



Notes:
1. The APEX Ranch recharge facility did not begin operation until 2002
   Condition 8 water is only available in flood years
   Corcoran Irrigation District (CID) recharge occurs in most years using only 1 or 2 ponds total 440 acres.
   In flood years CID may recharge using 2,760 acres of ponds
2. AF/Y = acre-feet per year

Tulare Lake Subbasin
Intentional Recharge
1990 to 2016

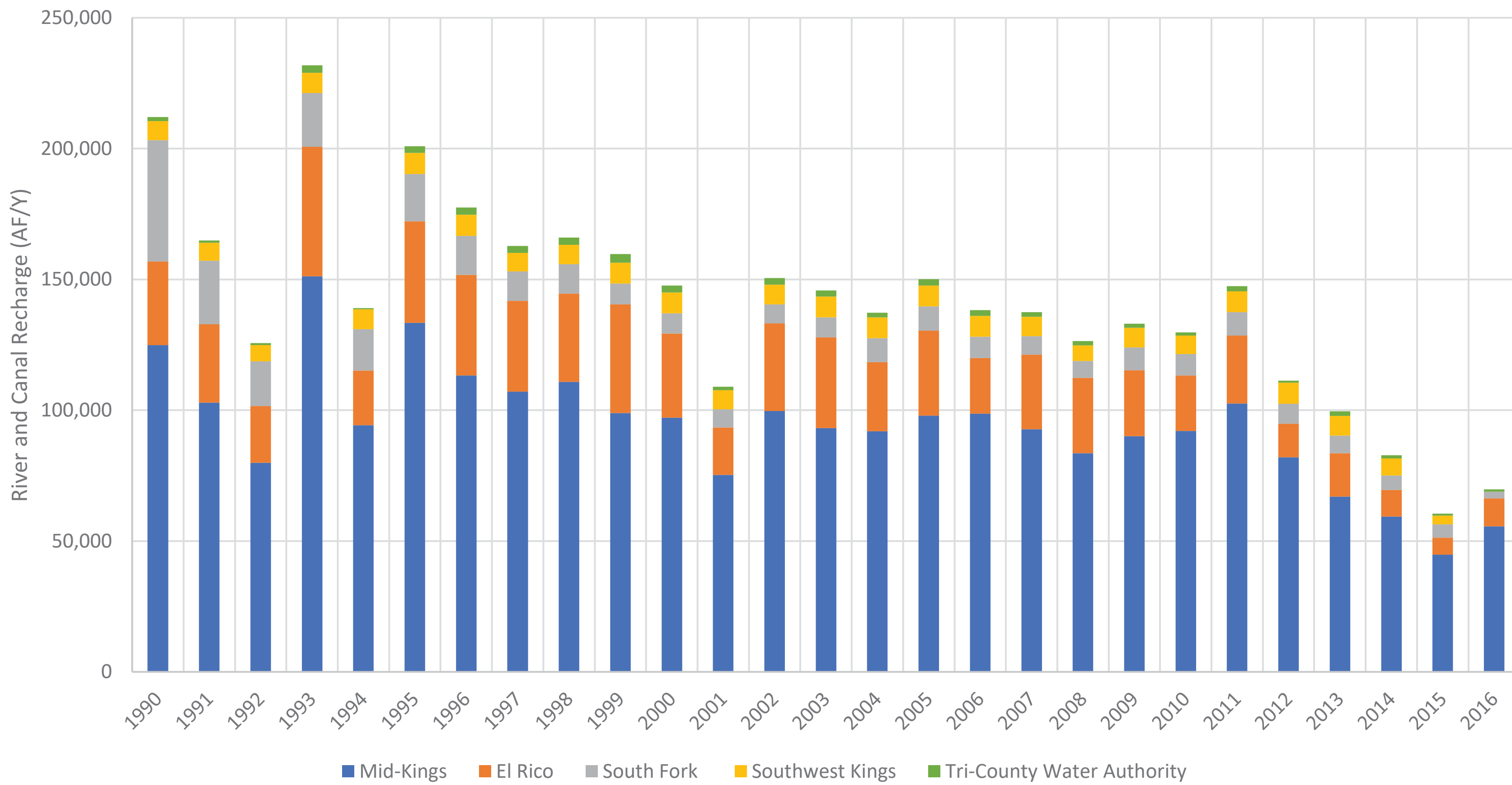
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 11/20/2018	Project No.: FR18161220

Geosyntec consultants

Figure 3.3.1-5

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-29_3-53_120619Figure 3-44 12/11/2019



Notes:
1. AF/Y = acre-feet per year

Tulare Lake Subbasin
River and Canal Recharge
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220

Geosyntec consultants

Figure 3.3.1-6

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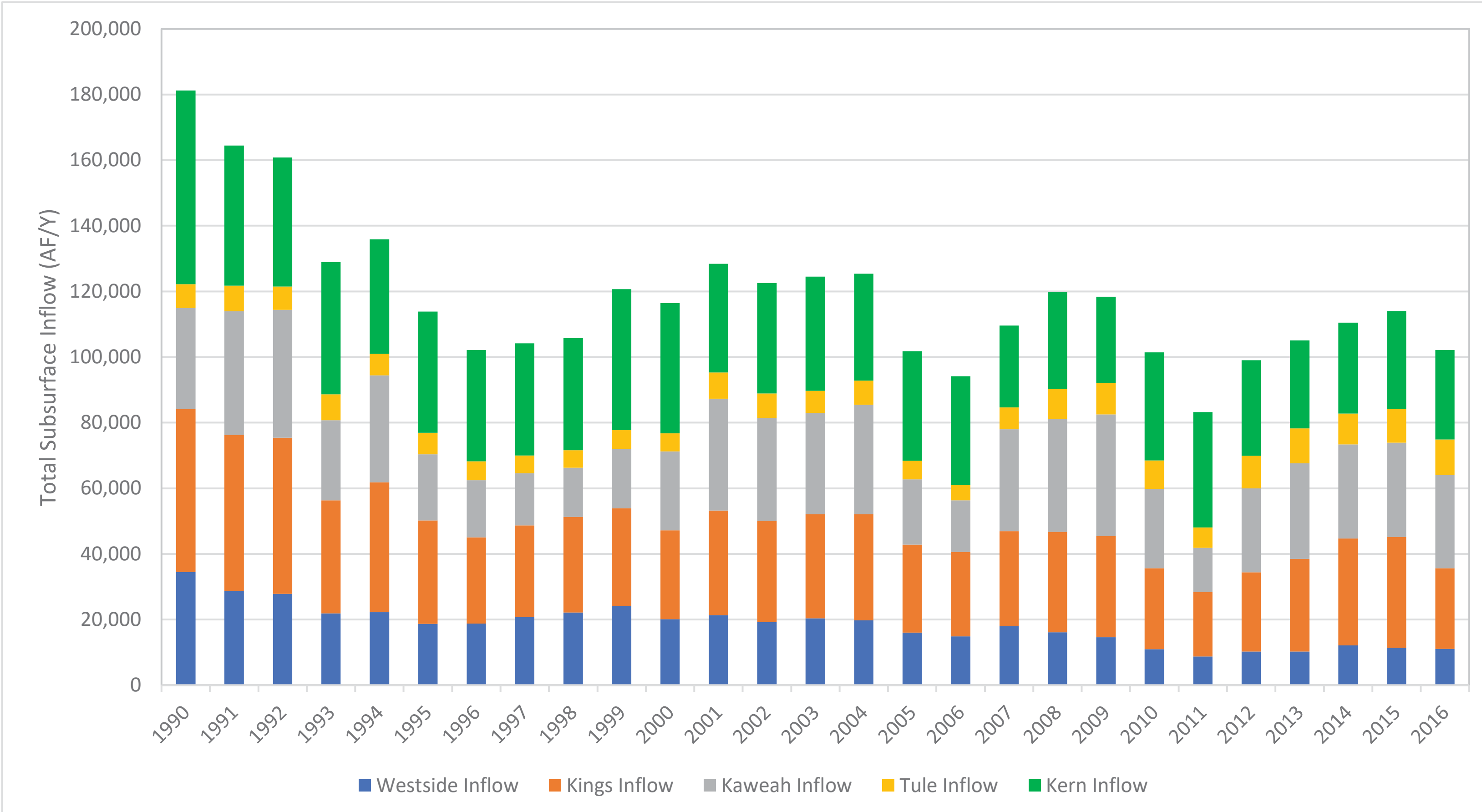

Notes:
1. AF/Y = acre-feet per year

Tulare Lake Subbasin
Total Subsurface Inflows
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220

Geosyntec consultants

Figure 3.3.1-7

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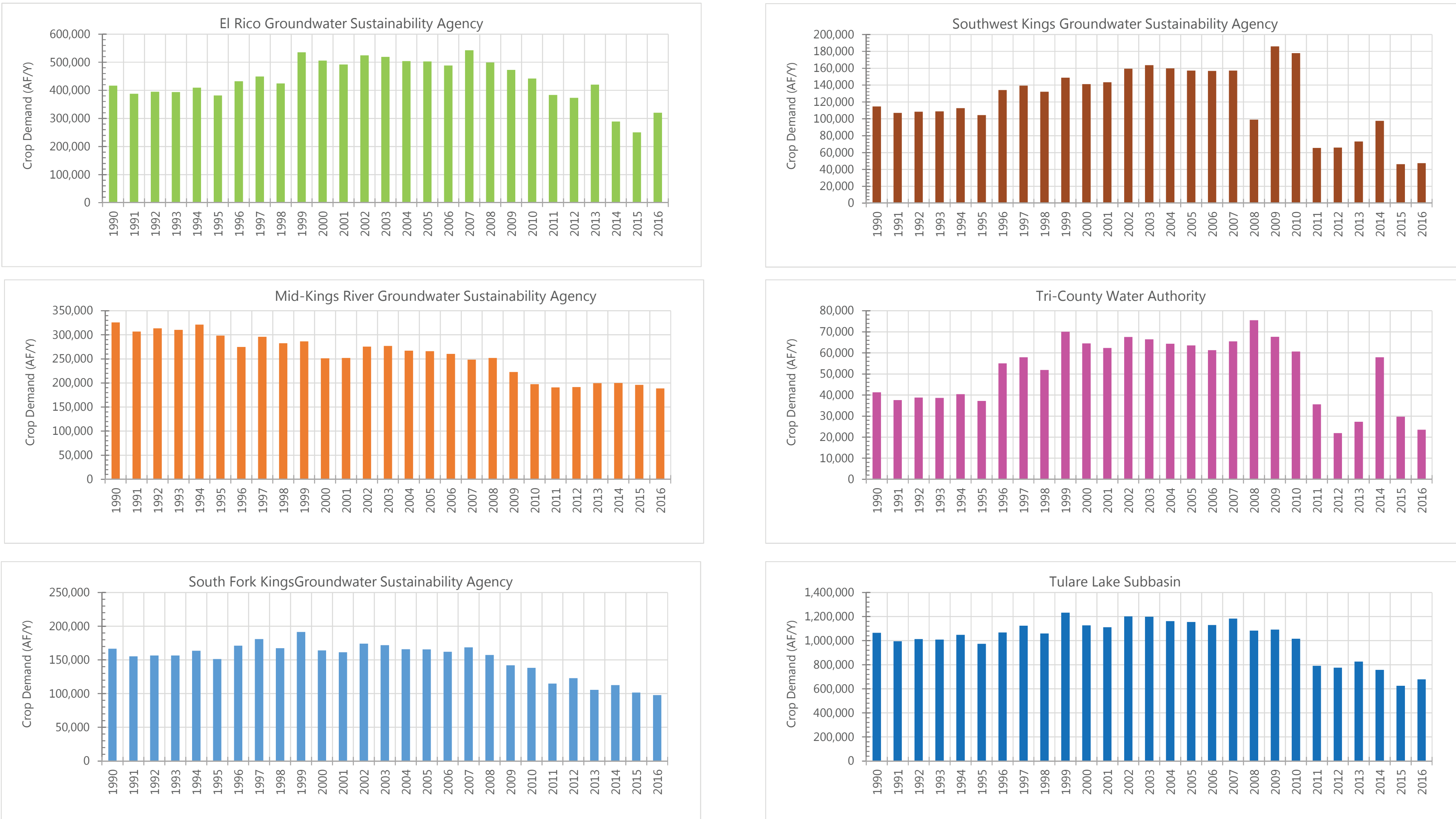

Notes:
1. AF/Y = acre-feet per year

Irrigated Crop Demand
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.3.1-8**

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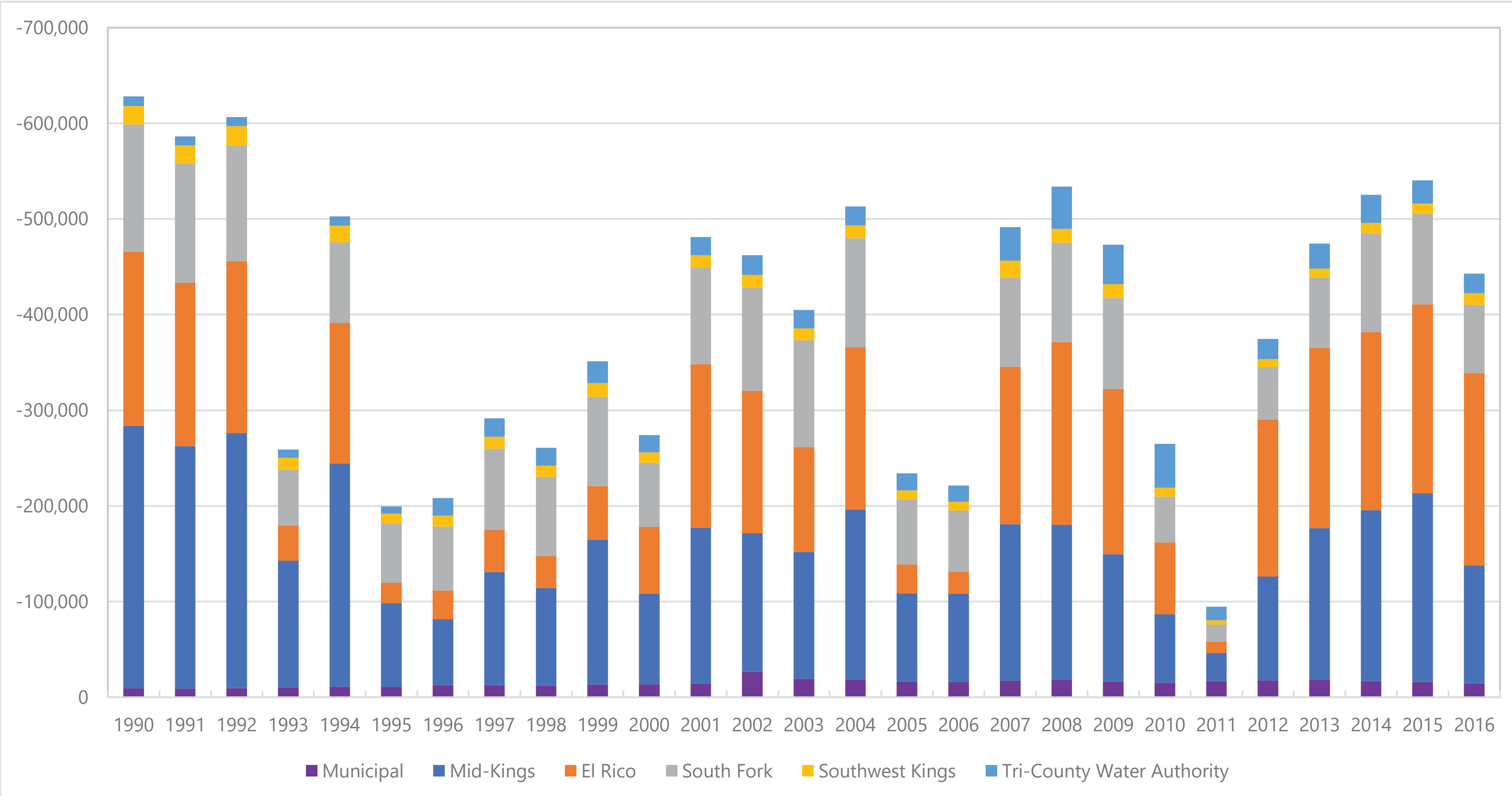

Notes:
1. AF/Y = acre-feet per year
2. TCWA = Tri-County Water Authority

Agricultural and Municipal Pumping
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure 3.3.1-9**

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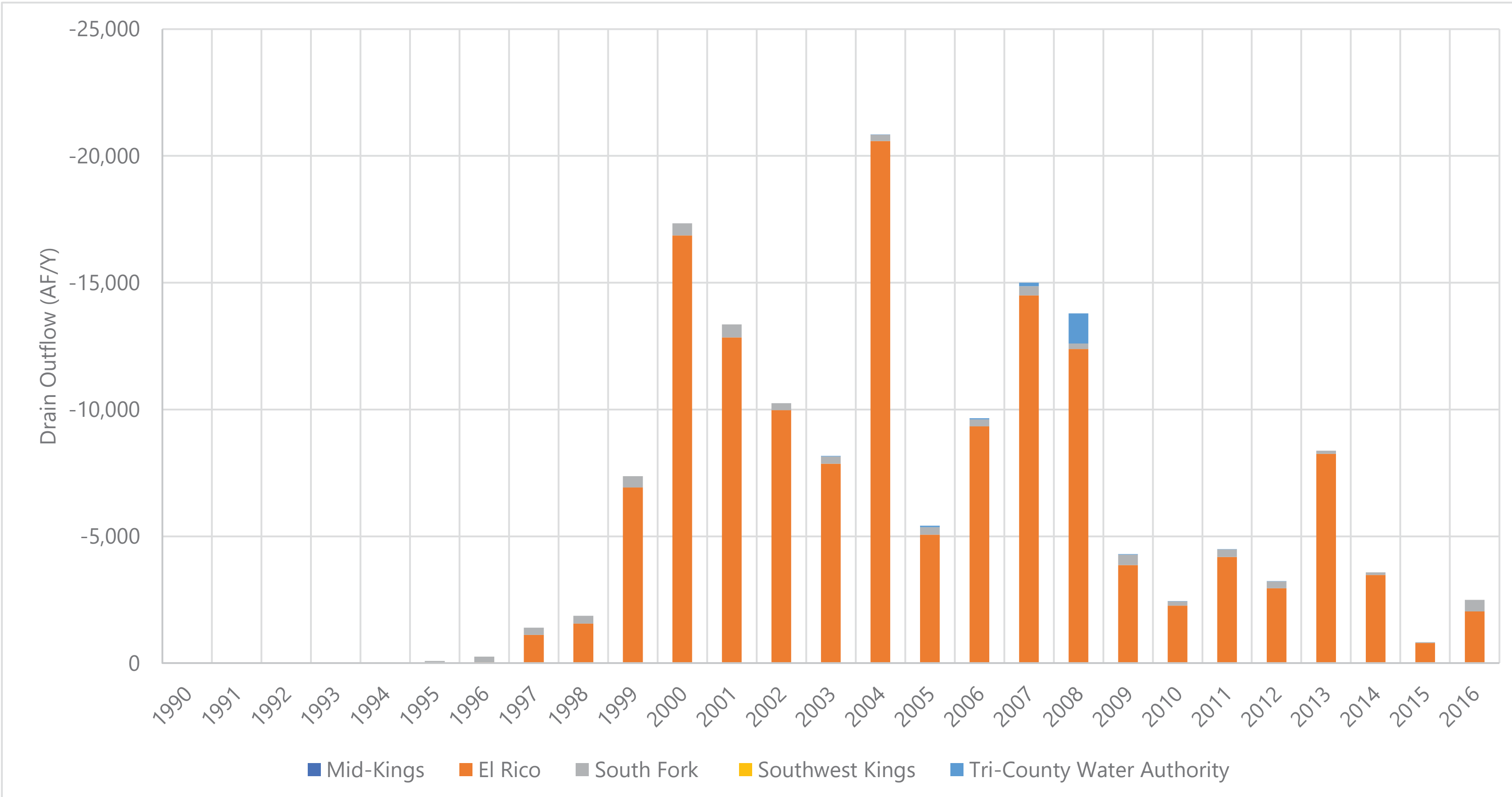
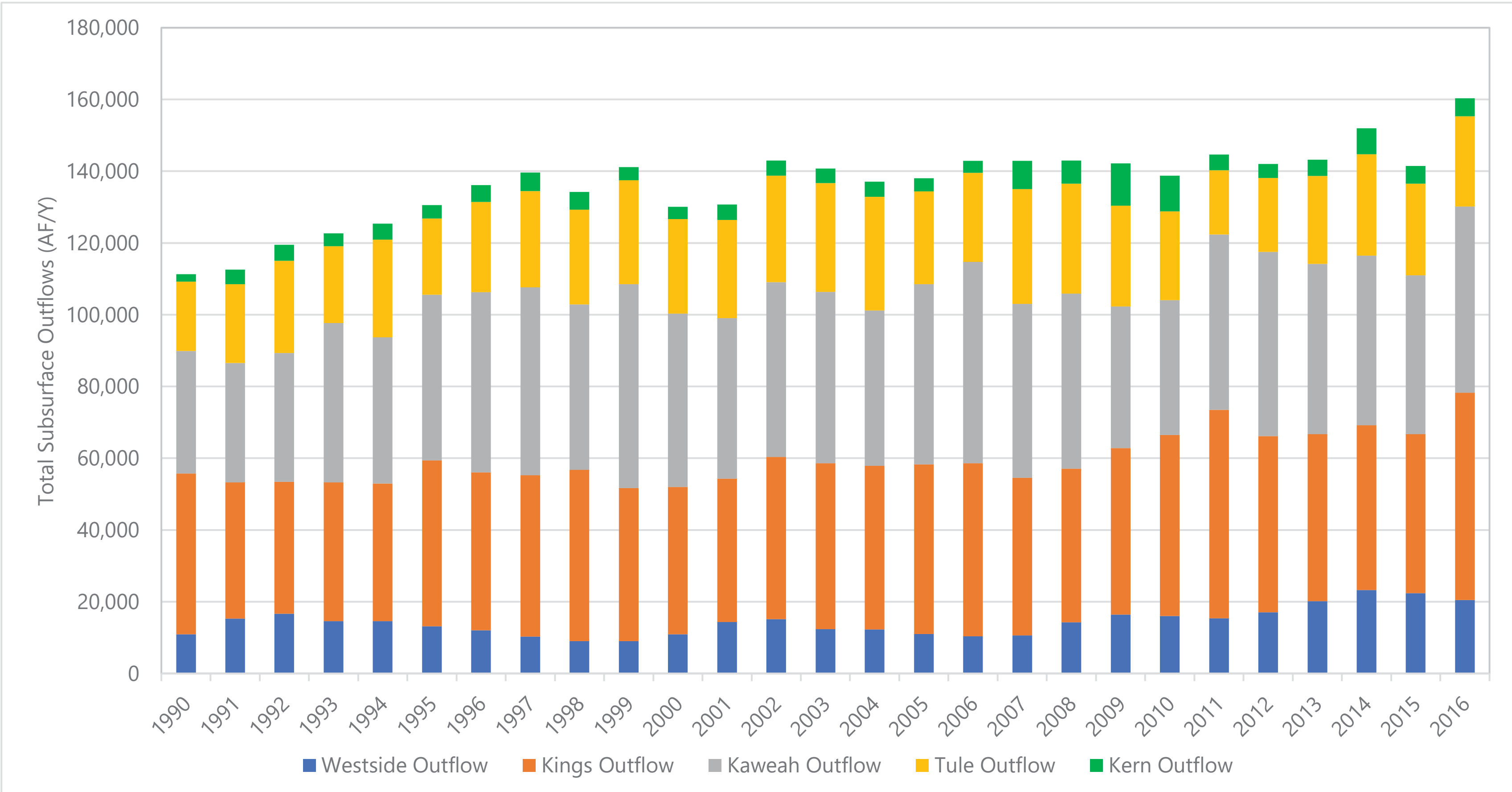


Notes:
1. Mid-Kings River GSA, South Fork Kings GSA, and Southwest Kings GSA do not have agricultural drain outflows.
2. AF/Y = acre-feet per year

Tulare Lake Subbasin Agricultural Drainage Outflows 1990 to 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure 3.3.1-10**



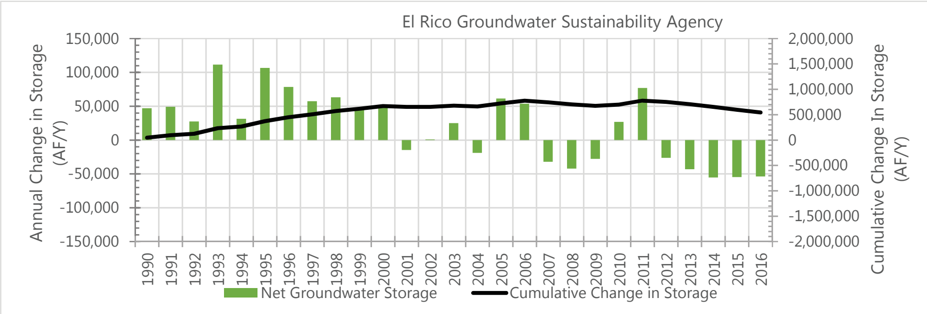
Notes:
1. AF/Y = acre-feet per year

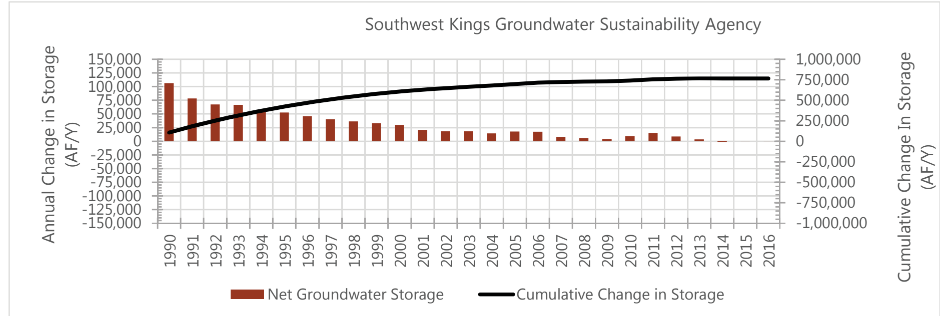
Tulare Lake Subbasin
Total Subsurface Outflows
1990 to 2016

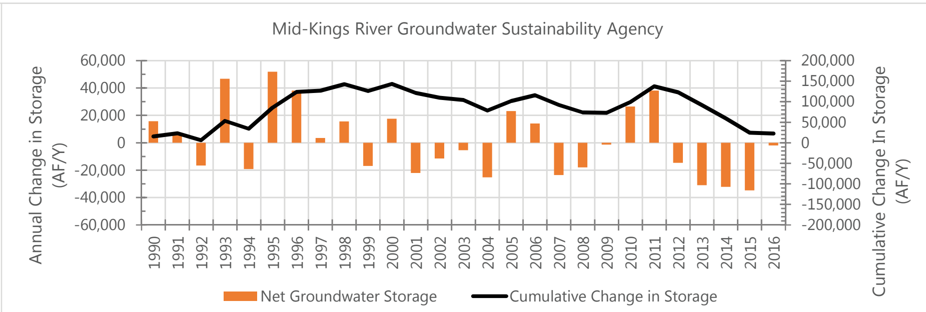
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

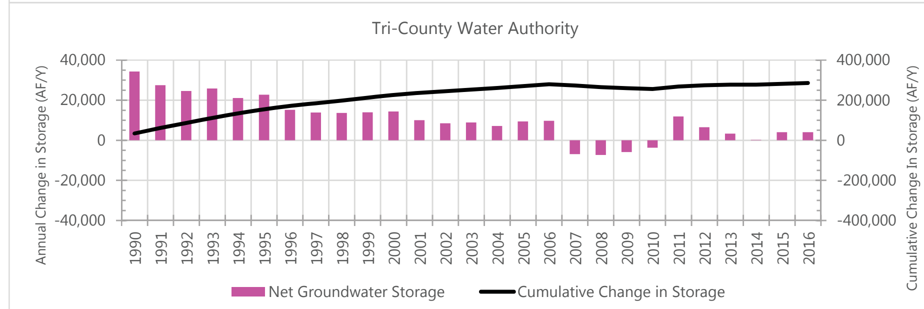
By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants	**Figure 3.3.1-11**	

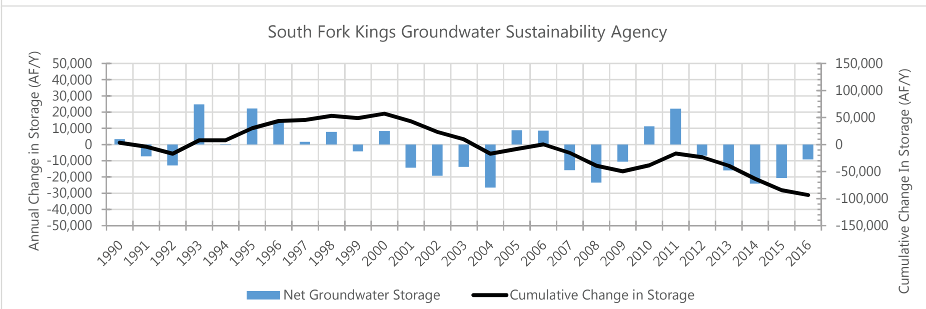
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-29_3-53_120619.xlsmFigure 3-29c 1/8/2020

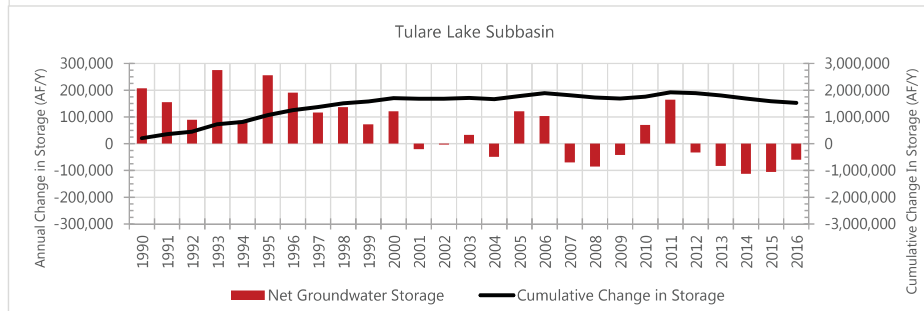












Notes:
1. AF/Y = acre-feet per year

Change in Groundwater Storage
Lower Aquifer Zone 1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.3.2-1**

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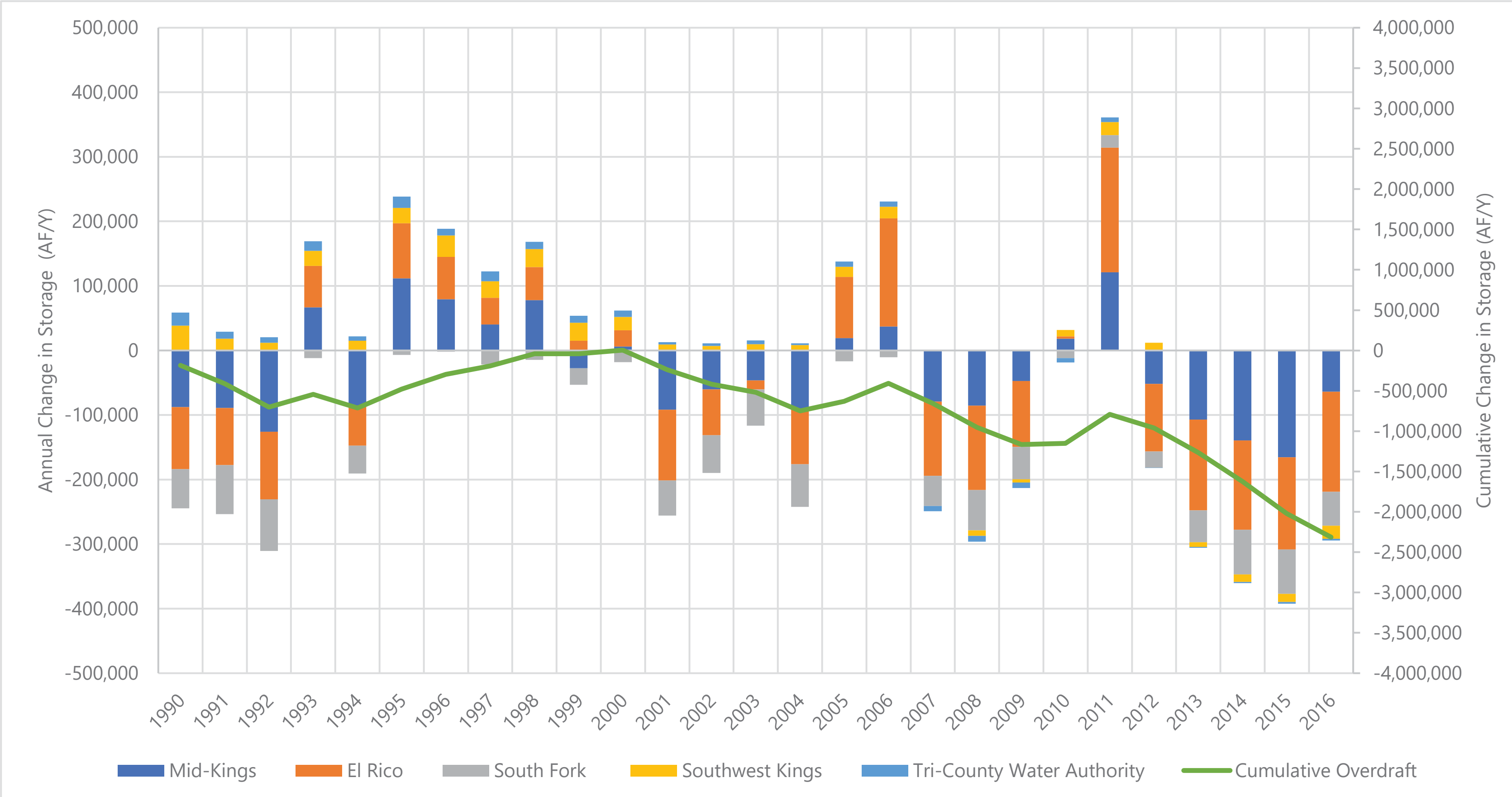
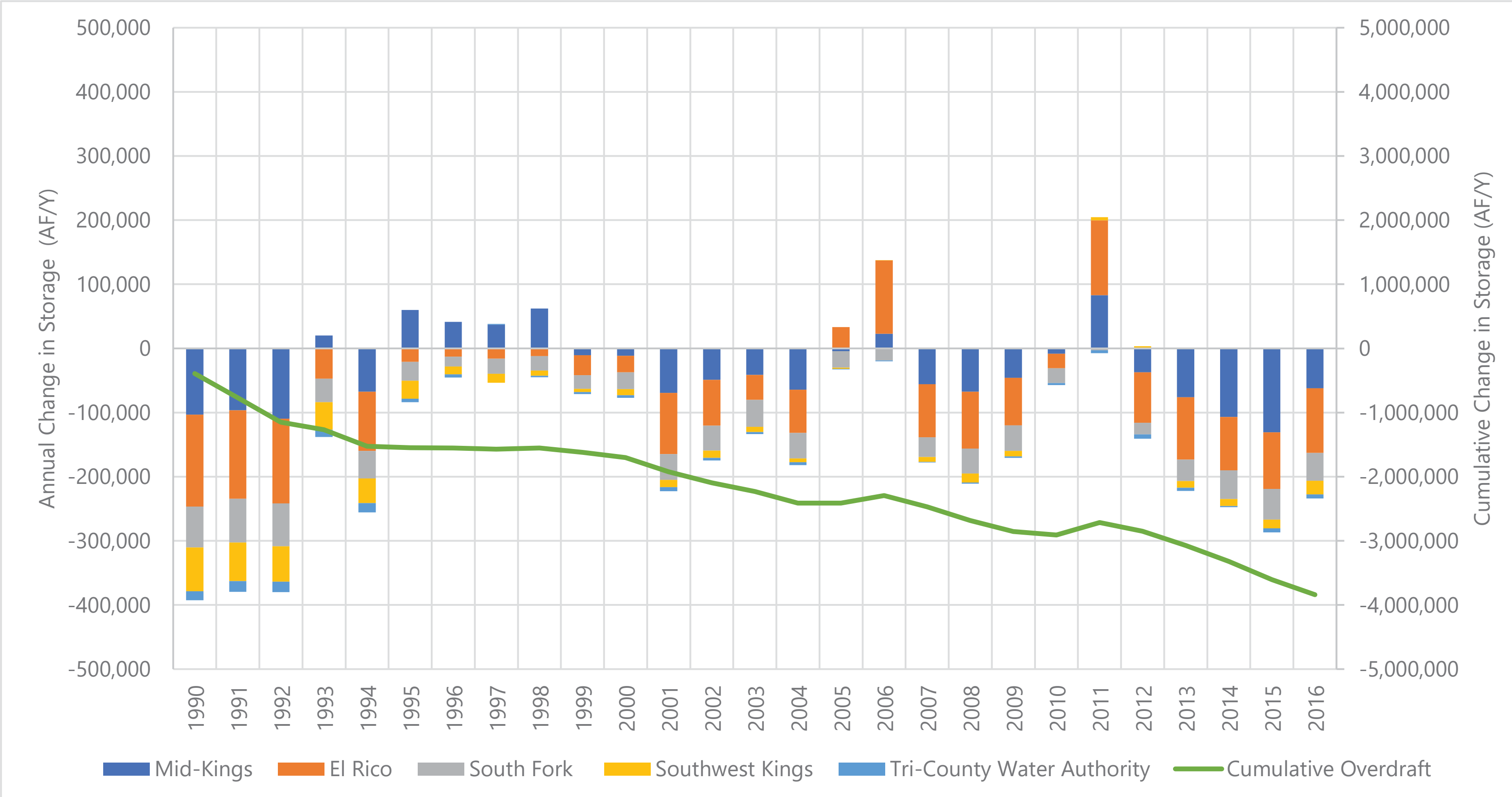


Notes:
1. AF/Y = acre-feet per year

Tulare Lake Subbasin Total Overdraft 1990 to 2016 Tulare Lake Subbasin Groundwater Sustainability Plan Kings County, California		
By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure 3.3.3-1a**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\GSPFigures 3-29_3-53_120619Figure 3-50b 12/11/2019



Notes:
1. AF/Y = acre-feet per year

Tulare Lake Subbasin
Upper Aquifer Overdraft
1990 to 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure 3.3.3-1b**

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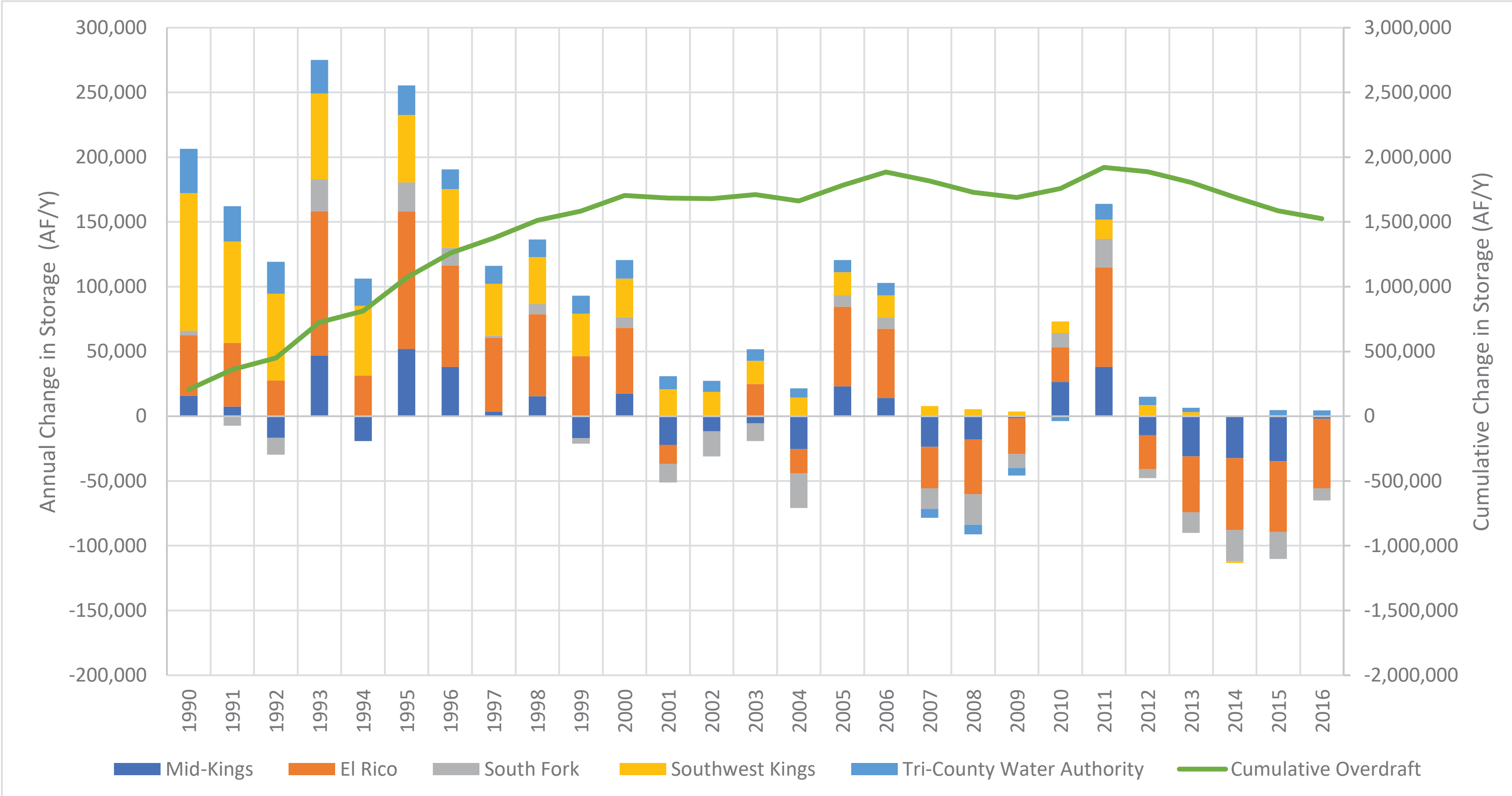
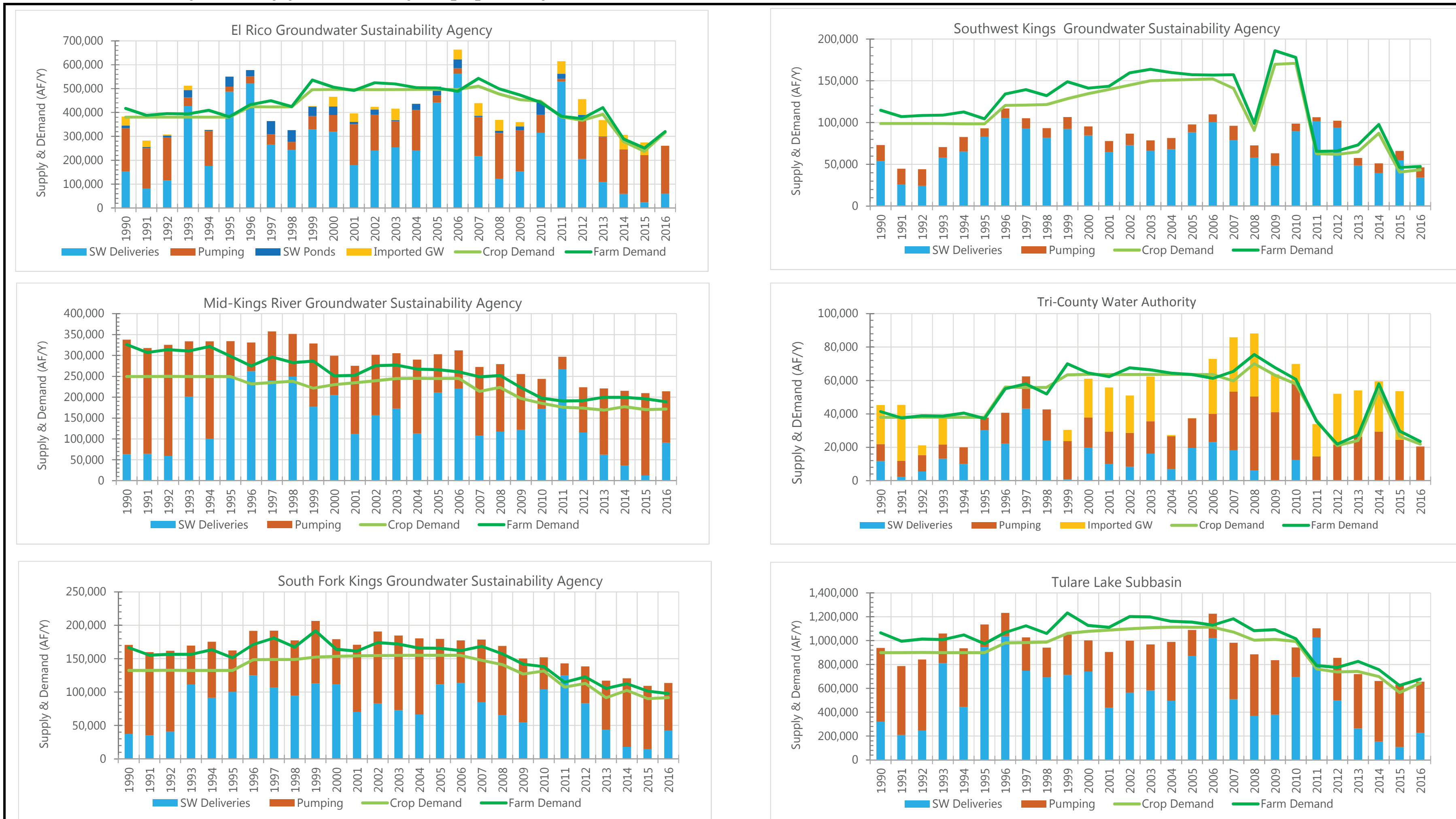


Notes:
1. AF/Y = acre-feet per year

Tulare Lake Subbasin
Lower Aquifer Overdraft
1990 to 2016
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure 3.3.3-1c**



Notes:
1. AF/Y = acre-feet per year

Water Supply and Demand
1990 to 2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.3.6-1**

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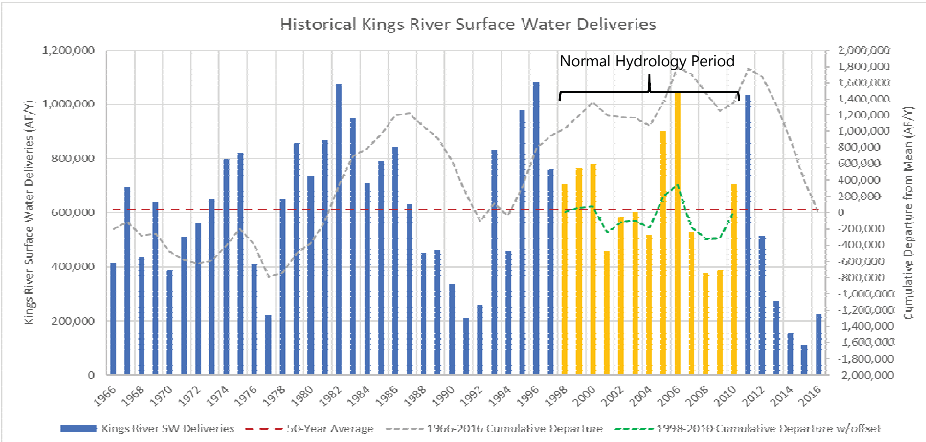
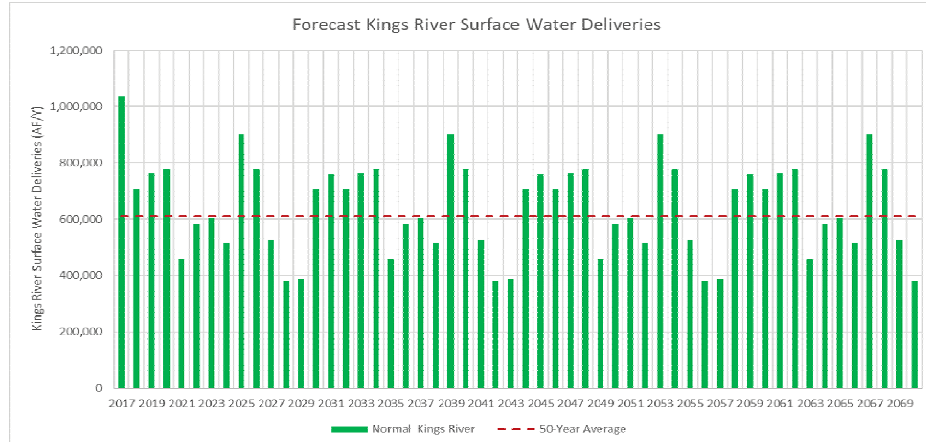
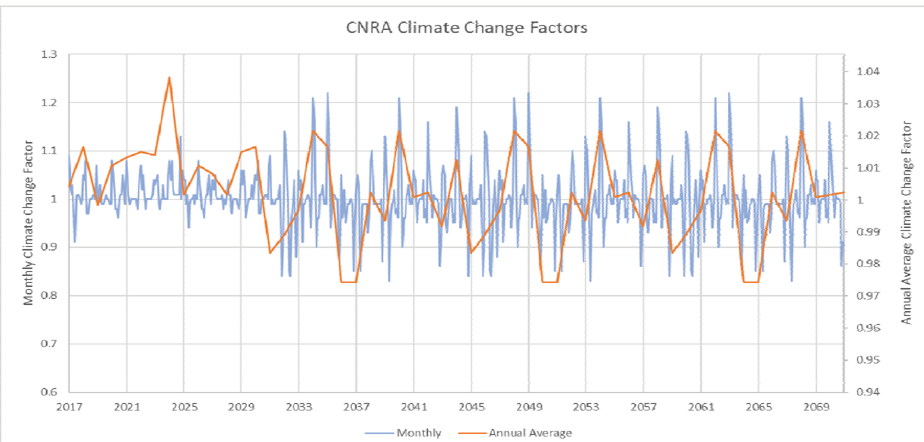
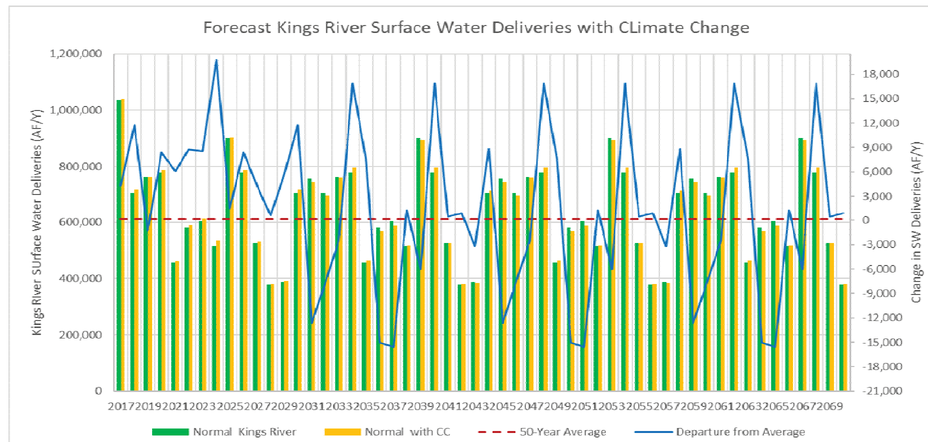






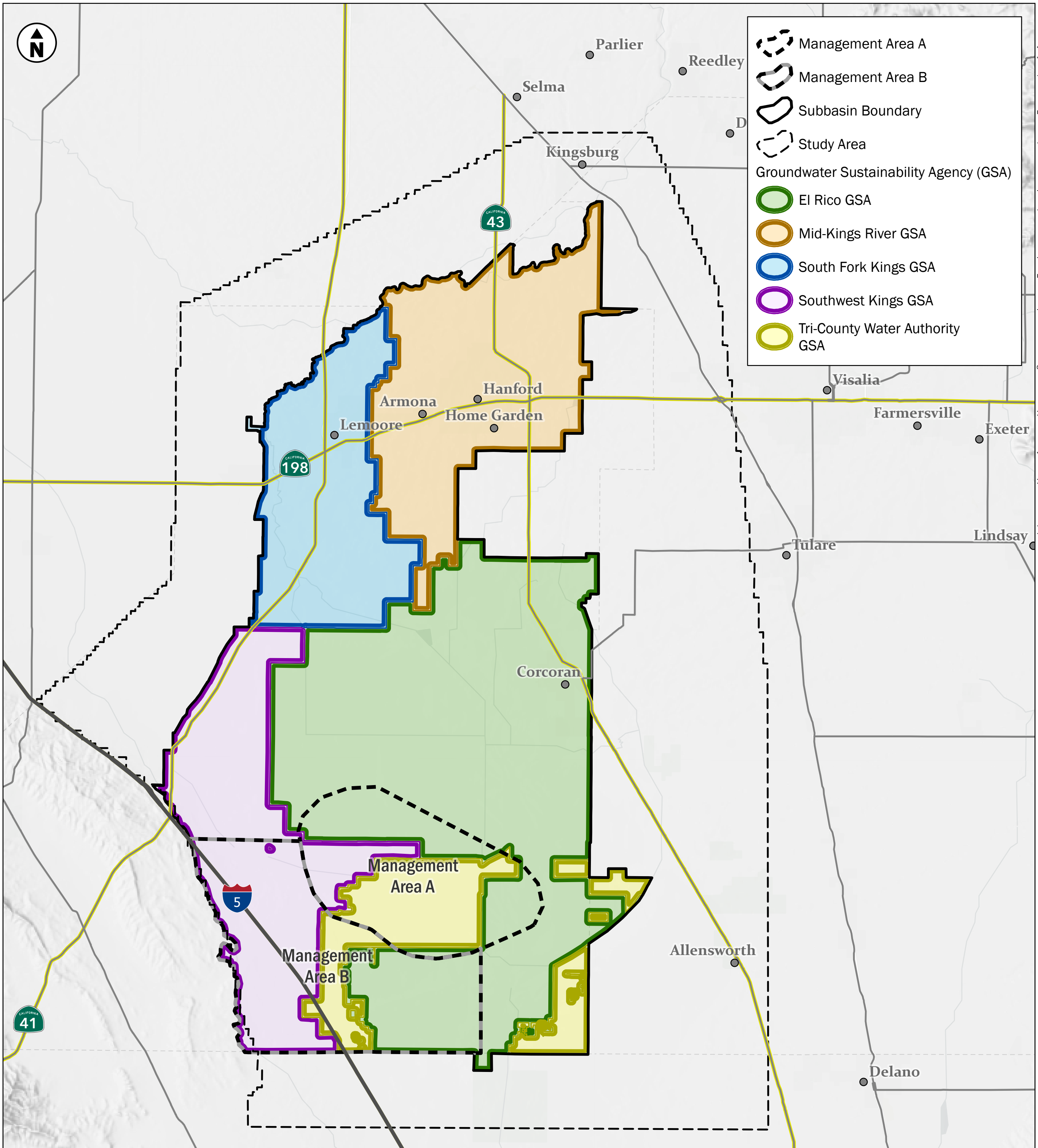


Notes:
1. AF/Y = acre-feet per year

Surface Water Delivery Foreacst with Climate Change

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		**Figure: 3.3.7-1**



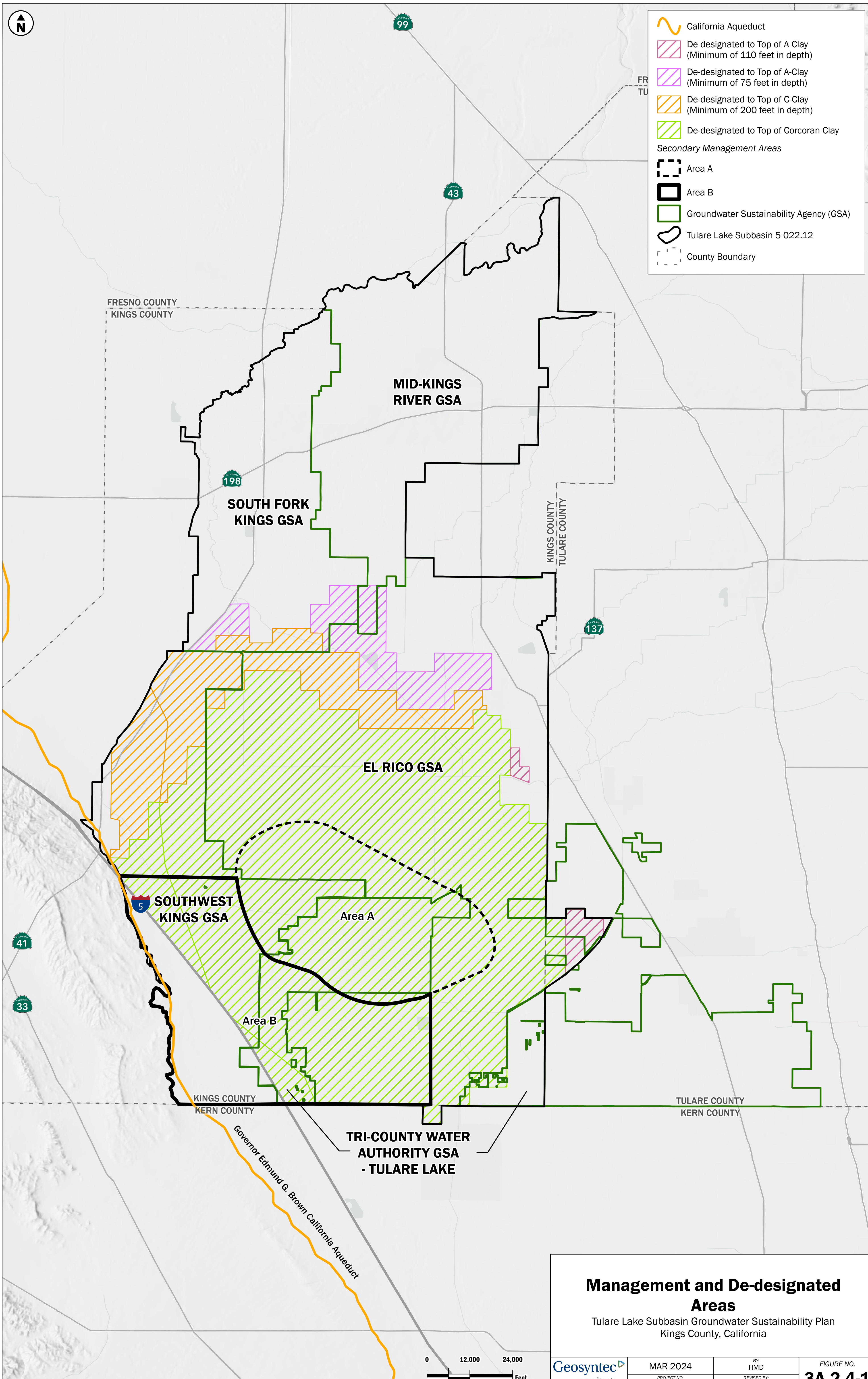
Management Areas

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3.4.1-1

GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx; 3.4.1-1 Management Areas || User: haley.duran || Print Date: 4/2/2024

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS



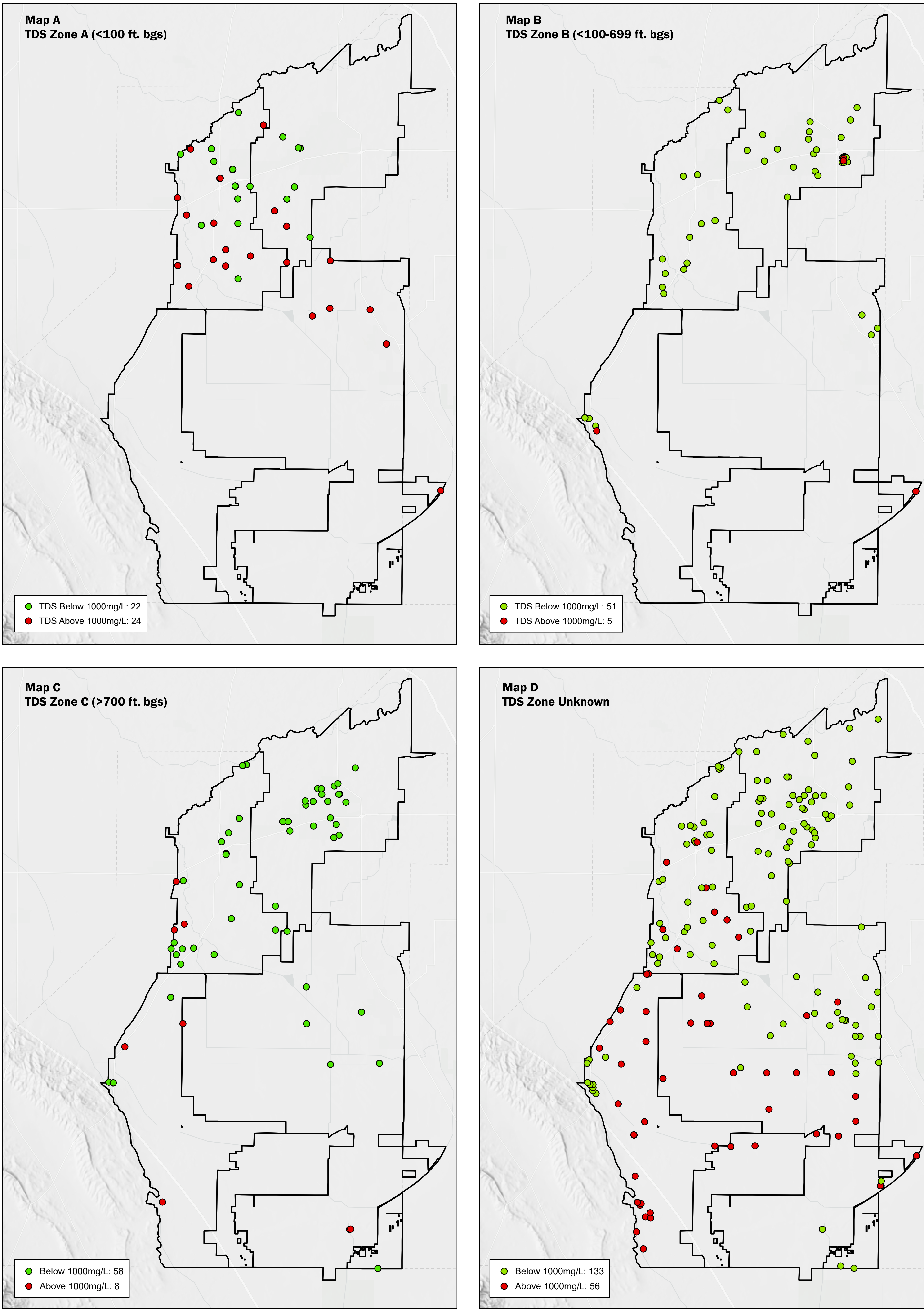
Management and De-designated Areas

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants

MAR-2024	BY: HMD	FIGURE NO.
PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.4-1

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



TDS Below 1000mg/L: Well Count

TDS Above 1000mg/L: Well Count

Groundwater Sustainability Agency (GSA)

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

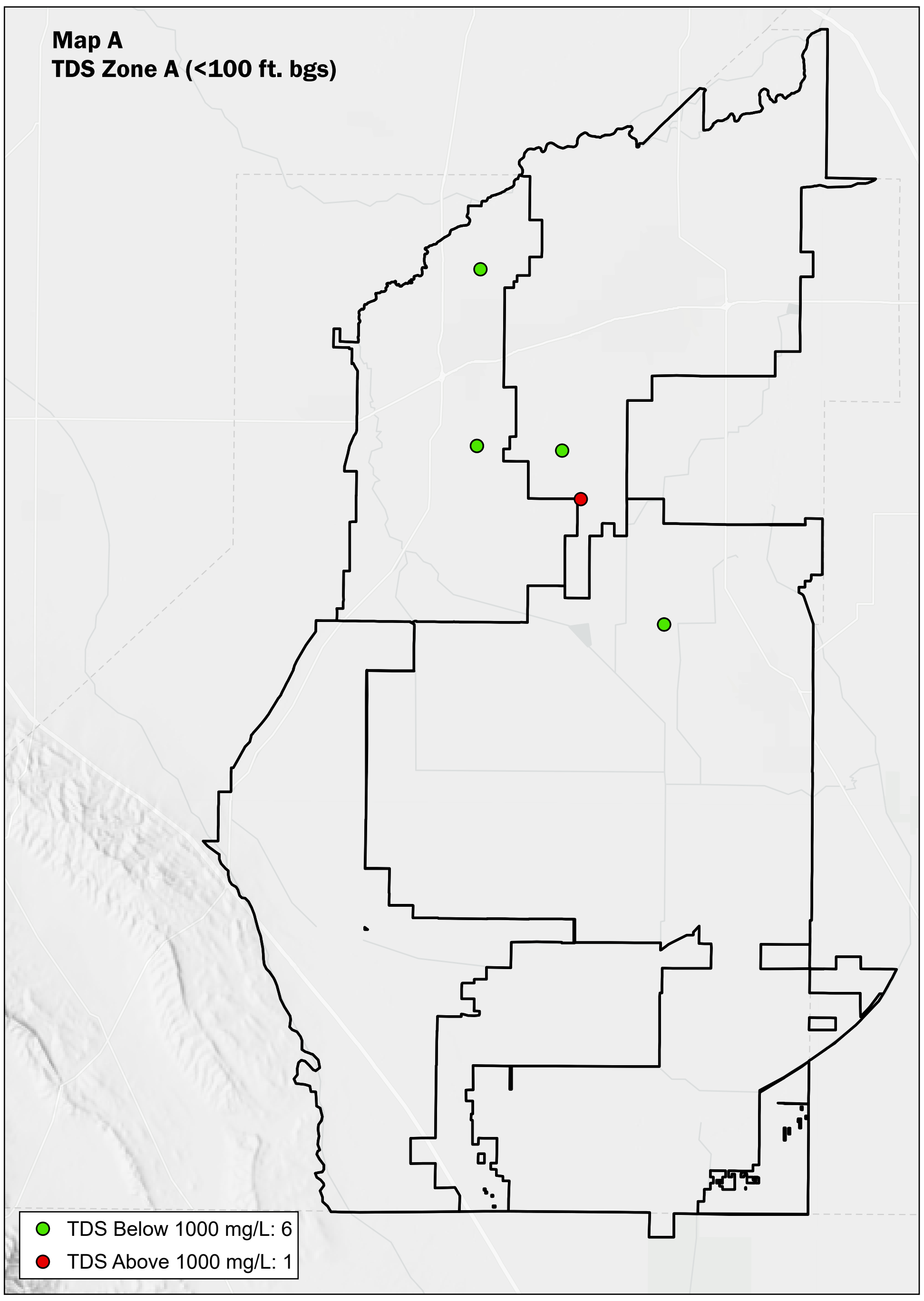
Earliest well sample was in 1929

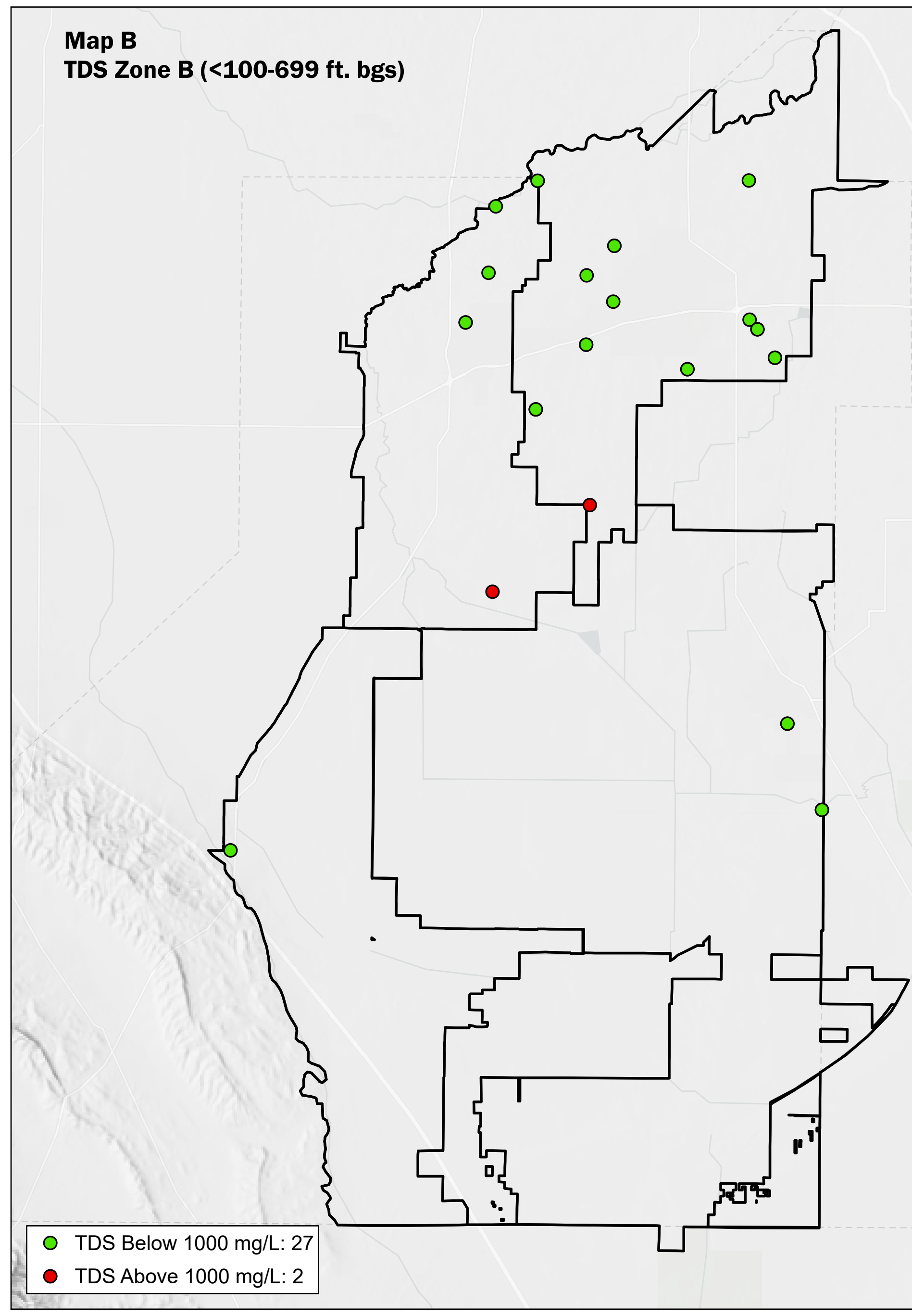
Notes: ft. bgs = Feet Below Ground Surface
TDS = Total Dissolved Solids
mg/L = milligrams per liter
Data retrieved from State Water Resources Control Board GAMA database.

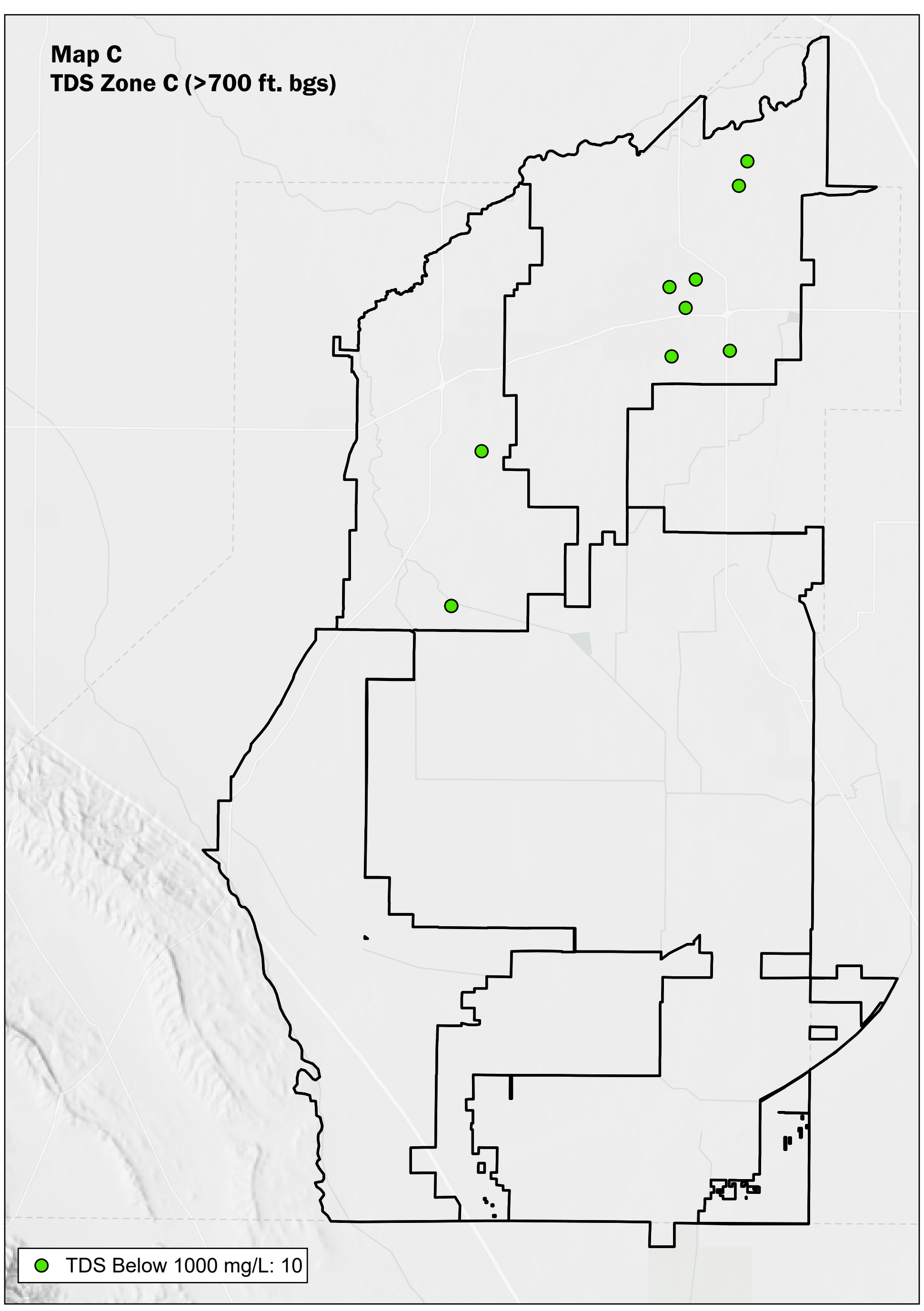
Pre 2015 Distribution of TDS Within Tulare Lake Subbasin

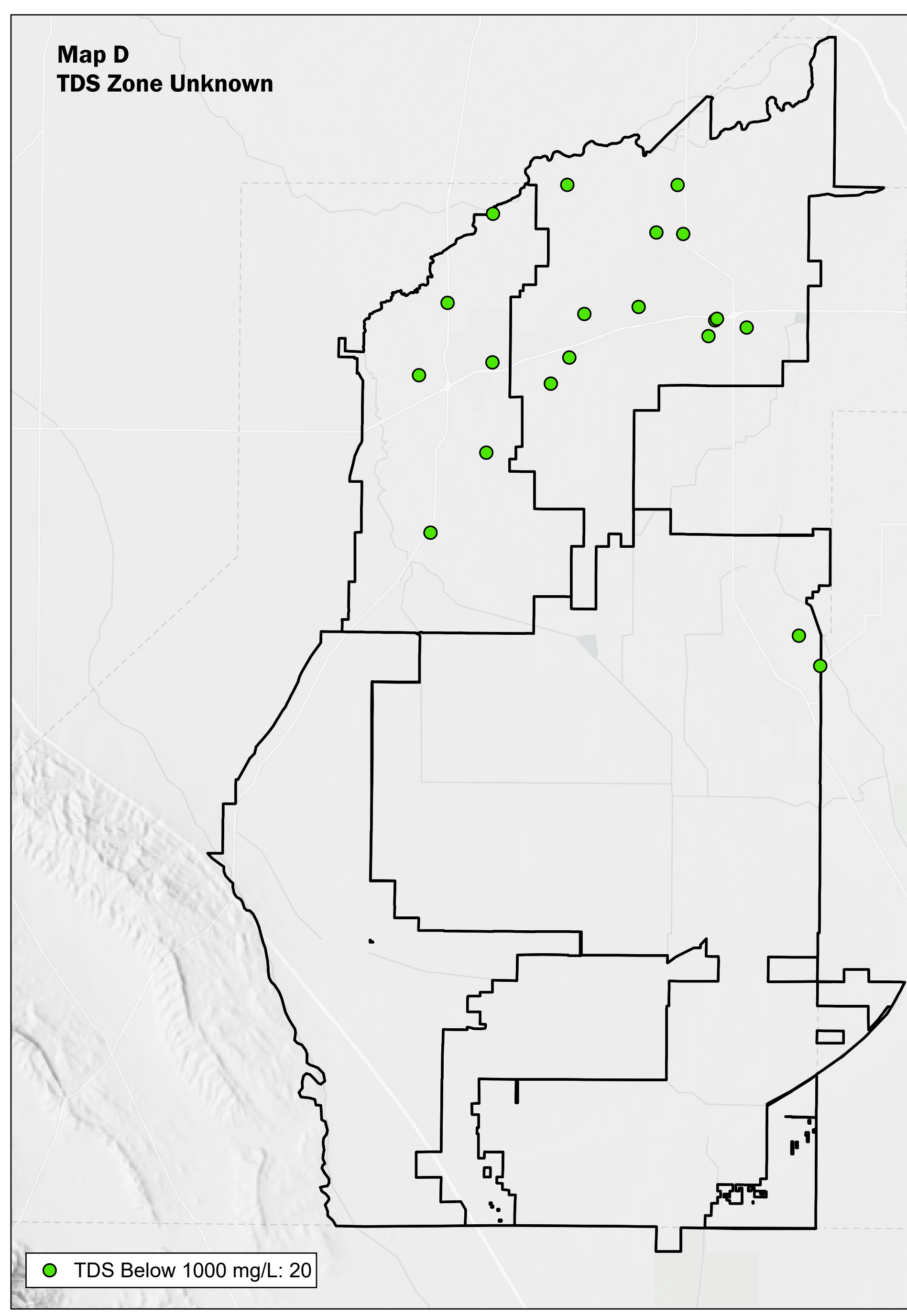
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3A.2.5-1a









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TDS Below 10000 mg/L: Well Count

TDS Above 1000 mg/L: Well Count

Groundwater Sustainability Agency (GSA)

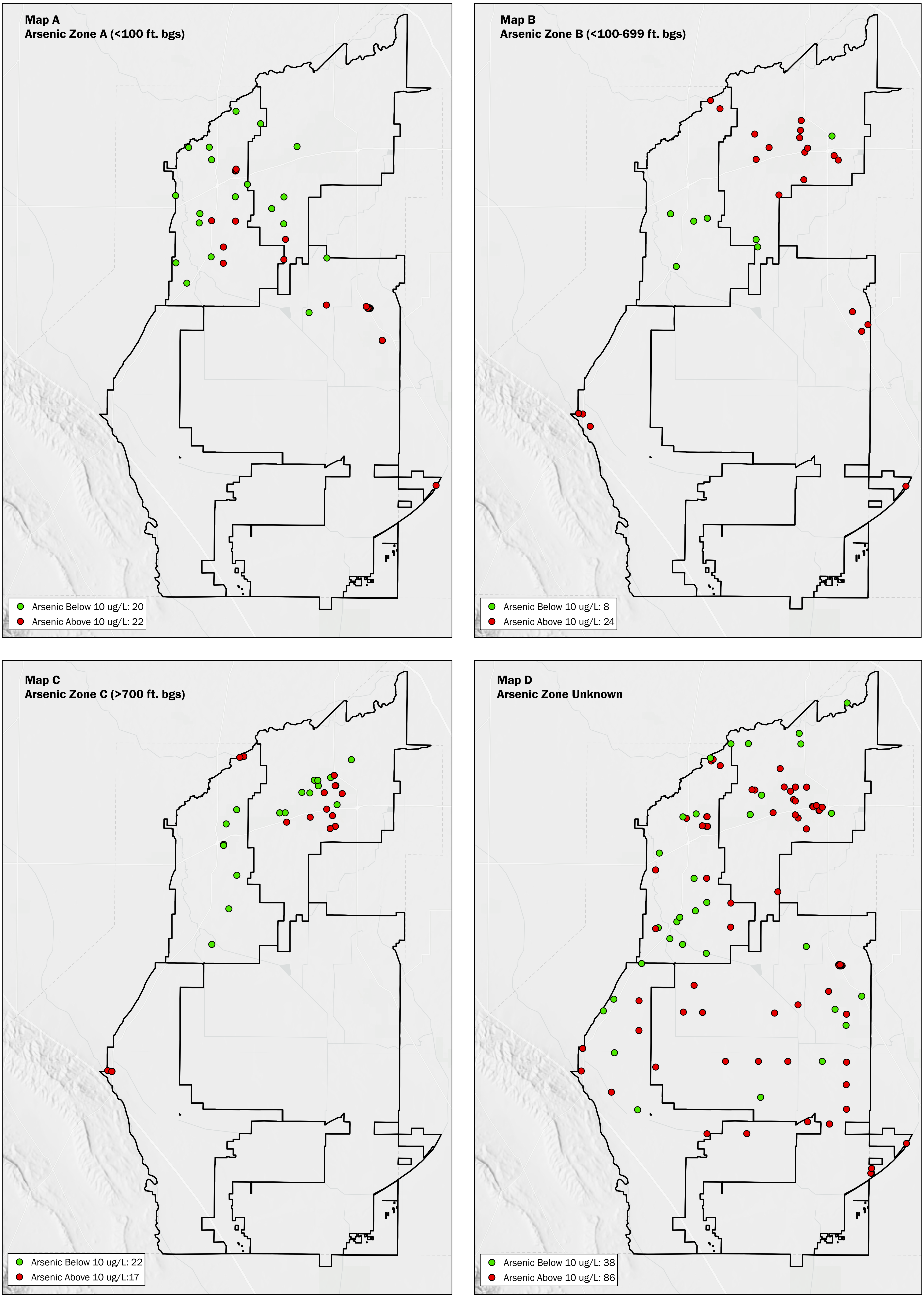
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Notes: ft. bgs = Feet Below Ground Surface
TDS = Total Dissolved Solids
mg/L = milligrams per liter
Data retrieved from State Water Resources Control Board GAMA database.

Post 2015 Distribution of TDS Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-1b



Arsenic Below 10 ug/L: Well Count

Arsenic Above 10 ug/L: Well Count

Groundwater Sustainability Agency (GSA)

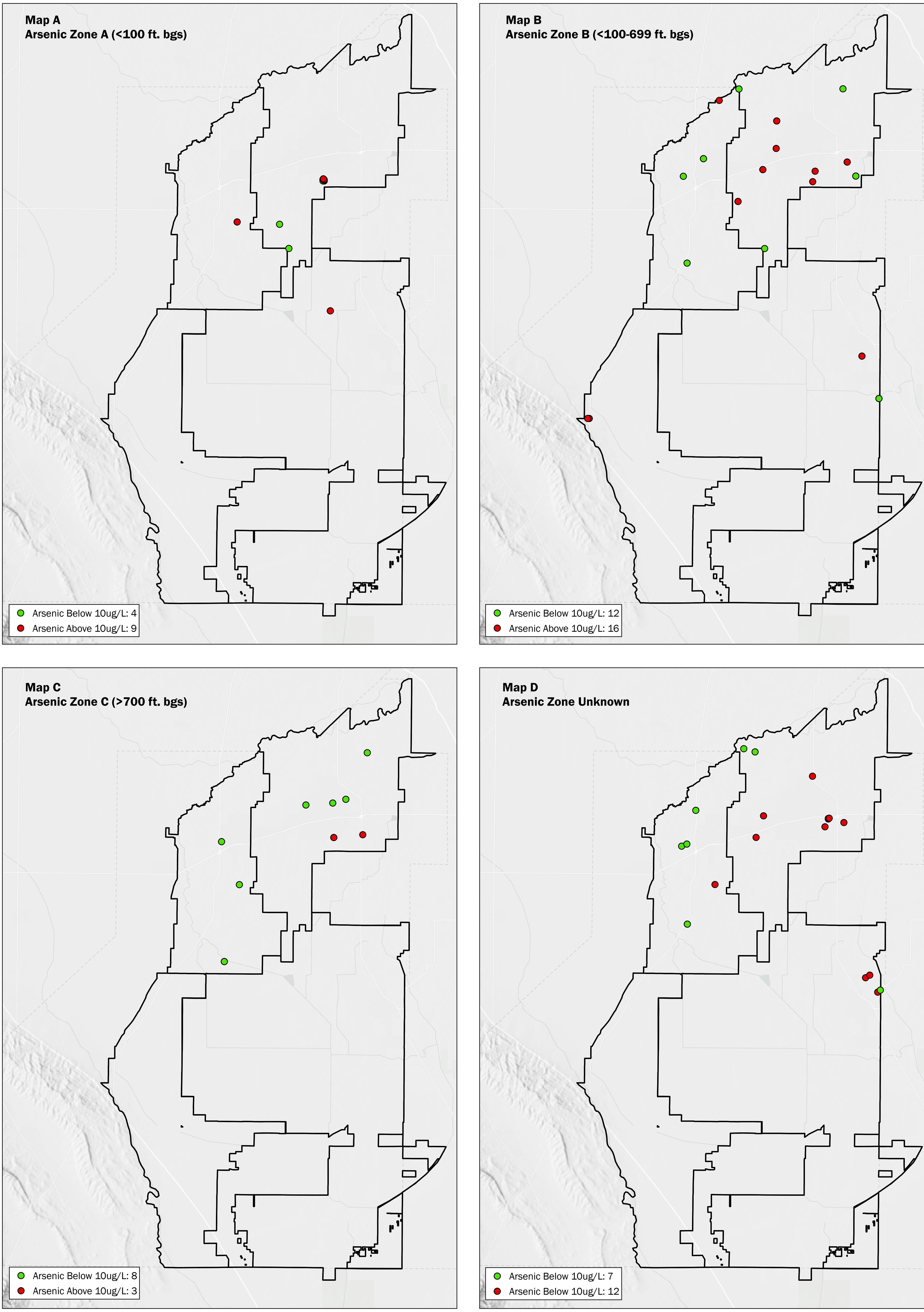
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Earliest well sample was in 1959

Notes: ft. bgs = Feet Below Ground Surface
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Pre 2015 Distribution of Arsenic Within Tulare Lake Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-3a



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Arsenic Below 10 ug/L: Well Count

Arsenic Above 10 ug/L: Well Count

Groundwater Sustainability Agency (GSA)

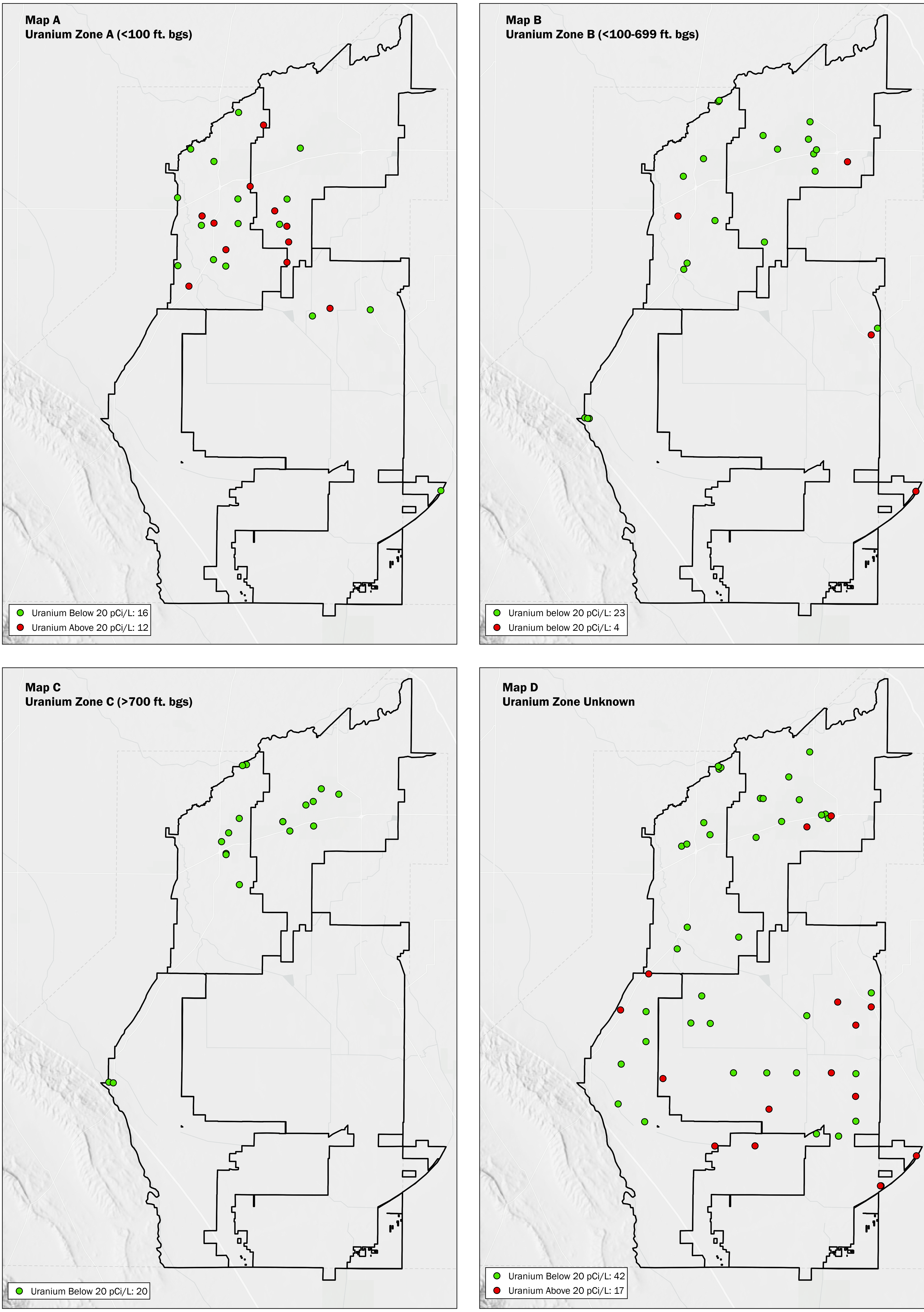
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Notes: ft. bgs = Feet Below Ground Surface
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Post 2015 Distribution of Arsenic Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-3b



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Uranium Below 20 pCi/L: Well Count

Uranium Above 20 pCi/L: Well Count

Groundwater Sustainability Agency (GSA)

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

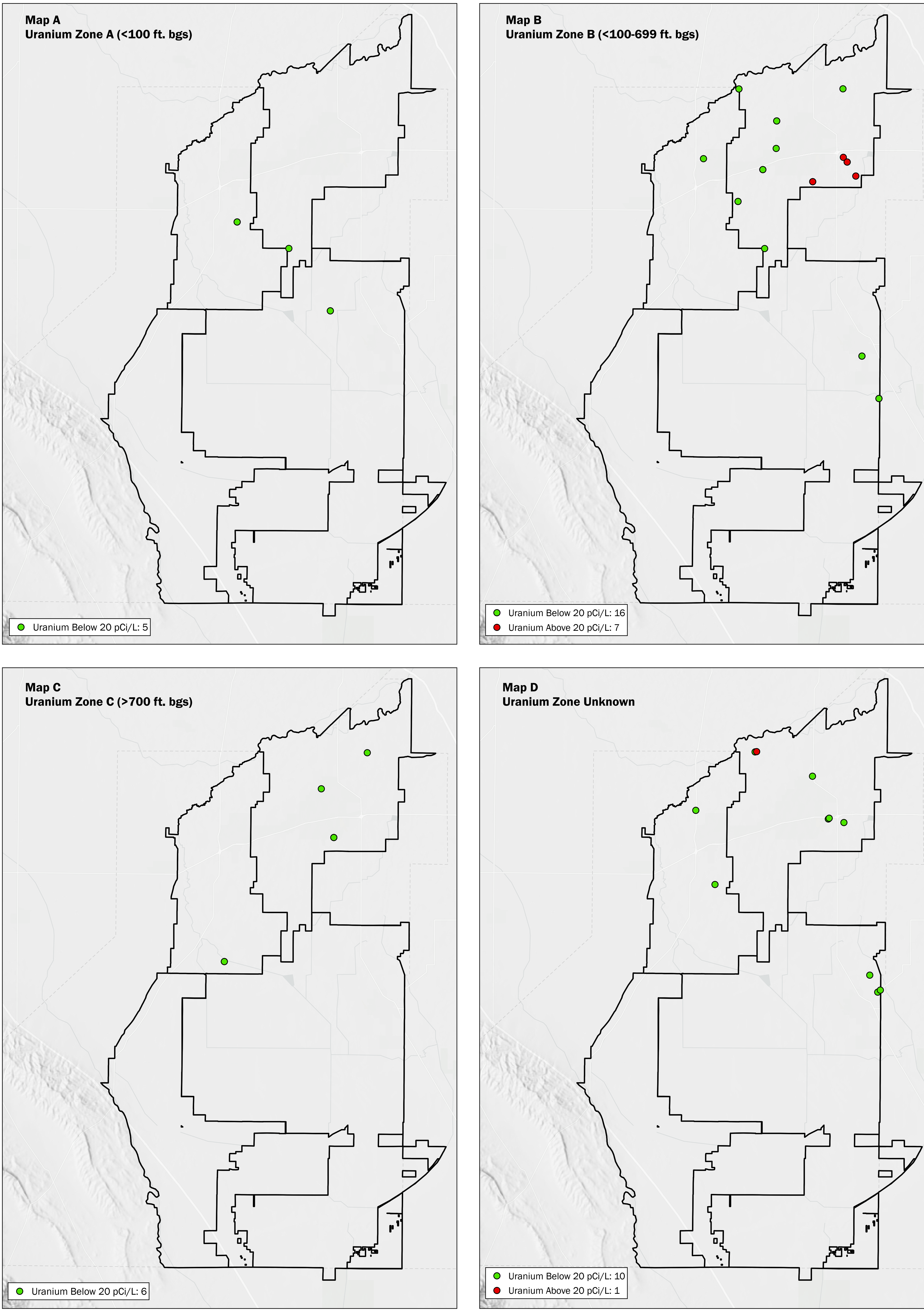
Earliest well sample was in 1989

Notes: ft. bgs = Feet Below Ground Surface
pCi/L = picocuries per liter
Data retrieved from State Water Resources Control Board GAMA database.

Pre 2015 Distribution of Uranium Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3A.2.5-4a



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- Uranium Below 20 pCi/L: Well Count
- Uranium Above 20 pCi/L: Well Count
- Groundwater Sustainability Agency (GSA)

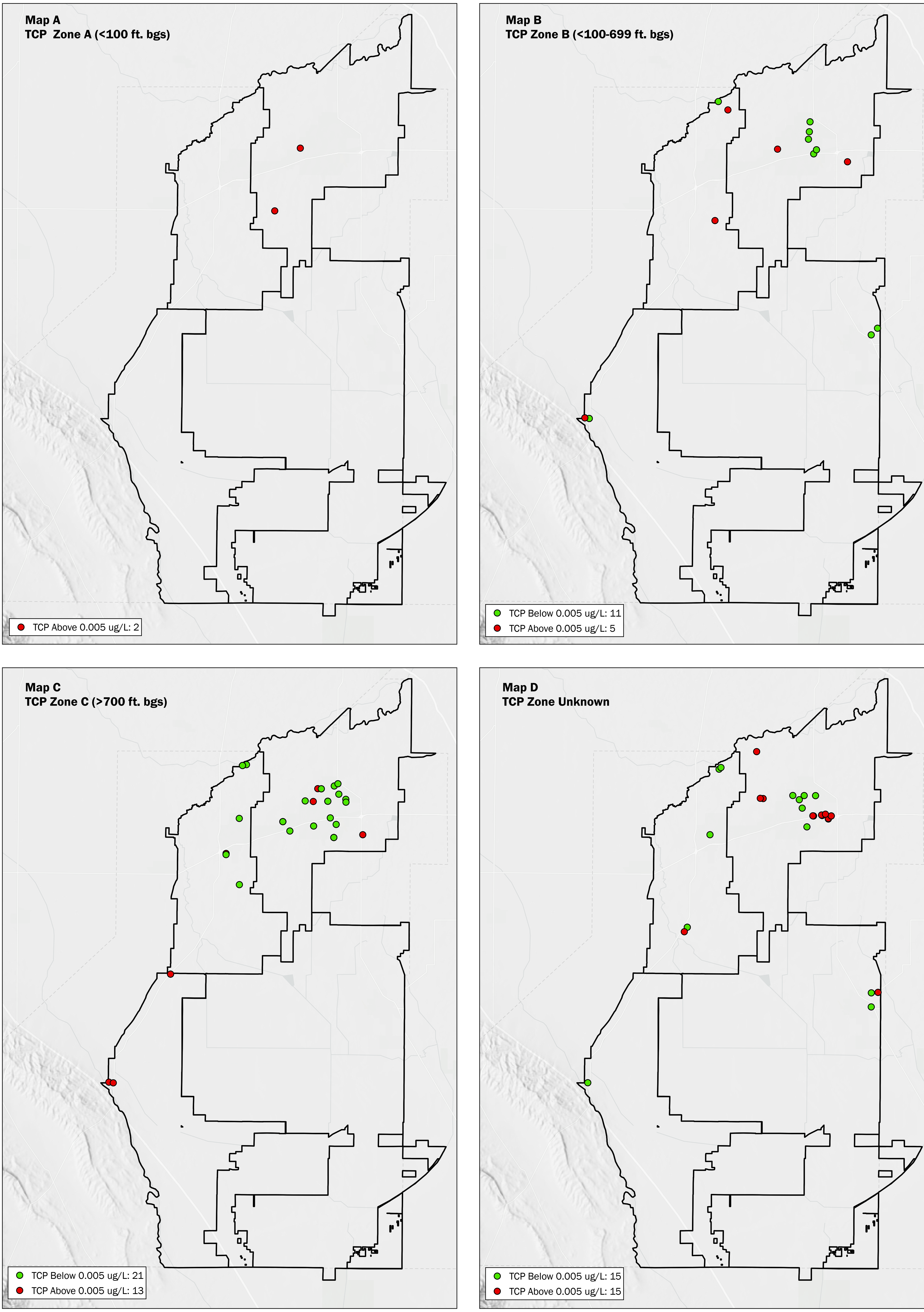
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Notes: ft. bgs = Feet Below Ground Surface
pCi/L = picocuries per liter
Data retrieved from State Water Resources Control Board GAMA database.

Post 2015 Distribution of Uranium Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3A.2.5-4b



TCP Below 0.005 ug/L:Well Count

TCP Above 0.005 ug/L:Well Count

Groundwater Sustainability Agency (GSA)

Notes: ft. bgs = Feet Below Ground Surface
TCP = 1,2,3-Trichloropropane
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

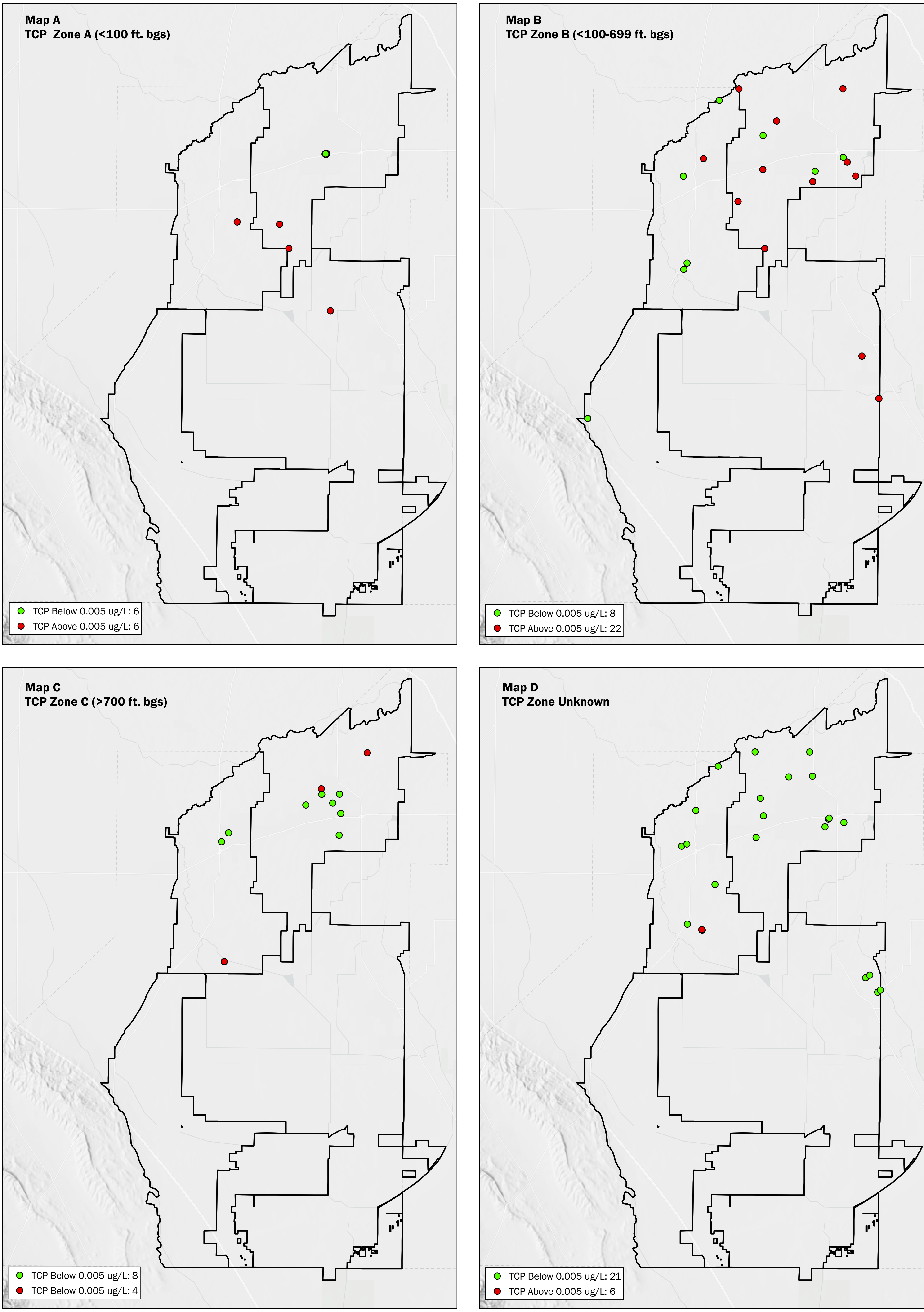
**Earliest well sample was in 1986*

Pre 2015 Distribution of 1,2,3-TCP Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants

APR-2024	BY: HMD	FIGURE NO.	
PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3A.2.5-5a	



TCP Below 0.005 ug/L: Well Count

TCP Above 0.005 ug/L:Well Count

Groundwater Sustainability Agency (GSA)

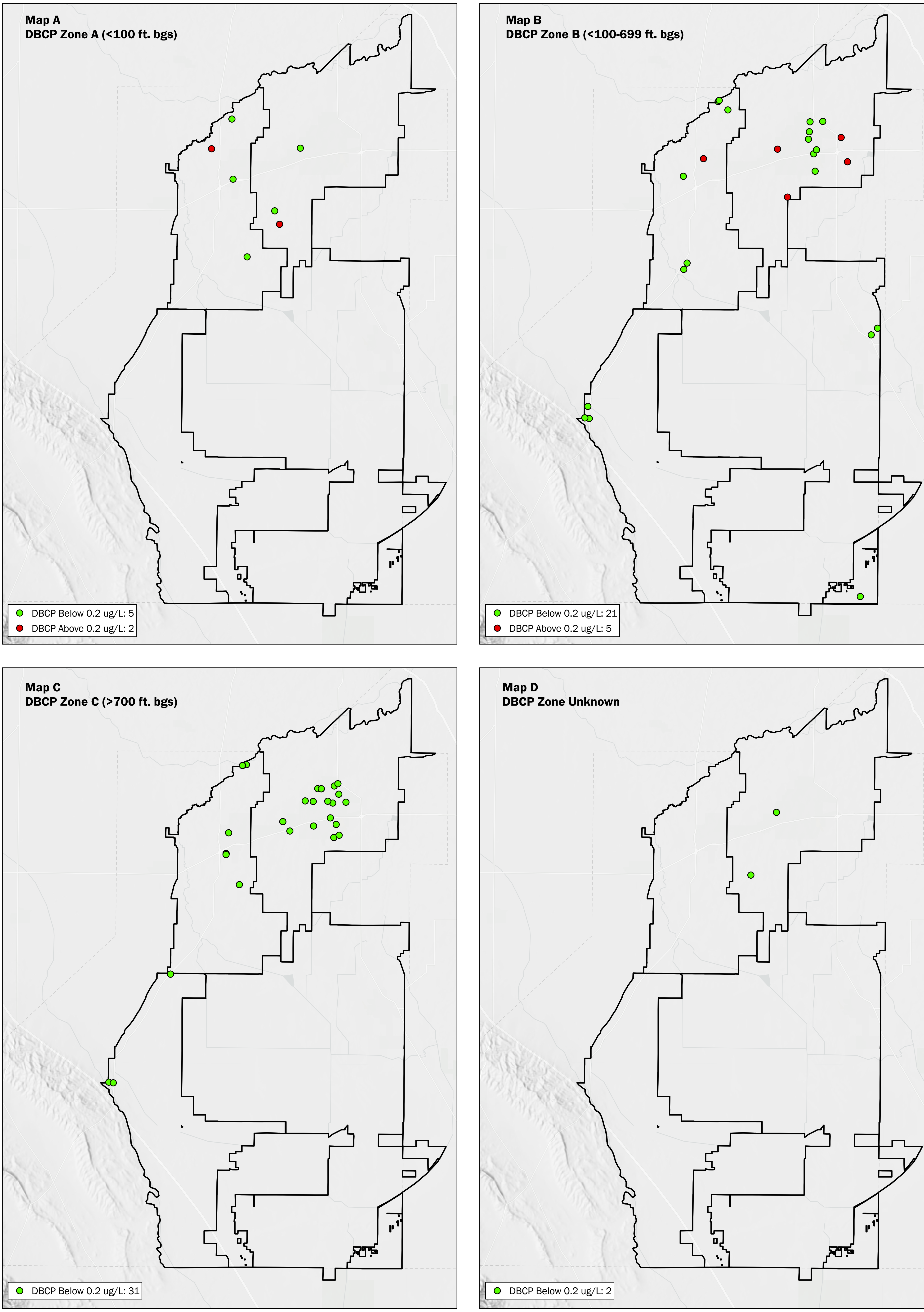
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Notes: ft. bgs = Feet Below Ground Surface
TCP = 1,2,3-Trichloropropane
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Post 2015 Distribution of 1,2,3-TCP Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-5b



DBCP Below 0.2 ug/L: Well Count

DBCP Above 0.2 ug/L: Well Count

Groundwater Sustainability Agency (GSA)

Notes:
ft. bgs = Feet Below Ground Surface
DBCP = 1,2-Dibromo-3-chloropropane
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

**Earliest well sample was in 1986*

Pre 2015 Distribution of DBCP Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-6a

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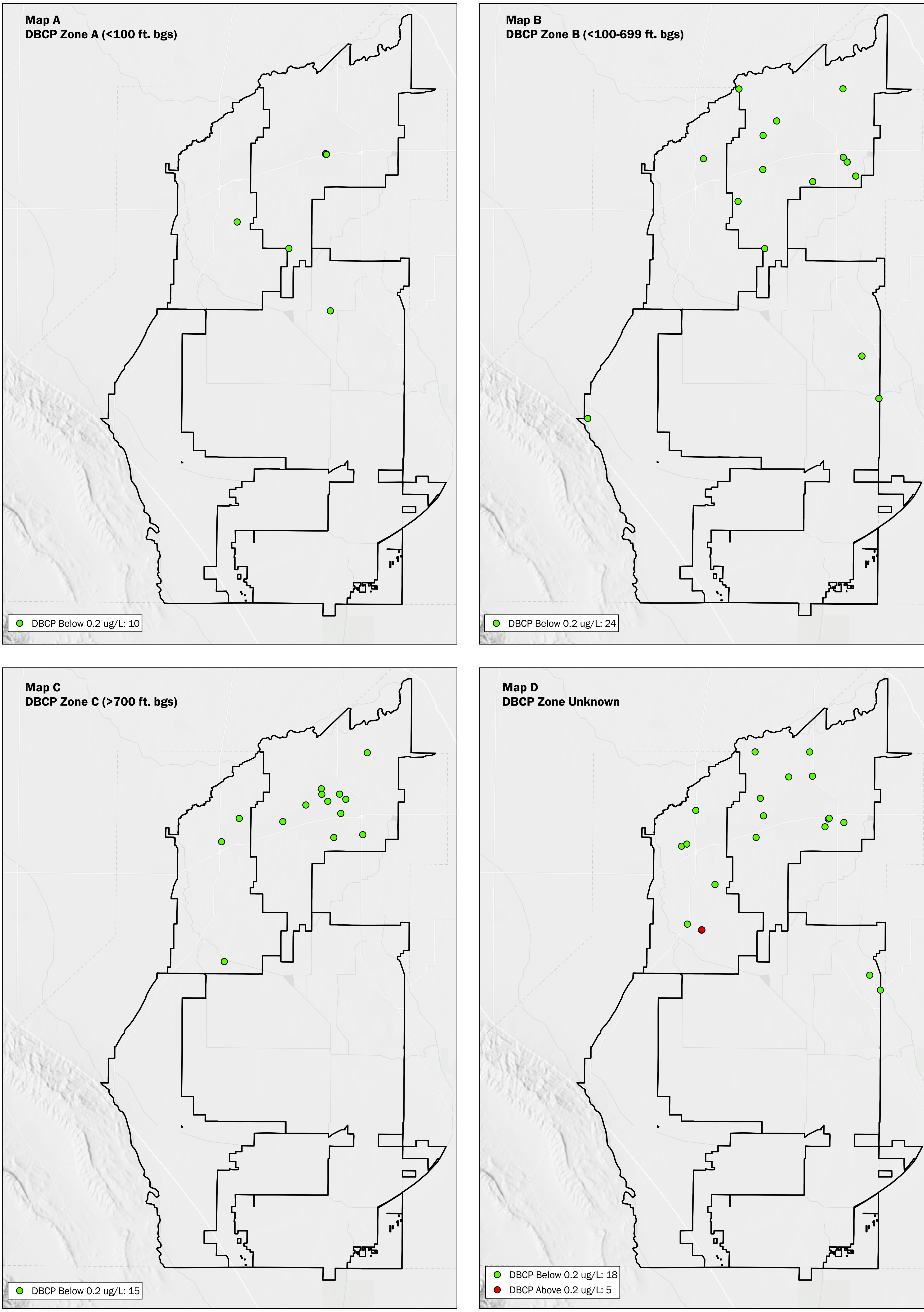

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DBCP Below 0.2 ug/L: Well Count

DBCP Above 0.2 ug/L: Well Count

Groundwater Sustainability Agency (GSA)

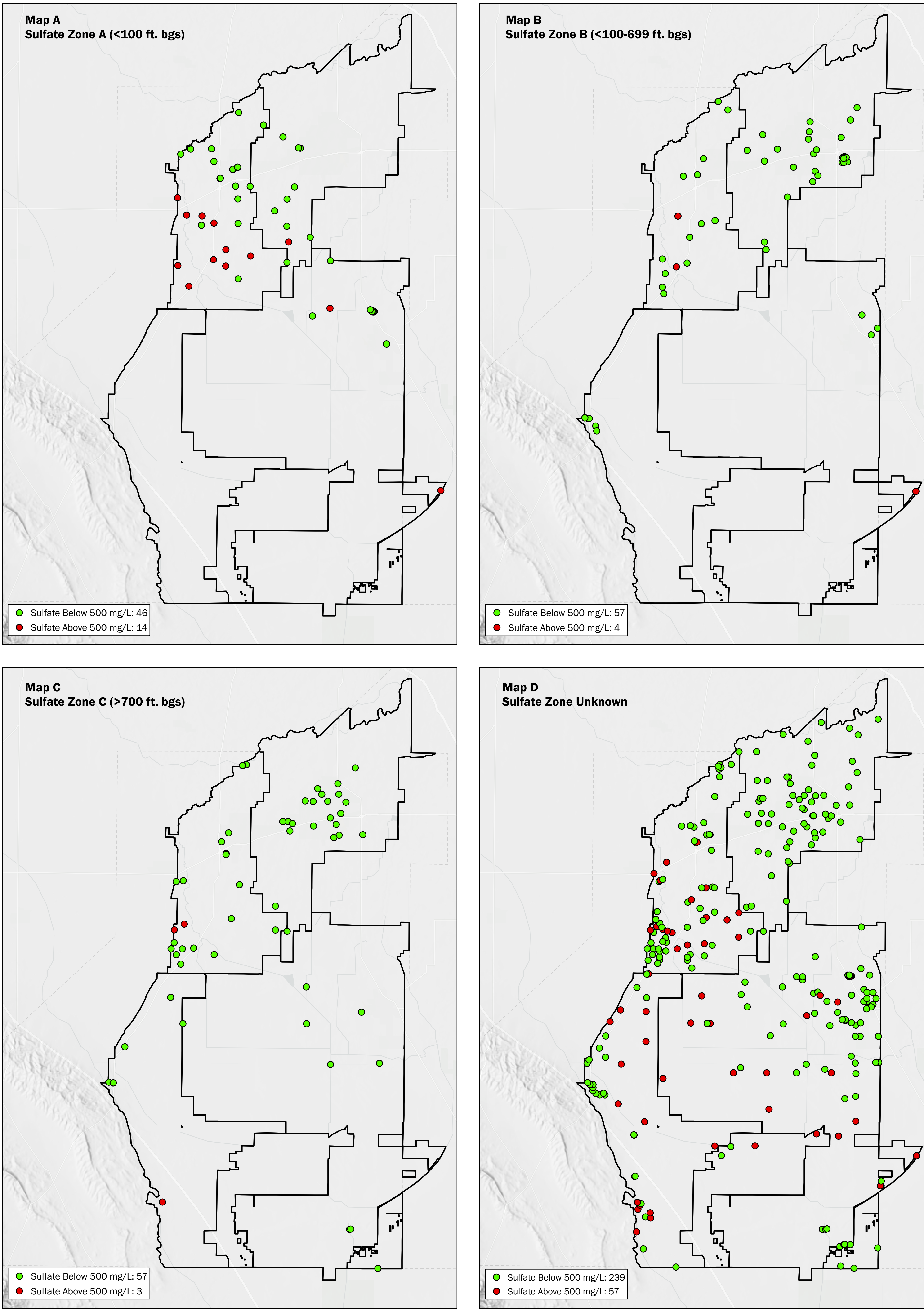
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Notes: ft. bgs = Feet Below Ground Surface
DBCP = 1,2-Dibromo-3-chloropropane
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Post 2015 Distribution of DBCP Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SFO138B	REVISED BY: ---/---	3A.2.5-6b



GIS Path: G:\projects\TulareLake_230301\TulareLakeChapter3\TulareLakeChapter3_230301.aprx: 3A.2.5-7a Pre 2015 Distribution of Sulfate Within Tulare Lake Subbasin || User: haley.duran || Print Date: 4/2/2024

Sulfate Below 500 mg/L: Well Count

Sulfate Above 500 mg/L: Well Count

Groundwater Sustainability Agency (GSA)

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Earliest well sample was in 1927

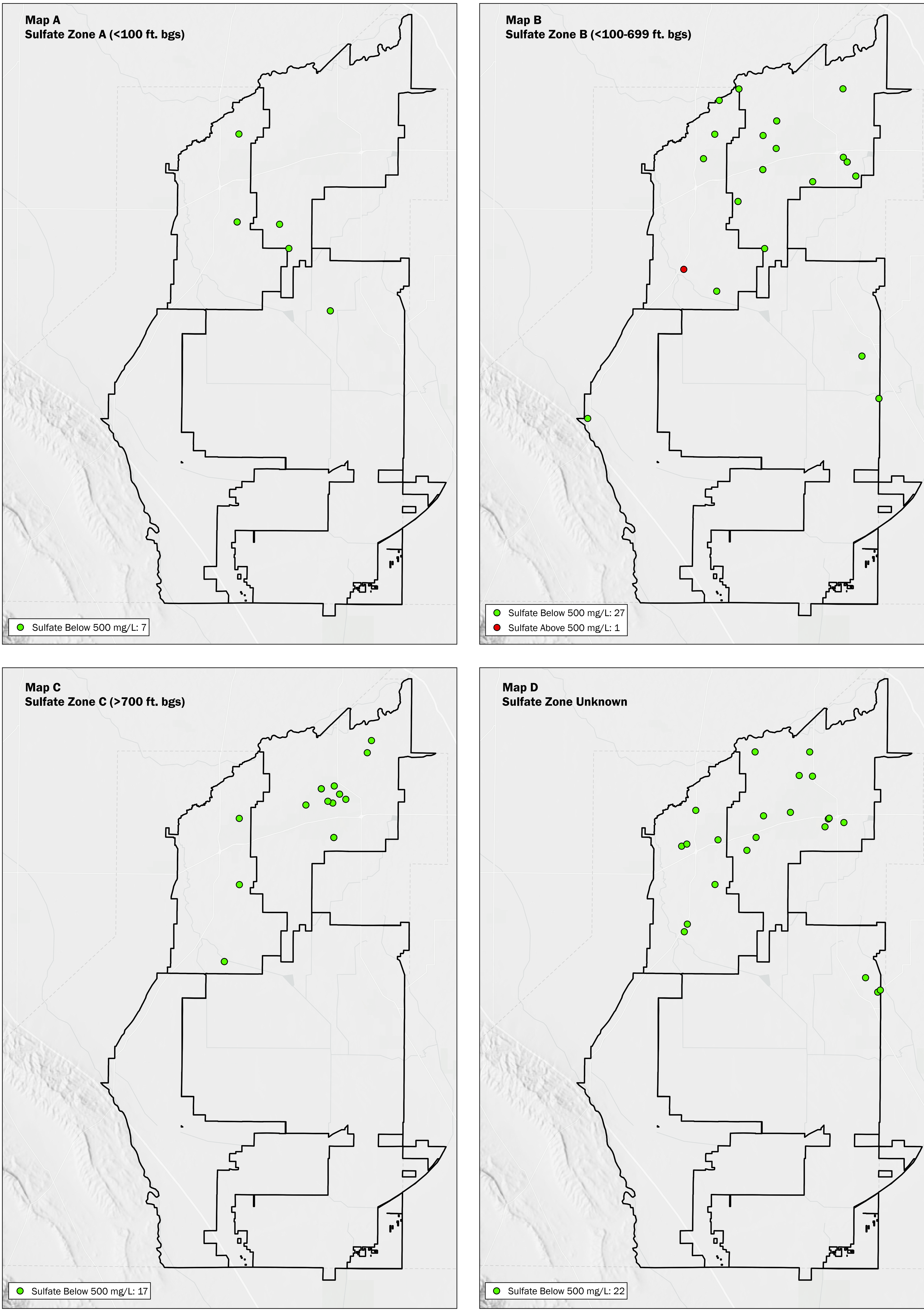
Notes:
ft. bgs = Feet Below Ground Surface
mg/L = milligram per liter
Data retrieved from State Water Resources Control Board GAMA database.

Pre 2015 Distribution of Sulfate Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants

APR-2024	BY: HMD	FIGURE NO.
PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-7a



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Sulfate Below 500 mg/L: Well Count

Sulfate Above 500 mg/L: Well Count

Groundwater Sustainability Agency (GSA)

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

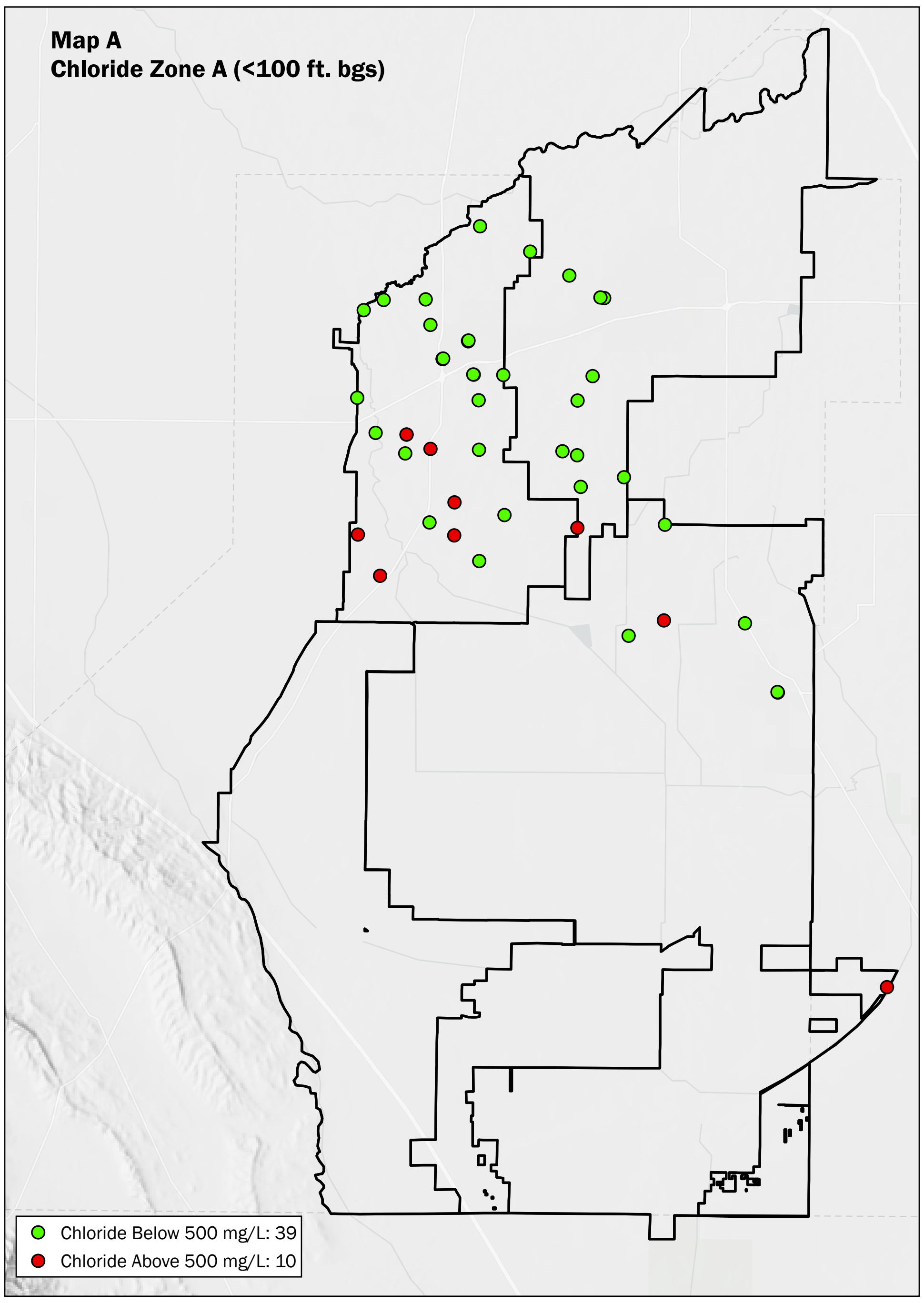
Notes:
ft. bgs = Feet Below Ground Surface
mg/L = milligram per liter
Data retrieved from State Water Resources Control Board GAMA database.

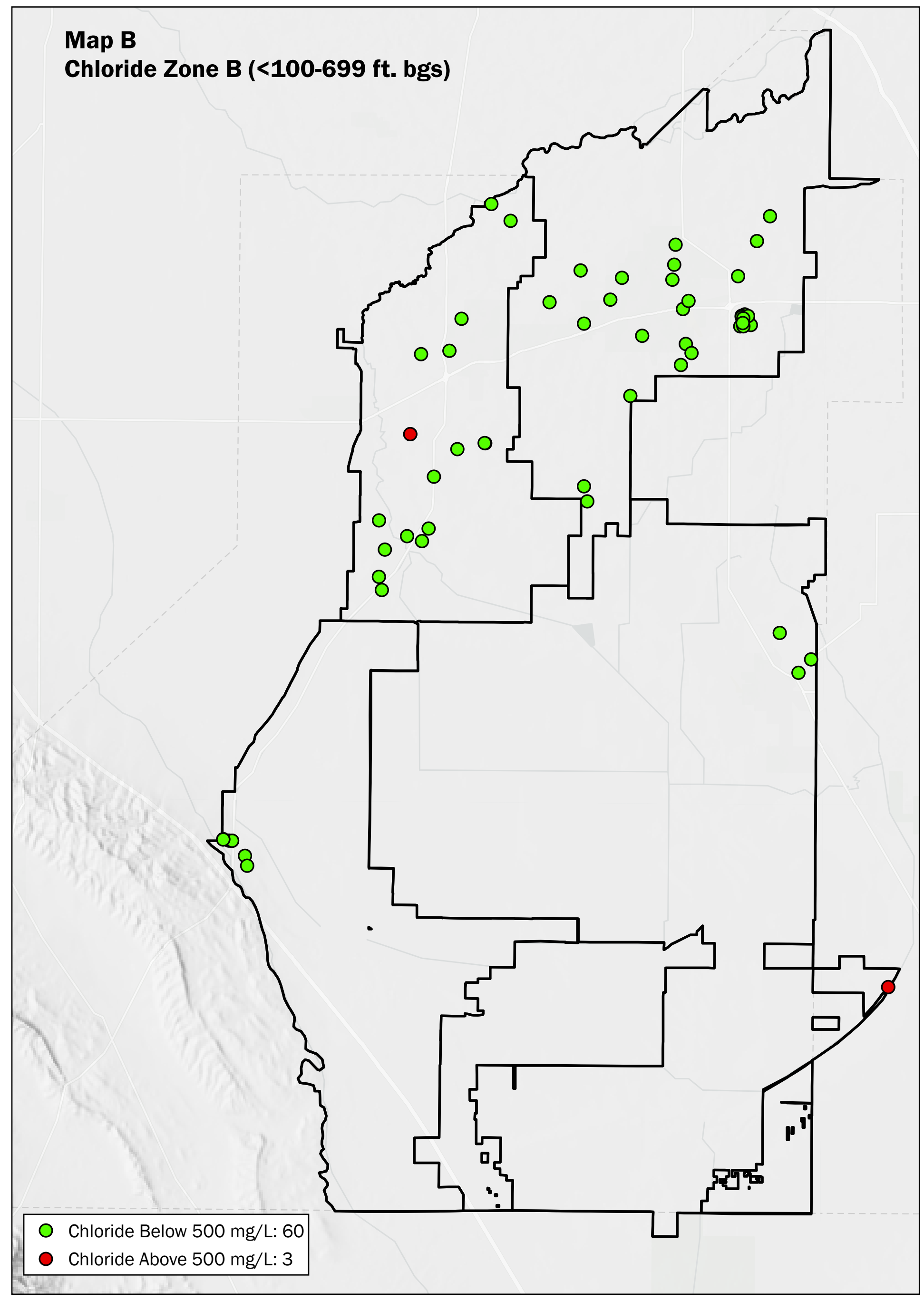
Post 2015 Distribution of Sulfate Within Tulare Lake Subbasin

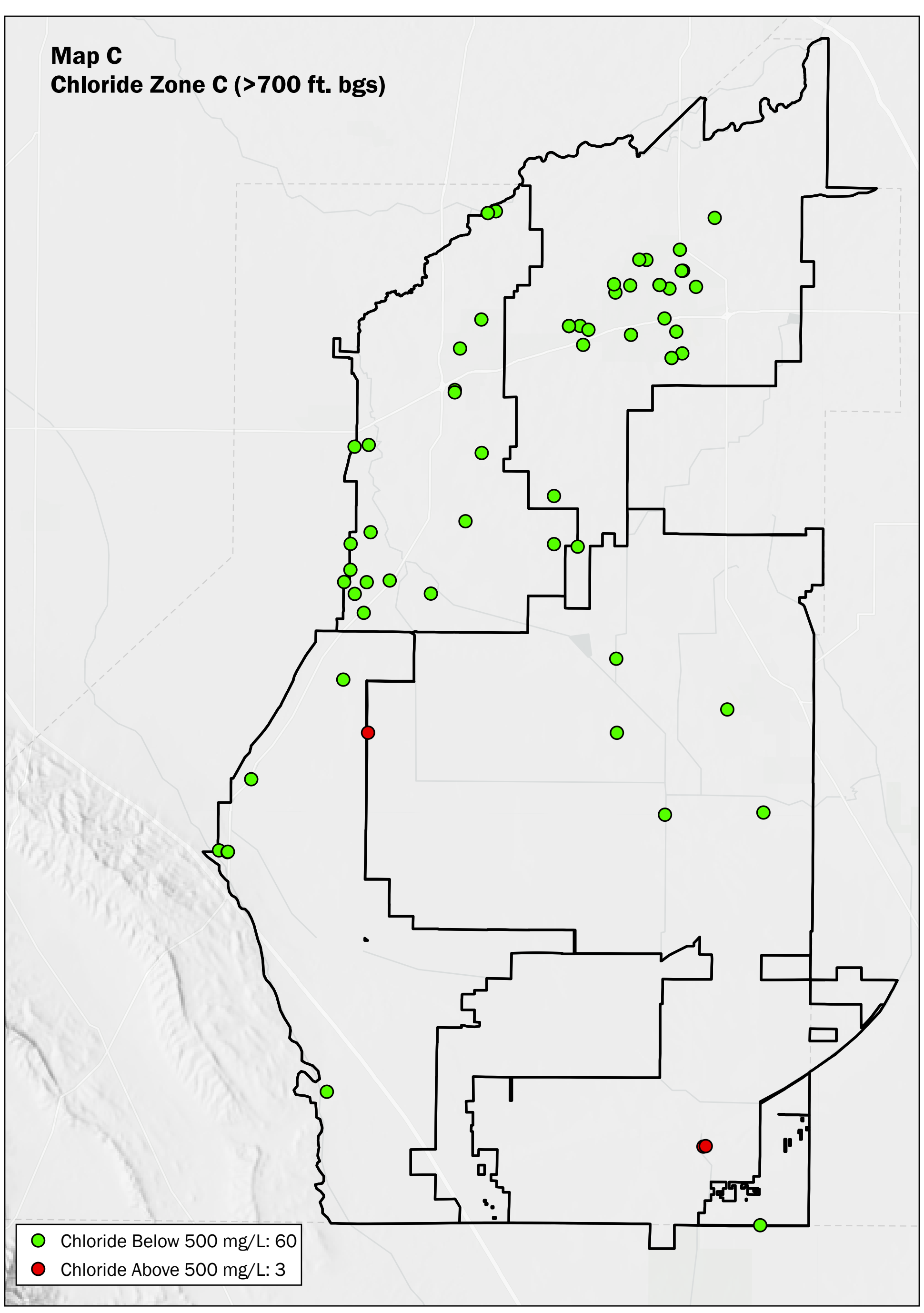
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

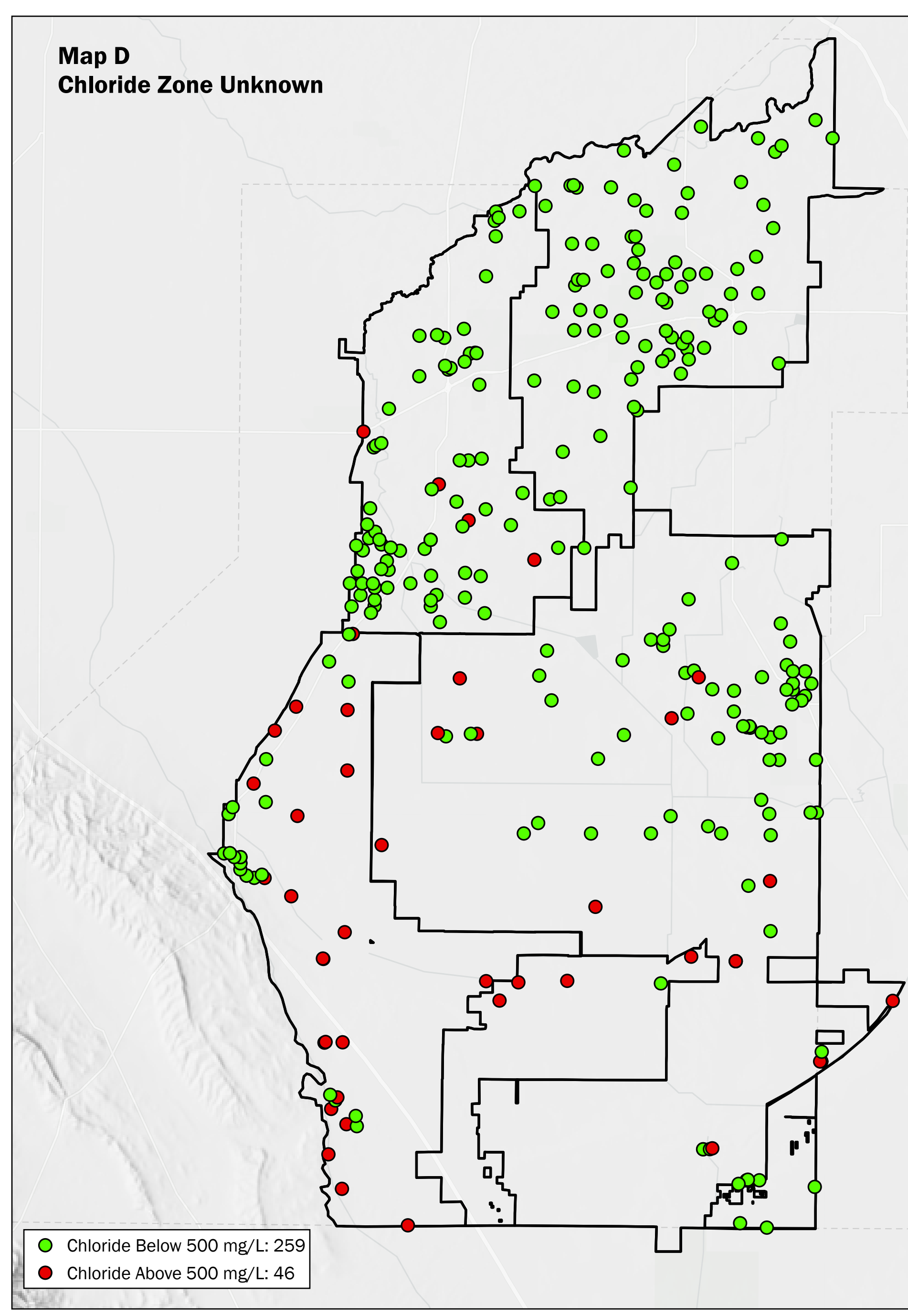
Geosyntec consultants

APR-2024	BY: HMD		FIGURE NO.
PROJECT NO. SF0138B	REVISED BY: ---/---		**3A.2.5-7b**









Chloride Below 500 mg/L: Well Count

Chloride Above 500 mg/L: Well Count

Groundwater Sustainability Agency (GSA)

Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

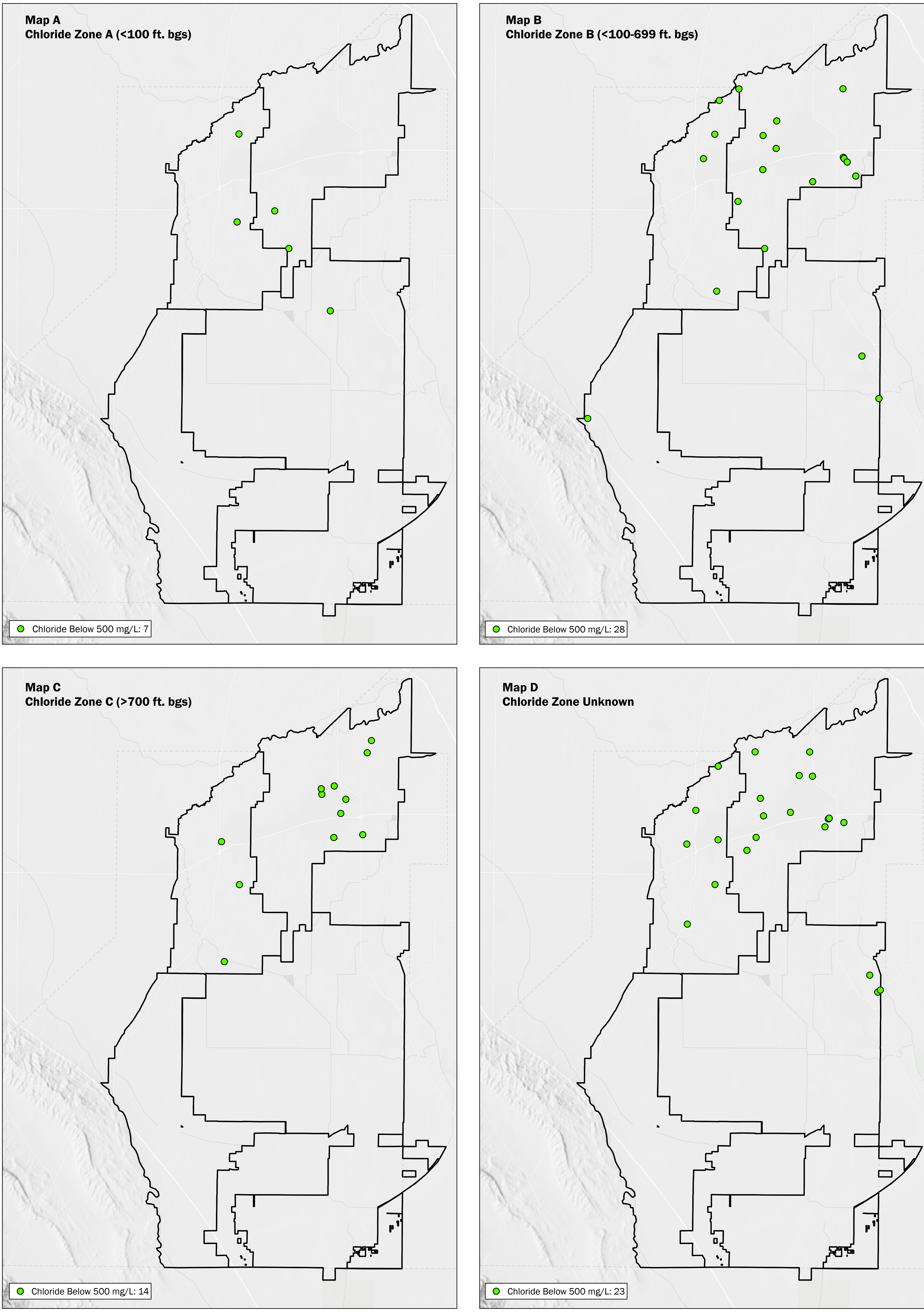
Earliest well sample was in 1927

Notes:
ft. bgs = Feet Below Ground Surface
mg/L = milligram per liter
Data retrieved from State Water Resources Control Board GAMA database.

Pre 2015 Distribution of Chloride Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3A.2.5-8a



Chloride Below 500 mg/L: Well Count

Chloride Above 500 mg/L: Well Count

Groundwater Sustainability Agency (GSA)

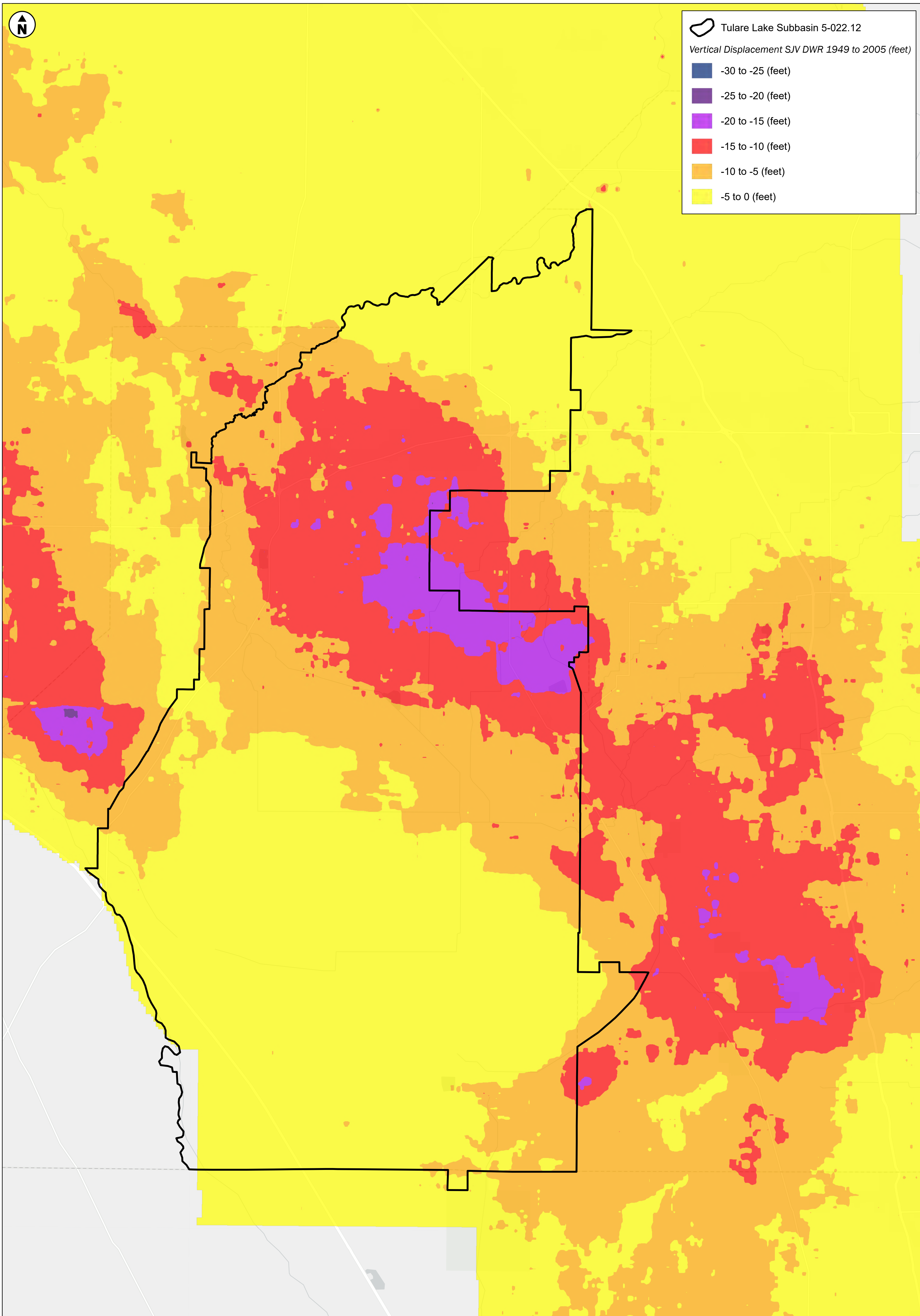
Map A) Wells screened above 100 ft bgs
Map B) Wells screened between 100-699 ft bgs
Map C) Wells screened below 700 ft bgs
Map D) Wells with unknown screen interval

Notes:
ft. bgs = Feet Below Ground Surface
mg/L = milligram per liter
Data retrieved from State Water Resources Control Board GAMA database.

Post 2015 Distribution of Chloride Within Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.2.5-8b



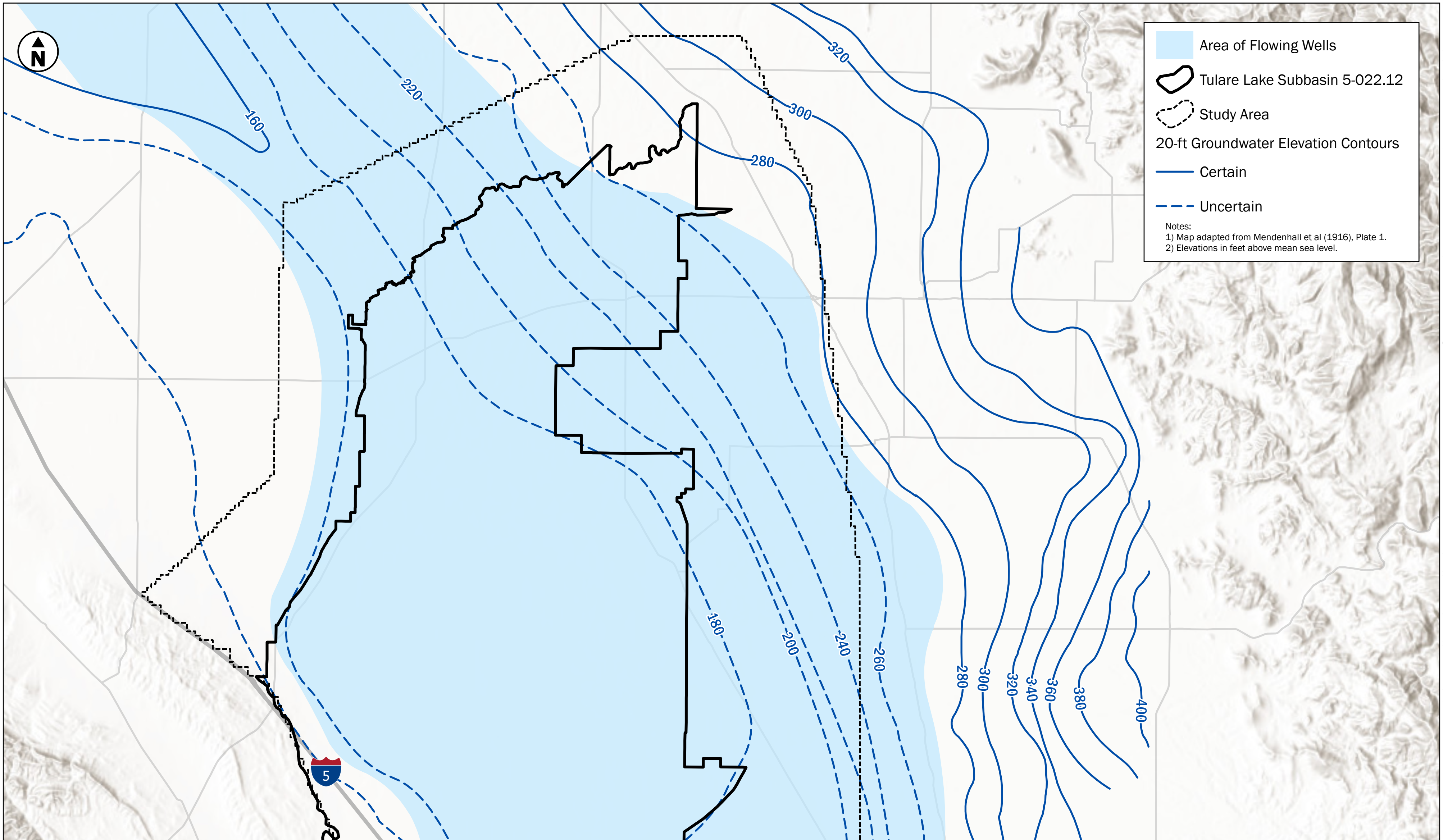
Magnitude of Subsidence Between 1949 and 2005 Measured Within TLSB

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.5.0-1

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SFO138B.aprx: 3.5.1-2 Magnitude of Subsidence between 1949 and 2005 measured within TLSB || User: haley.duran || Print Date: 1/23/2024

Data source credits: None || Basemap Service Layer Credits: California Department of Water Resources, Geodetic Branch, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



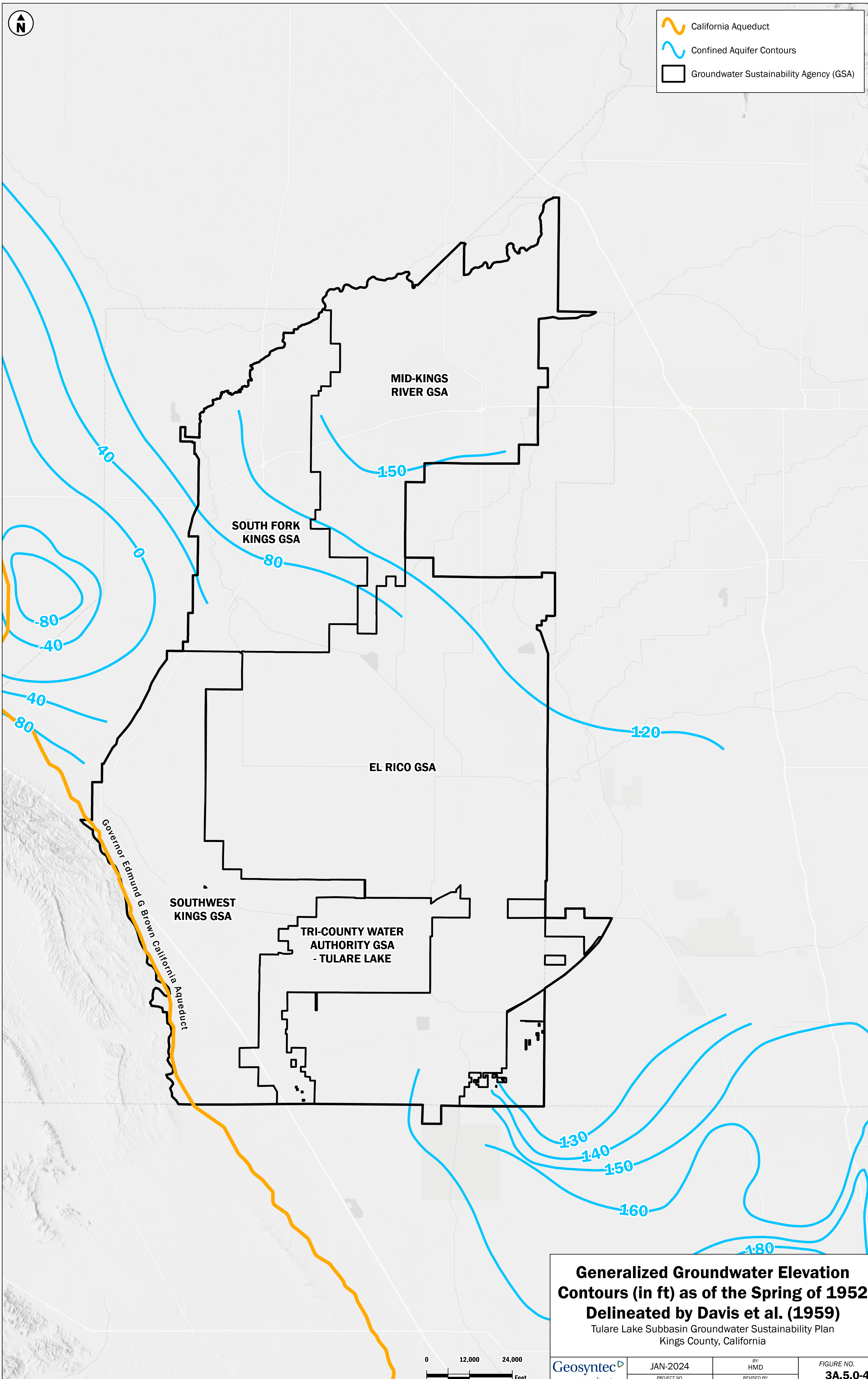
Area of Flowing Wells and Contours of Groundwater Elevation in the Confined Aquifer

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	3A.5.0-3

GIS Path: G:\projects\TulareLake_230301\TulareLake_230301_SF0138B.aprx: 3.5.1-3 Area of Flowing Wells and Contours of Groundwater Elevation in the Confined Aquifer | | User: haley.duran | | Print Date: 1/23/2024

Data source credits: None | | Basemap Service Layer Credits: Esri, CGIAR, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

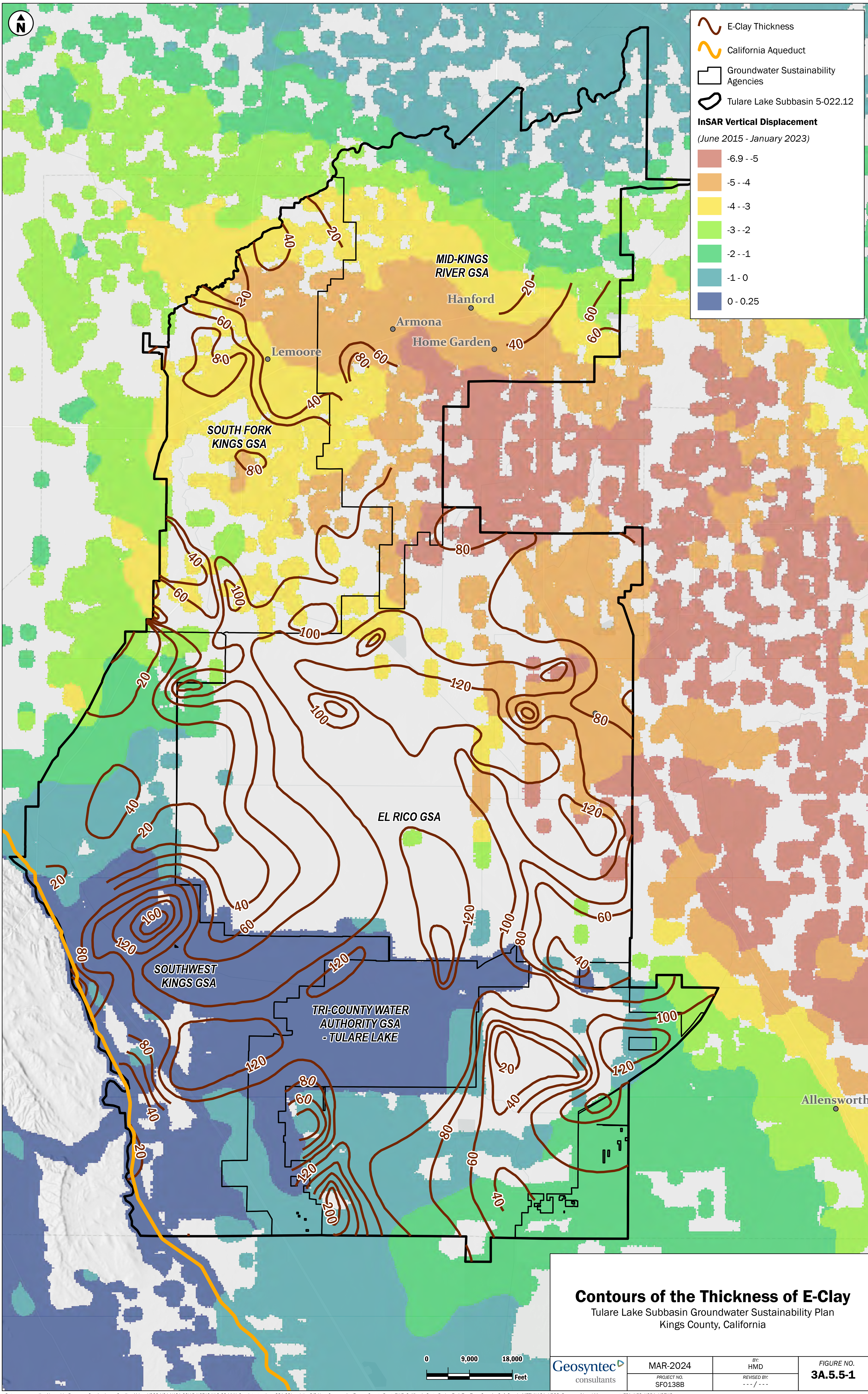


Generalized Groundwater Elevation Contours (in ft) as of the Spring of 1952 Delineated by Davis et al. (1959)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO. 3A.5.0-4
	PROJECT NO. SFO138B	REVISED BY: ---/---	

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

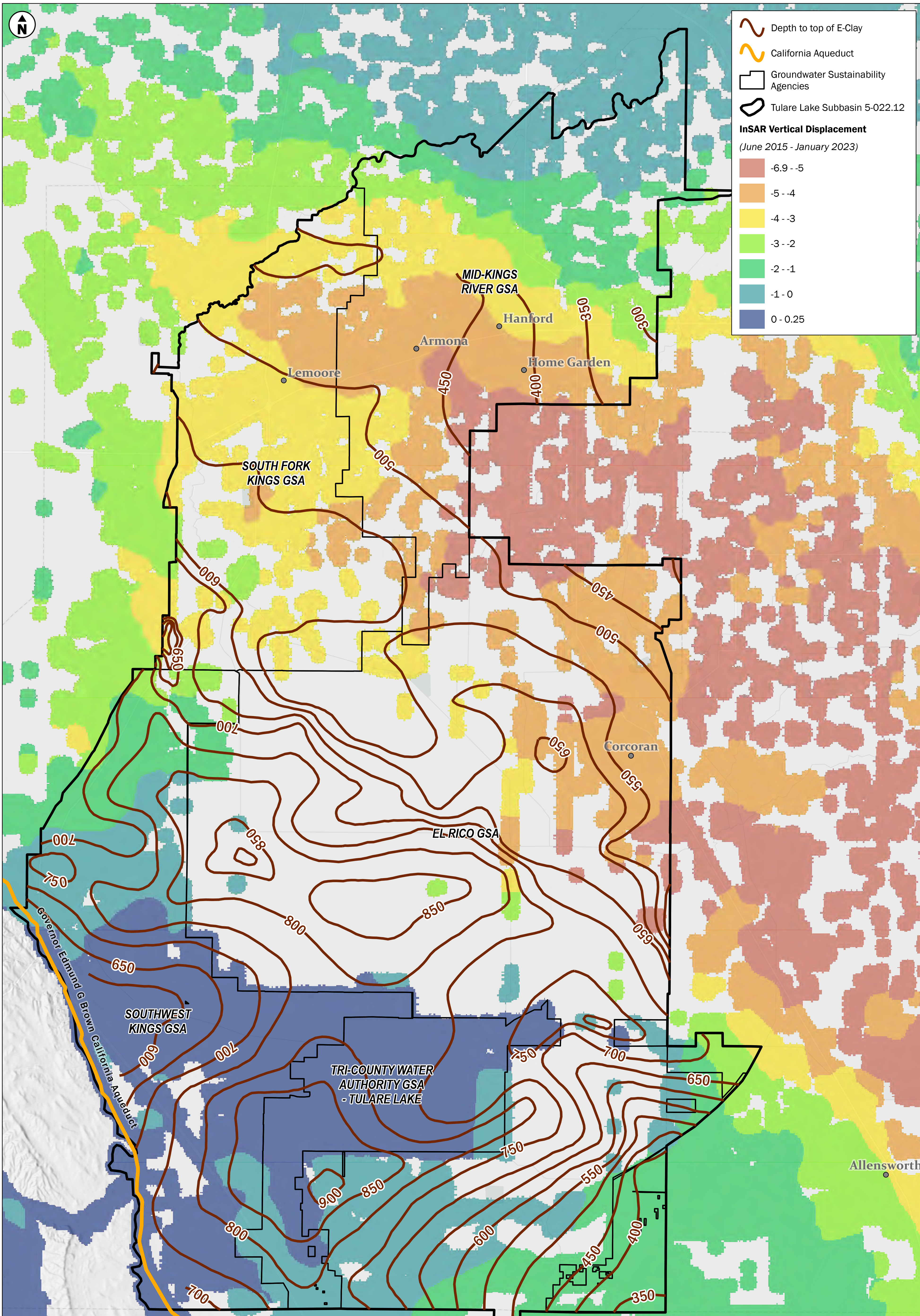


Contours of the Thickness of E-Clay

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO. 3A.5.5-1
	PROJECT NO. SF0138B	REVISED BY: ---/---	

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

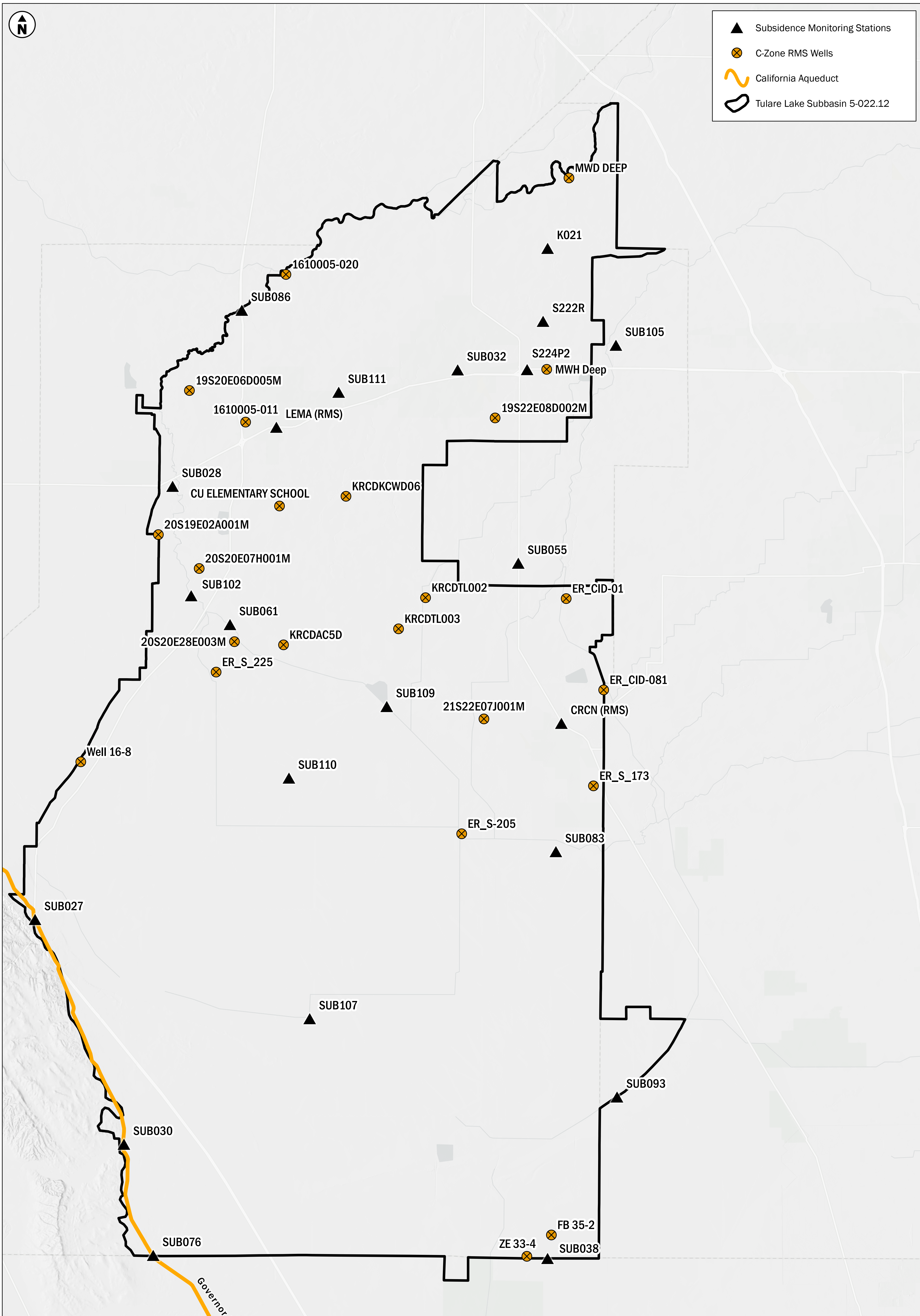


Contours of the Depth to the Top of the E-Clay

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO. 3A.5.5-2
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

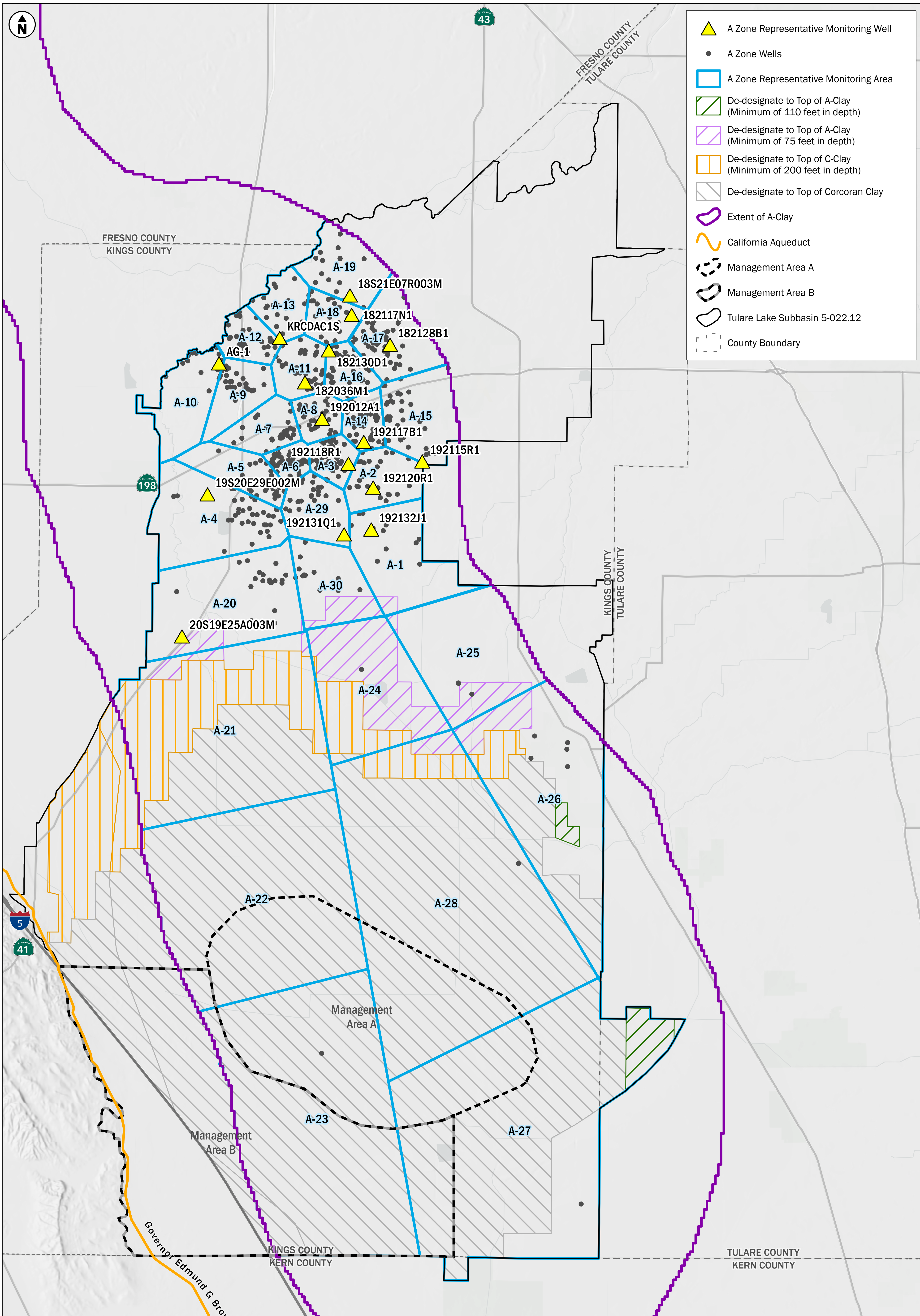


Location of Existing Subsidence Monitoring Stations and Monitoring Wells Installed Within Zone C

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	JAN-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	3A.5.6-2

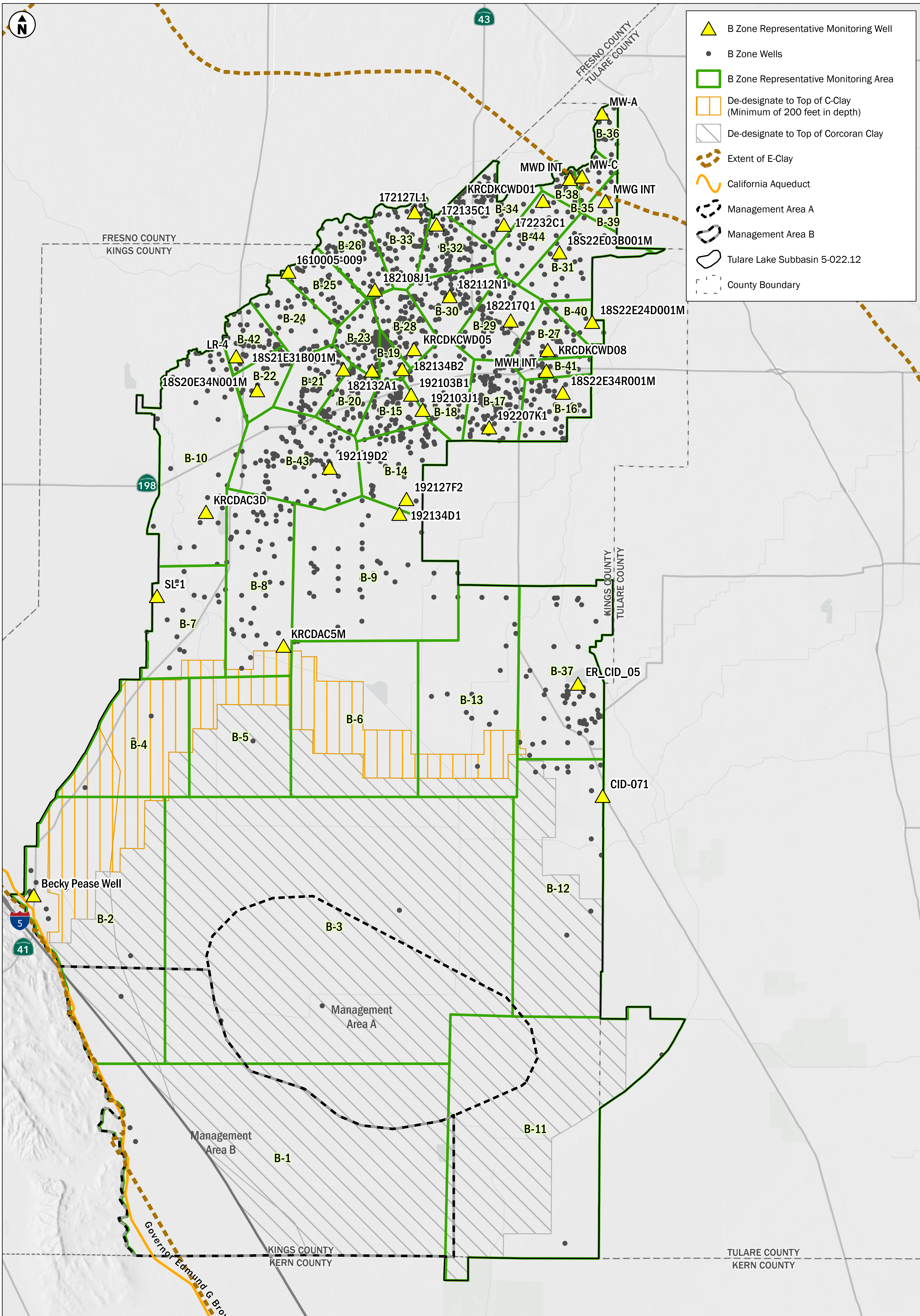
Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



Representative Monitoring Areas
A Zone
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SFO138B	REVISED BY: ---/---	**4.2.4-1**

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

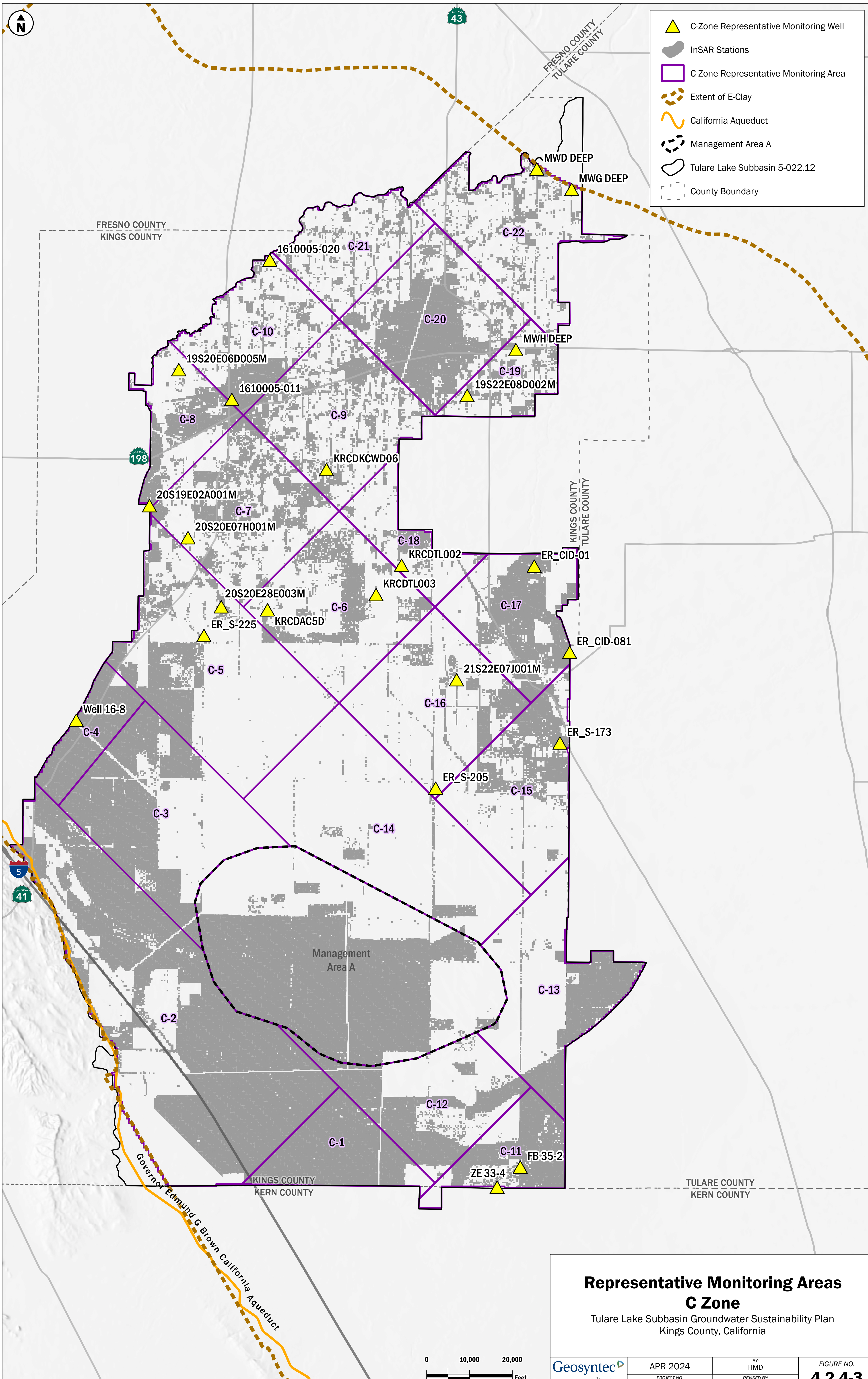


Representative Monitoring Areas B Zone

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SFO138B	REVISED BY: ---/---	4.2.4-2

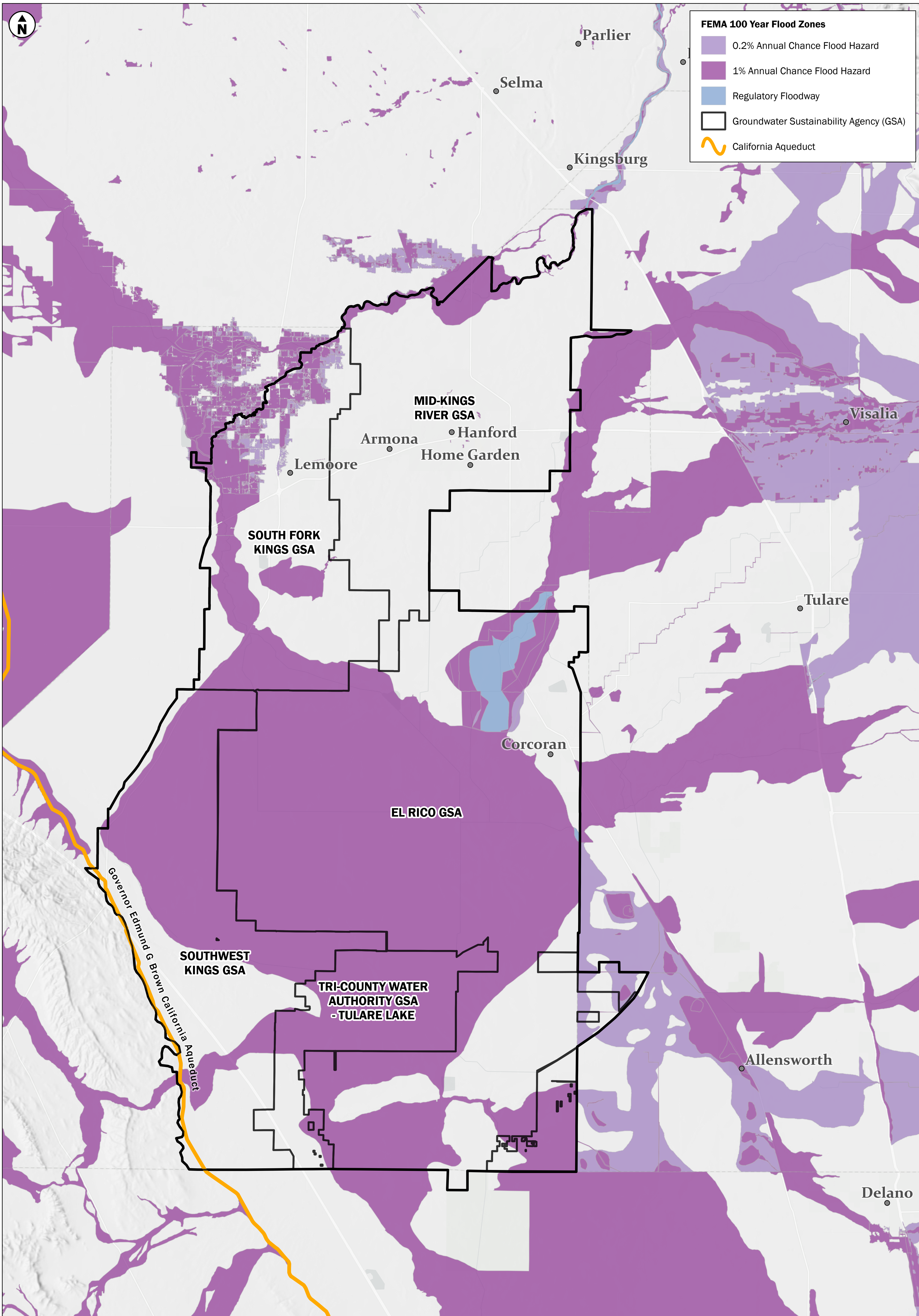
Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



Representative Monitoring Areas
C Zone

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	APR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SFO138B	REVISED BY: ---/---	**4.2.4-3**

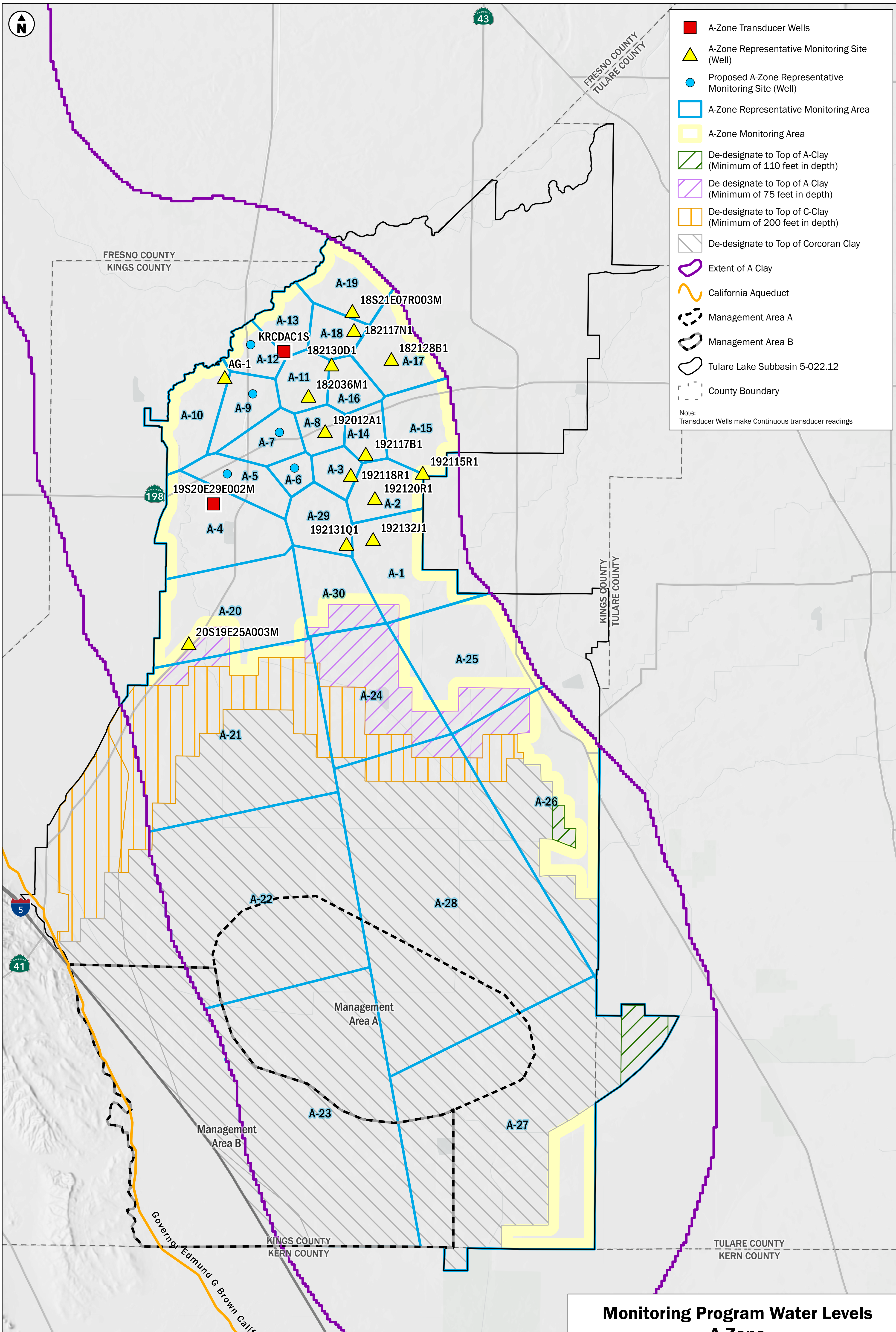


100-year Return Period Flood Zones Designated by FEMA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	4.7.2-1

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



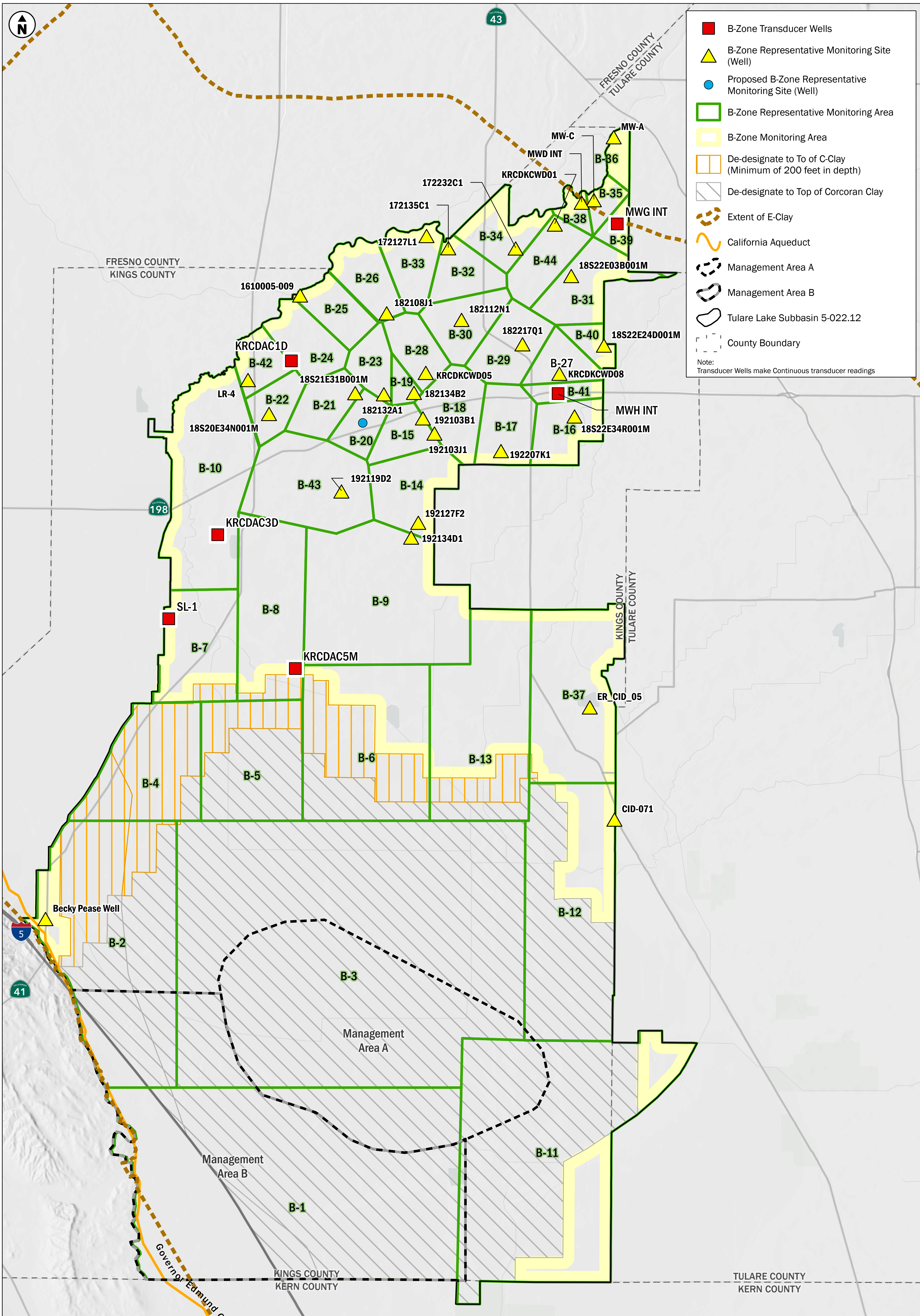
Monitoring Program Water Levels A Zone (Existing Wells + Proposed Wells)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants

MAR-2024	BY: HMD	FIGURE NO.
PROJECT NO. SF0138B	REVISED BY: ---/---	5.2.1-1

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

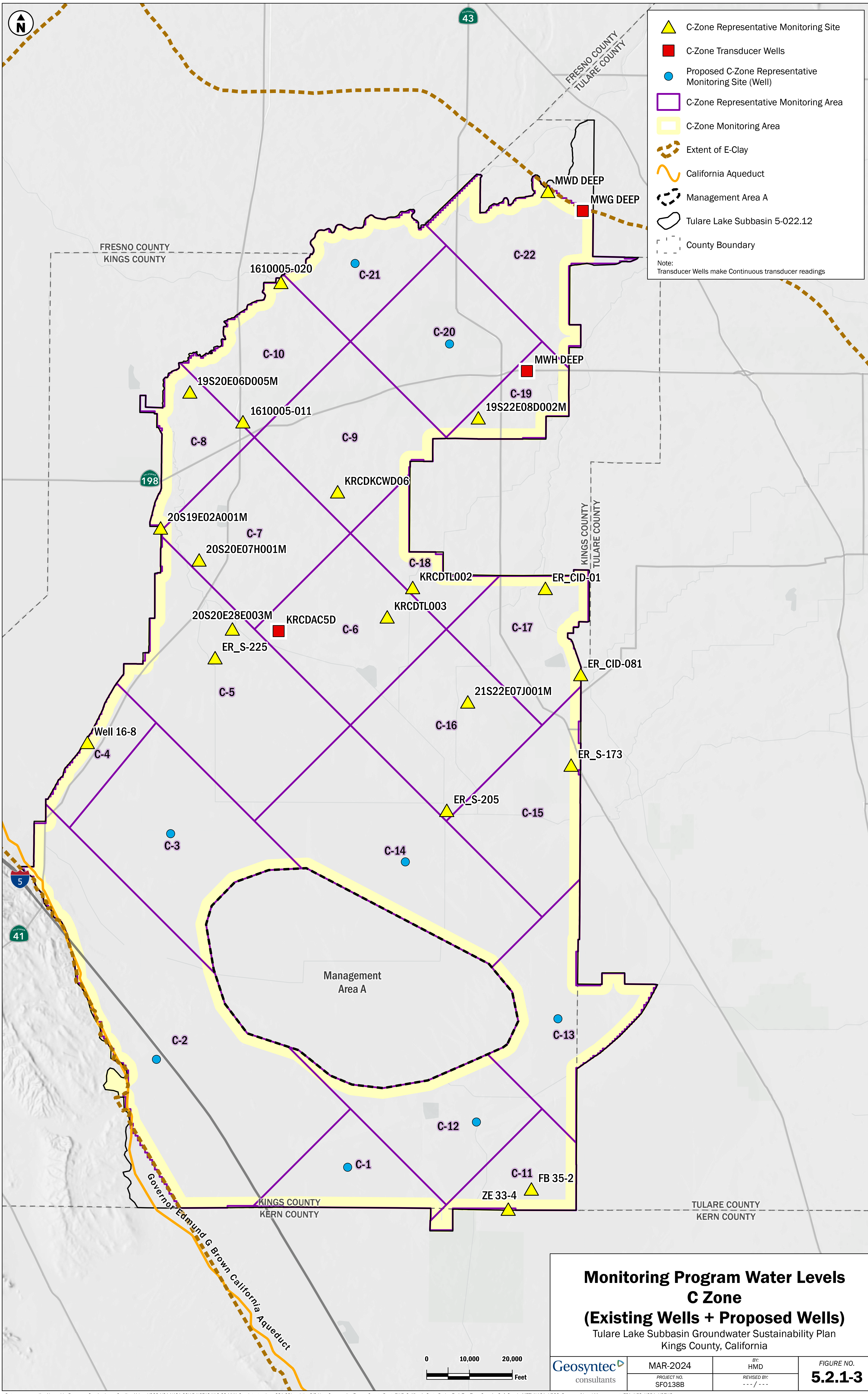


Monitoring Program Water Levels B Zone (Existing and Proposed)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	5.2.1-2

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

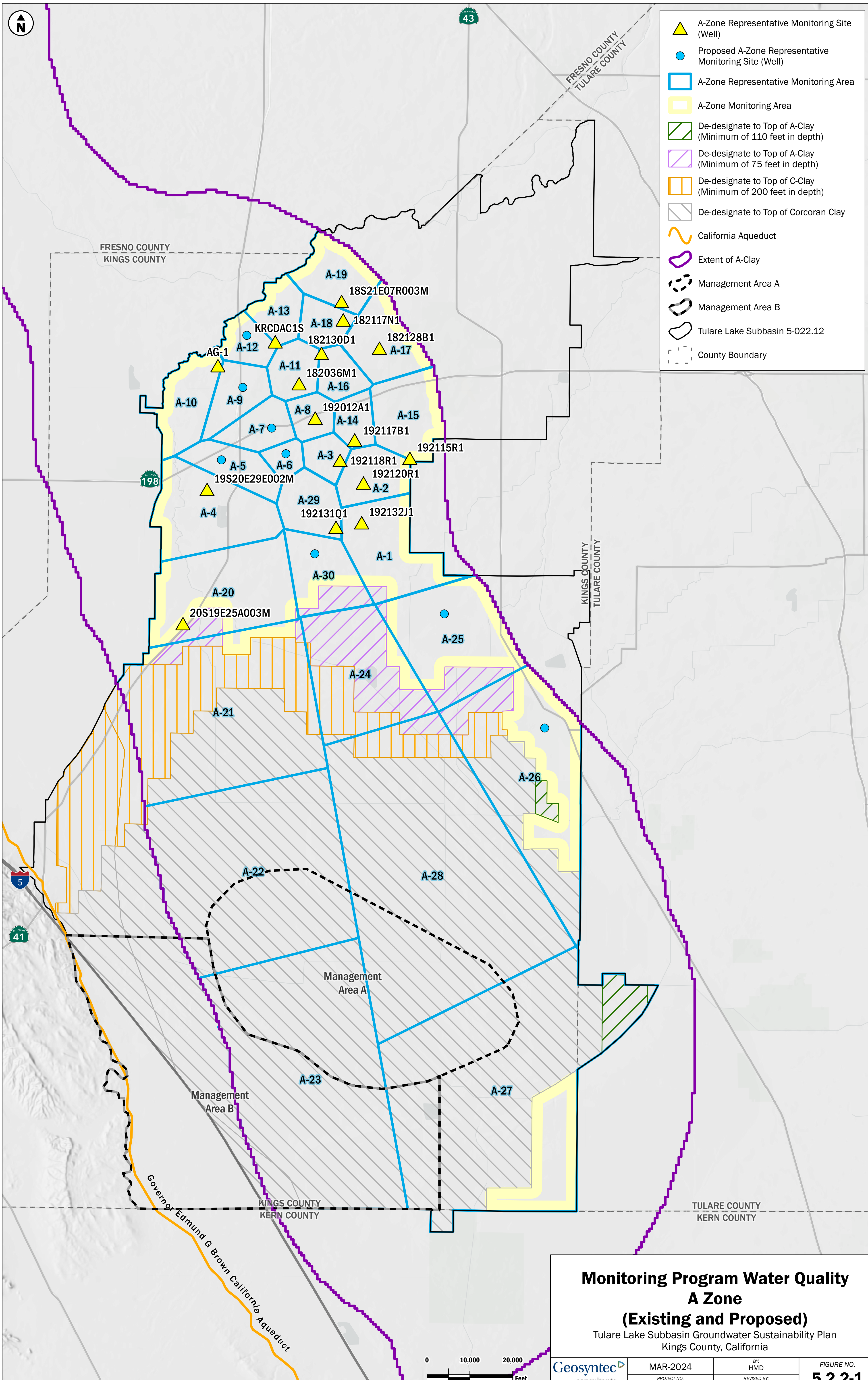


Monitoring Program Water Levels C Zone (Existing Wells + Proposed Wells)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	5.2.1-3

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

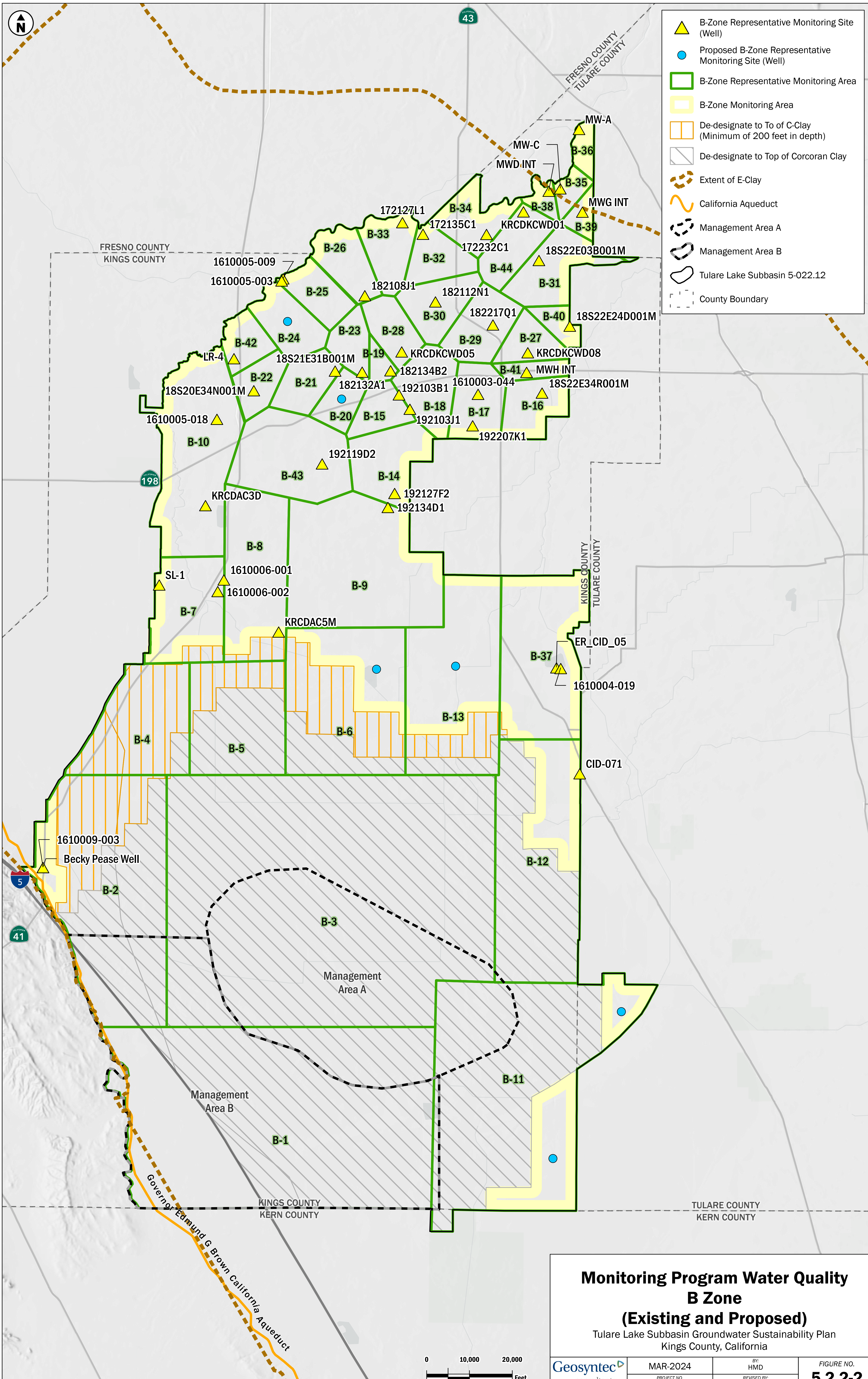


Monitoring Program Water Quality A Zone (Existing and Proposed)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants | MAR-2024 | BY: HMD | FIGURE NO. 5.2.2-1
PROJECT NO. SF0138B | REVISED BY: ---/---

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

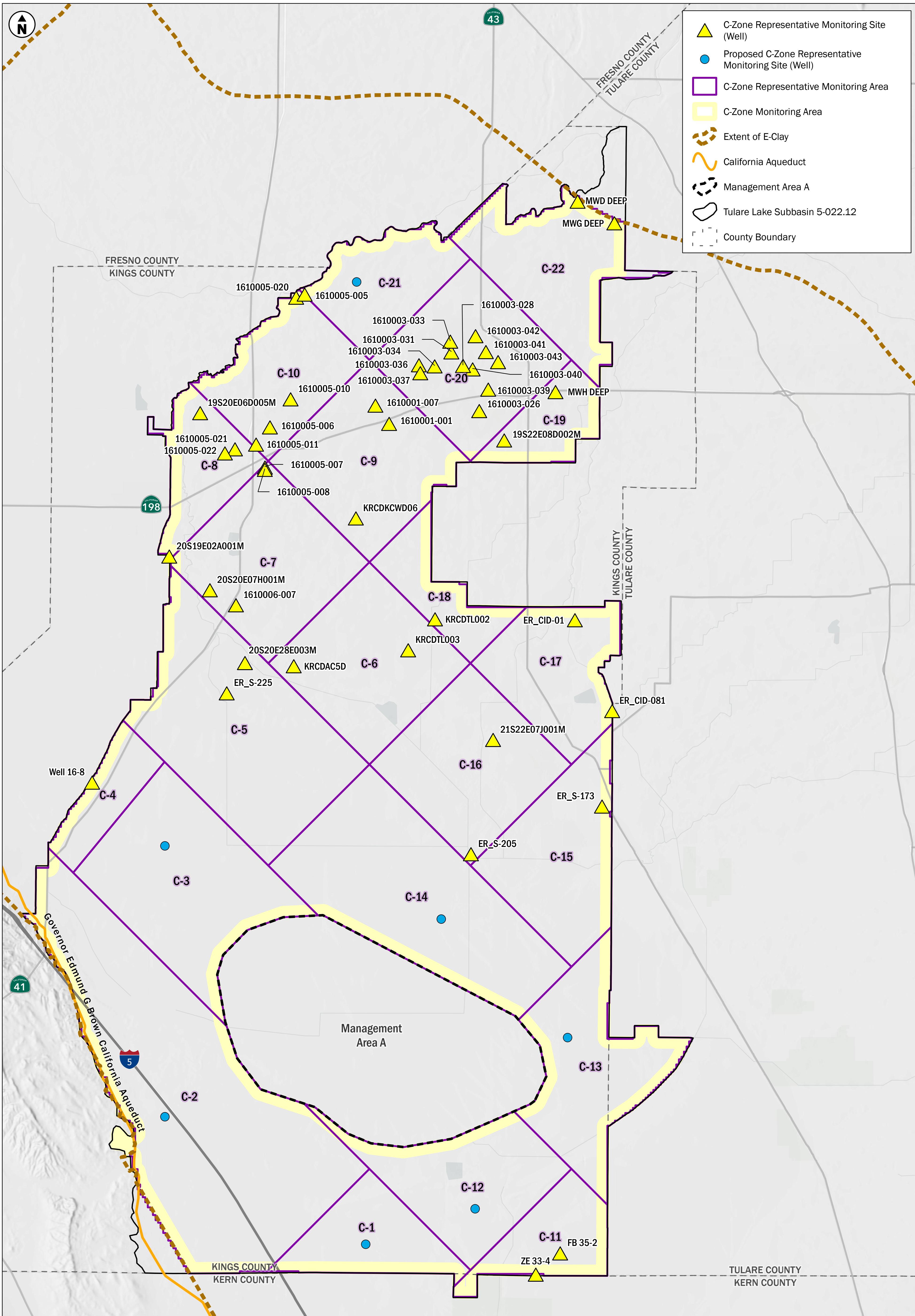


Monitoring Program Water Quality B Zone (Existing and Proposed)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SFO138B	REVISED BY: - - - / - - -	5.2.2-2

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

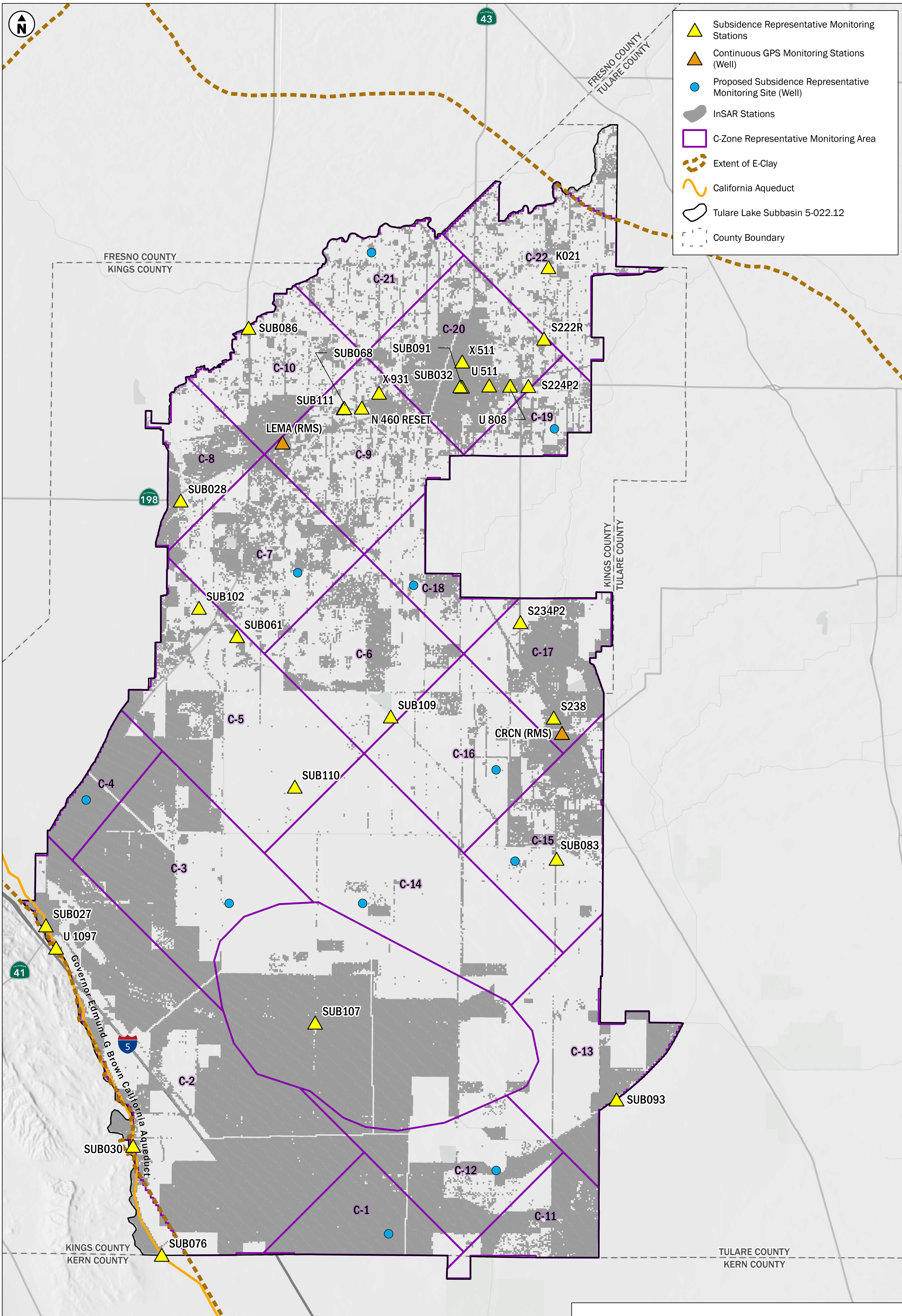


Monitoring Program Water Quality C Zone (Existing Wells + Proposed Wells)

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SFO138B	REVISED BY: ---/---	5.2.2-3

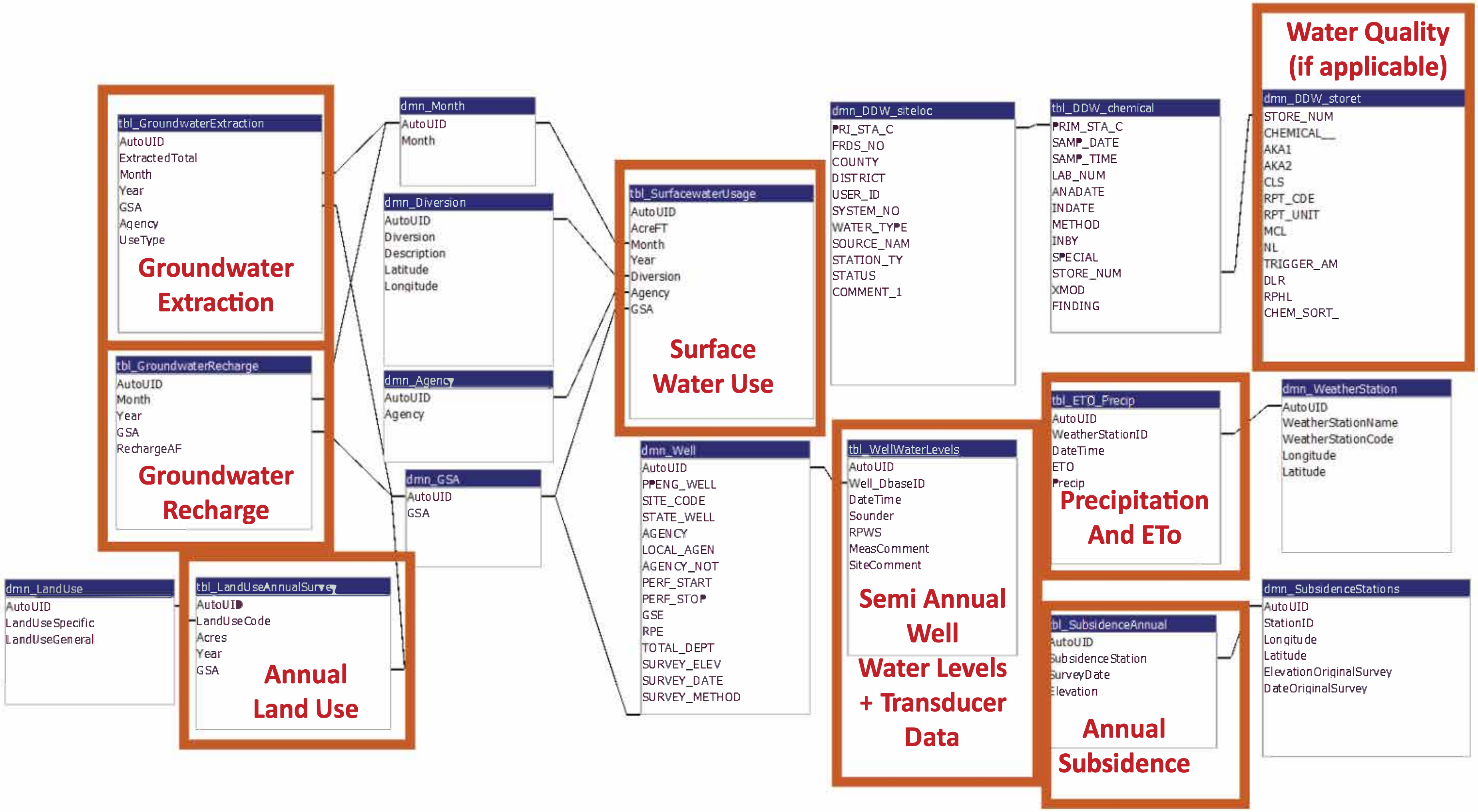
Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



Monitoring Program
Subsidence
(Existing Wells + Proposed Stations)
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	MAR-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	**5.2.3-1**

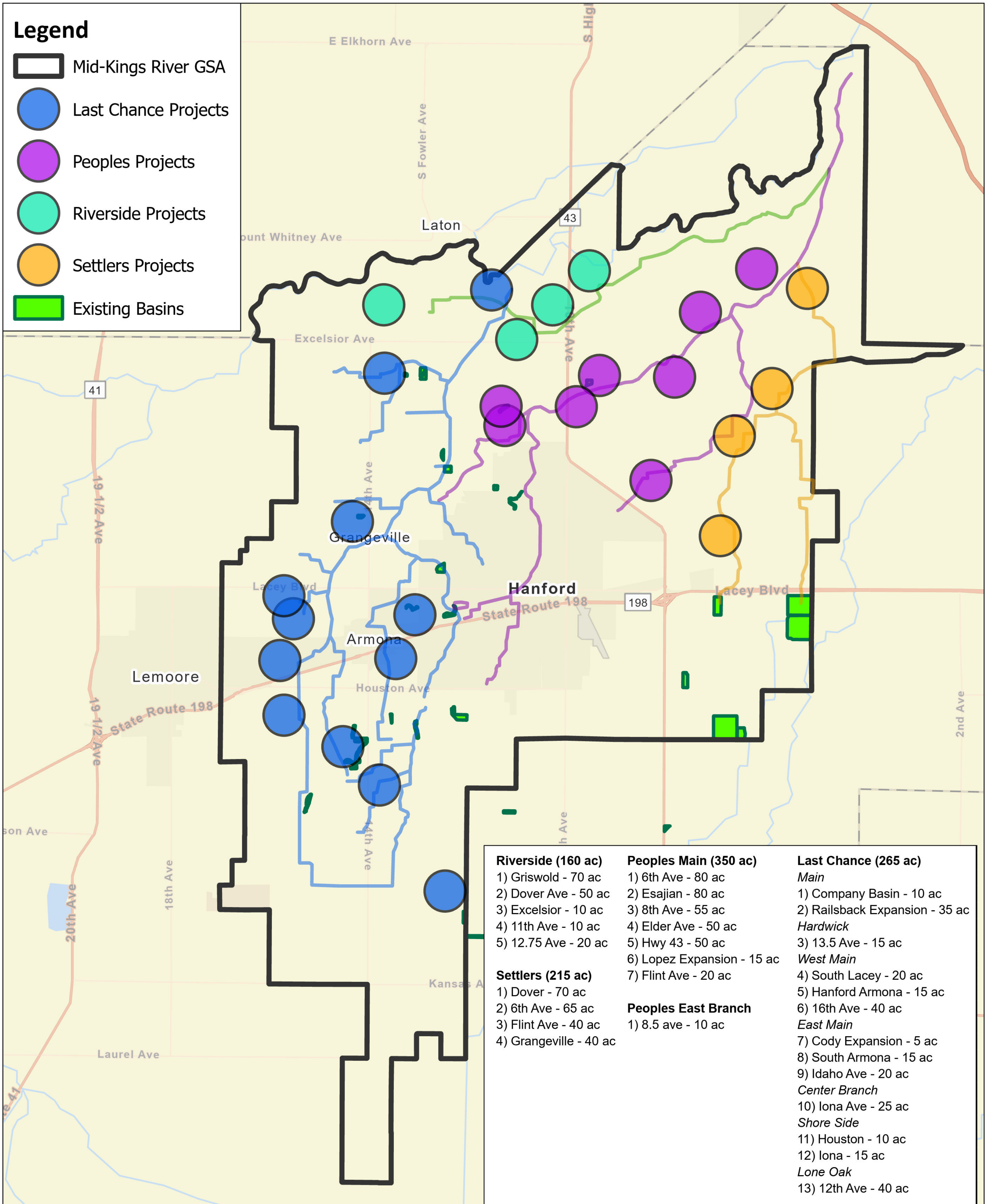
Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



DMS Table Relationships
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/25/2019	Project No.: 006741
Geosyntec consultants		Figure **5.7.1-1**

Date: 08/20/2019 Printed by Elizabeth.Chapman
Path: I:\FR18s\FR1816\1220 Tulare Lake GSP\Figures\5-MonitoringNetwork\Figures\November2019_fig5-6_TLSB_Draft.pdf



0 1 2
Miles

Mid-Kings River GSA

Recharge Basin Projects

Figure 6.2.8-1

PROVOST& PRITCHARD

3/8/2024 G:\Mid-Kings River GSA-2747\274724001 Mid Kings GSA\400 GIS\Map\AnnualReport\AnnualReport.aprx tbl_GroundwaterExtraction

AutoUID	ExtractedTotal	Month	Year	GSA	Agency	UseType	Click to Add
1	0	1	2016	1	1	1	
2	0	1	2016	1	2	2	
3	0	2	2016	2	4	3	

tbl_GroundwaterRecharge

	AutoUID	Month	Year	GSA	RechargeAF	Click to Add
*	(New)		0		0	

tbl_LandUseAnnualSurvey

AutoUID	LandUseCode	Acres	Year	GSA	LUGeneral	Click to Add
5313		581.7	2014	El Rico Groundwater Sustainability Agency	FIELD CROPS	
5306		44.2	2014	El Rico Groundwater Sustainability Agency	TRUCK, NURSERY AND BERRY CROPS	
5320		451.6	2014	El Rico Groundwater Sustainability Agency	IDLE	

tbl_SubsidenceAnnual

AutoUID	SubsidenceID	Year	Elevation	SurveyDate	Click to Add
1	SUB001	2010			
2	SUB002	2010			
3	SUB003	2010			

tbl_SurfacewaterUsage

AutoUID	Month	Year	Diversion	Agency	AcreFT	GSA	Click to Add
1225	1	2016	1	1	0	1	
1226	2	2016	1	1	207	1	
1227	3	2016	1	1	0	1	

tbl_WellWaterLevels

AutoUID	PPENG_ID	SITE_CODE	COOP_ORG_NAME	COOP_AGENCY_ORG_ID	MSMT_CMT	WLM_ORG_NAME	WLM_ORG_ID	WLM_ACC_DESC	WLM_DESC
360	357320N1196997W001	357320N1196997W001	Department of Water Re	1		Department of Water Resources	1	Water level accuracy is unknown	Unknown
361	357320N1196997W001	357320N1196997W001	Department of Water Re	1		Department of Water Resources	1	Water level accuracy is unknown	Unknown
362	357320N1196997W001	357320N1196997W001	Department of Water Re	1		Department of Water Resources	1	Water level accuracy is unknown	Unknown

tbl_WellWaterLevels

WLM_DESC	WLM_QA_DESC	GSE_WSE	RPE_WSE	WSE	RDNG_RP	RDNG_WS	WLM_GSE	WLM_RPE	MSMT_DATE	WLM_ID	STN_ID_1	Click to Add
Unknown		6.3	8.3	216.08	8.3	0	222.38	224.38	7/9/2010	852041	24614	
Unknown		5.7	7.7	216.68	7.7	0	222.38	224.38	4/26/2010	852040	24614	
Unknown		6.1	8.1	216.28	8.1	0	222.38	224.38	1/28/2010	852039	24614	

Sample DMS Tables with Associated Fields

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 11/20/2019	Project No.: FR18161220
Geosyntec consultants		Figure **6.7-1-2**

2024 Tulare Lake Subbasin GSP
Appendix

Appendix A
Contact Information for the Tulare Lake Subbasin Groundwater Sustainability Agencies

Contact Information for the Tulare Lake Subbasin Groundwater Sustainability Agencies

Groundwater Sustainability Agency	Plan Manager	Address	Telephone	Email
Mid-Kings River	Dennis Mills, General Manager	200 North Campus Dr. Hanford, CA 93230	(559) 584.6412	Dennis.Kingscwd.outlook.com
El Rico	Jeof Wyrick, Chairman	101 W. Walnut St. Pasadena, CA 91103	(626) 583.3000	jwyrick@jgboswell.com
South Fork Kings	Ceil Howe, Director	321 C Street Lemoore, CA 93245	(559) 423.5875	chowejr@westlakefarmsinc.com
Southwest Kings	Jared Hutchings, General Manager	944 Whitley Ave. Suite E. Corcoran, CA 93212	(559) 992-8980	jhutchings@angiolawd.org
Tri-County Water Authority	Deanna Jackson, Executive Director	944 Whitley Ave. Suite E. Corcoran, CA 93212	(559) 762.7240	djackson@tcwater.org

Appendix B
Stakeholder Communication and Engagement on the 2020 GSP

Appendix B: Stakeholder Communication & Engagement

A. Communication & Engagement Overview

As required by SGMA, GSAs must consider the interests of all beneficial uses and users of groundwater and include them in the GSP development process. The five GSAs within the Tulare Lake Subbasin developed a joint Communication & Engagement (**C&E**) Plan that addressed how stakeholders within the individual GSA boundaries (and when collaboration was plausible, at the subbasin-level) would be engaged through stakeholder education and opportunities for input and public review during the development and implementation of the GSP. This plan provides an overview of the Tulare Lake Subbasin GSAs, their stakeholders, and decision-making process; identifies opportunities for public engagement and discussion of how public input and responses would be used; describes how the Tulare Lake Subbasin GSAs encouraged the active involvement of diverse, social, cultural, and economic elements of the population within their individual boundaries and subbasin boundary; and the methods to be used to inform the public stakeholders about the progress of GSP development, public review and implementation. The Tulare Lake Subbasin GSAs' complete C&E Plan can be downloaded from the GSAs' individual websites.

As outlined by the DWR in the GSP Stakeholder Communication and Engagement Guidance Document, the Communication & Engagement Plan defines the Tulare Lake Subbasin GSAs' process for accomplishing the seven general steps in stakeholder communication and engagement:

- **Set Goals and Desired Outcomes –** Description of the situation at a high level with clear goals and objectives, identifying overriding concerns
- **Identify Stakeholders –** Development of a broad list of individuals, groups and organizations who need to be engaged in the process
- **Stakeholder Survey and Mapping –** Conducting a stakeholder survey to develop a "Lay of the Land" overview
- **Messages and Talking Points –** Definition of the key messages needed to effectively convey to the various subbasin stakeholders
- **Venues for Engaging –** Identification of opportunities (venues and methods) to engage stakeholders
- **Implementation Timeline –** Creation of a timeline to inform the process and highlight when to engage with stakeholders
- **Evaluation and Assessment –** Definition of a process to evaluate if communication and engagement goals are being met at the individual GSA level and through collaborative subbasin efforts

A.1 Communication Objectives to Support the GSP

The ultimate goal of communication objectives during the formation/coordination, GSP development, public review and implementation phases of the SGMA compliance, is to encourage active involvement of diverse, social, cultural, and economic elements of the population within the GSA boundary. The Tulare Lake Subbasin GSAs have given beneficial users and users of groundwater opportunities to engage in the GSP process, and provided educational outreach opportunities for stakeholders while reaching out through specific communication avenues. As active stakeholders, members of the Boards of Directors and Stakeholder/Advisory Committees are direct representatives of their districts, communities and industries, and they continually gather feedback/input, and the concerns/needs of their constituents and report back to their respective meetings. Any stakeholder input received was reviewed by the GSA and Subbasin technical teams and taken into consideration during GSP development.

A.1.1 Phase 1: GSA Formation and Coordination

Phase 1: GSA Formation and Coordination was the first phase completed. This phase stretched from 2015 through 2018, and consisted of forming the individual GSAs, development of a subbasin coordination agreement, establishing the List of Interested Parties, and creating the Communication & Engagement Plan to outline communication efforts for the GSP development, public review and implementation phases. Stakeholder input was utilized during the GSA formation phase, as beneficial users and stakeholders with interests in groundwater usage within the GSAs' boundaries were notified via public meeting notices as soon as the process began.

A.1.2 Phase 2: GSP Preparation and Submission

Phase 2: GSP Preparation and Submission spanned from 2018 through January 31, 2020. With the goal of having the draft GSP before the end of the third quarter in 2019, 2018 was primarily the technical development of the plan, while working with GSA Boards of Directors, technical teams/committees, and GSA management at the subbasin level, as well as stakeholders for feedback and input. During the last quarter of 2018, the first round of public outreach meetings and interaction with stakeholder groups and other community organizations and entities was held with the purpose of educating and informing stakeholders about SGMA and the GSP process, while also soliciting feedback and input from these groups to consider and possibly include feedback and input into the GSP. Public outreach for this phase was completed by the individual GSAs.

A.1.3 Phase 3: GSP Review and Evaluation

During 2019, Phase 3: GSP Review and Evaluation, the communication and engagement efforts continued. Once the draft of the GSP was completed in September 2019, the public review process began. A 90-day comment period was held, with the GSP draft posted on the Tulare Lake Subbasin GSAs' websites for all stakeholders to conveniently download and review and provide comments. Outreach meetings were held during this phase both on subbasin-wide level, as well as by individual GSAs. These meetings focused on an overview of the GSP content, while giving stakeholders a public forum to provide their feedback and comments. The public review period concluded with a public hearing regarding the GSP Draft on December 2, 2019.

Once the public review period was completed, public comments were taken into consideration and incorporated into the final version of the Tulare Lake Subbasin GSP before submitting to the DWR by January 31, 2020. Following submittal, stakeholders will be given a second 60-day 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.

A.1.4 Phase 4: Implementation and Reporting

Phase 4: Implementation and Reporting will begin once the plan is submitted by January 31, 2020. Even while the DWR is reviewing the GSP, SGMA-implementation at the GSA-level must begin. During the implementation phase, communication and engagement efforts will be shifted to educational and informational awareness of the requirements and processes for reaching groundwater sustainability as set forth in the submitted GSP. Active involvement of all stakeholders will be encouraged during this phase, and public notices are required for any public meetings and prior to imposing, and later increasing, any fees. Public outreach for this phase will also be completed by the individual GSAs with collaborative subbasin-wide efforts when target audiences span more than one GSA boundary.

B. Tulare Lake Subbasin GSAs' Decision-Making Process

The Tulare Lake Subbasin GSAs' decision-making process is broken down by the roles of the subbasin management team, Board of Directors and Stakeholder/Advisory Committees. The roles of these subbasin and GSA entities and their responsibilities are outlined below.

- **Subbasin Management Team –** Comprised of a representative from each of the five GSAs working collaboratively to jointly manage groundwater within the Tulare Lake Subbasin and to develop a GSP. These individuals met on a monthly and then bi-weekly basis throughout the GSP development and public review phases.
- **Boards of Directors –** Adopts general policies regarding development and implementation of the individual GSAs and the GSP.
- **Stakeholder/Advisory Committees –** Representing all beneficial uses and users of groundwater within the individual GSA boundaries, makes recommendations to the Boards of Directors and technical consultants regarding feedback from stakeholders and adoption of a GSP that accounts for local interests. Not all GSAs have stakeholder/advisory committees, and while allowed within SGMA, these committees are not required.

B.1 Role of Boards of Directors

The Tulare Lake Subbasin GSAs' Boards of Directors all consistently function as the governing body of the specific GSA, formed to adopt general policies regarding development and implementation of the GSP. Governance of each GSA is described below, and meeting dates, times and locations for each board are noted. All meetings were open to the public during the formation, development and public review phases, and will continue to be open to the public during the implementation phase.

B.1.1 El Rico GSA

El Rico GSA's Board of Directors consists of seven directors: one representative appointed by the Tulare Lake Basin Water Storage District board, one representative appointed by the governing board of Salyer Water District, two representatives appointed by the Corcoran Irrigation District, two representatives appointed by Melga Water District, and one representative appointed by the Lovelace Reclamation District No. 739.

El Rico GSA's board meetings are held on the first Wednesday of each month at 1 p.m. at the Tulare Lake Basin Water Storage District's office, located at 1001 Chase Avenue in Corcoran, unless otherwise posted on the Kings River Region Groundwater Portal's calendar.

B.1.2 Mid-Kings River GSA

The Board of Directors of the Mid-Kings River GSA are appointed, three elected members of the KCWD, and one elected member of the City of Hanford. The Mid-Kings River GSA Board of Directors meet on the second Tuesday of every month at 1 p.m. at the Kings County Water District, located at 200 Campus Drive in Hanford.

B.1.3 South Fork Kings GSA

The governing board of the South Fork Kings GSA is composed of one appointee of each member agency as a "principal director." The principal director is an individual currently serving on the board or council of each of the members. Board of Directors meetings for the South Fork Kings GSA are held bi-monthly on the third Thursday of every February, April, June, August, October and December at 5:30 p.m. in the Lemoore City Council Chambers, located at 429 C Street in Lemoore.

B.1.4 Southwest Kings GSA

Southwest Kings GSA is governed by a five-person board of directors comprised of two members of the Dudley Ridge Water District, two members of the Tulare Reclamation District No. 761, and one director selected by a majority vote of the other four appointed members. The non-district member is a landowner, or his/her representative, who owns land in the white areas of the GSA boundary.

The Southwest Kings GSA's board meetings are held on the second Wednesday of every month at 3 p.m. at 286 W. Cromwell Avenue in Fresno. A monthly GSA status report is posted on the GSA's website.

B.1.5 Tri-County Water Authority GSA

The Tri-County Water Authority GSA JPA board of directors is comprised of four signatories and five board seats: Angiola Water District (general manager and a representative), Deer Creek Storm Water District (general manager and representative), Wilbur Reclamation District #825 (one representative), and County of Kings (non-voting representative). The Board of Directors meetings are held on the second Thursday of every other month at 1 p.m. at the Tri-County Water Authority Boardroom, located at 944 Whitley Avenue in Corcoran.

B.2 Role of Stakeholder/Advisory Committees

In Section 10727.8 "Public Notification and Participation; Advisory Committee" of the Sustainable Groundwater Management Act, GSAs may appoint and consult with an advisory committee for the purpose of developing and implementing a GSP. Through a stakeholder/advisory committee, a GSA is able to encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the GSP.

B.2.1 Tri-County Water Authority GSA

The Tri-County Water Authority GSA's Technical Advisory Committee and Stakeholder Advisory Committee meet jointly on the fourth Wednesday of every month at 10 a.m. at the Tri-County Water Authority, located at the 944 Whitley Avenue in Corcoran.

C. Beneficial Uses and Users of Groundwater

Based on the applicable interests identified in SGMA, Section 10723.2 "Consideration of All Interests of All Beneficial Uses and Users of Groundwater", the five Tulare Lake Subbasin GSAs (El Rico, Mid-Kings River, South Fork Kings, Southwest Kings and Tri-County Water Authority) identified the stakeholder groups with interests within their GSA boundaries. These specific stakeholder groups have financial, political, business or personal stakes in the management of groundwater within the jurisdiction of the Tulare Lake Subbasin and were the focus of communication and engagement efforts during the GSP development and public review phases, and will continue to be engaged during the implementation phase. These stakeholders are listed by GSA in **Table 1**, **Table 2**, **Table 3**, **Table 4** and **Table 5**.

C.1 Environmental Users of Groundwater

It should be noted that environmental users of groundwater within the Tulare Lake Subbasin were investigated by the El Rico GSA, MKRGSA, SFKGSA, SWKGSA and TCWA, but there were not any identified that have specific groundwater interests within the subbasin.

C.2 Native American Tribes

The only Native American Tribe within the Tulare Lake Subbasin boundary is the Santa Rosa Rancheria Tachi-Yokut Tribe. The Tachi-Yokut Tribe was invited to participate in GSP development via a letter sent on June 28, 2016 by the then Upper Tulare Lake GSA MOU Group (now known as the South Fork Kings GSA). A copy of the letter is included in the Appendix A of the Tulare Lake Subbasin GSAs' Communication & Engagement Plan. The Tribe's EPA director attended one of the South Fork Kings GSA's board meetings, and has been on their Interested Parties List since April 2017, receiving regular updates about GSP development within the SFKGSA and the Tulare Lake Subbasin. In addition, a Sacred Lands File & Native American Contacts List Request was also sent to the Native American Heritage Commission.

C.3 Subbasin Industries and DACs

C.3.1 Industries

Collaboration meetings were held with the companies and organizations within the following industries to make sure their organizational visions and groundwater needs for facility operations were taken into consideration during GSP development and implementation phases. While an overview of the main industries within the Tulare Lake Subbasin are described below, the industries specific to each GSA are described in **Section C.4**.

Agriculture

Agriculture is one of the top three industries in Kings County. According to the 2017 Kings County Agricultural Crop Report published by the Kings County Ag Commissioner's office, the county is the tenth largest agriculture production county in California and grossed over $2 billion in 2017. With over 818,000 acres of farmland, the top commodities produced in Kings County are milk, cotton, cattle, nuts (almonds, pistachios and walnuts), tomatoes, silage corn, grapes, and stone fruit. As one of the primary industries, agriculture is the largest private employer in the county.

Because of the significant presence of agriculture production within the Tulare Lake Subbasin, agriculture industry stakeholders needed to be involved and informed during the development and public review phases of the GSP. Implementation will have a significant direct impact on the industry, and ultimately the local, state and national economies. The Tulare Lake Subbasin GSAs engaged with agriculture stakeholders routinely on an individual GSA-basis, and collaboratively at a subbasin level.

Food Processing

Kings County is a home to multiple food processors. Four of the top employers within the county are food processing facilities, accounting for over 4,000 jobs for the local workforce. Within the South Fork Kings GSA, Leprino Foods, alone, is responsible for 40 percent of water usage and provides just over 1,000 jobs. Because of their direct tie to the agricultural industry and reliance on groundwater supplies, to operate their facilities, food processors are included in the groundwater sustainability management within the subbasin boundary. The Tulare Lake Subbasin GSAs met with the food processing companies within their GSA boundaries on an individual basis for direct input and feedback during the GSP development and public review phases, and will continue to do so during the implementation phase.

Oil Production

Oil production is a main industry in certain areas of Kings County and the Tulare Lake Subbasin, primarily within in the Kettleman City area. Oil was discovered in the Kettleman Hills in 1928 at the Kettleman North Dome Oil Field. This oil field became one of the most productive oil fields in the United States in the early 1930s. Within this region, oil and agricultural production share the land surface, and will continue with joint usage of well drilling rigs and agricultural production activities such as grazing. The oil industry is considered a beneficial user of groundwater, and Tulare Lake Subbasin GSAs engaged with the oil companies within their GSA boundaries on an individual basis for direct input and feedback during the GSP development and public review phases, and will continue to do so during implementation phases.

C.3.2 DACs

Communication and educational outreach efforts with disadvantaged communities (**DAC**) and severely disadvantaged communities (**SDAC**) was needed for the development and implementation of the Tulare Lake Subbasin's GSP according to the Department of Water Resources' Best Management Practices. Information used to communicate to and engage the DACs in the GSP process, included an explanation of SGMA and soliciting feedback. GSA representatives regularly communicated with DACs and gave presentations on SGMA to community representatives, while gathering their feedback and input.

By including DACs and SDACs in communication efforts during the development, public review and implementation phases of the GSP, residents were more likely to participate and provide feedback that could be crucial to long-term solutions for groundwater sustainability within their communities. Any feedback received from DAC/SDAC residents was reviewed and evaluated by the Tulare Lake Subbasin GSAs during the GSP development and public review phases.

C.4 GSA-Specific Stakeholders

The GSAs worked cooperatively with their respective stakeholders throughout the development and public review of the GSP, and will continue to do so through the implementation phase.

C.4.1 El Rico GSA Stakeholders

The interests of the parties identified in **Table 1** were considered in the operation of the El Rico GSA and the development and implementation of the GSP. The primary industry within the El Rico GSA is agriculture. Other industries within the boundary include food processing, as well as warehousing and distribution, and standard commerce industry that is standard in a community of 10,000 people (automotive shops, supermarkets, etc.).

Table 1. Stakeholder Groups with Interests in the El Rico GSA

Stakeholder Group	Description
Agricultural Users	Represented through many of the GSA member agencies and/or by the County of Kings.
Domestic Well Owners	Represented through member agencies including the County of Kings or via exemption for small amounts of groundwater extraction.
Municipal Well Operators	City of Corcoran
Public Water Systems	City of Corcoran
Local Land Use Planning Agencies	City of Corcoran, County of Kings
Surface Water Users	Represented through GSA member agencies
Disadvantaged Communities	City of Corcoran
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	Represented by GSA member agencies including Tulare Lake Basin Water Storage District that collects and reports data for multiple members of the agency via the Tulare Lake Coordinated Groundwater Management Plan.

C.4.2 Mid-Kings River GSA Stakeholders

The interests of all beneficial uses and users of groundwater within the MKRGSA are identified in **Table 2**. The primary industries within the Mid-Kings River GSA is agriculture and food processing.

Table 2. Stakeholder Groups with Interests in the Mid-Kings River GSA

Stakeholder Group	Description
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users
Domestic Well Owners	There are domestic wells within the MKRGSA area, and it is understood that many rural domestic users will fall into the "de minimis extractor" category, so further work is being conducted to understand to what extent domestic users will be affected by GSP requirements.
Public Water Systems	Armona CSD, Home Garden CSD and Hardwick Water Company, as well as several transient public water systems for school districts are included in this category (Kings River-Hardwick, Pioneer, Hanford Christian).
Municipal Water Systems	City of Hanford
Local Land Use Planning Agencies	City of Hanford and County of Kings
California Native American Tribes	See Section C.2.
Disadvantaged Communities	Armona, Home Garden, Hardwick
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	Kings County Water District monitors groundwater levels within its service area and is providing a subset of that information to the Kings River Conservation District for submission to the CASGEM system.

C.4.3 South Fork Kings GSA Stakeholders

An initial list of stakeholders within the South Fork Kings GSA is described in **Table 3**. The primary industries within the South Fork Kings GSA is agriculture and food processing.

Table 3. Stakeholder Groups with Interests in the South Fork Kings GSA

Stakeholder Group	Description
Agricultural Users	Service area is composed of mostly agricultural lands and agricultural users
Domestic Well Owners	There are domestic wells within the SFKGSA, and it is understood that many domestic users will fall into the "de minimis extractor" category. Further work is being conducted to understand to what extent domestic users will be affected by GSP requirements.
Municipal Well Operators	City of Lemoore, Stratford Public Utility District
Local Land Use Planning Agencies	City of Lemoore, County of Kings
California Native American Tribes	See Section C.2.
Disadvantaged Communities	Community of Stratford
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. SFKGSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.

C.4.4 Southwest Kings GSA Stakeholders

The interests of all beneficial uses and users of groundwater within the Southwest Kings GSA are described in **Table 4**. The primary industries within the Southwest Kings GSA are agriculture, oil production and commercial usage specific to Kettleman City.

Table 4. Stakeholder Groups with Interests in the Southwest Kings GSA

Stakeholder Group	Description
Agricultural Users	Approximately 99 percent of the GSA's area is composed of agricultural lands. Representatives of the agricultural community are currently involved on the GSA Board of Directors.
Domestic Well Owners	Only one or two landowners utilize a domestic well, and are represented on the Board of Directors through member agencies.
Municipal Well Operators	Kettleman City CSD relies solely on surface water supply (effective October 2019). Their municipal wells are a back-up source to provide well water to residential and commercial customers within the GSA boundary in emergency situations when surface water is not accessible.
Local Land Use Planning Agencies	County of Kings
California Native American Tribes	See Section C.2.
Disadvantaged Communities	Kettleman City
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	KRCD is the designated monitoring entity for the Kings and Tulare Lake Subbasins under CASGEM program. SWKGSA will coordinate its SGMA monitoring efforts with the CASGEM monitoring effort led by KRCD.

C.4.5 Tri-County Water Authority GSA Stakeholders

The Tri-County Water Authority provided stakeholder groups identified in **Table 5** with opportunities to provide input throughout the process of developing, operating and implementing the GSA and GSP. The primary industry within the Tri-County Water Authority GSA is almost entirely agriculture.

Table 5. Stakeholder Groups with Interests in the Tri-County Water Authority GSA

Stakeholder Group	Description
Agricultural Users	Composed almost entirely of agricultural users, including nut grower commodity groups and other agricultural use growers
Domestic Well Owners	There are domestic wells within the GSA area, but because SGMA excludes "de minimis extractors," it is anticipated that the GSP will exclude domestic wells from such requirements.
Local Land Use Planning Agencies	County of Kings
Federal Government	Bureau of Land Management
Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin	Angiola Water District, Tulare Lake Basin Water Storage District

D. Public Outreach Meetings/Stakeholder Involvement Opportunities

D.1 Communication & Outreach Methods

There were a variety of opportunities, venues and methods for the Tulare Lake Subbasin GSAs to connect with and engage stakeholders throughout GSA formation, GSP development, GSP review, and will continue to be utilized through the GSP implementation phases. Stakeholder groups identified in **Section C** were engaged through communication methods outlined in this section.

D.1.1 Printed Communication

Printed materials incorporated the visual imagery established through individual GSA branding efforts and was tailored for specific means of communication throughout the phases of GSP development, public review and implementation. Printed materials were also translated into Spanish, when necessary for thorough, diverse stakeholder education.

- **Fliers –** Fliers designed and tailored for stakeholder audiences, encompassed infographics and text with key messages that were pertinent for that phase of GSP development. Distribution was via GSA-website posting, direct mail, email, and direct distribution as handouts throughout communities, GSA and subbasin outreach meetings. For outreach to DACs/SDACs, fliers were available in both English and Spanish languages.
- **Letter Correspondence –** When letter correspondence was necessary, particularly during the public review and implementation phases, letters were distributed via email and/or direct mail. Letters included pertinent facts and explanations that needed to be communicated to specific stakeholder groups.
- **Presentation Materials –** Power Point presentations were utilized at educational/outreach public meetings. For a consistent message subbasin-wide, a draft presentation was developed for the GSP development and public review phases, with placeholder slides for GSAs to update with GSA-

specific information. Handouts of presentations and smaller versions of display boards were distributed to stakeholders in attendance, emailed to the Interested Parties list, and posted on individual GSAs' websites for stakeholders to access, particularly if they were unable to attend.

D.1.2 Digital Communication

Digital communication outlets were also designed to incorporate Tulare Lake Subbasin GSAs' branding and was a significant mode of communication through the GSP development and public review phases, and will continue to be crucial during the implementation phase.

- **Websites –** Public meeting notices, agendas and minutes of the Board of Directors and Stakeholder/Advisory Committee meetings were posted on the individual GSAs' websites. These websites serve as integral resources for stakeholders within the Tulare Lake Subbasin boundary. Electronic files of printed materials, presentations and other educational resources, and direct links to stakeholder surveys (English and Spanish versions) were also accessible via the websites.

  As printed materials were created, PDFs of the same information were added to the GSAs' websites. This served as a way for stakeholders to easily educate themselves on the GSP process and phases.

  Table 6. Tulare Lake Subbasin GSAs' Websites

GSA	Website
El Rico GSA	None – Meetings posted at kingsgroundwater.info
Mid-Kings River GSA	www.midkingsrivergsa.org
South Fork Kings GSA	southforkkings.org
Southwest Kings GSA	www.swkgsa.org
Tri-County Water Authority GSA	tcwater.org
Kings River Regional Groundwater Info Portal *(an additional online informational resource)*	kingsgroundwater.info

- **Interested Parties List –** As required by SGMA 10723.4 "Maintenance of Interested Persons List," the Tulare Lake Subbasin GSAs maintain contact lists and regularly distribute emails to those who have expressed interest in the GSAs' progress. These emails consist of meeting notices and other documents that are pertinent to the Tulare Lake Subbasin GSAs and their communication efforts. This process will continue through the GSP implementation phase.

- **Email Blasts –** Email blasts for meeting notices, stakeholder surveys, public review notices, and other crucial information were coordinated with community organizations and stakeholder groups by utilizing their distribution lists. Examples of these organizations are Kings County Farm Bureau, and water/irrigation districts within the individual GSAs' boundaries.

D.1.3 Media Coverage

Press releases were written and distributed to the media list of local newspaper publications. These press releases focused on notification of public engagement opportunities such as targeted stakeholder meetings, public review/comment processes and opportunities, and will be distributed for meetings and notifications during the GSP implementation.

D.1.4 Stakeholder Surveys

Stakeholder surveys were used for the deliberate polling of stakeholders to give them a direct voice in the GSP development phase. The South Fork Kings GSA and Southwest Kings GSA circulated physical surveys, while the remaining three GSAs conducted verbal surveys through one-on-one discussions with stakeholders within their GSA boundaries. For the GSAs who administered physical stakeholder surveys, they developed both online and printed versions of their surveys. Survey links were posted as Google Forms on the individual GSAs' websites and were utilized in email blasts to the Interested Parties Lists. Hard copies were also available for distribution throughout the respective GSA. An outline of the survey questions is provided in **Table 7**.

Table 7. GSAs Circulating Stakeholder Surveys

GSA	Survey Questions
El Rico GSA	Conducted verbal stakeholder survey discussions.
Mid-Kings River GSA	Conducted verbal stakeholder survey discussions.
South Fork Kings GSA	1. How important are the following uses of water to you personally? *Please rank the categories with 1 being the most important use of water and 6 being the least important. (Municipal, Agricultural, Recreational, Mining/Petroleum, Manufacturing, Wildlife/Fisheries)* 2. How important are the following uses of water to the region? *Please rank the categories with 1 being the most important use of water and 6 being the least important. (Municipal, Agricultural, Recreational, Mining/Petroleum, Manufacturing, Wildlife/Fisheries)* 3. Please rank the categories with 1 being the most important for reason for managing groundwater and 5 being the least important. *(Ensure drinking water supply for domestic uses; My ability to earn a living is directly linked; Future economic growth for region; Ensure water supply for future generations; Provide reliable water for industry/business; Other)* 4. How knowledgeable do you consider yourself of local water issues? *(Circle one – Extremely Knowledgeable to Not Very Knowledge)* 5. How knowledgeable do you consider yourself of the new groundwater regulation, the Sustainable Groundwater Management Act? *(Circle one – Extremely Knowledgeable to Not Very Knowledge)* 6. Are you currently engaged in activity or discussions regarding groundwater management in your area? 7. How important to you is information on anticipated impacts of new state regulations. *(Circle one – Extremely Important to Not Very Important)* 8. Which format or formats would you prefer for receiving information about groundwater management planning process? *(Check all that apply – Newsletters, phone number to call for information, regular public meetings, electronic media, news stories, information through interest groups, don't know)* 9. Which applies to you? I am a stakeholder representing pumping for… (*Check all that apply – business use, small community use, domestic use, school use, agricultural use, federal use, industrial use, municipal use, tribal use, environmental use, does not apply)* 10. Which best describes the community in which you or your industry/business resides? *(Circle all that apply – Rural Kings County, within the City of Lemoore, within the Community of Stratford, outside of the South Fork Kings GSA service area, don't know)* 11. Please indicate your age range? *(Circle one – 25 and under, 26-35 years, 36-45 years, 46-55 years, 56-65 years, over 65 years, no answer)*
Southwest Kings GSA	1. Are you familiar with Sustainable Groundwater Management Act (SGMA) regulations? 2. Are you currently engaged in activity of discussions regarding groundwater management in this region? 3. Do you own or manage/operate land in this region? 4. Do you manage water resources? If yes, what is your role? 5. What is your primary interest in land or water resources management? 6. Do you have concerns about groundwater management? If so, what are they? 7. Do you have recommendations regarding groundwater management? If so, what are they?
Tri-County Water Authority GSA	Conducted verbal stakeholder survey discussions.

D.2 Tulare Lake Subbasin-Wide Outreach Efforts

The Tulare Lake Subbasin GSAs maintained a timeline of communication and outreach efforts completed throughout the GSA development and GSP development and public review phases, both on a subbasin-wide level and on the individual GSA level. Subbasin-wide public outreach meetings and presentations are shown in **Table 8**. **Figure 1**, **Figure 2** and **Figure 3** demonstrate a visual guide for consolidated subbasin and individual GSA stakeholder involvement completed since the GSAs were formed.

Table 8. Tulare Lake Subbasin-Wide Public Meetings, Notifications, Presentations & One-on-One Meetings

Event	Date
Kings County Water Commission Meeting – SGMA Update Presentation	May 21, 2018
Kings County Farm Bureau Board Meeting – SGMA Update Presentation	June 19, 2018
Kings County Ag/Water Commissions Joint Meeting – SGMA Update Presentation	March 25, 2019
Kings County Farm Bureau Meeting – GSP Public Review Presentation	August 20, 2019
Subbasin-Wide Public Review Outreach Meeting – Lakeside Community Church, Hanford	5:30 p.m., October 9, 2019
Subbasin-Wide Public Review Outreach Meeting – Lemoore Civic Auditorium, Lemoore	5:30 p.m., October 15, 2019
Subbasin-Wide Meeting regarding GSP with five GSA managers and County of Kings representatives (County Counsel SGMA liaison, CAO, Board of Supervisor Verboon)	November 6, 2019 at the TLBWSD office in Corcoran
Tulare Lake Subbasin GSP Public Hearing – Kings County Board of Supervisors Chambers	10 a.m., December 2, 2019

D.2.1 Public Noticing

I.D.2.1.1 Phase 1: GSA Formation and Coordination

During Phase 1: GSA Formation and Coordination, the five individual GSAs published public notices to notify stakeholders within their boundaries of the public hearings held prior to the official formation of the agencies. These notices are documented in **Table 9**.

Table 9. Public Notices for GSA Formation Public Hearings

GSA	Publication	Date Published	Date Public Hearing Held
El Rico GSA	The Corcoran Journal Visalia Times Delta The Bakersfield Californian	January 19, 2017; January 26, 2017 January 19, 2017; January 26, 2017 January 20, 2017; January 26, 2017	February 7, 2017
Mid-Kings River GSA	Hanford Sentinel	December 20, 2016; December 27, 2016	January 5, 2017
South Fork Kings GSA	Hanford Sentinel	February 15, 2017; February 22, 2017	March 8, 2017
Southwest Kings GSA	The Corcoran Journal	February 16, 2017; February 23, 2017; March 2, 2017	March 8, 2017
Tri-County Water Authority GSA	The Hanford Sentinel	January 17, 2017; January 24, 2017	January 31, 2017

I.D.2.1.2 Phase 3: GSP Review and Evaluation

A 90-day comment period was held the last quarter of 2019, with the GSP draft posted on the Tulare Lake Subbasin GSAs' websites for all stakeholders to conveniently download and review and provide comments. Public notices were published in local newspapers to notify stakeholders of the start of the public review period 90 days prior to the public hearing, and published again within 45 days of the public hearing (**Table 10**).

Table 10. Public Notices for GSP Public Review & Public Hearing

Publication	Date Published	Purpose of Notice
The Bakersfield Californian	September 3, 2019; September 10, 2019	Notice of Public Review of Tulare Lake Subbasin Draft GSP
The Corcoran Journal	September 5, 2019; September 12, 2019	
Hanford Sentinel	September 3, 2019; September 10, 2019	
Visalia Times Delta	September 3, 2019; September 10, 2019	
The Bakersfield Californian	October 19, 2019; October 25, 2019	Notice of Public Hearing on Tulare Lake Subbasin Draft GSP, scheduled for December 2, 2019
The Corcoran Journal	October 24, 2019; October 31, 2019	
Hanford Sentinel	October 18, 2019; October 25, 2019	
Visalia Times Delta	October 31, 2019; November 7, 2019	

D.2.2 Interbasin Coordination Efforts

Tulare Lake Subbasin GSAs and technical consultants met with surrounding subbasins throughout the development of the GSP to discuss how to achieve sustainability on a regional level, develop interbasin agreements, address boundary issues, discuss groundwater monitoring and groundwater modeling, and share data when possible. Between the five GSAs, meetings were held periodically with other GSAs within the Kern, Tule, Kaweah, Kings and Westside subbasins. GSA managers were also involved with other GSA boards and technical committees in other subbasins due to some member agencies' boundaries crossing into other subbasins. This allowed the managers to communicate a regional perspective in sustainability discussions, as their stakeholders hold interests in more than one subbasin.

While inter-basin issues were communicated and discussed during these numerous meetings, due to time constraints and each subbasin progressing at a different pace in the development of their GSPs, resolutions to conflicts are acknowledged but impractical to fully analyze prior to the GSP submittal deadline of January 31, 2020. These discussions will continue, and resolutions will be addressed in annual reports and/or the 2025 Tulare Lake Subbasin GSP Update.

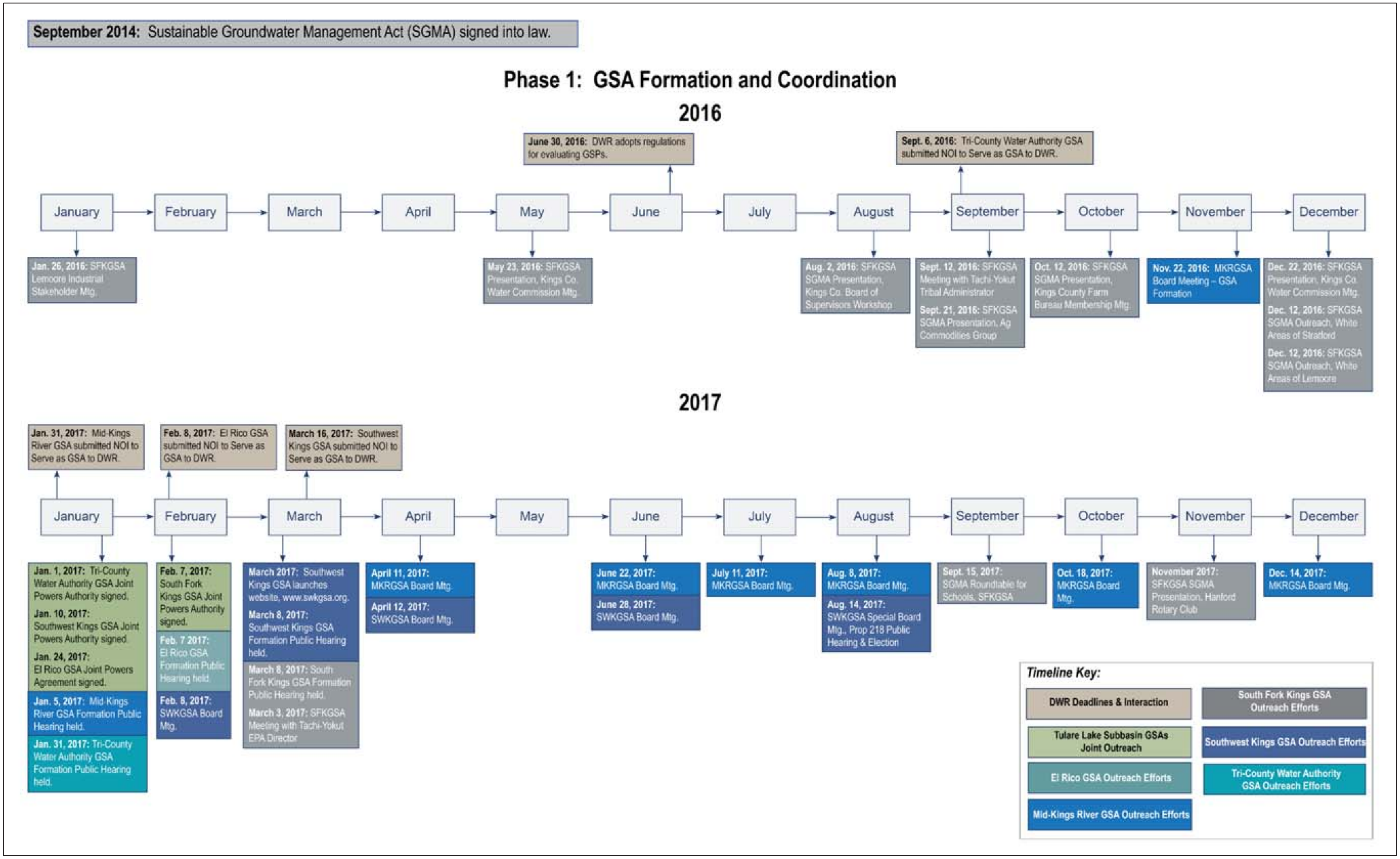


Figure 1. Tulare Lake Subbasin Communication & Engagement Timeline – Phase 1: GSA Formation and Coordination

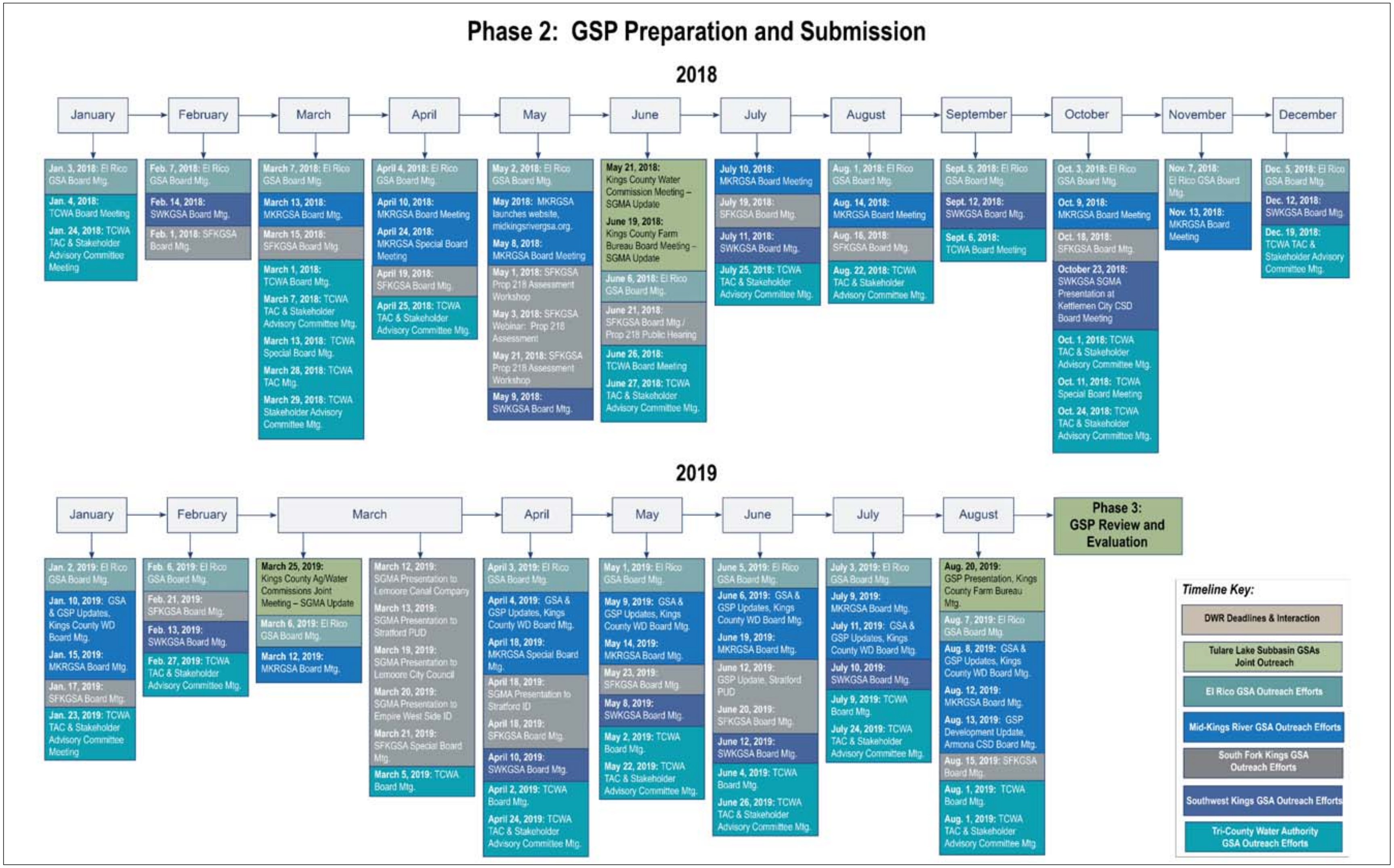


Figure 2. Tulare Lake Subbasin Communication & Engagement Timeline – Phase 2: GSP Preparation and Submission

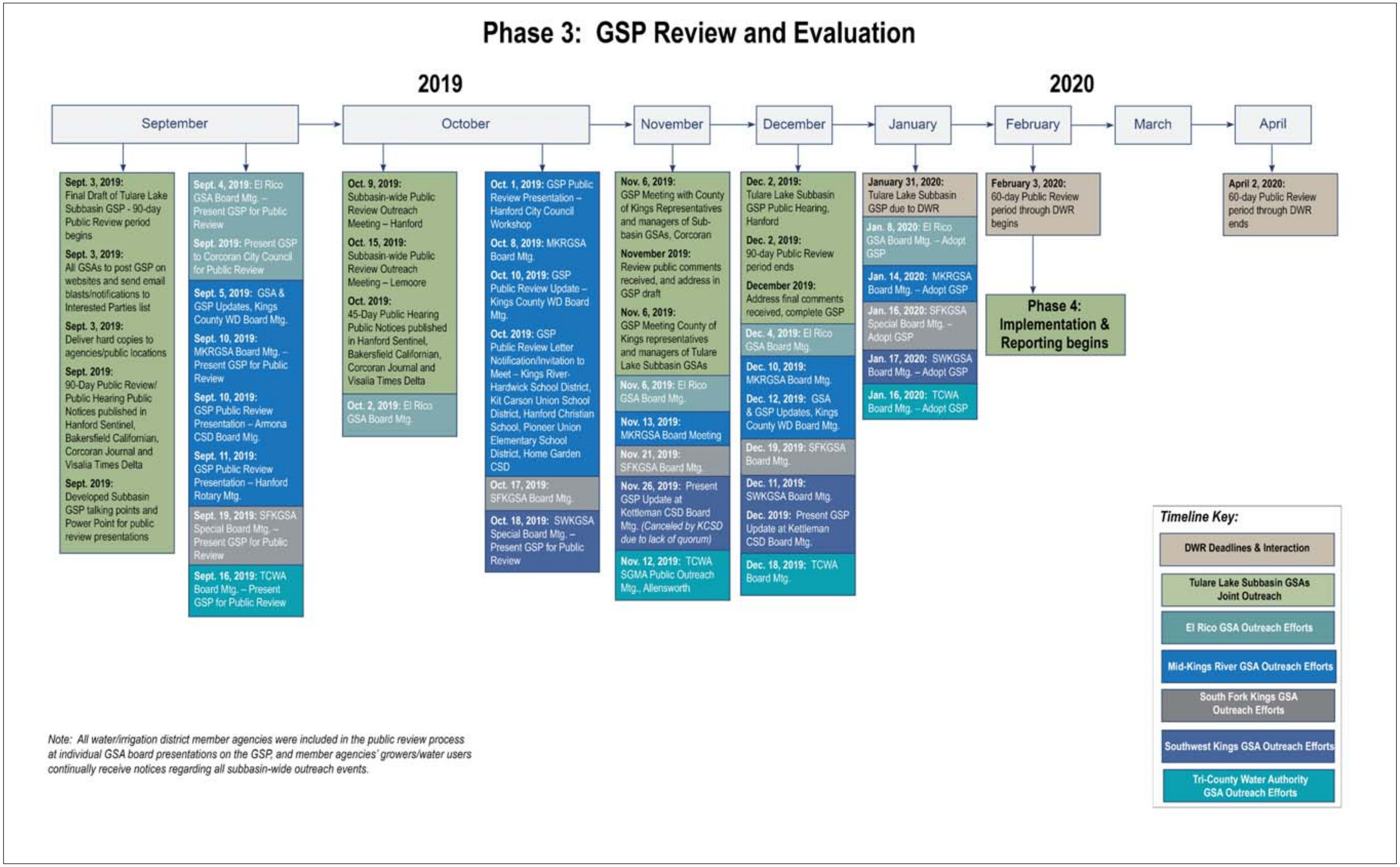


Figure 3. Tulare Lake Subbasin Communication & Engagement Timeline – Phase 3: GSP Review and Evaluation

D.3 El Rico GSA

Table 11. El Rico GSA Public Meetings, Presentations & One-on-One Meetings

Event	Date
One-on-one meetings with landowners of over 85 percent of the GSA area	Ongoing
SGMA & GSP Update meetings and negotiations with City of Corcoran personnel	Ongoing
GSA board meeting notices sent to all interested parties	Ongoing
Monthly meetings with "Un-districted Dairy Owners"	Ongoing
El Rico GSA Board Meeting	1 p.m., January 3, 2018
El Rico GSA Board Meeting	1 p.m., February 7, 2018
El Rico GSA Board Meeting	1 p.m., March 7, 2018
El Rico GSA Board Meeting	1 p.m., April 4, 2018
El Rico GSA Board Meeting	1 p.m., May 2, 2018
El Rico GSA Board Meeting	1 p.m., June 6, 2018
El Rico GSA Board Meeting	1 p.m., August 1, 2018
El Rico GSA Board Meeting	1 p.m., September 5, 2018
El Rico GSA Board Meeting	1 p.m., October 3, 2018
El Rico GSA Board Meeting	1 p.m., November 7, 2018
El Rico GSA Board Meeting	1 p.m., December 5, 2018
El Rico GSA Board Meeting	1 p.m., January 2, 2019
El Rico GSA Board Meeting	1 p.m., February 6, 2019
El Rico GSA Board Meeting	1 p.m., March 6, 2019
El Rico GSA Board Meeting	1 p.m., April 3, 2019
El Rico GSA Board Meeting	1 p.m., May 1, 2019
El Rico GSA Board Meeting	1 p.m., June 5, 2019
El Rico GSA Board Meeting	1 p.m., July 3, 2019
El Rico GSA Board Meeting	1 p.m., August 7, 2019
El Rico GSA Board Meeting	1 p.m., September 4, 2019
El Rico GSA Board Meeting	1 p.m., October 2, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Hanford	5:30 p.m., October 9, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Lemoore	5:30 p.m., October 15, 2019
El Rico GSA Board Meeting	1 p.m., November 6, 2019
GSP Meeting with County of Kings representatives and managers of Tulare Lake Subbasin GSAs	1:30 p.m., November 6, 2019
Tulare Lake Subbasin GSP Public Hearing – Hanford	10 a.m., December 2, 2019
El Rico GSA Board Meeting	1 p.m., December 4, 2019
El Rico GSA Board Meeting	1 p.m., January 8, 2020

D.4 Mid-Kings River GSA

D.4.1 Website – www.midkingsrivergsa.org

The Mid-Kings River GSA's website went live in May 2018 for the purpose of informing stakeholders about the GSA, public outreach opportunities, and as a resource with SGMA-related information. A site map is outlined below:

- **Homepage –** Introduction of Mid-Kings River GSA; GSA News
- **About Us –** Overview of SGMA; About the Mid-Kings River GSA; Member Agencies; Mid-Kings River GSA Information (links to Notice of Intent, JPA Members Agreement, GSA Boundary Map, Subbasin Boundary Map)
- **Board & Committees –** Board of Directors; (Agendas, Minutes, List of Board Members)
- **GSA Resources –** SGMA-Related Resources; Other Tulare Lake Subbasin GSAs (links); Partnering Agencies (links)
- **Contact Us –** Questions (telephone and email); Location/Mailing Address; Interested Parties List Sign-Up Form

Picture 1. Screenshot of www.midkingsrivergsa.org Homepage

D.4.2 Mid-Kings River GSA Outreach Tracking

Table 12. Mid-Kings River GSA Public Meetings, Notifications, Presentations & One-on-One Meetings

Event	Date
Landowner Meetings for requested updates on SGMA	Ongoing
Greater Kaweah GSA Collaboration – Updates to TAC and BOD on Tulare Lake Subbasin efforts	Ongoing
Participation in local DWR meetings	Ongoing
Coordination meetings with other subbasins and South Valley Practitioners Group	Ongoing
MKRGSA Board Meeting – GSA Formation	1 p.m., December 13, 2016
MKRGSA Board Meeting & Public Hearing to Become GSA	10 a.m., January 5, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., April 11, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., June 22, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., July 11, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., August 8, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., October 18, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., December 14, 2017
MKRGSA Board Meeting – SGMA and GSP Development Updates	3 p.m., March 13, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	3 p.m., April 10, 2018
MKRGSA Special Board Meeting	9:30 a.m., April 24, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., May 8, 2018
Kings County Water Commission Meeting – SGMA Update	May 21, 2018
Kings County Farm Bureau Board Meeting – SGMA Update	June 19, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., July 10, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., August 14, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., October 9, 2018
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., November 13, 2018
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., January 10, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., January 15, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., March 12, 2019
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., April 4, 2019
MKRGSA Special Board Meeting – SGMA and GSP Development Updates	1 p.m., April 18, 2019
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., May 9, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., May 14, 2019
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., June 6, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., June 19, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., July 9, 2019
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., July 11, 2019
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., August 8, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., August 12, 2019
Armona CSD Board Meeting Presentation – SGMA and GSP Development Updates	6 p.m., August 13, 2019
GSA & GSP Development Updates – Kings County Water District Board Meeting	1:30 p.m., September 5, 2019

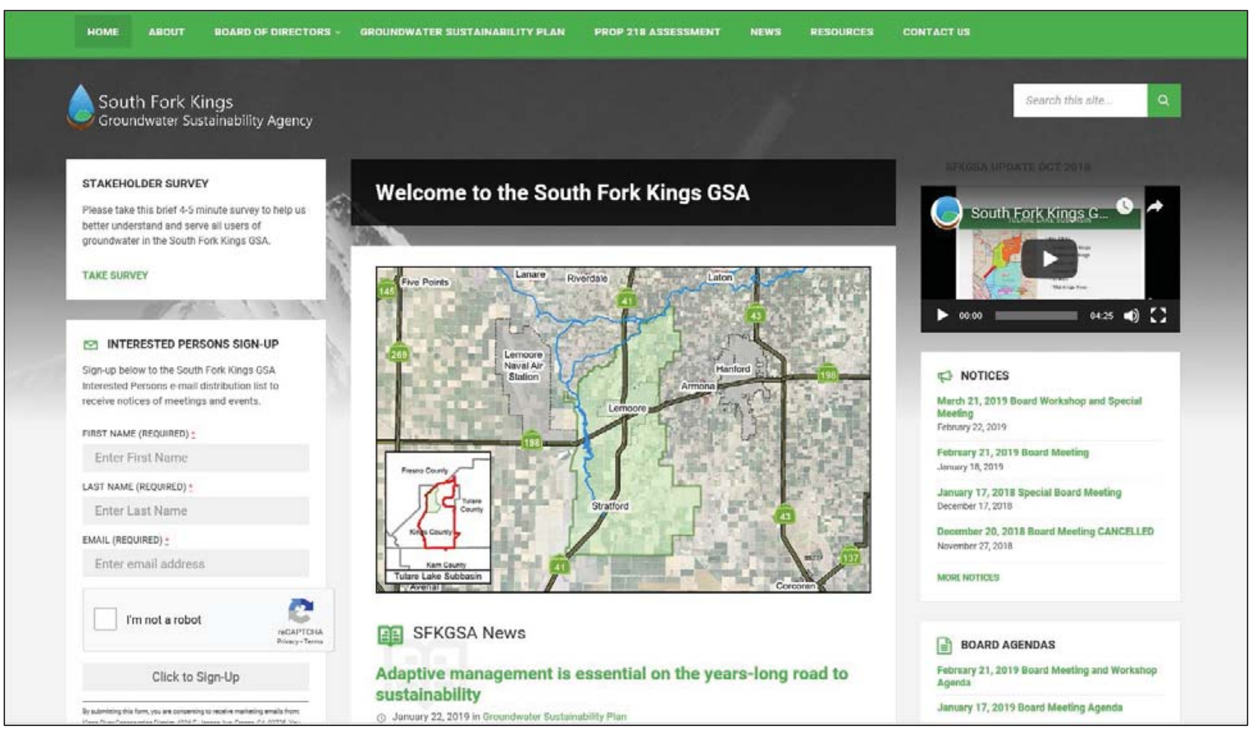
Event	Date
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., September 10, 2019
GSP Public Review Presentation at Armona CSD Board Meeting	6 p.m., September 10, 2019
GSP Public Review Presentation at Hanford Rotary Meeting	5:30 p.m., September 11, 2019
GSP Public Review Update – Kings County Water District Board Meeting	1:30 p.m., October 10, 2019
GSP Public Review Presentation at Hanford City Council Workshop	5:30 p.m., October 1, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., October 8, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Hanford	5:30 p.m., October 9, 2019
Home Garden CSD – Draft Tulare Lake Subbasin Groundwater Sustainability Plan Public Review Letter Notification & Invitation to Meet	Mailed via USPS and emailed October 11, 2019
Kings River-Hardwick School District – Draft Tulare Lake Subbasin Groundwater Sustainability Plan Public Review Letter Notification & Invitation to Meet	Mailed via USPS and emailed October 11, 2019
Kit Carson Union School District – Draft Tulare Lake Subbasin Groundwater Sustainability Plan Public Review Letter Notification & Invitation to Meet	Mailed via USPS and emailed October 11, 2019
Hanford Christian School – Draft Tulare Lake Subbasin Groundwater Sustainability Plan Public Review Letter Notification & Invitation to Meet	Mailed via USPS and emailed October 11, 2019
Pioneer Union Elementary School District – Draft Tulare Lake Subbasin Groundwater Sustainability Plan Public Review Letter Notification & Invitation to Meet	Mailed via USPS and emailed October 11, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Lemoore	5:30 p.m., October 15, 2019
GSP Meeting with County of Kings representatives and other GSA managers, Corcoran	1:30 p.m., November 6, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., November 13, 2019
Tulare Lake Subbasin GSP Public Hearing – Hanford	10 a.m., December 2, 2019
MKRGSA Board Meeting – SGMA and GSP Development Updates	1 p.m., December 10, 2019
GSA & GSP GSP Public Review Update – Kings County Water District Board Meeting	1:30 p.m., December 12, 2019
MKRGSA Board Meeting – Adoption of GSP	1 p.m., January 14, 2020

D.5 South Fork Kings GSA

D.5.1 Website – https://southforkkings.org/

The South Fork Kings GSA's website is a solid source of information for SGMA and the impacts within the GSA boundary. A site map is outlined below:

- **Homepage –** Welcome page with quick links to Stakeholder Survey, Interested Persons Sign-Up, GSA News, Notices, Board Agendas/Minutes, Proposition 218 Groundwater Assessment Resources
- **About Us –** About the South Fork Kings GSA; Quick links to Stakeholder Survey, Interested Persons Sign-Up, Board Agendas/Minutes, Documents
- **Board of Directors –** Board of Directors; Quick links to Stakeholder Survey, Interested Persons Sign-Up, Board Agendas/Minutes, Documents; Upcoming Events
- **Groundwater Sustainability Plan Portal –** Calendar, Projects, Coordination, Resources; Groundwater Sustainability Plan Development; GSP Implementation Roles (GSA, Stakeholder, DWR, SWRCB); GSP Schedule
- **Proposition 218 Assessment –** Election Results; Prop 218 Frequently Asked Questions; Prop 218 Election Documents; Overview of Groundwater Assessment
- **News**
- **Resources**
- **Contact Us –** Contact Us Inquiry Form; SGMA Update E-News Sign-Up; Quick links to Stakeholder Survey and Interested Persons Sign-Up



Picture 2. Screenshot of https://southforkkings.org/ Homepage

Table 13. 2017 SFKGSA Website Views

Month	Views
January	N/A
February	N/A
March	N/A
April	N/A
May	N/A
June	355
July	203
August	126
September	231
October	134
November	98
December	84

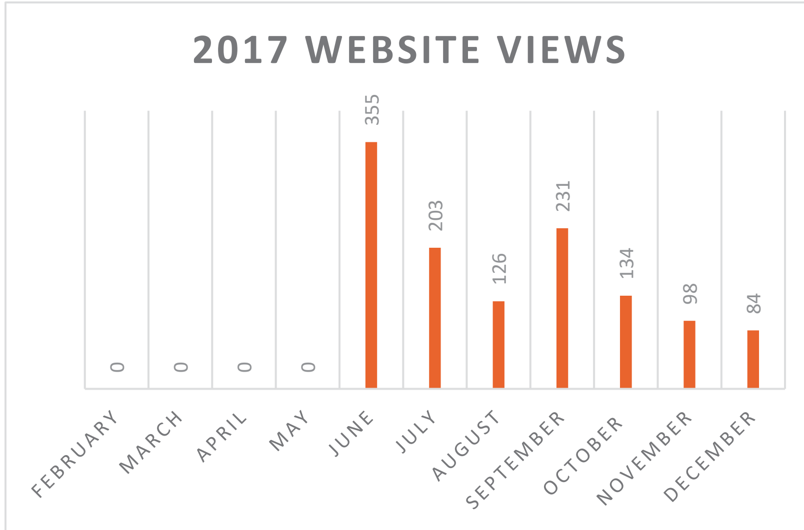


Table 14. 2018 SFKGSA Website Views

Month	Views
January	197
February	203
March	158
April	302
May	418
June	332
July	359
August	248
September	216
October	373
November	182
December	237

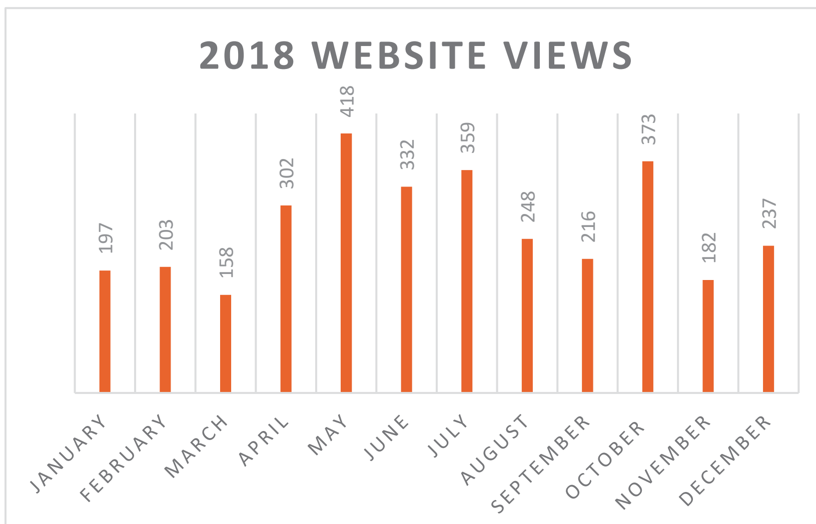
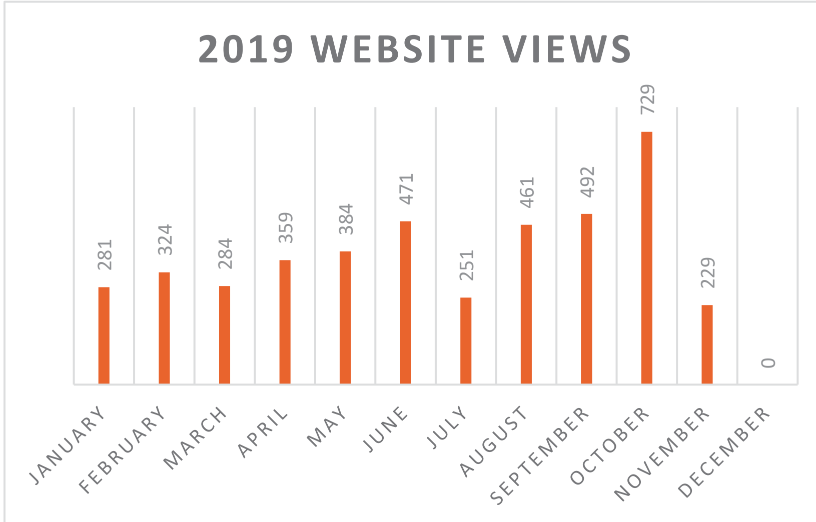


Table 15. 2019 SFKGSA Website Views

Month	Views
January	281
February	324
March	284
April	359
May	384
June	471
July	251
August	461
September	492
October	729
November	458
December	318



D.5.2 South Fork Kings GSA Outreach Tracking

Table 16. South Fork Kings GSA Public Meetings, Presentations & One-on-One Meetings

Event	Date	Attendance	Audience
Lemoore City Council Study Session	4/22/2015	15	Stakeholders
Empire Westside Water District Board Meeting	9/16/2015	7	Stakeholders
Stratford PUD Board Meeting	11/18/2015		Stakeholders (DAC)
Kings County Water Commission Meeting	11/23/2015	20	Stakeholders
Lemoore Industrial Stakeholder Meeting	1/26/2016	9	Stakeholders
Kings County Water Commission Meeting	5/23/2016	20	Stakeholders
Kings County Board of Supervisors Workshop	8/2/2016	30	Stakeholders
Janice Cuara, Tribal Administrator Tachi-Yokut	9/12/2016		Stakeholders – Native American
Ag Commodities Group Update	9/21/2016	8	
Kings County Farm Bureau Membership	10/12/2016	30	Stakeholders, Landowners
SFK White Areas – Stratford	12/12/2016		Stakeholders (DAC)
SFK White Areas – Lemoore	12/12/2016	35	Stakeholders
Kings County Water Commission Meeting	12/22/2016		Stakeholders
Noah Ignacio, EPA Director Tachi-Yokut	3/3/2017		Stakeholders – Native American
SGMA Roundtable for Schools SFK	9/15/2017	30	Stakeholders
SGMA Presentation, Hanford Rotary Club	11/2017	40	Stakeholders
Board Meeting, Lemoore City Council Chambers	02/1/2018	20	Stakeholders
Board Meeting, Lemoore City Council Chambers	3/15/2018	10	Stakeholders
Board Meeting, Lemoore City Council Chambers	4/19/2018	13	Stakeholders
Proposition 218 Assessment Workshop, Lemoore	5/1/2018	20	Landowners, City of Lemoore residents
Webinar: Proposition 218 Assessment	5/3/2018	1	Landowners

Event	Date	Attendance	Audience
Prop 218 Assessment Workshop, Lemoore	5/21/2018	21	Landowners, City of Lemoore residents
Board Meeting/Public Hearing for Proposition 218 Election	6/21/2018	25	Landowners, stakeholders
Board Meeting, Lemoore City Council Chambers	7/19/2018	19	Stakeholders
Board Meeting, Lemoore City Council Chambers	8/16/2018	16	Stakeholders
Board Meeting, Lemoore City Council Chambers	10/18/2018	19	Stakeholders
Board Meeting, Lemoore City Council Chambers	01/17/2019	24	Stakeholders
Board Meeting, Lemoore City Council Chambers	02/21/2019	14	Stakeholders
Presentation to Lemoore Canal Company	03/12/2019		Stakeholders
Presentation to Stratford Public Utility District	03/13/2019		Stakeholders
Presentation to Lemoore City Council	03/19/2019		Stakeholders
Presentation to Empire West Side Irrigation District	03/20/2019		Stakeholders
Special Board Meeting, Lemoore City Council Chambers	03/21/2019	19	Stakeholders
Presentation to Stratford Irrigation District	04/18/2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	04/18/2019	13	Stakeholders
Board Meeting, Lemoore City Council Chambers	05/23/2019	14	Stakeholders
GSP Update, Stratford Public Utility District	06/12/2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	06/20/2019	12	Stakeholders
Board Meeting, Lemoore City Council Chambers	08/15/2019	18	Stakeholders
Board Meeting – Lemoore City Council Chambers	09/19/2019	14	Stakeholders
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Hanford	10/9/2019	27	Stakeholders
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Lemoore	10/15/2019	35	Stakeholders
Board Meeting, Lemoore City Council Chambers	10/17/2019	12	Stakeholders
Board Meeting, Lemoore City Council Chambers	11/21/2019	13	Stakeholders
Tulare Lake Subbasin GSP Public Hearing – Hanford	12/2/2019		Stakeholders
Board Meeting, Lemoore City Council Chambers	12/19/2019		Stakeholders
Special Board Meeting – Adoption of GSP, Lemoore City Council Chambers	01/16/2020		Stakeholders

Table 17. South Fork Kings GSA Website Articles

Title/Topic	Date	Views
Kings County Farm Bureau newsletter article	Jul-15	N/A
SFK Board Approves Contract with Hydrogeological Consultant	6/20/2017	26
Board Supports Effort to Develop a Single GSP for the Tulare Lake Subbasin	7/20/2017	16
Contract Approved with Geosyntec Consultants	8/21/2017	28
Board Approves Preparation of Engineering Report for 218 Election	9/25/2017	23
Board Approves Data Sharing Agreements with North Fork Kings GSA, Westlands Water District	2/9/2018	17
The Model, the Data and Groundwater Sustainability	2/9/2018	225
Board Approves Engineer's Report, Moves Forward with Prop 218 Assessment	3/27/2018	84
Proposition 218 Election to Fund Local Groundwater Management Passes	6/22/2018	29
Consultants update Board on the groundwater model, a Groundwater Sustainability Plan foundation	7/24/2019	31
Groundwater Sustainability Plan schedule update	10/11/2018	28
Project and management action concepts discussed at Board workshop	10/22/2018	76
Adaptive management is essential on the years-long road to sustainability	1/22/2019	46
Preliminary Monitoring Network Identified	3/15/2019	49
Creativity and adaptive management will reduce 45,000 AF of estimated overdraft in the South Fork Kings	4/24/2019	70
Twelve Wells will Monitor Groundwater	6/7/2019	67
Board Approves $9.80 Assessment	6/25/2019	25

Table 18. Email Correspondence with Interested Persons List - Email Blasts

Message/Topic	Date Sent	Open Rate	Click Rate	Reach/Quantity
Board Agenda Packet	6/20/2017	43.5%	20.0%	24
Board Agenda Packet	7/21/2017	60.7%	5.9%	29
Board Agenda Packet	8/21/2017	46.4%	7.7%	30
Board Agenda Packet	9/25/2017	46.7%	7.1%	32
Board Agenda Packet	11/3/2017	53.3%	56.3%	32
Model, Data, Sustainability Tech Consultant; Data-Sharing Agreements Approved	2/9/18	49.2%	51.6%	67
Model, Data, Sustainability tech consultant; data sharing agreements approved	3/12/18	49%	51%	67
Board Agenda Packet	3/27/18	46%	50%	65
Engineer's Report Adopted; Prop 218 Election; Board meeting schedule update	4/16/18	44%	27%	68
Board Agenda Packet	5/2/18	48%	57%	76
Prop 218 Workshop Highlight, State Intervention, Groundwater Fee	5/7/18	N/A	N/A	0
Ballots mailed, local vs. state control, prop 218 resources, public hearing date	5/31/18	60%	33%	91
Submit your ballot by June 21 hearing date	7/27/18	47%	34%	106

Message/Topic	Date Sent	Open Rate	Click Rate	Reach/Quantity
Update to landowner on the overdraft number for the Tulare Lake Subbasin	7/16/18	N/A	N/A	1
Board Agenda Packet	7/24/18	57%	57%	113
Groundwater Model, Technical Services Continued with Geosyntec	8/13/18	52%	33%	117
Board Agenda Packet	10/15/18	54%	46%	119
Board Agenda Packet	10/23/18	46%	33%	120
Project and management actions discussed at workshop, DWR funding opportunity, Tulare Lake Subbasin Communication & Engagement Plan adopted, Stakeholder Survey, #SGMAMadeSimple	12/13/18	47%	42%	121
Meeting Cancellation Notice	12/17/18	44%	N/A	126
Board Agenda	1/17/2019	56%	44%	126
Adaptive management for sustainability, GSP Portal Updates, Stakeholder Survey, Water Budget video	1/23/2019	54%	35%	128
Board Agenda	2/15/2019	52%	33%	134
Meeting notice	2/22/2019	40%	8%	N/A
Timeline to GSP completion, Board appoints officers, monitoring network identified, water quality infographic	3/15/2019	50%	28%	141
Board Agenda	3/18/2019	44%	34%	141
Board Agenda	4/15/2019	43%	28%	142
Creativity and adaptive management will reduce overdraft, land subsidence infographic, board workshop slides	4/25/2019	51%	28%	142
Board Agenda, Budget Committee Agenda	5/20/2019	43%	24%	154
Twelve Wells will monitor groundwater, groundwater storage infographic	6/7/2019	41%	37%	153
Board Agenda	6/17/2019	39%	27%	152
Board approves &9.80 assessment, SGMA Made Simple video, June 20th workshop presentation	6/25/2019	35%	37%	153
Board Agenda	8/12/2019	51%	43%	209
Board Agenda	9/16/2019	45%	40%	218
GSP available for download, upcoming GSP workshops	10/2/2019	41%	18%	219
Board Agenda	10/14/2019	41%	24%	222
Upcoming GSP workshop promo	11/5/2019	42%	22%	222
Upcoming Irrigation Technology event at CSU Fresno	11/5/2019	36%	7%	224

Table 19. Direct Mailings to Stakeholders

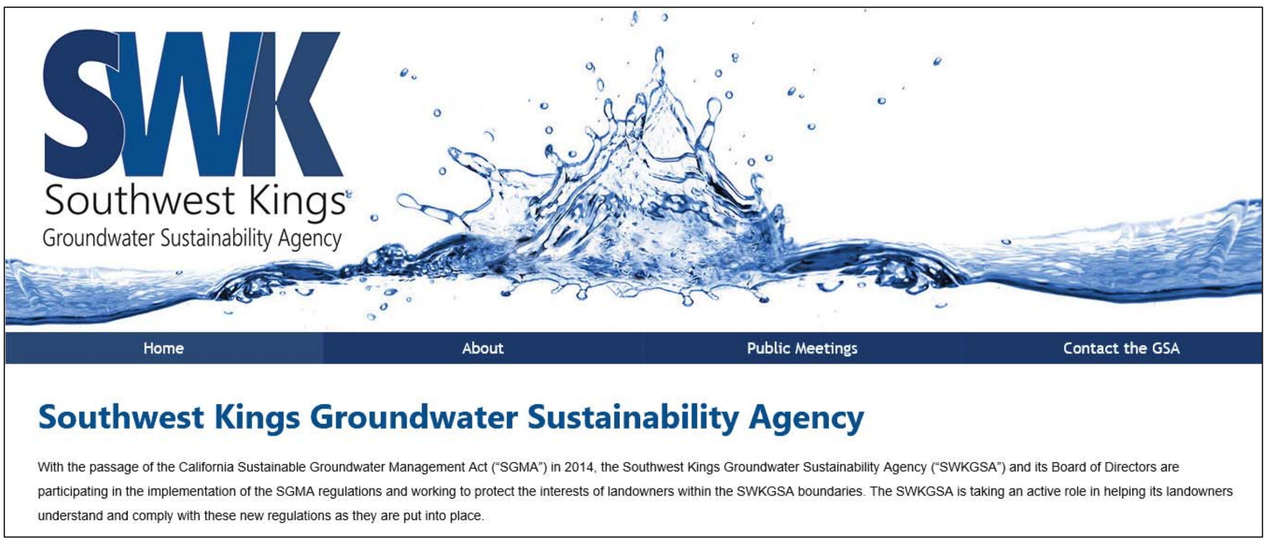
Date	Title	Audience	Quantity
April 2018	Prop 218 Informational Mailer	Landowners	897
April 2018	Prop 218 Informational Mailer (Spanish)	Residents	317
May 2018	Postcard: Final Workshop notice	Landowners	897
May 2018	Postcard: Final Workshop notice (Spanish)	Residents	317
June 2018	Postcard: final ballot reminder	Landowners	897
June 2018	Postcard: final ballot reminder (Spanish)	Residents	317
October 2018	Fall Mailer: Prop 28 results and GSP update	Landowners	897
October 2018	Fall Mailer: Prop 28 results and GSP update (Spanish)	Residents	317
July 2019	Contact Form and GSP education mailer	Landowners	1,089
July 2019	Contact Form and GSP education mailer (Spanish)	Residents	Online
October 2019	GSP Workshop promo mailer	Landowners	1,089
October 2019	GSP Workshop promo mailer (Spanish)	Residents	Online

D.6 Southwest Kings GSA

D.6.1 Website – www.swkgsa.org

The Southwest Kings GSA launched a website in March 2017 as a key avenue to inform stakeholders about the GSA, public outreach opportunities, and as a resource with SGMA-related information. A site map is outlined below:

- **Homepage –** Introduction of Southwest Kings GSA; Important Dates; News & Press Releases; and Quick Links to GSA Boundary Map and SGMA-Related Resources
- **About SGMA & SWKGSA –** What is SGMA?; SGMA and the Southwest Kings GSA; SWKGSA Information (links to boundary map, Bylaws & Policies, JPA Members Agreement, Cost-Sharing Agreement); Governance (Board of Directors, Alternate Directors, GSA Members, Management/Consultant Team)
- **Public Meetings –** Public Hearings; Board Meetings (agendas and minutes); Public Outreach Workshops
- **Contact the GSA –** Questions; Location; Interested Parties List Sign-Up Form



Picture 3. Screenshot of www.swkgsa.org Homepage

D.6.2 Outreach Tracking

Table 20. Southwest Kings GSA Public Meetings, Presentations & One-on-One Meetings

Meeting/Event	Date
Southwest Kings GSA Board Meeting – SGMA and GSA Formation	3 p.m., February 8, 2017
Southwest Kings GSA Board Meeting – SGMA and GSA Formation	3 p.m., March 8, 2017
Southwest Kings GSA Board Meeting – SGMA and GSP Development	3 p.m., April 12, 2017
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., June 28, 2017
Southwest Kings GSA Special Board Meeting – Proposition 218 Public Hearing & Election	10 a.m., August 14, 2017
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., February 14, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., May 9, 2018
Southwest Kings GSA Board Meeting with special presentation on Preliminary Water Budget	3 p.m., July 11, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., September 12, 2018
Kettleman City Community Services District Board Meeting – SGMA/GSA Presentation	6 p.m., October 23, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., December 12, 2018
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., February 13, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., May 8, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., July 10, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Hanford	5:30 p.m., October 9, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Lemoore	5:30 p.m., October 15, 2019
Southwest Kings GSA Special Board Meeting – GSP Public Review Update	3 p.m., October 18, 2019
GSP Meeting with County of Kings representatives and other GSA managers	1:30 p.m., November 6, 2019
GSP Public Review Presentation – Kettleman Community Services District Board Meeting *(Note: Presentation scheduled for Nov. 19, rescheduled for Nov. 26, but board meeting canceled by KCSD both dates due to lack of quorum)*	6 p.m., November 26, 2019
Tulare Lake Subbasin GSP Public Hearing – Hanford	10 a.m., December 2, 2019
Southwest Kings GSA Board Meeting – SGMA and GSP Development Updates	3 p.m., December 11, 2019
Special Board Meeting – Adoption of GSP	9 a.m., January 17, 2020

D.7 Tri-County Water Authority

D.7.1 Website – http://tcwater.org

The Tri-County Water Authority launched a website to aid in achieving the Authority's goal of world class groundwater management in the Tulare Lake Hydrologic Region. A site map of the website is outlined below:

- **Homepage –** Primary goal of Tri-County Water Authority; Updates/Reports; Notifications; Quick Links to SGMA Overview; Tri-County Water Authority Map; News; Calendar; About the Water Authority
- **SGMA –** What is The SGMA?; SGMA Purpose; What Are Your Rights?; Overview of The Water Problem; Frequently Asked Questions; Tri-County Water Authority Territory
- **About Us –** About Us Overview; Board of Directors; Trusted News Sources Links – http://tcwater.org/news/ ; Calendar – http://tcwater.org/events/
- **Contact the GSA**

Picture 4. Screenshot of http://tcwater.org Homepage

D.7.2 Outreach Tracking

Table 21. Tri-County Water Authority Public Meetings, Presentations & One-on-One Meetings

Tri-County Water Authority Meetings/Presentations/One-on-One Discussions	
Meeting/Event	Date
TCWA Board Meeting	1 p.m., January 4, 2018
TCWA Technical Advisory Committee Meeting	10 a.m., January 24, 2018
TCWA Stakeholder Advisory Committee Meeting	1 p.m., January 24, 2018
TCWA Board Meeting	1 p.m., March 1, 2018
TCWA Technical Advisory Committee Meeting	10 a.m., March 7, 2018

Tri-County Water Authority Meetings/Presentations/One-on-One Discussions	
Meeting/Event	Date
TCWA Stakeholder Advisory Committee Meeting	1 p.m., March 7, 2018
TCWA Special Board Meeting	1 p.m., March 13, 2018
TCWA Technical Advisory Committee Meeting	10 a.m., March 28, 2018
TCWA Stakeholder Advisory Committee Meeting	1 p.m., March 29, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., April 25, 2018
TCWA Board Meeting	1 p.m., June 26, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., June 27, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., July 25, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., August 22, 2018
TCWA Board Meeting	1 p.m., September 6, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., October 1, 2018
TCWA Special Board Meeting	1 p.m., October 11, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., October 24, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	9 a.m., December 19, 2018
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., January 23, 2019
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., February 27, 2019
TCWA Board Meeting	1 p.m., March 5, 2019
TCWA Board Meeting	1 p.m., April 2, 2019
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., April 24, 2019
TCWA Board Meeting	1 p.m., May 2, 2019
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., May 22, 2019
TCWA Board Meeting	1 p.m., June 4, 2019
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., June 26, 2019
TCWA Board Meeting	1 p.m., July 9, 2019
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., July 24, 2019
TCWA Technical Advisory Committee/Stakeholder Advisory Committee Meeting	10 a.m., August 1, 2019
TCWA Board Meeting	1 p.m., August 1, 2019
TCWA Board Meeting – Public Review of GSP Presentation	1 p.m., September 16, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Hanford	5:30 p.m., October 9, 2019
Tulare Lake Subbasin-Wide Public Outreach Meeting: GSP for the Subbasin, Lemoore	5:30 p.m., October 15, 2019
GSP Meeting with County of Kings representatives and other GSA managers	1:30 p.m., November 6, 2019
TCWA & SGMA – Public Outreach Meeting, Allensworth	2 p.m., November 12, 2019
Tulare Lake Subbasin GSP Public Hearing – Hanford	10 a.m., December 2, 2019
TCWA Board Meeting	1 p.m., December 18, 2019
TCWA Board Meeting – Adoption of GSP	1 p.m., January 16, 2020

Appendix C
Stakeholder Comments and Responses on the 2020 GSP

APPENDIX C – PUBLIC COMMENTS ON THE DRAFT GSP

The Groundwater Sustainability Agencies (GSAs) solicited public and stakeholder comments on the draft Tulare Lake Subbasin (Subbasin) Groundwater Sustainability Plan (GSP) from September 6, 2019, to December 2, 2019. During this period, the GSAs received comments transmitted to them in six letters and in one email. During the Public Hearing on December 2, 2019, one verbal comment was received. This section provides summaries of the comments contained in the letters and email and as presented verbally on the draft GSP and the responses to each comment.

Each letter, email, and verbal comment received is listed in Table C-1 and identified by comment author and date received by the GSAs.

Table C-1. List of Commenters

Comment ID	Comment Author	Comment Date
Organizations		
0-1	The Nature Conservancy	November 26, 2019
0-2	California Poultry Federation	November 27, 2019
0-3	Clean Water Action/Clean Water Fund; Local Government Commission; Audubon/California; The Nature Conservancy	December 2, 2019
0-4	Westlands Water District	December 2, 2019
0-5	Westlands Water District	December 2, 2019
Individuals		
I-1	Colleen Courtney	October 11,2019
I-2	Bill Miguel	October 15,2019
I-3	Bill Toss	December 2, 2019
I-4	Doug Verboon	December 2, 2019

Each of the comments is summarized below followed by responses from the GSAs. Hard copies of the comment correspondence received by the GSAs and a written summary of the verbal comment are compiled and presented following the comments and responses section.

Comment O-1

In The Nature Conservancy's letter to the South Fork Kings (SFK) GSA, they address the GSP's consideration of the beneficial uses and users of groundwater including environmental uses and users. The comment letter states:

> *Although there is a robust description of the confined (lower) and unconfined/semiconfined (upper) aquifers there is no explicit description with supporting data and information of how groundwater above the A- and C- clays in the upper aquifer interacts with the unconfined aquifer or is influenced by pumping in the unconfined portion of the aquifer. DWR's definition of a principal aquifer, is defined as an "aquifer of aquifer system that stores, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems."*
>
> *These shallow and perched areas within the upper aquifer range from near surface to 30 feet below ground surface and likely provide water supply to GDEs and ISWs. As such, they yield significant quantities of groundwater to surface water systems and beneficial users, and should not be dismissed because they do not yield groundwater for human use.*

These statements are the basis for the other resulting comments in their letter that request additional data and information, suggest that the GSA's and GSP recognize groundwater dependent ecosystems (GDEs) and interconnected surface water (ISW), and suggest a need for monitoring of these potential areas.

Response: Thank you for your letter and comments. Related to the Hydrologic Conceptual Model as presented in Section 3.1.8 of the draft GSP, there are geologic deposits in the Subbasin that are lacustrine clays named the A- through F-Clays. The A- through D-Clays may be more important locally in restricting the downward movement of groundwater. Figure 3-17 shows the areal extent of the A-Clay and the depth to groundwater above the A-Clay. Comparing this figure with your web-based GDE Pulse indicates an area along the South Fork Kings River where there would be the most interest in evaluating whether GDEs and ISWs occur.

From Section 4.0 of the draft GSP "Indicators for the sustainable management of groundwater were established under Sustainable Groundwater Management Act of 2014 (SGMA) based on factors that have the potential to impact the health and general well-being of the public. The following indicators were evaluated within the Subbasin: groundwater levels, groundwater storage volume, land subsidence, water quality, interconnected surface water, and seawater intrusion." ISW and seawater intrusion are not present within the Subbasin and were omitted from further consideration in the draft GSP. GDEs are not one of the sustainability indicators but rather dependent on ISW systems. Section 3.2.8 describes more fully the conditions found within the plan area.

It is also recognized that the GSP is adaptive in nature and will be updated as more information becomes available. It is noted in Section 5.4.1.2 that the ability to add and/or alter the existing monitor programs is envisioned. The individual GSAs will determine if or when additional attempts will be made to collect that data. Temporal adjustments may be made for the different aquifer zones or in certain areas. For example, semi-annual water level readings in above the A-Clay wells is probably sufficient to capture seasonal and long-term trends in most of that aquifer zone because water levels in the aquifer are relatively stable in most of the area. Near the Kings River it may be desirable to collect more frequent data from above the A-Clay to better understand the relationship between the river and shallow groundwater.

Comment O-2

The California Poultry Federation (CPF) is the trade association for California's poultry industry. In their letter to the Southwest Kings (SWK) GSA, they expressed their support for effective measures to assure reliable water supplies. CPF's comments largely focused on 2 main issues:

1. Supply augmentation should be a top priority of the GSP.
2. Regarding demand management, the GSP does not explain precisely how it will be done and the public will need to have opportunities to participate in the development of demand management measures. Also, the GSAs should do their best to ameliorate economic impacts by adopting demand management measures that are cost-effective.

Response: Thank you for your letter and comments. The GSAs agree that supply augmentation should be a top priority for this Subbasin. Several supply augmentation projects and their implementation are described in Chapters 6 and 7.

The draft GSP has been revised to remove demand management or demand reduction as a definitive programmatic action. The potential for demand management is described in Section 6.4 only as an option for the GSAs should it be needed to meet the Sustainability Goal. If implementation is necessary, the GSAs are committed to executing such programs in a cost effective manner and with the input of the local communities.

Comment O-3

This letter was submitted to the Tri-County Water Authority GSA on behalf of the Clean Water Action/Clean Water Fund, Local Government Commission, Audubon/California, and The Nature Conservancy in the interests of disadvantaged communities (DACs), drinking water, and the environment. The letter presented a checklist of GSP review criteria and summary comments addressing 9 elements as indicated in the response.

Response: Thank you for your letter and comments. Responses to the summary comments in the letter are provided below.

1. **How the DACs were determined and engaged in the GSP development process.**
DACs were identified using the California Department of Water Resources (DWR) DAC online mapping tool and associated Geographic Information System data (2018) and the Tulare Lake Basin DAC Water Study (published 2013). The GSAs conducted a substantial amount of stakeholder engagement, including outreach to DACs, during the development of the GSP. These efforts are described in detail in Appendix B.

2. **Financial assistance for DACs.**
SGMA did not intend for the GSAs to provide financial assistance to entities in the Subbasin. Representatives of the GSAs will reasonably assist entities in identifying potential sources of financial assistance, if requested and necessary, and will provide other non-financial assistance to the extent that it is required in the SGMA regulations and the GSAs have the resources to do so.

3. **The development of Measurable Objectives and Minimum Thresholds Sustainable Management Criteria needs to be explained.**
The development of Measurable Objectives and Minimum Thresholds are described in Chapter 4 of the draft GSP. The methods used and the rational for selecting these criteria are described in this chapter.

4. **There should be stakeholder engagement during GSP implementation.**
The GSAs conducted a substantial amount of stakeholder engagement during the development of the GSP. These efforts are described in detail in Appendix B. The GSAs intend to continue stakeholder engagement efforts through GSP implementation.

5. **The potential for impacts to domestic water supply wells from GSP implementation.**
Domestic water supply wells in the Subbasin typically are the shallowest wells in the Subbasin and have historically been subject to a dynamic groundwater system whereby water levels change frequently due to seasonal fluctuations and climatic changes (such as drought). Prior to SGMA, these wells also experienced gradual long-term decline of water levels due to the curtailment of federal and state surface water deliveries to the Subbasin. In this environment, owners of these wells have successfully adjusted by modifying the wells or drilling new wells. Under SGMA, water levels will continue to change frequently due to seasonal fluctuations and climatic changes and until the GSP is fully implemented, the wells may also experience gradual decline of water levels. However, as the GSP is

implemented, shallow water levels are expected to stabilize, thereby providing a positive benefit to domestic well owners.

6. **Groundwater Dependent Ecosystems should be addressed.**
   From Section 4.0 of the draft GSP "Indicators for the sustainable management of groundwater were established under SGMA based on factors that have the potential to impact the health and general well-being of the public. The following indicators were evaluated within the Subbasin: groundwater levels, groundwater storage volume, land subsidence, water quality, interconnected surface water, and seawater intrusion." Interconnected surface water and seawater intrusion are not present within the Subbasin and were omitted from further consideration in the draft GSP. GDEs are not one of the sustainability indicators but rather dependent on interconnected surface water systems. Section 3.2.8 describes more fully the conditions found within the plan area.

   It is also recognized that the GSP is adaptive in nature and will be updated as more information becomes available. It is noted in Section 5.4.1.2 that the ability to add and/or alter the existing monitor programs is envisioned. The following is offered; "The individual GSAs will determine if or when additional attempts will be made to collect that data. Temporal adjustments may be made for the different aquifer zones or in certain areas. For example, semi-annual water level readings in above the A-Clay wells is probably sufficient to capture seasonal and long-term trends in most of that aquifer zone because water levels in the aquifer are relatively stable in most of the area. Near the Kings River it may be desirable to collect more frequent data from above the A-Clay to better understand the relationship between the river and shallow groundwater."

7. **Climate change must be considered in development of the GSP.**
   As required by DWR, climate change is accounted for in the groundwater model (Appendix D) using assumptions and parameters provided by DWR.

8. **Drinking water should be considered in the water budget.**
   Municipal water use throughout the Subbasin is accounted for in the water budget. Water use from private domestic wells is not known nor is well construction known. The amount of water from domestic wells is estimated to be a *de minimis* amount in the overall water budget.

9. **Continued groundwater level decline during GSP implementation.**
   Per SGMA requirements, the GSAs have developed a GSP the implementation of which will result in groundwater sustainability for the Subbasin by 2040. At that point, average groundwater levels will become stable.

Comments O-4 and 0-5

Westlands Water District (Westlands) occupies the Westside Subbasin located to the southwest and adjacent to the Subbasin and is the GSA for this subbasin. In Westland's letters to the SWK GSA and SFK GSA (which are identical), they commented on 7 findings presented in the GSP, identified 3 discrepancies within the text, and offered 1 general comment.

Thank you for your letter and comments. Responses are provided below.

Finding 1 Comment
Finding 1 is in regard to groundwater flows into and out of the Subbasin and adjoining subbasins as described in Section 3.2.2 of the draft GSP. The letter states "*there is no substantial evidence to support the statements regarding groundwater flow directions out of the Subbasin to the Westside Subbasin."*

Response: Potentiometric surface maps prepared by DWR from 1990 through 2016 clearly show that heads in the unconfined aquifer in the SFK GSA area are decreasing towards the southwest from the Subbasin into the Westside Subbasin. The winter 2014/2015 potentiometric surface map for the lower (confined) aquifer provided by Westlands in the comment letter also shows that groundwater from the SWK GSA is flowing towards the northwest towards a pumping depression southeast of Huron and to the southeast towards what appears to be a pumping center at the border between SFK GSA and SWK GSA with a contour of -160 feet. A review of the available water level elevation data for lower aquifer monitoring wells (some of it provided by Westlands) in this area of the Subbasin show between 1990 and 2016 the heads typically ranged from -100 feet to +100 feet. During this same period, wells in the Westside Subbasin typically ranged from -130 to +100 feet, generally lower than the wells in the Subbasin. A few new deep El Rico GSA wells started pumping in the 2014/2015 time range and had water level elevation in the -230 feet range, and may possibly be the source for the -160 foot contour shown on the map. However, these wells only operated in the last couple of years and are not representative of the long-term groundwater levels along the boundary between Subbasin and Westside Subbasin. In summary, there is evidence that between 1990 and 2016, the general direction of groundwater flow was from the Subbasin towards the Westside Subbasin both in the unconfined and confined aquifers.

Finding 2 Comment

The letter states *Figures 3-28b to 3-28d shows long term hydrographs for wells within the Tulare Lake Subbasin. Unfortunately, the data displayed by the hydrographs is pixelated, therefore unreviewable. Westlands GSA recommends revising the mentioned figures to display hydrographs using a higher resolution to allow the public to review.*

Response: These figures have been revised to show the hydrographs at a higher resolution.

Finding 3 Comment

Finding 3 is in regard to groundwater quality, as described in Section 3.2.5 in the draft GSP and shown on Figures 3-30 through 32. The letter states *We recommend that the draft GSP be revised to accurately convey groundwater quality data by aquifer and by the timeframe the data represents. In addition, we recommend that the groundwater quality data be reviewed for accuracy.*

Response: The groundwater quality data have been reviewed for accuracy and have been corrected where needed. Figures 3-30, 3-31, 3-32, and 3-33 have been revised to show the highest concentration of the constituents reported and the most recent concentrations. The source for the groundwater quality data used in these figures does not indicate the aquifer from which the data were collected.

Finding 4 Comment

The letter states *Figures 3-34 contains a legend that is incomplete and is unable to be reviewed. Westlands GSA recommends applying the corresponding color scheme to the vertical displacement legend to allow readers to be able to review the presented information.*

Response: The figure has been revised as recommended.

Finding 5 Comment

Finding 5 is in regard to the Sustainable Management Criteria presented in the draft GSP, specifically with respect to future water level decline. The letter states *The potential for curtailing historic underflow into the Westside Subbasin may be a substantial factor in contributing to significant and unreasonable subsidence and frustrate the Westlands' GSA ability to achieve the sustainability goal.*

Response: Thank you for your comment.

To evaluate your concern, the data developed within the draft GSP's was placed on a map showing the location of representative wells, aquifer representation, measurable objective, and minimum thresholds. It should be noted that within the Tulare Lake GSP, there is a shallow zone above the A-Clay that is an additional aquifer that was not identified in the Westside Subbasin GSP. Thus the above E-Clay and Below E-Clay values were identified. Upon comparison for the above E-Clay designation, there are few wells in this zone in the westside basin. From the information, the data suggest that flow is from the Subbasin to the Westside Subbasin. For the below E-Clay aquifer, the data also suggest that the flow is from the Subbasin to the Westside Subbasin. So your initial suggestion that continued lowering of groundwater levels in the Tulare Lake GSP allows groundwater levels to become lower than levels established at 2015 is not supported. With the gradients that would result from these levels, it is recognized that groundwater outflow would continue to the Westside Subbasin. Per your point in your comment letter "The department shall evaluate whether a groundwater sustainability plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin".

As to historical underflow that you mention in your comments, we would refer you to Figures 3-23 and 3-24. Historical groundwater flows have historically flown from the Westside Subbasin into the Subbasin. It is believed that groundwater pumping from within the Westside Subbasin has altered these flow paths and it appears that the Westlands GSP is proposing to continue this practice. As you stated, overlying and appropriative uses of groundwater within the Subbasin are entitled to legal and equitable protection against infringement by an action that deprives them of their historical inflows. More coordination is warranted between our subbasins to reach a resolution. We look forward to discussing with you more thoroughly these boundary conditions and how we might develop a solution.

Finding 6 Comment

Finding 6 is in regard to the Sustainable Management Criteria presented in the draft GSP, specifically with respect to future subsidence. The letter states *Westlands GSA is concerned that allowing subsidence rates as proposed may impact critical infrastructure such as roads, railroads, and may increase flood risks to existing land uses, especially near Corcoran where subsidence rates are critical, in the Westside Subbasin and other neighboring subbasins.*

Response: Thank you for your comment. The GSA's within the Subbasin are concerned about lowering of groundwater levels as well as land subsidence. To this end, it is recognized that land subsidence is a regional concern and based upon historical information, is thought to be a result of groundwater pumping beneath the Corcoran Clay. The historical data and model developed for the basin suggests that regionally the largest change in land subsidence is located Southeast of the Subbasin and within the Tule Subbasin. The rate of subsidence continues into the Subbasin with rates experienced in Lemoore being approximately half of the rate at the Corcoran site.

Section 4.4.1.3 has been revised to reflect this historic information and set a minimum threshold of 8 feet of subsidence at the Lemoore site. To quote from the revised GSP, "These values have been selected using historical subsidence data. There has been no information suggesting that there has been local significant damage to infrastructure in both these areas. At each five-year milestone, information from the groundwater model suggests subsidence will continue for the first five years until project and management actions are fully implemented."

Finding 7 Comment

Finding 7 is in regard to analysis in the groundwater model report presented in Appendix D of the draft GSP indicate the General Head Boundary (GHB) is driving groundwater flow out of the Westside Subbasin and into the Subbasin. The letter states *Westlands recommends reanalyzing the water level contour data from the numerical model and GSP.*

Response: The GHBs in the Westside Subbasin basically follows the boundary between Fresno and Kings Counties. The GHB heads were interpolated from water level elevation data provided by DWR and Westlands for wells near the edge of the model on both side of the county line. The resulting GHB heads have historically tended to decrease from north and southwest to a low area near the bend in the county line. The winter 2014/2015 potentiometric surface map for the lower (confined) aquifer provided by Westlands in the comment letter also shows that the water level elevation contours along the county (GHB) line are also converging towards a low area near the bend in the county line. We believe the GHBs heads utilized in the Westside Subbasin are a reasonable interpretation of historical water level elevation in the area.

Reporting Discrepancy #1

The letter states *Total lateral subsurface inflow into the Westside Subbasin shown in Figure D5-5 averages 72,296 AFY (67,347 from the Tulare Lake Subbasin and 4,948 AFY from the Kings Subbasin). Table 3-6 of the GSP shows average annual subsurface flow from the Tulare Lake Subbasin to the Westside Subbasin of 41,390. What is the source of this discrepancy?*

Response: The figure was referencing an incorrect cell and has been corrected.

Reporting Discrepancy #2

The letter states *In the graphic depicting aquifer specific fluxes in Figure D5-5, the sum of the "Net GW Flux" (which presumably is lateral subsurface flow between adjacent subbasins) totals 4,936 AFY while the total in the table shown in Figure D5-5 is 72,296 AFY. What is the source of this discrepancy?*

Response: The figure was referencing an incorrect cell and has been corrected.

Reporting Discrepancy #3

The letter states *Figure numbers in the Appendix D text do not correspond to the correct figures. Figure DS-10 is titled "Simulated Subsidence 1990-2016". Figure D5-8 shows "Groundwater Mass Balance Tule Subbasin".*

Response: The figure numbers have been corrected.

General Comment

Westlands recommended that GSA representatives from the two subbasins meet and confer at the earliest opportunity to determine whether an interbasin agreement can be reached. The agreement would be used to reach a cooperative resolution of important issues that will enable coordinated sustainable management in our GSAs.

Response: The GSAs in the Subbasin agree that efforts should be made to develop and interbasin agreement and look forward to the opportunity following submittal of the respective GSPs.

Comment I-1

In her email of October 11, 2019, Ms. Courtney made clear her opposition to the GSP and using groundwater for agriculture.

Response: Thank you for your email and comments. The comments do not pertain to the GSP's analysis. Opposition to the GSP has been noted and the email is included in full herein and will be forwarded to the DWR for consideration.

Comment I-2

The comment letter from Mr. Miguel has a number of points related to surface water supplies and the Kings River Water Association. While the letter recognizes that the GSP and GSA's have no authority, he goes on to assert that the GSP could be used to be a proponent of change and public awareness. The letter suggests that there has been an opportunity missed in the capture and use of surface water flows from the Kings River and that storage contemplated and permitted has not been fully utilized.

Response: Thank you for your letter and comments. As is recognized in the letter, the GSA's and GSP have no authority of surface water rights, diversion and beneficial uses of these rights. These surface water rights have historic origins, were initially exercised in the 1800s, predate statehood and more recently have been permitted by the State Water Resources Control Board. A watermaster has been charged with oversight of the river and assuring that the surface water diversions are in accordance with the licenses for diversion. As to your suggestion that additional surface supplies could be utilized to offset overdraft, that is the plan. Please review Section 6.0 that identifies the projects envisioned to increased surface diversion and use. You will note that all the GSA's are planning on projects to divert and either recharge (where possible and the geologic conditions allow) or storage and reregulation of supply. These are most notable in the SFK, and El Rico, and Tri-County Water Agency GSA's. We look forward to the planning and implementation of these projects to allow for the continued farming and prosperity for the area.

Comment I-3

Mr. Toss provided a verbal comment at the Public Hearing on December 2, 2019, in which he stated that the demand reduction presented in Chapter 6 of the GSP as a management action to help achieve groundwater sustainability in the subbasin would be very damaging to Kings County and its growers. He requested that this management action be changed.

Response: Thank you for your comment. The draft GSP has been revised to remove demand management or demand reduction has a definitive programmatic action. The potential for demand management is described in Section 6.4 only as an option for the GSAs should it be needed to meet the Sustainability Goal. If implementation is necessary, the GSAs are committed to executing such programs in a cost effective manner and with the input of the local communities.

Comment I-4

Mr. Verboon is a Kings County Supervisor, but clarified that his comments were from him individually and "not on behalf of the Board of Supervisors". In his letter to the five GSAs, Mr. Verboon, on behalf of other signatories to the letter, made 3 main comments:

Comment 1: There were procedural defects that limited Kings County and its water uses in their opportunity to review and comment on the draft GSP.

Response: Thank you for your letter and comments. The GSAs understand that they have met their notice and other obligations to Kings County under Section 10728.4. The GSAs view that there were no procedural defects in the notice provided to the County. Consultation with Kings County took place at a meeting on November 6, 2019, roughly a month prior to the comment period close. Kings County chose to not submit any written or verbal comments on the draft GSP.

Comment 2: The projects presented in the draft GSP are too vague and non-committal.

Response: The draft GSP indicates that there exist a number of legal and practical uncertainties regarding project identification and adoption. Projects referenced in the draft GSP, and possibly others, will be identified and adopted by the GSAs, but only after sufficient data are collected, adequate analysis conducted, and funds are appropriated for the projects. Refer to Chapter 7 for further details on project implementation.

Comment 3: Land fallowing should be used as a demand reduction management action only as a last resort and after other demand reduction strategies and water recharge projects have been implemented.

Response: It appears that Mr. Verboon has interpreted the details of some groundwater model evaluations as planned GSA management strategies, and that is incorrect. Also, upon review, there were descriptions of land fallowing that were misleading and likely added to the confusion. These portion of the GSP have been revised. Also, the GSAs agree that supply augmentation should be a top priority for this Subbasin. Several supply augmentation projects and their implementation are described in Chapters 6 and 7.

Public Comment Letters

From: Colleen Courtney <colleencourtney66@gmail.com>

Sent: Saturday, October 12, 2019 1:01 AM

To: Colleen Courtney <colleencourtney66@gmail.com>; comments@southforkkings.org; jwyrick@jgboswell.com; kcwdh20@sbcglobal.net

Subject: GSAS-Kings County Resident STATES NO ON GROUND WATER FOR AGRICULTURAL PURPOSES!

Colleen Courtney
14234 16th Avenue
Lemoore, CA 93245-9517
Email: colleencourtney66@gmail.com

October 11,2019

To: GSAS Commissioners Board;

HELL NO! These sod Busters DO NOT DRAIN the Valleys Ground Water for their crops that ships out of State or over seas for your personal Padding Their wallets!

NOT AT this Valleys populations expense for their personal gains!

We need that water for drinking for people, animales we eat and other business endeavors other than these Sod Busters causing our lungs to fill with their crop dirt, pesticides from those dam planes or choppers that keep sprayers on to do a turns. Bull shit!

You sod Busters use your homes water well resource to water your acreages! Or drill more water wells on your own property or truck in tankers of water from the Rockies or Serras!

Or tap into your local City water line. Their water line is petty much secured source for your crop of your own choice of Occupational decision of becoming a FATCAT Farmer! At the other people's thirst expense!

We are already breathing your property's dirt and pesticides! Your surface soil covers our house and vechicals in one month! And pushing your sludge mixed with our water down that dam drive away!

I am about to phone the Sheriffs Department on that sod buster's property that constantly trespasses and squats on our property and buries everything!
We accumulated more of his farm land than he actually possesses!

These sodbusters are like city slumlords just purchased cheap property sell high, cut costs, don't maintain, rape the earth, suck it out of every earthly nutrients, minerals possible drain others water for your sole purposes to pad your wallets. And in the end abandon the worthless property your raped the hell out of. To go to another place to fu ck up for the next generation to overhaul that damage you caused in the first place!

NO GROUND WATER To SOD BUSTERS!
And SOD BUSTERS are NOT in the
AGRICULTURAL COMMUNITIES!

The Real Farmers know how to take care of the earth and would not ever think of asking people to give up their drinking water for themselves and their animals. For his crops. This Farmer would sacrifice his crops for those people when it came to water rights. And not directed by padding his wallet!

VOTE NO ON GROUND WATER! Let these sod busters truck in their water from Rockies or Serras! Just a cheap expense compared to Shipping crops to New York or Over Seas!

Cheap son of a bitches! Go dry up!

Colleen Courtney

RECEIVED K.R.C.D.

OCT 15 2019

File No. ______________

South Fork Kings Groundwater Sustainability Agency
4886 E Jensen Avenue
Fresno, CA 93725

TO: SFKGSA Board Members and members of the Public.

RE: Response to SFKGSA Sustainability Plan.

I use this opportunity to respond to the South Fork Kings Groundwater Sustainability Plan. I understand that the SFKGSA is limited in its scope of responsibility and governance, however I feel the SFKGSA can become a useful proponent and informational resource for public awareness.

The primary source of groundwater recharge is the sandy bottom of the Kings River. Domestic wells, agriculture wells, groundwater dependent ecosystems, and other beneficial users are dependent upon the river's natural surface water flows to recharge underground aquifers. These surface water flows are managed by the Kings River Water Association (KRWA) whose 28 member districts receive water from a designated "point of diversion" on the Kings River. It has become common practice to divert surface water from lower stream points of diversion to upper stream diversion points to reduce what is commonly termed "channel loss". However, channel loss is also groundwater recharge. These diversions have a direct and negative impact on holders of overlying groundwater rights by diminishing groundwater recharge and adding to groundwater overdraft.

PART 1.
GROUNDWATER RIGHT HOLDERS:
SUSTAINABLE GROUNDWATER MANAGEMENT ACT: 10723.2.

"The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans. These interests include, but are not limited to, all of the following:"

(a) Holders of overlying groundwater rights, including:

(1) Agricultural users.

(2) Domestic well owners.

(b) Municipal well operators.

(c) Public water systems.

(d) Local land use planning agencies.

(e) Environmental users of groundwater.

Excerpts from CALIFORNIA WATER CODE:

§ 1706. The person entitled to the use of water by virtue of an appropriation other than under the Water Commission Act or this code may change the point of diversion, place of use, or purpose of use if others are not injured by such change...

§ 1707. (a) (1) Any person entitled to the use of water, whether based upon an appropriative, riparian, or other right, may petition the board pursuant to this chapter, Chapter 6.6 (commencing with Section 1435) or Chapter 10.5 (commencing with Section 1725) for a change for purposes of preserving or enhancing wetlands habitat, fish and wildlife resources, or recreation in, or on, the water.

Being a public entity, it is incumbent on the SFKGSA monitor and quantify the amount of groundwater recharge lost due to points of diversion changes. Further, it is an inherent responsibility of the SFKGSA to challenge any such diversions per California Water Code Sections 1706 and 1707, and by other codes sections not mentioned, and to advocate on behalf of those harmed by such diversions.

PART 2.

DECISION 1290

In 1967 the State of California State Water Rights Board issued its Decision 1290, a pivotal benchmark for Kings River water management. The following are excerpts from the Decision:

Page 16: "The primary source of all ground water in the Kings River service area is the river and its distributaries...".

Page 21: "The contracts with members of the KRWA result in the controlled release of water from these reservoirs* (Courtright, Wishon, Pine Flat) *to satisfy downstream requirements for irrigation and ground-water recharge."

Page 35-36: "...the association* (KRWA) *members have planned their overall project to take maximum advantage of all storage facilities available to them. This includes recharge of ground water and underground storage as well as the storage of flood waters in Tulare Lake Basin and maximum retention in Pine Flat Reservoir. Consulting Engineer Henry Karrer testified to the effect that under certain ideal conditions, about 2,000,000 acre-feet could be stored and regulated in Pine Flat Reservoir in any one year (RT192). He also said that up to 1,000,000 acre-feet of water could be stored in the cellular dyke system in Tulare Lake Basin (RT 192)."

This position was reaffirmed in a July 30, 2019 letter to Mitchell Moody of the State Water Resource Control Board when stating; "Decision 1290 expressly recognized the KRWA member units planned their overall project to take maximum advantage of all available storage facilities...".

Present estimate of King River Basin groundwater overdraft is 120,000 acre-feet per year, while average annual floodwater diverted to the San Joaquin River is 100,000 acre-feet. Opportunities of using Tulare Lake as a storage facility have been repeatedly missed as it has become common practice to redirect flood release water away from the ***cellular dyke system in Tulare Lake Basin*** to the San Joaquin. The beneficial use of this un-stored water is then lost to all.

It is understandable that stakeholders who would be harmed by the flooding of the Tulare Lake Basin would wish that flood release waters be diverted. The flooding of the Tulare Lake Basin would cause economic hardship to business interests. However, as noted in Decision 1290 and empirically known, the Kings River waters do naturally flow to the Tulare Lake Basin, into what is known as Tulare Lake.

It is likewise understandable that this diversion of flood release water comes at an equal price to stakeholders outside the Tulare Lake Basin. Water diverted away from the dyke system storage facility is water waisted and unused for negating groundwater overdraft and recharge. If full usage of the cellular dyke system were utilized as stated in Decision 1290, groundwater overdraft could be diminished by as much as 100,000 per year.

With SGMA deadlines approaching, stakeholders up-stream of the Tulare Lake Basin find themselves mired in a groundwater overdraft problem. They face the economic consequence of fallowed land and tax surcharges for groundwater pumping, while 100,000 acre-feet of Kings River surface water is re-routed to the San Joaquin River. Simply put; until the cellular dyke system in Tulare Lake Basin is fully utilized as intended, upstream right-holders and stakeholders a will pay the price for the problem Tulare Lake Basin interests pass on.

As stated, SFKGSA is a public entity and has an inherent responsibility to monitor, quantify and make publicly known the amount of groundwater recharge lost and the groundwater overdraft resulting from the non-use of the cellular dyke storage system as stated in Decision 1290. Additionally, it is requested that the SFKGSA study and make known the impact changes in points of diversion (Part 1) and non-use of the cellular dyke storage system in Tulare Lake Basin (Part 2) have upon groundwater recharge and overdraft prior to implementation of overdraft enforcement procedures.

Thank you for your consideration.

Bill Miguel
21425 Grangeville Blvd
Lemoore, California
October 11, 2019

The Nature Conservancy
Protecting nature. Preserving life.

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November 26, 2019

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4886 E. Jensen Avenue
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Submitted online via: https://southforkkings.org/wp-content/uploads/2019/09/2019-0906-tulare-lake-subbasin-gsp-prelim-draft_for-upload.pdf

Re: Tulare Lake Subbasin Groundwater Sustainability Plan, Preliminary Draft

Dear Agency Staff,

The Nature Conservancy (TNC) appreciates the opportunity to comment on the Groundwater Sustainability Plan (GSP) for the Tulare Lake Subbasin that is being prepared under the Sustainable Groundwater Management Act (SGMA).

TNC as a Stakeholder Representative for the Environment

TNC is a global, nonprofit organization dedicated to conserving the lands and waters on which all life depends. We seek to achieve our mission through science-based planning and implementation of conservation strategies. For decades, we have dedicated resources to establishing diverse partnerships and developing foundational science products for achieving positive outcomes for people and nature in California. TNC was part of a stakeholder group formed by the Water Foundation in early 2014 to develop recommendations for groundwater reform and actively worked to shape and pass SGMA.

Our reason for engaging is simple: California's freshwater biodiversity is highly imperiled. We have lost more than 90 percent of our native wetland and river habitats, leading to precipitous declines in native plants and the populations of animals that call these places home. These natural resources are intricately connected to California's economy providing direct benefits through industries such as fisheries, timber and hunting, as well as indirect benefits such as clean water supplies. SGMA must be successful for us to achieve a sustainable future, in which people and nature can thrive within the Tulare Lake Groundwater Subbasin and California.

We believe that the success of SGMA depends on bringing the best available science to the table, engaging all stakeholders in robust dialog, providing strong incentives for beneficial outcomes and rigorous enforcement by the State of California.

Given our mission, we are particularly concerned about the inclusion of nature, as required, in GSPs. TNC has developed a suite of tools based on best available science to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders efficiently incorporate nature into GSPs. These tools and resources are available online at

GroundwaterResourceHub.org. TNC's tools and resources are intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Addressing Nature's Water Needs in GSPs

SGMA requires that all beneficial uses and users, including environmental users of groundwater, be considered in the development and implementation of GSPs (Water Code § 10723.2).

The GSP Regulations include specific requirements to identify and consider groundwater-dependent ecosystems (GDEs) [23 CCR §354.16(g)] when determining whether groundwater conditions are having potential effects on beneficial uses and users. GSAs must also assess whether sustainable management criteria may cause adverse impacts to beneficial uses and users, which include environmental uses, such as plants and animals. TNC has identified each part of GSPs where consideration of beneficial uses and users are required. That list is available here: https://groundwaterresourcehub.org/importance-of-gdes/provisions-related-to-groundwater-dependent-ecosystems-in-the-groundwater-s. Please ensure that environmental beneficial users are addressed accordingly throughout the GSP. Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decision, and using data collected through monitoring to revise decisions in the future. Over time, GSPs should improve as data gaps are reduced and uncertainties addressed.

To help ensure that GSPs adequately address nature as required under SGMA, TNC has prepared a checklist (**Attachment A**) for GSAs and their consultants to use. TNC believes the following elements are foundational for 2020 GSP submittals. For detailed guidance on how to address the checklist items, please also see our publication, *GDEs under SGMA: Guidance for Preparing GSPs*[1].

1. Environmental Representation

SGMA requires that GSAs consider the interests of all beneficial uses and users of groundwater. To meet this requirement, we recommend actively engaging environmental stakeholders by including environmental representation on the GSA board, technical advisory group, and/or working groups. This could include local staff from state and federal resource agencies, nonprofit organizations and other environmental interests. By engaging these stakeholders, GSAs will benefit from access to additional data and resources, as well as a more robust and inclusive GSP.

2. Basin GDE and ISW Maps

SGMA requires that GDEs and interconnected surface waters (ISWs) be identified in the GSP. We recommend using the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) provided online[2] by the Department of Water Resources (DWR) as a <u>starting point</u> for the GDE map. The NC Dataset was developed through a collaboration between DWR, the California Department of Fish and Wildlife (CDFW) and TNC. We also recommend using GDE Pulse, which is also available on the internet at https://gde.codefornature.org/#/home. We also recommend using the California Natural

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[1]GDEs under SGMA: Guidance for Preparing GSPs is available at: https://groundwaterresourcehub.org/public/uploads/pdfs/GWR_Hub_GDE_Guidance_Doc_2-1-18.pdf

[2] The Department of Water Resources' Natural Communities Commonly Associated with Groundwater dataset is available at: https://gis.water.ca.gov/app/NCDatasetViewer/

Diversity Database (CNDDB) provided by CDFW to look up species occurrences within your area.

3. Potential Effects on Environmental Beneficial Users

SGMA requires that potential effects on GDEs and environmental surface water users be described when defining undesirable results. In addition to identifying GDEs in the basin, TNC recommends identifying beneficial users of surface water, which include environmental users. This is a critical step, as it is impossible to define "significant and unreasonable adverse impacts" without knowing *what* is being impacted. For your convenience, we've provided a list of freshwater species within the boundary of the Tulare Lake Groundwater Subbasin (Subbasin) in **Attachment C**. Our hope is that this information will help your GSA better evaluate the impacts of groundwater management on environmental beneficial users of surface water. We recommend that after identifying which freshwater species exist in your basin, especially federal- and state-listed species, that you contact staff at CDFW, United States Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Services (NMFS) to obtain their input on the groundwater and surface water needs of the organisms on the GSA's freshwater species list. We also refer you to the Critical Species Lookbook[3] prepared by TNC and partner organizations for additional background information on the water needs and groundwater reliance of critical species. Since effects to plants and animals are difficult and sometimes impossible to reverse, we recommend erring on the side of caution to preserve sufficient groundwater conditions to sustain GDEs and ISWs.

4. Biological and Hydrological Monitoring

If sufficient hydrological and biological data in and around GDEs is not available in time for the 2020/2022 plan, data gaps should be identified along with actions to reconcile the gaps in the monitoring network.

TNC has reviewed the Tulare Lake Preliminary Draft GSP and appreciates the use of some our relevant resources in addressing GDE-related topics. However, we consider it to be **inadequate** under SGMA since key environmental beneficial uses and users are not adequately identified and considered. In particular, 1) ISWs and GDEs are not adequately identified and evaluated for ecological importance or adequately considered in the basin's sustainable management criteria, and 2) connectivity and extent of the of ISWs and GDEs with the shallow / perched zones of the unconfined / semiconfined aquifer were not characterized. **Please present a more thorough analysis of the 1) connectivity of the shallow and perched portions of the unconfined aquifer, 2) extent of the perched and shallow areas within the aquifer, and 3) identification and evaluation of ISWs and GDEs in subsequent drafts of the GSP. Once potential GDEs and ISWs are identified, they must be considered when defining undesirable results and evaluated for further monitoring needs until data gaps are filled in the future. If they are not adequately defined, then they need to be identified as a data gap in the interim.**

Our specific comments related to the Tulare Lake GSP are provided in detail in **Attachment B** and are in reference to the numbered items in **Attachment A. Attachment C** provides a list of the freshwater species located in the Subbasin. **Attachment D** describes six best practices that GSAs and their consultants can apply when using local groundwater data to confirm a connection to groundwater for DWR's NC Dataset. **Attachment E** provides an overview of a new, free online tool (i.e., GDE Pulse) that allows GSAs to assess changes in GDE health using satellite, rainfall, and groundwater data.

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[3] Available online at: https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

Thank you for fully considering our comments as you develop your GSP.

Best Regards,

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy

Attachment A

Environmental User Checklist

The Nature Conservancy is neither dispensing legal advice nor warranting any outcome that could result from the use of this checklist. Following this checklist does not guarantee approval of a GSP or compliance with SGMA, both of which will be determined by DWR and the State Water Resources Control Board.

GSP Plan Element*		GDE Inclusion in GSPs: Identification and Consideration Elements	Check Box
Admin Info	**2.1.5 Notice & Communication** *23 CCR §354.10*	**Description of the types of environmental beneficial uses of groundwater that exist within GDEs and a description of how environmental stakeholders were engaged throughout the development of the GSP.**	1
Planning Framework	**2.1.2 to 2.1.4 Description of Plan Area** *23 CCR §354.8*	**Description of jurisdictional boundaries, existing land use designations, water use management and monitoring programs; general plans and other land use plans relevant to GDEs and their relationship to the GSP.**	2
		Description of instream flow requirements, threatened and endangered species habitat, critical habitat, and protected areas.	3
		Summary of process for permitting new or replacement wells for the basin, and how the process incorporates any protection of GDEs	4
Basin Setting	**2.2.1 Hydrogeologic Conceptual Model** *23 CCR §354.14*	**Basin Bottom Boundary:** Is the bottom of the basin defined as at least as deep as the deepest groundwater extractions?	5
		Principal aquifers and aquitards: Are shallow aquifers adequately described, so that interconnections with surface water and vertical groundwater gradients with other aquifers can be characterized?	6
		Basin cross sections: Do cross-sections illustrate the relationships between GDEs, surface waters and principal aquifers?	7
	2.2.2 Current & Historical Groundwater Conditions *23 CCR §354.16*	**Interconnected surface waters:**	8
		Interconnected surface water maps for the basin with gaining and losing reaches defined (included as a figure in GSP & submitted as a shapefile on SGMA portal).	9
		Estimates of current and historical surface water depletions for interconnected surface waters quantified and described by reach, season, and water year type.	10
		Basin GDE map included (as figure in text & submitted as a shapefile on SGMA Portal).	11

		If NC Dataset *was* used:	Basin GDE map denotes which polygons were kept, removed, and added from NC Dataset (Worksheet 1, can be attached in GSP section 6.0).	12
			The basin's GDE shapefile, which is submitted via the SGMA Portal, includes two new fields in its attribute table denoting: 1) which polygons were kept/removed/added, and 2) the change reason (e.g., why polygons were removed).	13
			GDEs polygons are consolidated into larger units and named for easier identification throughout GSP.	14
		If NC Dataset *was not* used:	Description of why NC dataset was not used, and how an alternative dataset and/or mapping approach used is best available information.	15
		Description of GDEs included:		16
		Historical and current groundwater conditions and variability are described in each GDE unit.		17
		Historical and current ecological conditions and variability are described in each GDE unit.		18
		Each GDE unit has been characterized as having high, moderate, or low ecological value.		19
		Inventory of species, habitats, and protected lands for each GDE unit with ecological importance (Worksheet 2, can be attached in GSP section 6.0).		20
	2.2.3 Water Budget *23 CCR §354.18*	Groundwater inputs and outputs (e.g., evapotranspiration) of native vegetation and managed wetlands are included in the basin's historical and current water budget.		21
		Potential impacts to groundwater conditions due to land use changes, climate change, and population growth to GDEs and aquatic ecosystems are considered in the projected water budget.		22
Sustainable Management Criteria	**3.1 Sustainability Goal** *23 CCR §354.24*	**Environmental stakeholders/representatives were consulted.**		23
		Sustainability goal mentions GDEs or species and habitats that are of particular concern or interest.		24
		Sustainability goal mentions whether the intention is to address pre-SGMA impacts, maintain or improve conditions within GDEs or species and habitats that are of particular concern or interest.		25
	3.2 Measurable Objectives *23 CCR §354.30*	**Description of how GDEs were considered and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.**		26
	3.3 Minimum Thresholds *23 CCR §354.28*	**Description of how GDEs and environmental uses of surface water were considered when setting minimum thresholds for relevant sustainability indicators:**		27
		Will adverse impacts to GDEs and/or aquatic ecosystems dependent on interconnected surface waters (beneficial user of surface water) be avoided with the selected minimum thresholds?		28
		Are there any differences between the selected minimum threshold and state, federal, or local standards relevant to the species or habitats residing in GDEs or aquatic ecosystems dependent on interconnected surface waters?		29
	3.4 Undesirable Results *23 CCR §354.26*	**For GDEs, hydrological data are compiled and synthesized for each GDE unit:**		30
		If hydrological data *are available* within/nearby the GDE	Hydrological datasets are plotted and provided for each GDE unit (Worksheet 3, can be attached in GSP Section 6.0).	31
			Baseline period in the hydrologic data is defined.	32

			GDE unit is classified as having high, moderate, or low susceptibility to changes in groundwater.	33
			Cause-and-effect relationships between groundwater changes and GDEs are explored.	34
		If hydrological data *are not available* within/nearby the GDE	Data gaps/insufficiencies are described.	35
			Plans to reconcile data gaps in the monitoring network are stated.	36
		For GDEs, biological data are compiled and synthesized for each GDE unit:		37
		Biological datasets are plotted and provided for each GDE unit, and when possible provide baseline conditions for assessment of trends and variability.		38
		Data gaps/insufficiencies are described.		39
		Plans to reconcile data gaps in the monitoring network are stated.		40
		Description of potential effects on GDEs, land uses and property interests:		41
		Cause-and-effect relationships between GDE and groundwater conditions are described.		42
		Impacts to GDEs that are considered to be "significant and unreasonable" are described.		43
		Known hydrological thresholds or triggers (e.g., instream flow criteria, groundwater depths, water quality parameters) for significant impacts to relevant species or ecological communities are reported.		44
		Land uses include and consider recreational uses (e.g., fishing/hunting, hiking, boating).		45
		Property interests include and consider privately and publicly protected conservation lands and opens spaces, including wildlife refuges, parks, and natural preserves.		46
Sustainable Management Criteria	**3.5 Monitoring Network** *23 CCR §354.34*	Description of whether hydrological data are spatially and temporally sufficient to monitor groundwater conditions for each GDE unit.		47
		Description of how hydrological data gaps and insufficiencies will be reconciled in the monitoring network.		48
		Description of how impacts to GDEs and environmental surface water users, as detected by biological responses, will be monitored and which GDE monitoring methods will be used in conjunction with hydrologic data to evaluate cause-and-effect relationships with groundwater conditions.		49
Projects & Mgmt Actions	**4.0. Projects & Mgmt Actions to Achieve Sustainability Goal** *23 CCR §354.44*	Description of how GDEs will benefit from relevant project or management actions.		50
		Description of how projects and management actions will be evaluated to assess whether adverse impacts to the GDE will be mitigated or prevented.		51

* In reference to DWR's GSP annotated outline guidance document, available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf

Attachment B

TNC Evaluation of the
Tulare Lake Subbasin Groundwater Sustainability Plan, Preliminary Draft

A complete draft of the Tulare Lake Subbasin GSP is available at https://southforkkings.org/wp-content/uploads/2019/09/2019-0906-tulare-lake-subbasin-gsp-prelim-draft_for-upload.pdf for public review and comment and is dated August 2019. This attachment summarizes our comments on the complete public draft GSP. Comments are provided in the order of the checklist items included as Attachment A.

Checklist Item 1 - Notice & Communication (23 CCR §354.10)

[Section 2.5.3 Beneficial Uses and Users (p. 2-28)]

- The flow chart on p. 2-28 shows the engagement process with groundwater users during the development and implementation of the GSP. Table 2-4 (pp. 2-47 to 2-49) identifies all the beneficial uses and users of groundwater within the Subbasin by GSA in greater detail, but does not include environmental uses and users. Users identified include agricultural, public water systems, domestic well owners, municipal water systems, planning agencies, Native American Tribes, Disadvantaged Communities, monitoring entities, and surface water users (as represented by GSA members). California Water Code §1305(f) defines that beneficial uses of waters of the State include "preservation and enhancement of fish, wildlife, and other aquatic resources and preserves". **Please expand Table 2-4 to include environmental uses and users that are present in the Subbasin, such as:**
    - **ecological areas; preserves; potential ISWs and GDEs; managed wetlands;**
    - **Protected Lands, including conservation areas; and**
    - **Public Trust Uses including wildlife, aquatic habitat, fisheries, and recreation.**

Checklist Items 2 to 4 - Description of the Plan Area (23 CCR §354.8)

[Section 2.0 Plan Area (pp. 2-1 to 2-2)]

- The types and locations of environmental uses, species and habitats supported, and the designated beneficial environmental uses and users of surface waters that may be affected by groundwater extraction in the Subbasin should be specified in the section and in Table 2-4. **Please elaborate on the "surface water uses and users" by identifying the environmental uses and users of surface water <u>for all GSAs in Table 2-4</u>. Please explicitly identify the environmental users and take particular note of the species with protected status and any critical habitat that exists within the Subbasin.** The following are resources that can be used:
    - Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) - https://gis.water.ca.gov/app/NCDatasetViewer/

- The list of freshwater species located in the Tulare Lake Subbasin in Attachment C of this letter.
- The California Department of Fish and Wildlife's California Natural Diversity Database (CNDDB) for species occurrences.
- The USFWS's Environmental Conservation Online System (ECOS) for mapping critical habitat, wildlife and contaminants - https://ecos.fws.gov/ecp/

- The GSP addresses state and federal land ownership to some degree, but there is no mention of uses related to open space areas, managed wetlands, natural preserve areas, or other protected lands that contain natural resources. Per the USFWS ECOS website the Kern National Wildlife Refuge Complex, Tulare Basin Wildlife Management Area (on southern boundary), and Pixley National Wildlife Refuge (to the east of Highway 43) abut the GSP area. Within these areas there is critical habitat mapped for the Buena Vista Lake ornate shrew (*Sorex ornatus relictus*) near the Lemoore Naval Air Station and in the Kern National Wildlife Refuge, and the vernal pool fairy shrimp (*Branchinecta lynchyi*) in the Pixley National Wildlife Refuge. These habitat areas or species are not addressed in the description of the plan area, nor are sensitive habitats within the plan area acknowledged.
  - **Please identify the natural resources within the plan area and elaborate on any and all state, federal or other land ownership that exists within the plan area that provide protection of natural resources.**
  - **Please address how the GSP will address natural resource management on a regional scale since management within the GSP could affect neighboring sensitive resources.**
- The GSP goes on to state on p. 2-2 that the primary land use designations are for agricultural, urban, residential, commercial and industrial lands; however, the figure on that page shows riparian vegetation and water surface land use classifications that amount to more than residential and semi-agricultural. **Please revise the statement concerning primary land use designations to accurately reflect the percentages on the chart (i.e., agricultural, urban, riparian vegetation, water surface, etc.). Please identify the natural resources within the plan area and elaborate on any and all state, federal or other land ownership that exists within the plan area that provide protection of natural resources.**
- On page 2-2, it is stated that it was not possible to differentiate types of well uses between irrigation and domestic extractors because DWR does not have that data. However, these data are available on well completion reports which may be accessed on line through the GeoTracker GAMA website (https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/Default.asp). This is the approach taken in almost every other GSP we have reviewed and is an important distinction of use as it relates to prioritization of project needs and management decisions. _**Please either address this issue or identify this as a data gap to reconcile in the 5-year GSP update.**

[Section 2.1 Summary of Jurisdictional Areas and Other Features (pp. 2-3 to 2-10)]

- The Plan summarizes the GSP Area and describes the jurisdictional areas and entities of the GSAs, but does not say anything about the jurisdictional areas of the resource agencies. **Please elaborate on the jurisdictional areas of the resource agencies and what resources they are in place to protect.**
- With exception of a short description of the Kings River Fisheries Management Program in Section 2.2.2.4, the GSP does not provide a description of other instream flow requirements, if any, or how the water infrastructure is in compliance with regulatory requirements set to protect species of concern. **Please provide a description of any current and planned instream flow requirements for Tulare Subbasin streams / rivers including Kings, Tule, White, Kaweah, and St. John's Rivers; and undammed streams including Deer, Dry, Mill, Cottonwood, and Poso Creeks. If there are no other instream flow requirements in place or planned, then please state that in the document.**

[Section 2.2.1 Monitoring and Management Programs (pp. 2-11 to 2-12)]

- This section addresses the water resources management actions that are being undertaken to monitor groundwater level, extraction and quality; subsidence; irrigated lands; and surface water. Management of natural resources is not considered in this section but should be described in order to provide a context for how groundwater management actions will be coordinated with environmental requirements to prevent undesirable results. **Please include a description of the natural resource management and monitoring programs occurring within the GSP area that affects instream, wetland and riparian ecosystems that have the potential to be groundwater dependent (i.e., interconnected surface water [ISWs] and groundwater dependent ecosystems [GDEs]).**

[Section 2.3 Relation to General Plans (pp. 2-14 to 2-17)]

- The GSP includes a very short description of the general plans within the GSP area but fails to specifically elaborate on the goals and policies outlined in the plans, and how the GSP will fit in with or affect the general plans' goals and policies related to the protection and management of GDEs, ISWs and aquatic resources that could be affected by groundwater withdrawals. **Please include a discussion of how implementation of the GSP may affect and be coordinated with General Plan policies and procedures regarding the protection of wetlands, aquatic resources, other GDEs and ISWs, and related threatened or endangered species.**
- This section should identify other land use plans, including Habitat Conservation Plans (HCPs) or Natural Community Conservation Plans (NCCPs) within the Subbasin and if they are associated with areas with instream flow requirements; or critical, GDE or ISW habitats. **Please identify all relevant HCPs and NCCPs within the Subbasin, and any reaches with instream flow and critical habitat requirements. Please elaborate on the natural resources within the Subbasin and address how GSP implementation will coordinate with the**

goals of these plans and requirements. If there are no HCPs, NCCPs, or preservation areas that could be affected, then that should be stated. The Critical Species Lookbook[4] includes the potential groundwater reliance of critical species in the basin. **Please include a discussion regarding the management of critical species and their habitats for these aquatic ecosystems and its relationship to the GSP.**

- **Please describe how the GSP will coordinate with the General Plan elements within the GSP area. Specifically, please elaborate on conservation, recreation and open space elements.**
- This section states (p. 2-15) that "It is considered unlikely that any Kern County General Plan Policies have any practical relevance to the plan area". The Kern National Wildlife Refuge Complex abuts the GSP area and it is difficult to understand that the General Plan for Kern County does not address habitat concerns and conservation that could be directly or indirectly affected by potential groundwater management actions within and adjacent to the Kern Subbasin. **Please 1) elaborate on the Kern County General Plan's conservation elements, 2) how the Tulare Lake Subbasin's GSP will comply with or not impact conservation elements being employed within protected habitat areas adjacent to the Tulare Subbasin, and 3) expand this conversation to include other neighboring habitat areas, such as Pixley National Wildlife Refuge.**

[Section 2.3.4 Permitting Process for New or Replacement Wells (pp. 2-17 to 2-19)]

- This section summarizes well permitting requirements and county ordinances for the counties of Kings, Kern and Tulare. **Please include a discussion of the following in this section:**
  - Future well permitting must be coordinated with the GSP to assure achievement of the Plan's sustainability goals.
  - How the well permitting process incorporates protection of GDEs within the Subbasin.
  - The State Third Appellate District recently found that Counties have a responsibility to consider the potential impacts of groundwater withdrawals on public trust resources when permitting new wells near streams with public trust uses (ELF v. SWRCB and Siskiyou County, No. C083239). **The need for well permitting programs to comply with this requirement should be stated in the text.**

<u>Checklist Items 5 to 7 – Hydrogeologic Conceptual Model (23 CCR §354.14)</u>

[Section 3.1.7 Definable Bottom of the Basin (pp. 3-16 to 3-19)]

- The GSP uses two methods (Water Quality and Geologic) to define the bottom of the basin but which method, or combination of the methods, that is being relied on for this GSP is not clearly stated. **Please explicitly state the final decision on how the bottom of the basin was determined, and what it was determined to be.**

[4] Available online at: https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

- Defining the bottom of the Subbasin based on geochemical properties is a suitable approach for defining the base of freshwater, however, as noted on page 9 of DWR's Hydrogeologic Conceptual Model BMP (https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf) "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions". **Thus, groundwater extraction well depth data should also be included in the determination of the basin bottom.** This will prevent the possibility of extractors with wells deeper than the basin boundary (defined by the base of freshwater) from claiming exemption of SGMA due to their well residing outside the vertical extent of the basin boundary. **Please characterize groundwater well extractions from the deepest wells in relation to defining the basin bottom.**

[Section 3.1.8 Hydrogeologic Setting: Principal Groundwater Aquifers and Aquitards (pp. 3-19 to 3-23)]

- Although there is robust description of the confined (lower) and unconfined / semi-confined (upper) aquifers there is no explicit description with supporting data and information of how groundwater above the A- and C-clays in the upper aquifer interacts with the unconfined aquifer, or is influenced by pumping in the unconfined portion of the upper aquifer. DWR's definition of a principal aquifer, is defined as an "aquifer or aquifer system that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" [*23 CCR §351(aa)*]. These shallow and perched areas within the upper aquifer range from near surface to 30 feet below ground surface (bgs) (Figure 3-17, p. 3-74) and likely provide water supply to GDEs and ISWs. As such, they yield significant quantities of groundwater to surface water systems and beneficial users, and should not be dismissed because they do not yield groundwater for human use. **Please expand the description of the upper aquifer to include the interaction of the unconfined and shallow areas of the upper aquifer. Include cross-sections to show their connectivity and relationship to potential ISWs and GDEs.**
- Regional geologic cross sections are provided in Figures 3-14a, 3-14b and 3-14c (pp. 3-69 to 3-71). These cross-sections do not include a graphical representation of the shallow groundwater-bearing zones that may be connected to GDEs and ISWs in the GSP area, and how they are connected to the upper aquifer system. **Please include example near-surface cross section details that depict the conceptual understanding of shallow groundwater and stream interactions at different locations, including the shallow zones, any perched aquifers, and the unconfined / semi-confined upper aquifer.**
- Based on the information provided in the GSP, it appears that the confined lower aquifer is being considered a principal aquifer because of the large amount of consumption for agriculture and municipal water supply, but this is not explicitly stated. The unconfined / semi-confined aquifer is stated to have limited use because of water quality. On pages 3-18 and 3-19, there is a discussion of water quality and although water with TDS higher than 3,000 is not considered suitable for water supply or most agriculture, it is potentially suitable for livestock and production of crops with higher tolerance to salinity. Conversely, in Section 3.1.11 (pages 3-25

and 3-26), the GSP states that the upper aquifer is primarily used for domestic and municipal supplies, and agricultural pumping does occur in the deeper portion of the upper aquifer. Also, if water in the unconfined aquifer is significantly supporting GDEs and ISWs, production of salt tolerant crops, or livestock operations, then it should also be identified as a principal aquifer. Even if ultimately the GSA doesn't define shallow groundwater as a principal aquifer, the text indicates current or future use that could impact ISWs and GDEs. **Thus, disregarding this shallow groundwater as a principal aquifer due to its water quality is not supported by the data and is inadequate.** SGMA requires GSAs to sustainably manage groundwater resources in all aquifers, especially if groundwater use and management can result in impacts to beneficial uses and users. Please refer to Best Practice #1 in Attachment D for further explanation and accompanying graphics. **Please explicitly enumerate the principal aquifer(s) and intervening aquitards, their relationship to each other, and their role in supplying groundwater to all beneficial uses and users of groundwater (including environmental).**

[Section 3.2 Groundwater Conditions (pp. 3-26 to 3-28)]

- Groundwater elevation contours are shown for 1905-1907, 1952, 1990, 1995, 2000, 2005, 2010 and 2016 on Figures 3-24 through 3-27 with respect to mean sea level. However, the wells used to contour groundwater levels in the upper aquifer do not necessarily monitor shallow or perched groundwater that may be in communication with GDEs and ISWs. In addition, depth to groundwater cannot be readily assessed from the maps because they are presented with respect to sea level. **Please provide the following:**
    1) **Groundwater level contour maps representative of the uppermost aquifer where GDEs and ISWs may be reliant. If this data does not exist, then identify it as a data gap that will be addressed in the GSP when the GSP is updated.**
    2) **Depth to water contour maps that allow interpretation of beneficial groundwater uses by environmental users.**
    3) **If these data are not available, please identify this as a data gap and outline measures to address the data gap in subsequent sections of the GSP.**

[Section 3.2.5 Groundwater Quality (pp. 3-30 to 3-31)]

- There is water quality information for the upper aquifer and a statement that increases in TDS concentrations, arsenic, nitrate and volatile organic chemicals (VOCs) are largely due to agricultural practices and pumping, but there is no information regarding water quality of the perched water or other areas of the upper aquifer to understand how water quality may affect GDEs, ISWs and associated aquatic species. **Please modify this section of the GSP to include data about water quality in the zones where GDEs are present. If there are no data available, then please recognize this as a data gap and specify that additional data will be collected and analyzed for the GSP update.**

Checklist Items 8 to 10 – Interconnected Surface Waters (ISWs) (23 CCR §354.16)

[Figure 3.1.10 Groundwater Recharge and Discharge Areas (p. 3-25)]

- The text states that "Some discharge is impacted by direct soil evaporation and evapotranspiration, particularly in areas where groundwater is less than 10 feet bgs." Elsewhere the text states that agricultural drainage must be provided in some areas, indicating very shallow groundwater, or makes reference to deeper groundwater levels of about 30 feet for groundwater above the A-Clay. Earlier in this comment letter we pointed out the discrepancy between the various shallow groundwater levels that are presented (see Section 3.2 Groundwater Conditions [pp. 3-26 to 3-28]). This GSP also states that riparian and emergent marsh ecosystems are prevalent in certain areas where they have not already been degraded by land development. **Please 1) rectify the discrepancies in groundwater levels, particularly as they pertain to ISWs and GDEs; and 2) include the locations of phreatophytes and other GDEs to provide a complete representation of evapotranspiration within all groundwater discharge areas. If the regional groundwater connection of phreatophytes and other GDEs is not known, 1) please identify this data gap, 2) provide an approach to address it, and 3) include the ISWs and GDEs as potential features on a figure until they can be more conclusively evaluated.**

[Section 3.2.8 Interconnected Surface Water and Groundwater Systems (pp. 3-33 to 3-34)]

- The regulations [23 CCR §351(o)] define ISWs as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted". "At any point" has both a spatial and temporal component. Even short durations of interconnections of groundwater and surface water can be crucial for surface water flow and supporting environmental users of groundwater and surface water. ISWs can be either gaining or losing. The GSP disregards IWSs by stating that hydrologic conditions have been so altered that the ISWs that were historically connected are not any longer. There are inconsistencies throughout this GSP in regard to ISWs. The GSP states:
  - Section 3.1.10 (p. 3-25, also see the comment directly above): "Groundwater recharge in the Subbasin occurs primarily by two methods: 1) infiltration of surface water from the Kings River and unlined conveyances; and 2) infiltration of applied water for irrigation of crops." **ISWs can be either gaining or losing (see the definition above). If recharge primarily occurs through infiltration from rivers and streams, then these features must be included as an ISW with gaining and losing reaches defined on a map.**
  - Section 3.2.8 (p. 34): "A persistent, shallow perched water table at a depth of about 30 feet bgs is often present above the A-clay in the vicinity of surface water conveyances and below recharge facilities; however, this shallow perched zone is disconnected from the regional unconfined aquifer. Other localized shallow perched zones may exist elsewhere in the Subbasin, but these are not considered a significant source of groundwater." Section 3.1.8

states (p. 3-21) that the perched water is as shallow as 15 feet in some areas, and the groundwater elevation contour maps show it ranging from 0-20 feet AMSL. Data to support the claims about the nature of the perched aquifers is conflicting and the claims that perched units are disconnected or insignificant are not supported by data. **Please clarify the discrepancy between groundwater depths reported for the shallow perched water table that are provided in the text and on figures. If the location and size of other shallow perched zones is unknown, this information needs to be identified as a data gap, rather than a reason to completely disregard the features.** It is inadequate to assume that shallow perched zones are not a significant source of groundwater if they have not been fully characterized, and could be a significant source for GDEs and ISWs. **Please reconcile data gaps (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP to improve identification of ISWs prior to disregarding them in the GSP.**

<u>Checklist Items 11 to 15 – Identifying and Mapping GDEs (23 CCR §354.16)</u>

[Section 3.2.8.1 Groundwater Dependent Ecosystems (GDEs) (p. 3-34 to 3-35)]

- The text states (p. 3-35): "Groundwater pumping from the principal aquifer system is not likely to impact the occurrence of perched groundwater because the two systems are separated by the A-Clay aquitard. Perched groundwater above the A-Clay is not directly interconnected with the underlying unconfined / semiconfined aquifer in that pumping from the unconfined / semiconfined aquifer does not induce increased leakage through the A-Clay aquitard." This statement is not supported by the data provided in the GSP (see comments above) and is not a valid reason to disregard potential GSPs without further evidence. The A-Clay is reported to vary significantly in thickness and to contain permeable sands in some locations. **Please:**
    1) **Explicitly identify the principal aquifers;**
    2) **Provide data regarding the competence of the A-Clay as an aquitard**
    3) **Evaluate the potential degree of connection between the perched and unconfined aquifer based on objective data;**
    4) **Acknowledge the extent of the perched aquifers throughout the Subbasin as a data gap;**
    5) **Address data gaps associated with the interconnectivity with the unconfined / semiconfined aquifer to be reconciled in the GSP update; and**
    6) **Acknowledge the potential for GDEs and ISWs to be dependent on these groundwater resources.**
- Although this GSP did use the NCCAG database to preliminarily identify GDEs (p. 3-34), all were disregarded without acknowledgment of data gaps and further characterization of the natural communities in association with potential perched aquifers, and disparities in groundwater levels that have not yet been characterized. This evaluation potentially misses GDEs due to the potential for GDEs to utilize the

shallow and perched areas of the unconfined / semi-confined aquifer. The following comments apply:

- While depth to groundwater levels within 30 feet are generally accepted as being a proxy for deciding if polygons in the NC dataset are connected to groundwater, it is highly advised that seasonal and interannual groundwater fluctuations in the groundwater regime are taken into consideration. Utilizing groundwater data from one point in time or during a discrete season can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Based on a study we recently submitted to *Frontiers in Environmental Science*, we've observed riparian forests along the Cosumnes River to experience a range in groundwater levels between 1.5 and 75 feet over seasonal and interannual timescales. Seasonal fluctuations in the regional water table can support perched groundwater near an intermittent river that seasonally runs dry due to such fluctuations. While perched groundwater itself cannot directly be managed due to its position in the vadose zone, the water table position within the regional aquifer (via pumping rate restrictions, restricted pumping at certain depths, restricted pumping around GDEs, well density rules, etc.) and its interactions with surface water (e.g., timing and duration) can be managed to prevent adverse impacts to ecosystems due to changes in groundwater quality and quantity under SGMA. **We highly recommend using depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. Please refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset seasonally and interannually, or to determine conclusively whether shallow groundwater is hydraulically connected (directly or indirectly) to underlying aquifers, include those polygons in the GSP until data gaps are reconciled in the monitoring network, and include specific measures and time tables to address the data gaps.**
- If there are insufficient groundwater level data in the shallow and perched zones, then the NCCAGs in these areas should be included as GDEs in the GSP until data gaps are reconciled in the monitoring network. **Confirmation of GDEs should be based on depth to groundwater in the shallow and perched areas. Please revise the GDE analysis in the GSP to include a complete analysis and identification of data gaps.**
- **Please provide depth to groundwater contour maps and note the following best practices for doing so:**
    - Are the wells used for interpolating depth to groundwater sufficiently close (<5km) to NC Dataset polygons to reflect local conditions relevant to ecosystems?

- Are the wells used for interpolating depth to groundwater screened within the surficial unconfined aquifer and capable of measuring the true water table?
- Is depth to groundwater contoured using groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape? This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM) to estimate depth-to-groundwater contours across the landscape. This will provide much more accurate contours of depth to groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make. It is better to assume that water surface elevations are constant in between wells, and then calculate depth to groundwater using a DEM of the land surface to contour depth to groundwater.

- Groundwater requirements of GDEs vary with vegetation types and rooting depths. In identifying GDEs, care should be taken to consider rooting depths of vegetation. **Please indicate what vegetation is present in the potential GDEs, and whether the GDE was eliminated or retained based solely on a specified depth limit.** While Valley Oak (*Quercus lobata*) have been observed to have a maximum rooting depth of ~24 feet (https://groundwaterresourcehub.org/gde-tools/gde-rooting-depths-database-for-gdes/), rooting depths vary spatially and temporally based on local hydrologic conditions. Also, maximum rooting depths do not take capillary action into consideration, which will vary with soil type and is an important consideration since woody phreatophytes generally do not prefer to have their roots submerged in groundwater for extended periods of time, and hence effectively redistribute their root systems to straddle the water table as it fluctuates. Hence, many riparian, floodplain and desert ecosystem species are highly capable of accessing groundwater at much deeper depths when needed.
- Rohde, Froend and Howard (2017) acknowledged GDEs as ecosystems that can rely on groundwater for <u>some or all</u> their requirements. This publication can be found at: https://ngwa.onlinelibrary.wiley.com/doi/pdf/10.1111/gwat.12511. GDEs can rely on multiple water sources simultaneously and at different temporal and / or spatial scales (e.g., precipitation, river water, reservoir water, soil moisture in the vadose zone, groundwater, applied water, treated wastewater effluent, urban stormwater, irrigated return flow). SGMA (Section 351.0) defines GDEs as "ecological communities and species that depend on groundwater <u>emerging from aquifers</u> or on groundwater <u>occurring near</u> the ground surface". **Hence, we recommend using depth to groundwater contour maps derived from subtracting groundwater levels from a DEM, as described above, to identify whether a connection to groundwater exists for the wetlands mapped in Figure 3-38 in the Subbasin.**

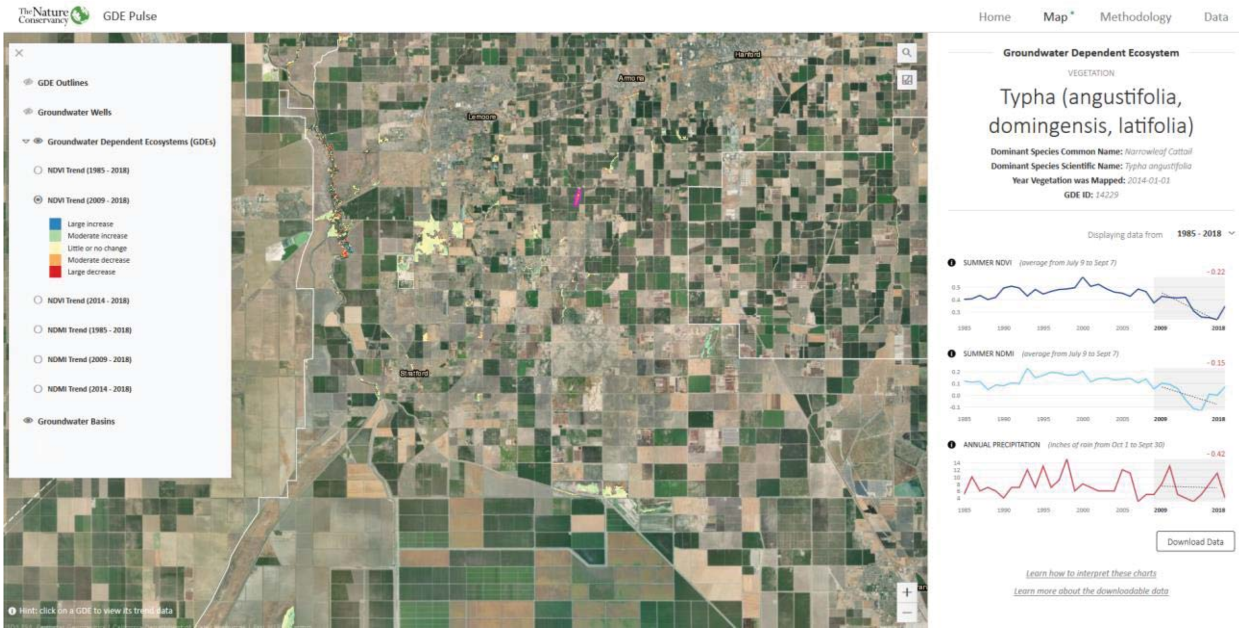
Please refer to Attachments D and E of this letter for best practices for using local groundwater data to 1) verify whether polygons in the NC Dataset are supported by groundwater in an aquifer, and 2) verify ecosystem decline or recovery is correlated with groundwater levels.

- The GSP states (p. 3-35), "Most of these vegetation types/plant species [identified in the NCCGA] are associated with riparian habitat that rely on surface water", and goes on to disregard them because they are primarily located on the perched areas above the A-Clay layer and the " A-Clay is not directly interconnected with the underlying unconfined / semi-confined aquifer". Section 354.16 of the California Code of Regulations states that "each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes…GDEs". Just because GDEs are <u>thought</u> to rely on surface water and the perched areas are <u>thought</u> to not be <u>directly</u> connected to the unconfined aquifer, does not make them insignificant to the environment. Many data gaps exist that could clarify these statements, for example: 1) indirect and direct connection of perched aquifers have not been fully characterized, 2) the location and extent of perched areas have not been fully characterized, and 3) species composition and potential max rooting depths have not be tabulated. Many rare and protected species reside in GDEs since they are very unique ecosystems. **Please provide further information on the analysis of GDEs and potential ISWs, including citing field studies or modeling studies that show the hydrologic nature of these systems. Specifically indicate 1) which streams and GDE polygons were excluded, 2) identify any data gaps, and 3) ensure that GDE polygons are <u>retained until data gaps are reconciled</u>.**

<u>Checklist Items 16 to 20 - Describing GDEs (23 CCR §354.16)</u>

[Section 3.2.8.1 Groundwater Dependent Ecosystems (GDEs) (p. 3-34 to 3-35)]

- **Please provide information on the historical or current groundwater conditions specifically near the GDEs or the ecological conditions present. If data gaps exist, please acknowledge them and state how they may be reconciled in the future.** Refer to GDE Pulse (https://gde.codefornature.org; See Attachment E of this letter for more details) or any other locally available data (e.g., leaf area index, evapotranspiration or other data) to describe depth to groundwater trends in and around GDE areas, as well as trends in plant growth (e.g., NDVI) and plant moisture (e.g., NDMI). Below is a screenshot example of data available in GDE Pulse for NC dataset polygons found in the Tulare Lake GSP Area.



- **Please provide an ecological inventory (see Appendix III, Worksheet 2 of the GDE Guidance) for all potential GDEs that includes vegetation or habitat types and rank the GDEs as having a high, moderate or low value. Explain how each rank was characterized.**
- **Please identify whether any endangered or threatened freshwater species of animals and plants, or areas with critical habitat were found in or near any of the GDEs since some organisms rely on uplands and wetlands during different stages of their lifecycle.** Resources for this include the list of freshwater species located in the Subbasin that can be found in Attachment C of this letter, the Critical Species Lookbook, and the USFWS's ECOS and CDFW's CNDDB databases / mapping tools.

Checklist Items 21 and 22 – Water Budget (23 CCR §354.18)

[Section 3.3.1.2 Outflows (pp. 3-39 to 3-40)]

- Evapotranspiration (ET) is included as an outflow category in the water budget; however, it is only included as it pertains to crop water requirements. Groundwater outflow to the ET of natural ecosystems (i.e., GDEs, riparian areas, etc.) should be identified as a groundwater budget component. If the outflow is not known, it should be identified as a data gap and provisional information should be provided until an analysis can be performed to address the data gap. **Since natural ecosystems may be beneficial users of groundwater: 1) please provide a breakdown of ET for all land-cover types, including native and riparian vegetation (such as wetlands, riparian vegetation, phreatophytes and other communities); 2) identify any data gaps; 3) outline the actions needed to address them; 4) and the schedule for their implementation.**

Checklist Item 23-26 Sustainability Goal (23 CCR §354.24)

[Section 4.0 Sustainable Management Criteria (p. 4-1)]

- The GSP states that there is no ISW connectivity within the entire Subbasin, but data to support this broad assertion are insufficient to dismiss this sustainability indicator. It is acknowledged earlier in the GSP that recharge primarily occurs through surface streams / rivers and unlined canals; however, there isn't any quantitative analysis, monitoring data, or other information provided to support that ISWs are not present, and statements within the GSP are contradictory. **Please address ISWs in the Sustainable Management Criteria and the Sustainability Goal until sufficient data is available to conclude the status of ISWs.**
- The GSP states "Indicators for the sustainable management of groundwater were determined by SGMA based on factors that have the potential to impact the health and general well-being of the public." This chapter starts off by disregarding the environmental use and users of groundwater. Sweeping statements like this should be modified throughout the chapter to acknowledge <u>all</u> beneficial users. **Since GDEs and ISWs may be present in and near the GSP area due to the prevalence of shallow groundwater (please see comments under Checklist Items 16-20) they should be explicitly recognized in the establishment of sustainable management criteria for the groundwater level decline and ISW sustainability indicators. Please also update this section to recognize environmental beneficial groundwater uses as a component of the sustainable management goals.**

[Section 4.1 Sustainability Goal (pp. 4-1 to 4-3)]

- The Sustainability Goal states that "…the sustainability goal works as a tool for managing groundwater, basin-wide, on a long-term basis to protect quality of life through the continuation of existing economic industries in the area, including but not limited to agriculture". The overall theme is to protect groundwater resources for developed water users, particularly agriculture. **The narrative discussion of the sustainability goal should be expanded to include other beneficial uses and users of groundwater including environmental uses and users of groundwater.**
- The Discussion of Measures states that "management actions will be implemented to help mitigate overdraft based on the demand from beneficial uses and users", but developed users are the only parties identified in this chapter. Criteria used to evaluate the priority given to beneficial users during overdraft periods is not described. **Please update this section to provide a discussion of how human and environmental beneficial uses will be balanced in the implementation of management actions during periods of drought and overdraft.**
- **Since GDEs and ISWs may be present in the Subbasin (please see comments under Checklist Items 16-20) they should be recognized as beneficial users of groundwater and should be included in the Sustainability Goal and Discussion of Measures. In addition, a statement about any intention to address pre-SGMA impacts should be included.**

- GDEs are dependent, in part, on suitable water quality; however, the GSP focuses on subsidence, groundwater levels and changes in groundwater storage; and only considers water quality for irrigation and domestic use. **Given that there are potential GDEs and ISWs in the Subbasin, and they may be affected by water quality they should be included in the Sustainability Goal and addressed in the Sustainable Management Criteria established for the Water Quality Sustainability Indicator.**

[Section 4.2.4 Groundwater Quality Indicator (pp. 4-5 to 4-6)]

- The GSP states that the GSAs will rely on the existing programs in place for monitoring groundwater quality, and the "local GSAs will focus on water quality issues that are related to groundwater pumping rather than on issues related to contamination". However, since much of the groundwater is being used for irrigation, which then leaches back into the soil or drains elsewhere and carries nutrients and other solutes with it, the GSA should monitor constituents related to agriculture in addition to those related to pumping, such as arsenic. This includes nitrates, phosphates, salts, sodium, boron, chloride and acidification from carbonic acid which affects soil biota, structure, geochemistry, GDEs and ISWs. **Please consider revising this section to include monitoring for agricultural constituents.**

<u>Checklist Item 26 – Measurable Objectives (23 CCR §354.30</u>)

[Section 4.5 Measurable Objectives (pp. 4-18 to 4-20)]

- This Measurable Objectives do not consider the water quality needs of GDEs and ISWs. **Please modify this section to include impacts from degraded water quality on the plant and wildlife communities, and species they support within these habitats.**
- This GSP states that "ISWs do not exist within the Subbasin". However, this conclusion was based on well groundwater levels that are not reasonably close to the drainages, shallow or nested monitoring wells to assess potential interaction with surface water and GDEs and connectivity to underlying aquifers, or hydrogeologic data that does not fully characterize the location and extent of perched and shallow zones within the upper aquifer. In addition, there are no supporting data and information that demonstrates shallow groundwater near the streams and rivers is not supporting ISWs or GDEs. As such, the data are insufficient to dismiss this sustainability indicator under the GSP regulations. **Please modify this section of the GSP to retain ISWs as a sustainability indicator, pending the characterization of the shallow / perched zones and analysis of monitoring data or monitoring from additional wells to be installed in the future.**
- Since there are wildlife refuges and protected wildlife area that contain critical habitat directly adjacent to the GSP area, the GSP needs to address these areas, whether there are potential GDEs or ISWs, and how management actions within the Subbasin would affect these sensitive habitats. **Please explain how the measurable objectives will benefit adjacent subbasins and not hinder the**

ability of adjacent subbasins to be sustainable; and how the measurable objectives would benefit adjacent critical habitat areas. What are the mechanisms for this benefit?

- Sweeping statements, such as (p. 4-20) "interconnected surface waters do not exist within the Subbasin, so this indicator will not be further discussed in terms of Measurable Objectives" are completely dismissive with disregard for data gaps. There is not enough evidence to make statements like these. Many of the wells are screened too deep, not in the proper location to make comparisons, and / or nested wells have not been installed to inform how shallow groundwater interacts with potential ISWs, GDEs or the unconfined aquifer. **Please include all potential ISWs in the analysis and develop measurable objectives and minimum thresholds for these, to be managed until data gaps prove they are not interconnected.**

<u>Checklist Item 27-29 – Minimum Thresholds (23 CCR §354.28</u>)

[Section 4.4.1.2 Description of Minimum Thresholds and Processes to Establish [for Groundwater Level Indicator (p. 4-13), Section 4.4.1.4 Description of Minimum Thresholds and Processes to Establish [for Groundwater Quality Indicator (p. 4-14), and Section 4.4.1.5 Description of Minimum Thresholds and Processes to Establish [for Interconnected Surface Water Intrusion (p. 4-14)]

- These Minimum Thresholds do not consider GDEs and ISWs. **Please include GDEs (see comments under checklist items 8-20) in this section and whether the minimum thresholds and interim milestones will help achieve the potential sustainability goal as it pertains to the environment.**
- Section 4.4.1.5 (p. 4-14) states that "Interconnected surfaces waters are not considered present in the Subbasin are; therefore, no further discussion will occur on this indictor in terms of MTs". However, the GSP fails to provide any monitoring data, analysis or other information to substantiate this position. Based on the inconsistencies in groundwater levels presented previously in the GSP and this letter, and the unknowns associated with the extent and location of shallow and/or perched zones in the upper aquifer, it is possible that rivers, streams and GDEs may be hydraulically connected to the regional aquifer system. Minimum thresholds must be established for ISWs and GDEs unless and until sufficient data are provided to eliminate them from consideration. **Please modify this section of the GSP to 1) develop minimum thresholds for possible ISWs, including GDEs, and 2) include a statement that a data gap exists related to the interconnectedness of the of the Tulare Lakebed, rivers / streams, and shallow groundwater zones.**

[Section 4.4.4 Potential Effects to Beneficial Uses and Users (p. 4-17 to 4-18)]

- The evaluation of minimum thresholds completely disregards consideration of environmental beneficial users, such as ISWs, GDEs or the species they support. Effects to beneficial uses and users is focused on well capacity, pumping costs, extraction, and impacts from subsidence on infrastructure. There is no mention about potential impacts to GDEs or ISWs that could be affected by lowering of the shallow portions of the unconfined or semi-confined portions of the upper aquifer since a continuity / discontinuity between the two is a data gap. Although there are many data gaps associated with ISWs and GDEs, it must be assumed that potential significant and unreasonable impacts to these beneficial users could occur. As such, they should be addressed in the evaluation of minimum thresholds. Section 4.4.4 should be modified to address how potential ISWs and GDEs would be affected by further lowering of groundwater levels. **Please address how 1) potential ISWs and GDEs would be affected by further lowering of groundwater levels, 2) these beneficial users will be protected / managed in the interim until data gaps are filled, and 3) what measures will be employed to protect GDEs and ISWs that are confirmed after data gaps are filled.**

- This Section does not include the required analysis of how the selected minimum thresholds for decline in groundwater levels could affect potential ISWs and GDEs within and near the GSP area. **Please include an analysis of the potential effect of the established minimum thresholds on ISWs and GDES within and near the GSP area, particularly in adjacent wildlife preserves / refuges.**
- Although agricultural and domestic water quality concerns have been articulated, similar concerns were not identified for environmental users. Degradation of water quality can impact terrestrial and aquatic wildlife that live in or near these ecosystems during at least part of the year even if the water is not a concern from an agricultural or municipal standpoint. **Please include a discussion about GDEs and water quality and whether the minimum thresholds and interim milestones will help achieve sustainability for environmental users.**

<u>Checklist Item 30-46 – Undesirable Results (23 CCR §354.26</u>)

[Section 4.3 Undesirable Results (pp. 4-6 to 4-12), and Subsection 4.3.3 Potential Effects to Beneficial Uses and Users (pp. 4-11 to 4-12)]

- The GSP states that there are no ISWs; however, this is largely based on assumptions and there are no monitoring data, analyses or other information to support this statement. In addition, the GSP indicates that 1) streams and rivers are the primary source of recharge; 2) a connection may exist between shallow and perched groundwater, but the extent and location of perched groundwater is unknown; and 3) surface and groundwater may be periodically connected in Tulare Lake. Furthermore, GDEs may exist within and near the GSP area. This is a data gap that needs to be identified and rectified by employing a monitoring network to verify the status of ISWs prior to complete dismissal of ISWs from the GSP. **Please modify this section of the GSP to include:**
    1) **A statement that there are potential ISWs and GDEs, unless adequate data can be provided to dismiss them.**
    2) **An assessment of the nature of potential undesirable results to ISWs and GDEs.**
    3) **A statement that the aquifers will be managed such there will be no depletion of ISWs that results in a significant and unreasonable impacts to ISWs or GDEs.**

4) **Data gaps and specific steps to verify the presence or absence of ISWs and GDEs with monitoring wells screened at the appropriate depths.**

- This section only describes undesirable results relating to human beneficial uses of groundwater and neglects environmental beneficial uses / users that could be adversely affected by chronic groundwater level decline or depletion of ISWs. **Please add "possible adverse impacts to potential GDEs and ISWs" to the list of potential undesirable results.**
- The GDE Pulse web application developed by TNC provides easy access to 35 years of satellite data to view trends of vegetation metrics, groundwater depth (where available), and precipitation data. This satellite imagery can be used to observe trends for NC dataset polygons within and near the GSA. Over the past 10 years (2009-2018), some NC dataset vegetation polygons have experienced adverse impacts to vegetation growth and moisture. An example screen shot of GDEs near Lemoore, California from the GDE Pulse tool is presented under Checklist items 16 to 20 above.
    - **For each potential GDE unit with supporting hydrological datasets please include the following:**
        - Plot and provide hydrological datasets for each GDE.
        - Define the baseline period in the hydrologic data.
        - Classify GDE units as having high, moderate, or low susceptibility to changes in groundwater.
        - Explore cause-and-effect relationships between groundwater changes and GDEs.
    - **For each identifiable GDE unit without supporting hydrological datasets please describe data gaps and / or insufficiencies.**
    - **Compile and synthesize biological data from CDFW's CNDDB, USFWS' ECOS Mapper, NC dataset, and / or the GDE Pulse tool (as applicable) for each GDE unit by:**
        - Characterizing biological resources for each GDE unit, and when possible provide baseline conditions for assessment of trends and variability.
        - Describing data gaps / insufficiencies.
    - **Describe possible effects on potential ISWs, GDEs, land uses, and property interests, including:**
        - Cause-and-effect relationships between potential ISWs and GDEs with groundwater conditions.
        - Impacts to potential ISWs and GDEs that are considered to be "significant and unreasonable".
        - Report known hydrological thresholds or triggers (e.g., instream flow criteria, groundwater depths, water quality parameters) for significant impacts to relevant species or ecological communities.
        - Land uses should include recreational uses (e.g., fishing/hunting, hiking, boating).
        - Property interests should include and consider privately and publicly protected conservation lands and opens spaces, including wildlife refuges, parks, and natural preserves.

- This section discusses water quality with respect to agricultural and municipal use but does not include a discussion of potential undesirable results for GDEs and ISWs. **Please modify this section to address how degraded water quality could affect vegetation and wildlife species that rely on GDEs and ISWs. Although arsenic is mentioned in this GSP, please consider adding a statement that over-pumping and dewatering of aquitards has been identified as a potential source of elevated arsenic concentrations above drinking water standards in San Joaquin Valley aquifers.** The following is a link to a paper by Smith, Knight and Fendorf (2018) titled "Overpumping leads to California groundwater arsenic threat": https://www.nature.com/articles/s41467-018-04475-3

Checklist Items 47-49 – Monitoring Network (23 CCR §354.34)

[Chapter 5 Monitoring Network (pp. 5-1 to 5-3), and Section 5.1 Description of Monitoring Network (pp. 5-3 to 5-15)]

- The GSP describes groundwater monitoring locations and states that groundwater monitoring in areas de-designated by the Tulare Lake Basin Plan amendment and associated aquifer zones is not proposed as decided by the GSAs. Although these areas (designated Management Area A and B) are not designated for municipal and agricultural uses in the Basin Plan, the groundwater could still potentially be used or is being used for livestock, crops with a higher tolerance to salt, domestic supply, public supply, and potentially other uses in the future. Since it is currently unclear how withdrawals within the unconfined aquifer will affect the perched and shallow areas of the aquifer (as associated with the A-Clay and C-Clay layers), Management Areas A and B still need to be monitored to assess effects to the unconfined aquifer as a whole. As stated above in the comments for other Checklist Items, **please reconcile data gaps (shallow monitoring wells, stream gauges, and nested/clustered wells, GDE and ISW responses to groundwater levels) along rivers, creek and the Tulare Lakebed in this section of the GSP to improve ISW and GDE mapping in future GSPs**.
- It is not acceptable to completely disregard these Management Areas based purely on a de-designation from municipal and agricultural uses only when there are still current and potential environmental uses of this groundwater. In addition, there is much uncertainty how the shallow aquifers are interacting with GDEs and ISWs. **Please add Representative Monitoring Sites (RMS) for these areas in order to better understand the interaction of the A-Clay and C-Clay layers with the unconfined aquifer, and potential GDEs and ISWs.**
- This section lists the proposed facilities for monitoring groundwater levels, storage and quality, and subsidence on pp. 5-9 through 5-15. This section proposes to use groundwater level monitoring to assess potential groundwater level and storage declines, existing programs to monitor water quality, and monitored surface conditions to evaluate land subsidence. It may acceptable to use groundwater level [in combination with assessment of vegetation response, for example by remote sensing] as a proxy for assessing potential effects on ISWs and GDEs, but the data gaps associated with the A-Clay, C-Clay, and shallow water tables need to be addressed. A set of representative wells have been selected to monitor the upper

and lower aquifer (Figures 5-1 to 5-3). There are only five wells that represent the "Above A-Clay and Shallow Groundwater Levels (i.e., Zone A)", and there are three data gaps areas identified (Figure 5-1). **Please describe 1) how these five wells are considered representative of the entire GSP Area, 2) how those data gap areas were selected, and 3) what methodologies would be used to extrapolate results to other areas where there are no wells or identified data gaps.**

- Many of the monitoring wells are not screened in the upper portion of the unconfined aquifer, where environmental beneficial users would obtain the groundwater on which they rely. Finally, there are currently no plans to monitor groundwater level declines to assess the potential for significant and unreasonable impacts to ISWs or GDEs in response to groundwater level declines. **Please modify the description of the new well network in the Proposed Facilities Section (Sections 5.1.4, p. 5-9) and Groundwater Levels Section (Section 5.1.4, p.5-9 to 5-11) to provide methodologies, data and other information to support the monitoring of GDEs and ISWs so as to assess and prevent potential significant and unreasonable impacts. This modification should include 1) locating new wells that are appropriately screened to detect connectivity of GDEs and ISWs with the unconfined aquifer and 2) identifying or installing additional stream gages in areas where there is potential for ISWs and GDEs. In addition, monitoring GDE responses to groundwater level declines should be included. GDE Pulse represents an example of how remote sensing can be used to achieve this objective. Please expand on the discussion of how the new well, stream and other data will be used to improve ISW mapping and inform an adequate analysis, and how the data will be used to verify possible GDEs and their sensitivity to groundwater level declines.**

[Section 5.1.1 Monitoring Network Objectives (p. 5-6)]

- The monitoring objectives listed include developing data to evaluate impacts to beneficial uses and users of groundwater but does not include filling data gaps as they specifically pertain to environmental users of groundwater. **Please expand this list to include monitoring to inform data gaps associated with groundwater use by potential GDEs, ISWs and the species that they support.**

[Section 5.4.1.4 Site Selection (p. 5-23)]

- This section includes the scientific rationale for the groundwater level monitoring network and the rationale used to add new wells to the monitoring system. However, evaluation and monitoring of potential GDEs and ISWs were not considered in new well site selection. **Please modify the site selection criteria to include the potential to install new wells that will provide information to support the investigation of GDEs and ISWs. This modification should include locating new / existing wells that are appropriately screened to detect connectivity of GDEs and ISWs with the shallow zones of the unconfined**

aquifer, and 2) expanding information on the extent and location of shallow / perched areas within the unconfined aquifer.

[Section 5.5 Data Storage and Reporting (pp. 5-31 to 5-32)]

- The data management system (DMS) described in this section allows for upload and storage of information related to the development and implementation of the GSP. The types of information that will be stored in the DMS are listed. Other than groundwater elevations, quality, and site information, there is no information being stored specific to the monitoring and evaluation of GDEs or ISWs. **We recommend adding remote sensing information to this list to evaluate possible correlations of ecosystem response to potential declines in groundwater level or quality due to pumping. This can be accomplished by incorporating the GDE pulse tool, Sentinel data, evapotranspiration, or leaf area index.**

<u>Checklist Items 50 and 51 – Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)</u>

[Chapter 6 Projects and Management Actions to Achieve Sustainability (pp. 6-1 to 6-21)]

- **This chapter should identify the specific actions and schedules proposed to address data gaps in the hydrogeologic conceptual model, water budget and monitoring network.**

[Section 6.3 Projects (pp. 6-4 to 6-17)]

- This section identifies many important types of projects, including conveyance facilities modifications and construction of new facilities, above-ground surface water storage, intentional recharge basins, on-farm recharge, and aquifer storage and recovery through injection. However, the descriptions of Measurable Objectives for these projects only identifies benefits to water level and storage through changes in allocation, imports, surface water diversions, pumping allowances; and adding recharge projects or water banking. Since maintenance or recovery of groundwater levels, or construction of recharge facilities, may have potential environmental benefits it would be advantageous to demonstrate multiple benefits from a funding and prioritization perspective.
    - **For the projects already identified, please consider stating how ISWs and GDEs will benefit or be protected, or what other environmental benefits will accrue.**
    - If ISWs will not be adequately protected by those listed, **please include and describe additional management actions and projects targeted for protecting potential ISWs.**
    - Storage and recharge projects can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. In some cases, such facilities have been incorporated into local HCPs and NCCPs, more fully recognizing the value of the habitat that they provide and the species they support. On-farm recharge may benefit waterfowl during migration, and recreational hunting and birdwatching depending on the time of year that fields are flooded. For

recharge projects, **please consider identifying if there is habitat value incorporated into the design and how the recharge ponds can be managed as multiple-benefit projects to benefit environmental users. Grant and funding opportunities for SGMA-related work may be available for multi-benefit projects that can address water quantity as well as provide environmental benefits. Please include environmental benefits and multiple benefits as criteria for assessing project priorities.**

- The GSP states that recharged water typically remains in the unconfined aquifer, above the A-Clay, C-Clay and E-Clay; and that existing wells in the area will be used for extraction of stored water. There appear to be many unknowns as to the extent and location of perched and shallow areas in the unconfined aquifer, and the connectivity of those areas with the aquifer. In addition, there are currently only five wells that will be used to monitor shallow zones throughout the entire GSP area. There remains a fair amount of uncertainty as to how this would operate or affect potential GDEs and ISWs. **Please acknowledge these uncertainties and address 1) how these recharge operations could affect environmental beneficial users, 2) how ecosystems that could be affected by recharge in the unconfined aquifer, particularly above the A- and C-Clay layers will be monitored if there are only five wells.**
- For examples of case studies on how to incorporate environmental benefits into groundwater projects, please visit our website: https://groundwaterresourcehub.org/case-studies/recharge-case-studies/

[Section 6.5 GSA Sustainable Methods (pp. 6-18 to 6-21)]

- The Subbasin potentially includes GDEs and ISWs (see our comments under Checklist Items 8-10 and 16-20 above) that are beneficial uses and users of groundwater and may include sensitive and protected resources. Protection of these environmental users and uses should be considered in establishing project priorities. In addition, and consistent with existing grant and funding guidelines for SGMA-related work, **priority should be given to multi-benefit projects that can address water quantity and quality as well as providing environmental benefits or benefits to disadvantaged communities.**

Attachment C

Freshwater Species Located in the Tulare Lake Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result "depletion of interconnected surface waters", Attachment C provides a list of freshwater species located within the Tulare Lake Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the GSA's boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[5]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[6] as well as on TNC's science website[7].

		Legally Protected Status		
Scientific Name	**Common Name**	**Federal**	**State**	**Other**
BIRDS				
Actitis macularius	Spotted Sandpiper			
Aechmophorus clarkii	Clark's Grebe			
Aechmophorus occidentalis	Western Grebe			
Agelaius tricolor	Tricolored Blackbird	BCC	SSC	BSSC - First priority, BLM
Aix sponsa	Wood Duck			
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas discors	Blue-winged Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Aythya affinis	Lesser Scaup			
Aythya americana	Redhead		SSC	BSSC - Third priority
Aythya collaris	Ring-necked Duck			

[5] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710
[6] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS
[7] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Aythya marila	Greater Scaup			
Aythya valisineria	Canvasback		SSC	
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			
Calidris alpina	Dunlin			
Calidris mauri	Western Sandpiper			
Calidris minutilla	Least Sandpiper			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chlidonias niger	Black Tern		SSC	BSSC - Second priority
Chroicocephalus philadelphia	Bonaparte's Gull			
Cistothorus palustris palustris	Marsh Wren			
Cygnus columbianus	Tundra Swan			
Dendrocygna bicolor	Fulvous Whistling-Duck		SSC	BSSC - First priority
Egretta thula	Snowy Egret			
Empidonax traillii	Willow Flycatcher	BCC	Endangered	USFS
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Gallinula chloropus	Common Moorhen			
Grus canadensis	Sandhill Crane			
Himantopus mexicanus	Black-necked Stilt			
Icteria virens	Yellow-breasted Chat		SSC	BSSC - Third priority
Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus serrator	Red-breasted Merganser			
Numenius americanus	Long-billed Curlew			
Numenius phaeopus	Whimbrel			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			

Pelecanus erythrorhynchos	American White Pelican		SSC	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Phalaropus tricolor	Wilson's Phalarope			
Plegadis chihi	White-faced Ibis		Watch list	
Pluvialis squatarola	Black-bellied Plover			
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Riparia riparia	Bank Swallow		Threatened	
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa semipalmata	Willet			
Tringa solitaria	Solitary Sandpiper			
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		SSC	BSSC - Third priority
CRUSTACEANS				
Branchinecta lindahli	Versatile Fairy Shrimp			
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		SSC	ARSSC, BLM, USFS
Ambystoma californiense californiense	California Tiger Salamander	Threatened	Threatened	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	SSC	ARSSC, BLM
Thamnophis sirtalis sirtalis	Common Gartersnake			
INSECTS AND OTHER INVERTEBRATES				
Ameletus amador	A Mayfly			
Ameletus spp.	Ameletus spp.			

Anax walsinghami	Giant Green Darner			
Archilestes californica	California Spreadwing			
Argia emma	Emma's Dancer			
Baetis adonis	A Mayfly			
Baetis spp.	Baetis spp.			
Caudatella columbiella				Not on any status lists
Caudatella spp.	Caudatella spp.			
Cinygmula gartrelli	A Mayfly			
Cinygmula spp.	Cinygmula spp.			
Doroneuria baumanni	Cascades Stone			
Drunella coloradensis	A Mayfly			
Drunella doddsii	A Mayfly			
Drunella spinifera	A Mayfly			
Drunella spp.	Drunella spp.			
Enallagma carunculatum	Tule Bluet			
Enallagma civile	Familiar Bluet			
Epeorus albertae	A Mayfly			
Epeorus spp.	Epeorus spp.			
Ephemerella tibialis	A Mayfly			
Erythemis collocata	Western Pondhawk			
Hetaerina americana	American Rubyspot			
Heterlimnius corpulentus				Not on any status lists
Ischnura barberi	Desert Forktail			
Ischnura cervula	Pacific Forktail			
Ischnura denticollis	Black-fronted Forktail			
Libellula saturata	Flame Skimmer			
Malenka bifurcata				Not on any status lists
Malenka spp.	Malenka spp.			
Optioservus canus	Pinnacles Optioservus Riffle Beetle		SSC	
Optioservus spp.	Optioservus spp.			
Oroperla barbara	Gilltail Springfly			
Pachydiplax longipennis	Blue Dasher			
Pantala flavescens	Wandering Glider			
Pantala hymenaea	Spot-winged Glider			
Parapsyche almota	A Caddisfly			
Parapsyche elsis	A Caddisfly			

Parapsyche spp.	Parapsyche spp.			
Rhionaeschna multicolor	Blue-eyed Darner			
Rhithrogena decora	A Mayfly			
Rhithrogena spp.	Rhithrogena spp.			
Rhyacophila acuminata	A Caddisfly			Not on any status lists
Rhyacophila spp.	Rhyacophila spp.			
Simulium anduzei				Not on any status lists
Simulium spp.	Simulium spp.			
Skwala americana	American Springfly			
Skwala spp.	Skwala spp.			
Sperchon spp.	Sperchon spp.			
Sperchon stellata				Not on any status lists
Sweltsa adamantea				Not on any status lists
Sweltsa spp.	Sweltsa spp.			
Telebasis salva	Desert Firetail			
Tramea lacerata	Black Saddlebags			
Zapada columbiana	Columbian Forestfly			
MAMMALS				
Castor canadensis	American Beaver			Not on any status lists
Ondatra zibethicus	Common Muskrat			Not on any status lists
MOLLUSKS				
Anodonta californiensis	California Floater		SSC	USFS
PLANTS				
Cephalanthus occidentalis	Common Buttonbush			
Cirsium crassicaule	Slough Thistle		SSC	CRPR - 1B.1, BLM
Cyperus erythrorhizos	Red-root Flatsedge			
Cyperus squarrosus	Awned Cyperus			
Eragrostis hypnoides	Teal Lovegrass			
Euthamia occidentalis	Western Fragrant Goldenrod			
Galium trifidum	Small Bedstraw			
Juncus effusus effusus	NA			
Lasthenia ferrisiae	Ferris' Goldfields		SSC	CRPR - 4.2

Ludwigia peploides peploides	NA			Not on any status lists
Myosurus minimus	NA			
Persicaria lapathifolia				Not on any status lists
Rorippa palustris palustris	Bog Yellowcress			
Salix gooddingii	Goodding's Willow			
FISHES				
Catostomus occidentalis occidentalis	Sacramento sucker			Least Concern - Moyle 2013
Cottus asper ssp. 1	Prickly sculpin			Least Concern - Moyle 2013
Lavinia exilicauda exilicauda	Sacramento hitch		SSC	Near-Threatened - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus tshawytscha - CV fall	Central Valley fall Chinook salmon	SSC	SSC	Vulnerable - Moyle 2013
Oncorhynchus tshawytscha - CV late fall	Central Valley late fall Chinook salmon	SSC		Endangered - Moyle 2013
Orthodon microlepidotus	Sacramento blackfish			Least Concern - Moyle 2013
Ptychocheilus grandis	Sacramento pikeminnow			Least Concern - Moyle 2013

Notes:
ARSSC = At-Risk Species of Special Concern
BCC = Bird of Conservation Concern
BSSC = Bird Species of Special Concern
CRPR = California Rare Plant Rank
CS = Currently Stable
IUCN = International Union for Conservation of Nature
SSC = Species of Special Concern

Attachment D

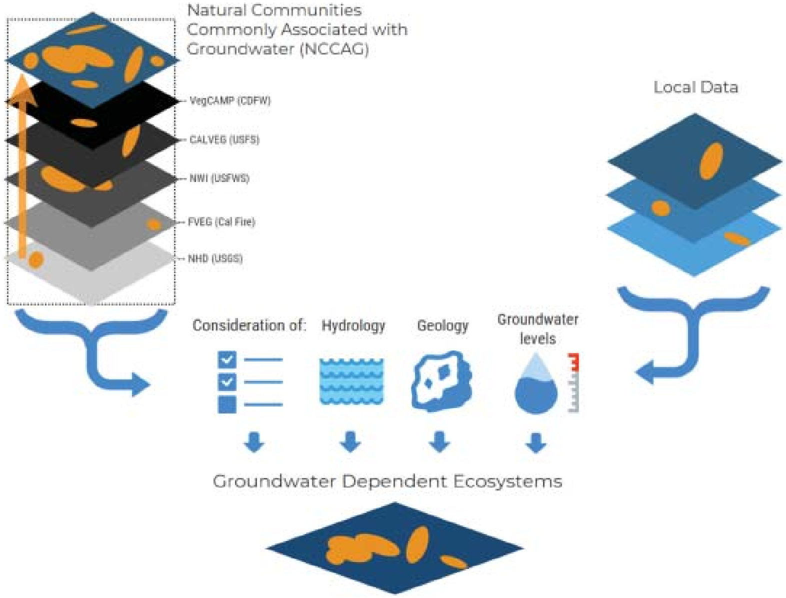
The Nature Conservancy

July 2019

IDENTIFYING GDEs UNDER SGMA

Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[8] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[9]. This document highlights six best practices for using local groundwater data to confirm whether mapped features in the NC dataset are supported by groundwater.



[8] *NC Dataset Online Viewer:* *https://gis.water.ca.gov/app/NCDatasetViewer/*

[9] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[10]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[11] on the Groundwater Resource Hub[12], a website dedicated to GDEs.

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2a) or multiple aquifers stacked on top of each other (Figure 2b). In unconfined aquifers (Figure 2a), using the depth-to-groundwater and the rooting depth of the vegetation is a reasonable method to infer groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2d). However, it is important to consider local conditions (e.g., soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2c). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2b) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and GDEs (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it's an aquifer*.

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[10] *For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf*

[11] "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans" is available at: https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/

[12] *The Groundwater Resource Hub: www.GroundwaterResourceHub.org*

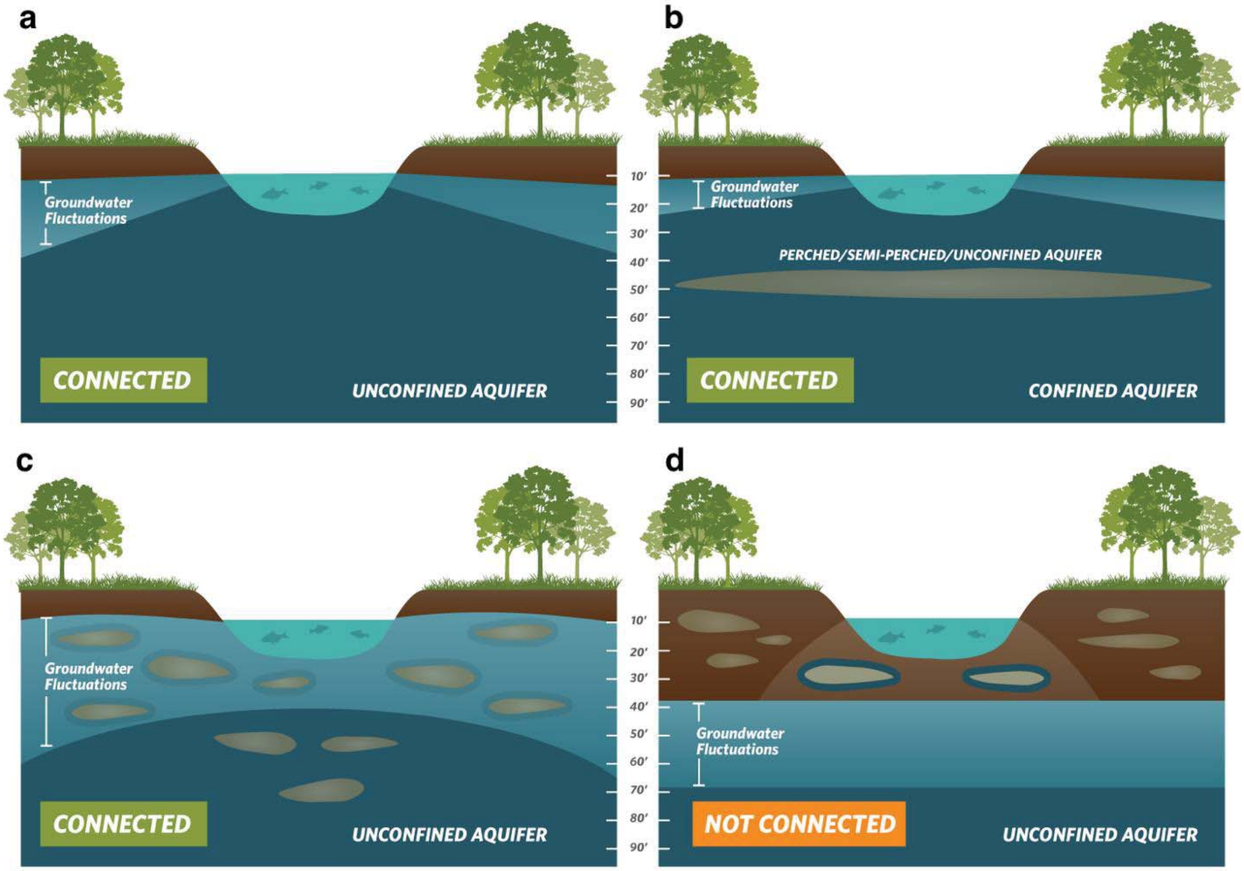

Figure 2. Confirming whether an ecosystem is connected to groundwater. Top: (a) Under the ecosystem is an unconfined aquifer with depth-to-groundwater fluctuating seasonally and interannually within 30 feet from land surface. **(b)** Depth-to-groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. **Bottom: (c)** Depth-to-groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. **(d)** Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under the surface water feature. These areas are not connected to groundwater and typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[13] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[14] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[15] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (see Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however if these groundwater conditions are prolonged, adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] of the land surface are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[16]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network (see Best Practice #6).

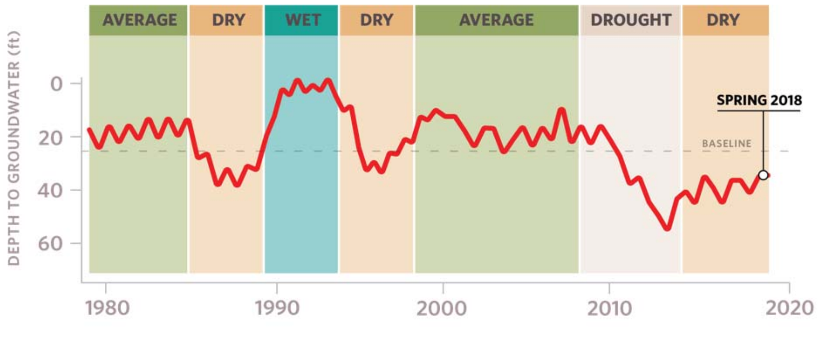

Figure 3. Example seasonality and interannual variability in depth-to-groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[13] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[14] *Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]*

[15] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs[4]).

[16] *SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer*

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around a GDE does not preclude the possibility that it is supported by groundwater, too. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[17], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

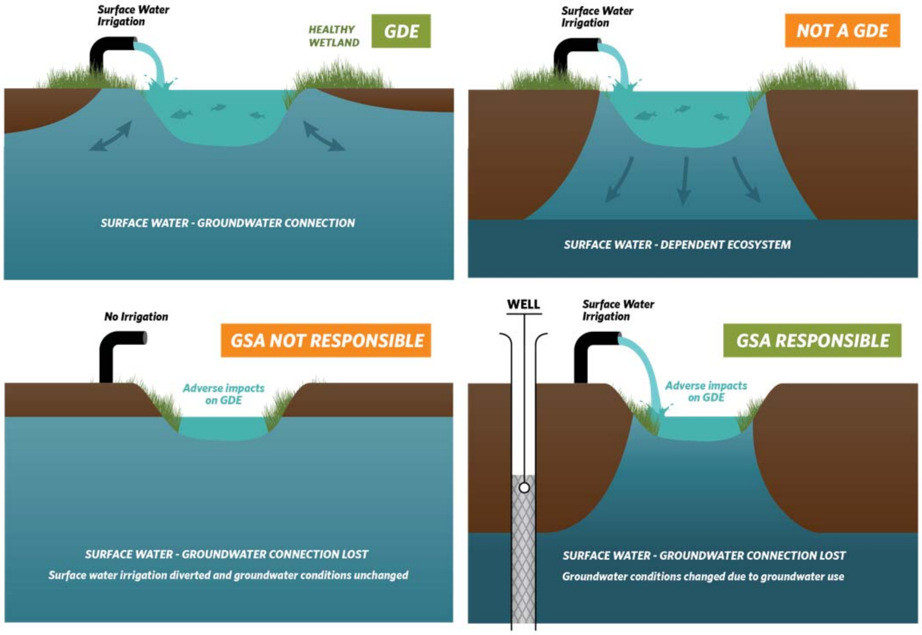

Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. **(Right)** Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. **Bottom: (Left)** An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. **(Right)** Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

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[17] *For a list of environmental beneficial users of surface water by basin, visit: https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/*

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

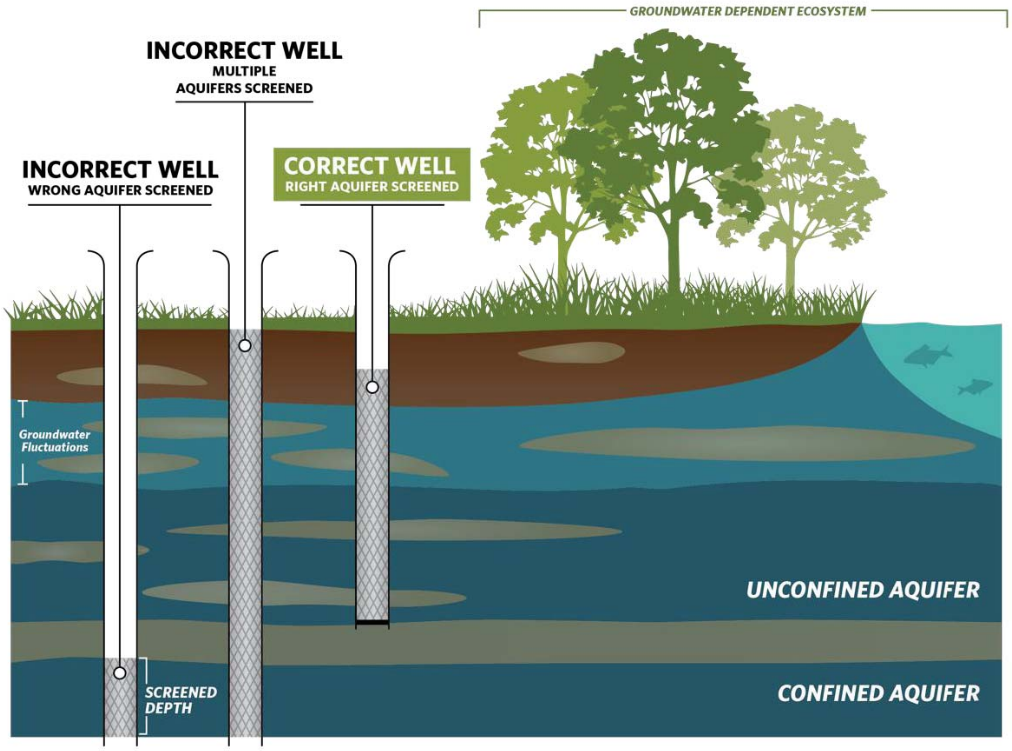


Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like stream and wetland depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6a). A more accurate approach is to interpolate **groundwater elevations** at monitoring wells to get groundwater elevation contours across the landscape. This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)[18] to estimate depth-to-groundwater contours across the landscape (Figure b; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

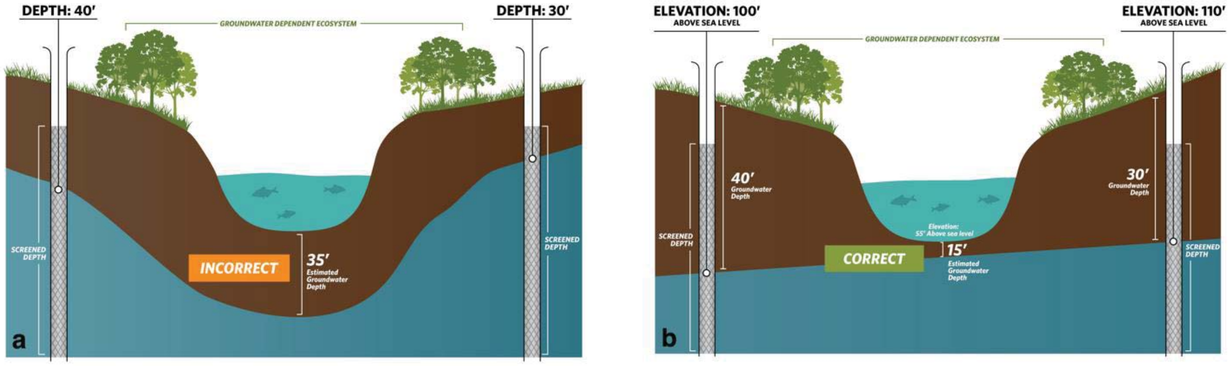


Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (a) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. **(b)** Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

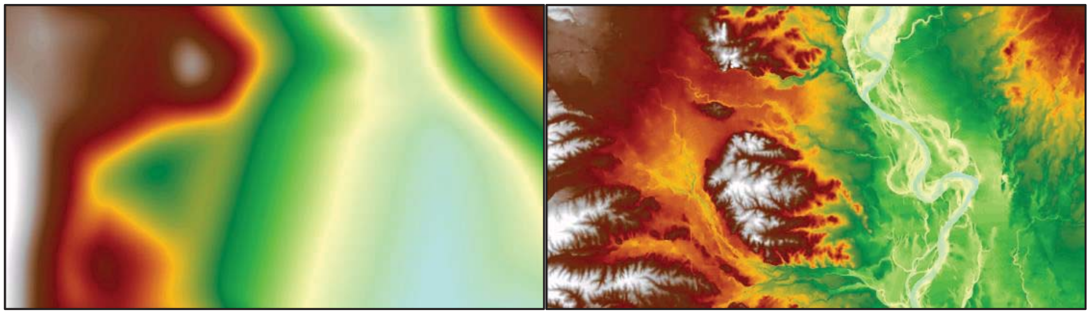


Figure 7. Depth-to-groundwater contours in Northern California. (Left) Contours were interpolated using depth-to-groundwater measurements determined at each well. **(Right)** Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth-to-groundwater contours. The image on the right shows a more accurate depth-to-groundwater estimate because it takes the local topography and elevation changes into account.

[18] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://iewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring programs to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, **The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network.** Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

Interconnected surface water (ISW) surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. *23 CCR §351(o)*

Principal aquifers are aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. *23 CCR §351(aa)*

ABOUT US

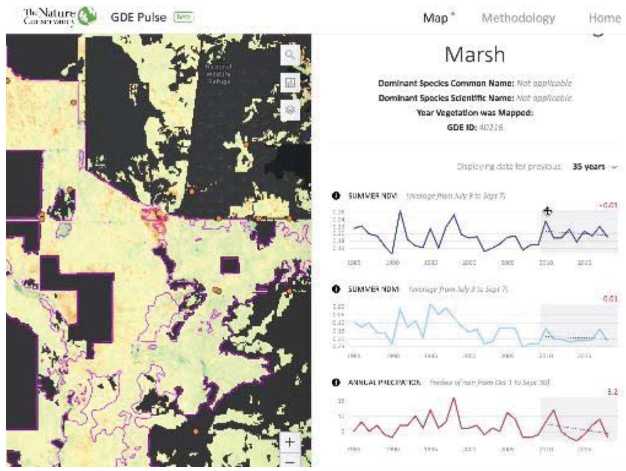
The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Attachment E

GDE Pulse

A new, free online tool that allows Groundwater Sustainability Agencies to assess changes in groundwater dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data.

Visit https://gde.codefornature.org/



Remote sensing data from satellites has been used to monitor the health of vegetation all over the planet. GDE pulse has compiled 35 years of satellite imagery from NASA's Landsat mission for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset[19]. The following datasets are included:

Normalized Difference Vegetation Index (NDVI) is a satellite-derived index that represents the greenness of vegetation. Healthy green vegetation tends to have a higher NDVI, while dead leaves have a lower NDVI. We calculated the average NDVI during the driest part of the year (July - Sept) to estimate vegetation health when the plants are most likely dependent on groundwater.

Normalized Difference Moisture Index (NDMI) is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) channels. Vegetation with adequate access to water tends to have higher NDMI, while vegetation that is water stressed tends to have lower NDMI. We calculated the average NDVI during the driest part of the year (July–September) to estimate vegetation health when the plants are most likely dependent on groundwater.

Annual Precipitation is the total precipitation for the water year (October 1st – September 30th) from the PRISM dataset[20]. The amount of local precipitation can affect vegetation with more precipitation generally leading to higher NDVI and NDMI.

Depth to Groundwater measurements provide an indication of the groundwater levels and changes over time for the surrounding area. We used groundwater well measurements from nearby (<1km) wells to estimate the depth to groundwater below the GDE based on the average elevation of the GDE (using a digital elevation model) minus the measured groundwater surface elevation.

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[19] The Natural Communities Commonly Associated with Groundwater Dataset is hosted on the California Department of Water Resources' website: https://gis.water.ca.gov/app/NCDatasetViewer/#

[20] The PRISM dataset is hosted on Oregon State University's website: http://www.prism.oregonstate.edu/

California Poultry Federation
4640 Spyres Way, Suite 4 | Modesto, CA 95356 | Phone: (209) 576-6355 | Fax: (209) 576-6119 | www.cpif.org

VIA E-MAIL (lsales@ppeng.com)

November 27, 2019

Members of the Tulare Lake Subbasin Board
of Directors
c/o Laurie Sales, Project Administrator
Southwest Kings GSA
286 West Cromwell Avenue
Fresno, California 93711

Re: Tulare Lake Subbasin GSP

Dear Board Members:

The California Poultry Federation ("CPF") appreciates the opportunity to comment on the draft Tulare Lake Subbasin Groundwater Sustainability Plan (the "Draft GSP"). CPF is the trade association for California's diverse and dynamic poultry industry. Our members include growers, hatchers, breeders, and processors that work with chickens, turkeys, ducks, game birds, and squab. Water is essential for all of them—both for nutrition and for maintaining sanitary conditions. CPF therefore supports effective measures to assure reliable water supplies.

In this regard, CPF recommends that each Tulare Lake Subbasin Groundwater Sustainability Agency ("GSA") make supply augmentation its top priority. We were encouraged to see that the Draft GSP incorporated storage, recharge, and conveyance projects and that Table 7-1 listed consideration of incentives as a means of encouraging participation in augmentation. Additional extraction rights in particular would be an excellent method of increasing landowner support for supply projects.

But we are concerned that the Draft GSP also emphasized substantial demand management without explaining precisely how that would be done. The listed management actions are "conceptual" (Draft GSP page 6-2) and Appendix E, which is to contain GSA appendices, is blank. Nor does the Draft GSP appear to set out any principles—which should include minimizing economic impact, maintaining established water rights, and incentivizing investment in water supply infrastructure—for developing demand management measures. The public will need to have meaningful opportunities to participate in the development of any specific demand management measures, which means that there must be sufficient time to evaluate supporting information and submit written comments. That is especially important in light of the finding (at Draft GSP page 7-7) that "[a]t this time there is not sufficient information to develop a financial impact due to demand reduction." CPF expects all the Subbasin GSAs to do their best to ameliorate economic impacts by adopting implementation measures that are cost-effective.

One other point about public comment deserves mention. It was difficult to ascertain when written comments on the Draft GSP were due and where they should be sent. The Subbasin GSAs should establish, utilize, and publicize one central clearinghouse available through the Internet for disseminating information about further proposed actions in the Subbasin and receiving written comments.

Please contact me if you need any further information about these comments.

Very truly yours,

Bill Mattos

Bill Mattos
President

December 1, 2019

Sent via email to djackson@tcwater.org and dmelville@ppeng.com

Re: Comments on Draft Groundwater Sustainability Plan for Tri County Water Authority Tulare Lake Groundwater Basin

To Whom It May Concern,

On behalf of the above-listed organizations, we would like to offer the attached comments on the draft Groundwater Sustainability Plan for the Tri County Water Authority Tulare Lake Groundwater Basin. Our organizations are deeply engaged in and committed to the successful implementation of the Sustainable Groundwater Management Act (SGMA) because we understand that groundwater is a critical piece of a resilient California water portfolio, particularly in light of our changing climate. Because California's water and economy are interconnected, the sustainable management of each basin is of interest to both local communities and the state as a whole. This letter adopts by reference the comments and recommendations submitted by The Nature Conservancy on this draft plan.

Our organizations have significant expertise in the environmental needs of groundwater and the needs of disadvantaged communities.

- The Nature Conservancy, in collaboration with state agencies, has developed several tools[1] for identifying groundwater dependent ecosystems in every SGMA groundwater basin and has made that tool available to each Groundwater Sustainability Agency.
- Local Government Commission supports leadership development, performs community engagement, and provides technical assistance dealing with groundwater management and other resilience-related topics at the local and regional scales; we provide guidance and resources for statewide applicability to the communities and GSAs we are working with directly in multiple groundwater basins.
- Audubon California is an expert in understanding wetlands and their role in groundwater recharge and applying conservation science to develop multiple-benefit solutions for sustainable groundwater management.
- Clean Water Action and Clean Water Fund are sister organizations that have deep expertise in the provision of safe drinking water, particularly in California's small disadvantaged communities, and co-authored a report on public and stakeholder engagement in SGMA[2].

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[1] https://groundwaterresourcehub.org/

[2] https://www.cleanwater.org/publications/collaborating-success-stakeholder-engagement-sustainable-groundwater-management-act

Because of the number of draft plans being released and our interest in reviewing every plan, we have identified key plan elements that are necessary to ensure that each plan adequately addresses essential requirements of SGMA. A summary review of your plan using our evaluation framework is attached to this letter as Appendix A. Our hope is that you can use our feedback to improve your plan before it is submitted in January 2020.

This review does not look at data quality but instead looks at how data was presented and used to identify and address the needs of disadvantaged communities (DACs), drinking water and the environment. In addition to informing individual groundwater sustainability agencies of our analysis, we plan to aggregate the results of our reviews to identify trends in GSP development, compare plans and determine which basins may require greater attention from our organizations.

Key Indicators

Appendix A provides a list of the questions we posed, how the draft plan responds to those questions and an evaluation by element of major issues with the plan. Below is a summary by element of the questions used to evaluate the plan.

1. Identification of Beneficial Users. This element is meant to ascertain whether and how DACs and groundwater-dependent ecosystems (GDEs) were identified, what standards and guidance were used to determine groundwater quality conditions and establish minimum thresholds for groundwater quality, and how environmental beneficial users and stakeholders were engaged through the development of the draft plan.
2. Communications plan. This element looks at the sufficiency of the communications plan in identifying ongoing stakeholder engagement during plan implementation, explicit information about how DACs were engaged in the planning process and how stakeholder input was incorporated into the GSP process and decision-making.
3. Maps related to Key Beneficial Uses. This element looks for maps related to drinking water users, including the density, location and depths of public supply and domestic wells; maps of GDE and interconnected surface waters with gaining and losing reaches; and monitoring networks.
4. Water Budgets. This element looks at how climate change is explicitly incorporated into current and future water budgets; how demands from urban and domestic water users were incorporated; and whether the historic, current and future water demands of native vegetation and wetlands are included in the budget.
5. Management areas and Monitoring Network. This element looks at where, why and how management areas are established, as well what data gaps have been identified and how the plan addresses those gaps.
6. Measurable Objectives and Undesirable Results. This element evaluates whether the plan explicitly considers the impacts on DACs, GDEs and environmental beneficial users in the development of Undesirable Results and Measurable Objectives. In addition, it examines whether stakeholder input was solicited from these beneficial users during the development of those metrics.
7. Management Actions and Costs. This element looks at how identified management actions impact DACs, GDEs and interconnected surface water bodies; whether mitigation for impacts to DACs is discussed or funded; and what efforts will be made to fill identified data gaps in the first five years of the plan. Additionally, this element asks whether any changes to local ordinances or land use plans are included as management actions.

Conclusion

We know that SGMA plan development and implementation is a major undertaking, and we want every basin to be successful. We would be happy to meet with you to discuss our evaluation as you finalize your Plan for submittal to DWR. Feel free to contact Suzannah Sosman at suzannah@aginnovations.org for more information or to schedule a conversation.

Sincerely,

Jennifer Clary
Water Program Manager
Clean Water Action/Clean Water Fund

Danielle V. Dolan
Water Program Director
Local Government Commission

Samantha Arthur
Working Lands Program Director
Audubon California

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy

Appendix A
Review of Public Draft GSP

Groundwater Basin/Subbasin: Tulare Lake Subbasin (DWR 5-22-12)
GSA: Five GSAs (Mid-Kings River, South Fork Kings, Southwest Kings, El Rico, and the Tri-County Water Authority GSAs)
GSP Date: August 2019 Public Review Draft

1. Identification of Beneficial Users

Were key beneficial users identified and engaged?

Selected relevant requirements and guidance:
GSP Element 2.1.5, "Notice & Communication" (§354.10):
(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.
GSP Element 2.2.2, "Groundwater Conditions" (§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.
(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 the best available information.
(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.
GSP Element 3.3, "Minimum Thresholds" (§354.28):
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

Review Criteria		Yes	No	N/A	Relevant Info per GSP	Location (Section, Page[1])
1. Do beneficial users (BUs) identified within the GSP area include:	a. Disadvantaged Communities (DACs)	X			From Table 2-4, DACs include Armona, Home Garde, Hardwick, Community of Stratford, Kettleman City, and City of Corcoran.	Table 2-4, Page 94
	b. Tribes	X			"The only Native American Tribe within the Tulare Lake Subbasin boundary is the Santa Rosa Rancheria Tachi-Yokut Tribe. The Tachi-Yokut Tribe was invited to participate in GSP development via a letter sent on June 28, 2016 by the then Upper Tulare Lake GSA MOU Group (now known as the South Fork Kings GSA). A copy of the letter is included in the Appendix A of the Tulare Lake Subbasin GSAs' Communication & Engagement Plan. The Tribe's EPA director attended one of the South Fork Kings GSA's board meetings, and has been on their Interested Parties List since April 2017, receiving regular updates about GSP development within the SFKGSA and the Tulare Lake Subbasin. In addition, a Sacred Lands File & Native American Contacts List Request was also sent to the Native American Heritage Commission."	Appendix B, Page 373
	c. Small community public water systems (<3,300 connections)	X			Public water systems such as Armona CSD and Home Garden CSD are included in Table 2-4. It is not clear from the GSP which systems have fewer than 3,300 connections.	Table 2-4, Page 94
2. What data were used to identify presence or absence	d. DWR DAC Mapping Tool[2]		X		Data source is not clear from the GSP.	
	i. Census Places		X			

[1] Page numbers refer to the page of the PDF.
[2] DWR DAC Mapping Tool: https://gis.water.ca.gov/app/dacs/

of DACs?	ii. Census Block Groups		X			
	iii. Census Tracts		X			
	e. Other data source		X			
3. Groundwater Conditions section includes discussion of:	f. Drinking Water Quality	X			"Currently, as described in Section 5.4.3, groundwater quality in the northern portion of the Subbasin encompassing the Mid-Kings River GSA and South Fork Kings GSA is generally excellent for irrigation and satisfactory for municipal and industrial use (KCWD 2011). South of Stratford and Corcoran, groundwater quality diminishes, and portions of the Tulare Lakebed have been undesignated from being suitable for municipal, domestic, agricultural irrigation, and stock watering supply. Shallow groundwater contamination from fuel hydrocarbons, agricultural chemicals, or solvents are localized in the urbanized areas of Lemoore and Hanford and some smaller communities. Limited regional data is available for determining current nutrient concentrations based on groundwater depth and location. As discussed in Section 3.2.5, shallow groundwater can have elevated concentrations of nitrates and TDS, but the majority of the region is generally below Maximum Contaminant Levels (MCLs)."	4.4.1.4, Page 248
	g. California Maximum Contaminant Levels (CA MCLs)[3] (or Public Health Goals where MCL does not exist, e.g. Chromium VI)		X		See above. MCLs are only briefly discussed.	4.4.1.4, Page 248
4. What local, state, and federal standards or plans were used to assess drinking water BUs in the development of Minimum Thresholds (MTs)?	h. Office of Environmental Health Hazard Assessment Public Health Goal (OEHHA PHGs)[4]		X			
	i. CA MCLs[3]	X			"The basic authority of the GSAs is to locally determine the sustainable amount of groundwater that can be pumped and to manage the transition from the current groundwater usage to a groundwater usage that is sustainable. Also, GSAs do not have the authority to modify surface water rights. Federal and state agencies provide direct oversight of quality and set their own appropriate thresholds such as Maximum Contaminant Levels for drinking water. These will be utilized by the Subbasin for MOs and MTs. For these reasons, the local GSAs will focus on water quality issues that are related to groundwater pumping rather than on issues related to contamination." "MTs will follow the state, federal, and local standards related to the relevant sustainability indicators set by the coalitions."	4.2.4, Page 239 4.4.2.4, Page 249
	j. Water Quality Objectives (WQOs) in Regional Water Quality Control Plans		X			
	k. Sustainable Communities Strategies/ Regional Transportation Plans[5]		X			

[3] CA MCLs: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html
[4] OEHHA PHGs: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html
[5] CARB: https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources

	l. County and/or City General Plans, Zoning Codes and Ordinances[6]		X			

Summary/ Comments
It is recommended that the GSP clearly identify the data sources that were used to identify the presence of DACs, and include as maps showing the locations of DACs. The representative monitoring networks should be shown on maps that include the location of DACs so that one can assess the networks' ability to monitor potential impacts to these sensitive beneficial users.

The GSP should provide much more thorough information on what the water quality MTs/MOs are and what standards were used in the development of MTs/MOs. Such information is crucial to the drinking water beneficial users in the subbasin.

[6] OPR General Plan Guidelines: http://www.opr.ca.gov/planning/general-plan/

2. Communications Plan

How were key beneficial users engaged and how was their input incorporated into the GSP process and decisions?

Selected relevant requirements and guidance:
GSP Element 2.1.5, “Notice & Communication” (§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:
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency’s decision-making process.
(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the 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.

DWR Guidance Document for GSP Stakeholder Communication and Engagement[7]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Is a Stakeholder Communication and Engagement Plan (SCEP) included?	X			Appendix B: Stakeholder Communication and Engagement Plan (no date)	Appendix B, Page 368
2. Does the SCEP or GSP identify that ongoing engagement will be conducted during GSP implementation?	X			“During the implementation phase, communication and engagement efforts focus on educational and informational awareness of the requirements and processes for reaching groundwater sustainability as set forth in the submitted GSP. Active involvement of all stakeholders is encouraged during implementation, and public notices are required for any public meetings, as well as prior to imposing or increasing any fees. Public outreach is also completed by the individual GSAs with collaborative efforts when target audiences span more than one GSA boundary.”	2.5.1, Page 73
3. Does the SCEP or GSP specifically identify how DAC beneficial users were engaged in the planning process?	X			“Communication and educational outreach efforts with disadvantaged communities (DAC) and severely disadvantaged communities (SDAC) was needed for the development and implementation of the Tulare Lake Subbasin’s GSP according to the Department of Water Resources’ Best Management Practices. Information used to communicate to and engage the DACs in the GSP process, included an explanation of SGMA and soliciting feedback. GSA representatives regularly communicated with DACs and gave presentations on SGMA to community representatives, while gathering their feedback and input. By including DACs and SDACs in communication efforts during the development, public review and implementation phases of the GSP, residents were more likely to participate and provide feedback that could be crucial to long-term solutions for groundwater sustainability within their communities.	Appendix B, Page 374, 377

[7] DWR Guidance Document for GSP Stakeholder Communication and Engagement
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Guidance-Document-for-Groundwater-Sustainability-Plan---Stakeholder-Communication-and-Engagement.pdf

				Any feedback received from DAC/SDAC residents was reviewed and evaluated by the Tulare Lake Subbasin GSAs during the GSP development and public review phases.” “For outreach to DACs/SDACs, fliers were available in both English and Spanish languages.”	
4. Does the SCEP or GSP explicitly describe how stakeholder input was incorporated into the GSP process and decisions?	X			“As active stakeholders, members of the Boards of Directors and Stakeholder/Advisory Committees are direct representatives of their districts, communities and industries, and they continually gather feedback/input, and the concerns/needs of their constituents and report back to their respective meetings. Any stakeholder input received was reviewed by the GSA and Subbasin technical teams and taken into consideration during GSP development.” “Stakeholder input was utilized during the GSA formation phase, as beneficial users and stakeholders with interests in groundwater usage within the GSAs’ boundaries were notified via public meeting notices as soon as the process began.” “With the goal of having the draft GSP before the end of the third quarter in 2019, 2018 was primarily the technical development of the plan, while working with GSA Boards of Directors, technical teams/committees, and GSA management at the subbasin level, as well as stakeholders for feedback and input. During the last quarter of 2018, the first round of public outreach meetings and interaction with stakeholder groups and other community organizations and entities was held with the purpose of educating and informing stakeholders about SGMA and the GSP process, while also soliciting feedback and input from these groups to consider and possibly include feedback and input into the GSP. Public outreach for this phase was completed by the individual GSAs.” “Once the draft of the GSP was completed in September 2019, the public review process began. A 90-day comment period was held, with the GSP draft posted on the Tulare Lake Subbasin GSAs’ websites for all stakeholders to conveniently download and review and provide comments. Outreach meetings were held during this phase both on subbasin-wide level, as well as by individual GSAs. These meetings focused on an overview of the GSP content, while giving stakeholders a public forum to provide their feedback and comments.” Outreach tracking is also presented in tables by each GSA in Appendix D.	Appendix B, Page 370

Summary/ Comment
It is important that stakeholder engagement be maintained through the development of future projects and management actions and other SGMA compliance and implementation steps.

3. Maps Related to Key Beneficial Uses

Were best available data sources used for information related to key beneficial users?

<u>Selected relevant requirements and guidance:</u>
GSP Element 2.1.4 "Additional GSP Elements" (§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:
(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 the best available information.

<u>GSP Element 3.5 Monitoring Network (§354.34)</u>
(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 affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:
(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(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 monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.
(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.
(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.

Review Criteria		Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP Include Maps Related to Drinking Water Users?	a. Well Density		X		No maps are provided. Page 47 indicates that there are 75 public supply wells in the Subbasin and the total number of wells is about 3,871.	Section 2, Page 47
	b. Domestic and Public Supply Well Locations & Depths		X		The GSP does not appear to include information on domestic and public supply well locations and depths.	
	i. Based on DWR Well Completion Report Map Application[8]?			X		

[8] DWR Well Completion Report Map Application: https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

	ii. Based on Other Source(s)?				X		
2. Does the GSP include maps of monitoring networks?	a. Existing Monitoring Wells		X			Existing monitoring wells for subsidence and water quality can be found in Figure 5-4 and 5-5.	Figure 5-4, Page 301 Figure 5-4, Page 302
	b. Existing Monitoring Well Data sources:	i. California Statewide Groundwater Elevation Monitoring (CASGEM)	X			"Groundwater levels are measured in the various networks and types of wells including: […] CASGEM Wells: DWR collects groundwater levels reported by local agencies and reports them through the CASGEM program. There are currently 17 CASGEM wells in the Subbasin."	5.1.5, Page 276
		ii. Water Board Regulated monitoring sites	X			"Water quality data will be obtained from the below-mentioned coalitions: […] RWQCB - Regional Water Quality Control Board" "Though water quality has been periodically analyzed within the Subbasin for irrigation suitability, monitoring programs are generally not in place with defined temporal and spatial distribution, except for municipal water suppliers, RWQCB sites with WDRs, and monitoring at evaporation ponds."	4.4.2.4, Page 250 5.4.3, Page 291
		iii. Department of Pesticide Regulation (DPR) monitoring wells	X			"The California Department of Pesticide Regulation (DPR) maintains a Surface Water Database (SURF) containing data from a wide variety of environmental monitoring studies designed to test for the presence or absence of pesticides in California surface waters. As part of DPR's effort to provide public access to pesticide information, this database provides access to data from DPR's SURF (DPR 2019)."	2.4.3.3, Page 68
	c. SGMA-Compliance Monitoring Network		X			Figure 5-1 to Figure 5-5	Figure 5-1 to Figure 5-5, Page298-302
	i. SGMA Monitoring Network map includes identified DACs?			X		DACs are not included. However, public water systems are shown on the maps.	
	ii. SGMA Monitoring Network map includes identified GDEs?			X		GDEs are not included.	

Summary/ Comments

The draft GSP does not provide maps showing "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 the best available information" as required by 23 CCR § 354.8.(a)(5). The GSP should include the density, location and depths of all domestic and public supply wells in the GSA area using the best available information, and present this information on maps along with the proposed SGMA-compliance monitoring network so that the public can evaluate how well the monitoring network addresses these key beneficial users.

Providing maps of the monitoring network overlaid with location of DACs, GDEs, and any other sensitive beneficial users will also allow the reader to evaluate adequacy of the network to monitor conditions near these beneficial users.

4. Water Budgets

How were climate change projections incorporated into projected/future water budget and how were key beneficial users addressed?

Selected relevant requirements and guidance:
GSP Element 2.2.3 "Water Budget Information" (Reg. § 354.18)
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.

*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:*
(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(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.
(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:
*(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.*

DWR Water Budget BMP[9]
DWR Guidance for Climate Change Data Use During GSP Development and Resource Guide[10]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Are climate change projections explicitly incorporated in future/ projected water budget scenario(s)?	X			"The projected water budget for the Subbasin represents a hypothetical forecast for the 54-year period from 2017 through 2070 based on an assumed "normal hydrology" period and estimated future climate change impacts."	3.3.7, Page 141
2. Is there a description of the methodology used to include climate change?	X			"In a climate period analysis, climate change is modeled as a shift from a baseline condition, usually historically observed climate where every year or month of the simulation it is shifted in a way that represents the climate change signal at a future 30-year climate period. Climate period analysis provides advantages in this situation because it isolates the climate change signal independent of the monthly variability signal. In a climate period analysis, monthly variability is based on the reference period from which change is being measured, meaning that all differences between the future	3.3.7.3, Page 142-143

[9] DWR BMP for the Sustainable <management of Groundwater Water Budget: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget.pdf
[10] DWR Guidance Document for the Sustainable Management of Groundwater Guidance for Climate Change Data Use During GSP Development: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final.pdf

						simulation and the reference period are the result of the climate change signal alone. Climate period analysis was utilized to modify the 54-year forecast of “normal hydrology” to account for future climate change. The 2017-2070 forecast incorporates climate period analysis using the 2030 and 2070 monthly change factors (CNRA 2018) for each forecast analog month (Figure 3-52). The 2030 monthly change factors were applied to the forecast months January 2017 through December 2030. The 2070 monthly change factors were applied to the forecast months January 2031 through December 2070. There is a notable increase in magnitude of the 2070 change factors compared to the 2030 change factors.”	
3. What is used as the basis for climate change assumptions?	a. DWR-Provided Climate Change Data and Guidance[11]		X			“The DWR provides guidance on how to incorporate climate change into hydrology forecasts. There are two basic approaches that have been used to simulate climate change in water resource modeling: 1) transient analysis; and 2) climate period analysis (DWR 2018).”	3.3.7.3, Page 142
	b. Other			X			
4. Does the GSP use multiple climate scenarios?				X			
5. Does the GSP quantitatively incorporate climate change projections?			X			Based on the information presented in Figure 3-53, the GSP appears to have quantitatively incorporated climate change projections. However, no descriptions or tables are provided regarding the quantitative results of the climate change projections.	Figure 3-53, Page 219
6. Does the GSP explicitly account for climate change in the following elements of the future/projected water budget?	a. Inflows:	i. Precipitation	X			“The climate change factors were also applied to 54-year forecasts of monthly inflows (effective precipitation, surface water deliveries, lake bottom storage, and canal and river seepage) and outflows (agricultural demand) for the “normal hydrology” forecast.”	3.3.7.4, Page 143
		ii. Surface Water	X				
		iii. Imported Water	X				
		iv. Subsurface Inflow	X				
	b. Outflows:	i. Evapotranspiration	X				
		ii. Surface Water Outflows (incl. Exports)			X		
		iii. Groundwater Outflows (incl. Exports)	X				
7. Are demands by these sectors (drinking water users) explicitly included in the future/projected	a. Domestic Well users (<5 connections)		X			“Municipal and domestic groundwater pumping are estimated upward based on projected population growth at an annual rate of 0.03%.” It is not clear from the GSP if demands by some or all of these community and non-community water systems were considered. The GSP also does not identify the number of connections of the various	3.3.7.4, Page 143
	b. State Small Water systems (5-14 connections)			X			
	c. Small community water systems (<3,300 connections)			X			

[11] DWR Guidance Document for the Sustainable Management of Groundwater Guidance for Climate Change Data Use During GSP Development: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final.pdf
DWR Resource Guide DWR-Provided Climate Change Data and Guidance for Use During GSP Development: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Resource-Guide-Climate-Change-Guidance_v8.pdf

water budget?	d. Medium and Large community water systems (> 3,300 connections)		X		public water systems present in the basin.	
	e. Non-community water systems		X			

Summary/ Comments

Given the uncertainties of climate change, the GSP should include and analyze the effects of multiple climate change scenarios.

The GSP should present the results of the projected water budget in a tabulated, transparent format. The GSP should also clearly identify and quantify water demands of all drinking water users in the projected water budget, including the small and large public water systems. Such information is necessary for the public to assess whether drinking water demands were fully and appropriately considered in the GSP.

5. Management Areas and Monitoring Network

How were key beneficial users considered in the selection and monitoring of Management Areas and was the monitoring network designed appropriately to identify impacts on DACs and GDEs?

Selected relevant requirements and guidance:
GSP Element 3.3, "Management Areas" (§354.20):

(b) A basin that includes one or more management areas shall describe the following in the Plan:
(2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.
(3) The level of monitoring and analysis appropriate for each management area.
(4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.
(c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.

CWC Guide to Protecting Drinking Water Quality under the SGMA[12]
TNC's Groundwater Dependent Ecosystems under the SGMA, Guidance for Preparing GSPs[13]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP define one or more Management Area?	X			"In order to facilitate implementation of the GSP, management areas have been created for the Subbasin. There are five Primary Management Areas and two Secondary Management Areas."	3.4, Page 144 Figure 3-54, Page 220
2. Were the management areas defined specifically to manage GDEs?		X		"Primary Management Areas have been formed from each of the five GSAs." "Two Secondary Management Areas have been formed for the Subbasin. These two Secondary Management Areas are different from the Primary Management Areas and each other due to distinctly different groundwater conditions in each area."	3.4, Page 144
3. Were the management areas defined specifically to manage DACs?		X			
a. If yes, are the Measurable Objectives (MOs) and MTs for GDE/DAC management areas more restrictive than for the basin as a whole?			X		
b. If yes, are the proposed management actions for GDE/DAC management areas more restrictive/ aggressive than for the basin as a whole?			X		
4. Does the GSP include maps or descriptions indicating what DACs are located in each Management Area(s)?	X			Table 2-4 describes DACs in each GSA area.	Table 2-4, Page 94
5. Does the GSP include maps or descriptions indicating what GDEs are located in each Management Area(s)?	X			Figure 3-38. Distribution of Wetlands and Phreatophyte Vegetation	Figure 3-38, Page 198

[12] CWC Guide to Protecting Drinking Water Quality under the SGMA: https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858
[13] TNC's Groundwater Dependent Ecosystems under the SGMA, Guidance for Preparing GSPs: https://www.scienceforconservation.org/assets/downloads/GDEsUnderSGMA.pdf

Summary/ Comments
It is recommended that the GSP includes maps of the identified DACs located within each Management Area.

Care should be taken so that the management areas and the associated monitoring network are designed to adequately assess and protect against impacts to all beneficial users, including GDEs and DACs.

6. Measurable Objectives, Minimum Thresholds, and Undesirable Results

How were DAC and GDE beneficial uses and users considered in the establishment of Sustainable Management Criteria?

Selected relevant requirements and guidance:
GSP Element 3.4 “Undesirable Results” (§ 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

GSP Element 3.2 “Measurable Objectives” (§ 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 within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Are DAC impacts considered in the development of Undesirable Results (URs), MOs, and MTs for groundwater levels and groundwater quality?		X		The impacts to DACs are not explicitly considered. Water Level URs: “Exceedance of MTs leading to undesirable results related to groundwater level in the Subbasin would cause a diminished level of groundwater supplies for agricultural and municipal needs. Groundwater levels are anticipated to continue to decrease at current rates in the next several years before implemented programs have a positive effect on the stabilization of groundwater levels based on the variability of hydrology and availability of flood water. As stated above, agriculture is the main economic enterprise of the Subbasin, so effective management of groundwater for sustainable future use is critical to the continuation of current economic interests, which add value to the Subbasin’s communities. Decreases in groundwater levels will continue to increase the cost of energy for pumping. If MT levels are reached or exceeded, wells have the potential to go dry and require deepening to reach the lowered water table. Alternatively, pumps may be lowered if the existing well casing is sufficiently deeper. However, once the Subbasin reaches sustainability in the future, the depth of the wells will be known and can be designed to meet those depths to prevent future wells from becoming dry.” Water Level MTs: “Due to the timely process of infrastructure development and program implementation, and variability in hydrology and the availability of flood water, groundwater levels are expected to continue to decrease in the next several years before programs have a positive effect on the stabilization of groundwater levels. Decreases in groundwater levels will continue to increase the cost of energy for pumping. If MT levels are reached, there may be some wells that go dry and require deepening to reach the water table. Alternatively, pumps may be lowered if the existing well casing is sufficiently deeper. However, once the Subbasin reaches sustainability in the future, the design depth for wells will be known and will be used in planning of future	4.3.3, Page 245 4.4.4, Page 251

				well construction to minimize future wells from becoming dry." Water Quality MTs: "If water quality is allowed to deteriorate to levels set by MTs, agricultural producers may experience a decrease in crop yield and/or crop quality. Poor water quality would cause a buildup of salts and nitrates in the surface layers of soil. The best way to treat nutrient build up is by leaching or over-irrigating enough to push soluble contaminants through the soil column."	
2. Does the GSP explicitly discuss how stakeholder input from DAC community members was considered in the development of URs, MOs, and MTs?		X		The GSP does not explicitly discuss how stakeholder input from DACs was considered.	
3. Does the GSP clearly identify and detail the anticipated degree of water level decline from current elevations to the water level MOs and MTs?		X		The GSP does not clearly identify the anticipated degree of water level decline. However, current water levels and MOs/MTs are presented in Table 4-1. Based on this if water levels reach MTs, this will represent an average decline of approx. 100 feet below 2017 conditions, and over 200 feet below current conditions in some parts of the subbasin (i.e., wells SFK_B_1920E19A001M, SFK_C_20S20E07H001M, and SFK_C_LEM_12). Even MOs represent over 100 feet of decline below 2017 water levels in many areas of the Subbasin.	Table 4-1, Page 262
4. If yes, does it include: a. Is this information presented in table(s)?		X			
b. Is this information presented on map(s)?		X			
c. Is this information presented relative to the locations of DACs and domestic well users?		X			
d. Is this information presented relative to the locations of ISW and GDEs?		X			
5. Does the GSP include an analysis of the anticipated impacts of water level MOs and MTs on drinking water users?		X		"Due to the timely process of infrastructure development and program implementation, and variability in hydrology and the availability of flood water, groundwater levels are expected to continue to decrease in the next several years before programs have a positive effect on the stabilization of groundwater levels. Decreases in groundwater levels will continue to increase the cost of energy for pumping. If MT levels are reached, there may be some wells that go dry and require deepening to reach the water table. Alternatively, pumps may be lowered if the existing well casing is sufficiently deeper. However, once the Subbasin reaches sustainability in the future, the design depth for wells will be known and will be used in planning of future well construction to minimize future wells from becoming dry." Impacts on drinking water users are not explicitly considered. Based on the water level declines identified above, it would be expected that such impacts could be significant.	4.4.4, Page 251
6. If yes: a. On domestic well users?		X			
b. On small water system production wells?		X			
c. Was an analysis conducted and clearly illustrated (with maps) to identify what wells would be expected to be partially and fully dewatered at the MOs?		X			
d. Was an analysis conducted and clearly illustrated (with maps) to identify what wells would be expected to be partially and fully dewatered at the MTs?		X			
e. Was an economic analysis performed to assess the increased operation costs associated with increased lift as a result of water level decline?		X			
9. Does the sustainability goal explicitly include drinking water and nature?		X		"This GSP aims to manage groundwater resources to continue to provide an adequate water supply for existing beneficial uses and users in accordance with counties and cities general plans while meeting established measurable objectives (MO) to maintain a sustainable yield. This goal aims to continue to provide adequate water supply for existing beneficial uses and users while ensuring the future, sustainable use of groundwater. Additionally, the sustainability goal works as a tool for managing groundwater, basin-wide, on a long-term basis to protect quality of life through the continuation of existing economic industries in the area including but not limited to agriculture."	1.3.1, Page 40 Table 2-4, Page 94

				Table 2-4. Beneficial Uses and Users by GSA The sustainability goal does not include nature.	

Summary/ Comments
Based on the presented information, impacts to DACs are not explicitly considered in the discussion of URs, MOs, and MTs. More detail and specifics regarding DACs, including those that rely on smaller community drinking water systems and domestic wells, is necessary to demonstrate that these beneficial users were adequately considered. It is recommended that the GSP present a thorough and robust analysis, supported by maps, that identifies: (1) what domestic wells are likely to be impacted (including partially dewatered) at the MTs and at the MOs and (2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater.

Based on the information presented in Table 4-1 of the draft GSP, if water levels reach MTs, this will represent an average decline of approx. 100 feet below 2017 water levels, and over 200 feet below current conditions in some parts of the subbasin (i.e., wells SFK_B_1920E19A001M, SFK_C_20S20E07H001M, and SFK_C_LEM_12). Even MOs represent an average decline of over 50 feet below current conditions and over 100 feet of decline in many areas of the Subbasin. The GSP needs to explain how such water level declines represent sustainable conditions and are protective of beneficial uses and users in the Subbasin.

A proactive assistance program should be developed for potentially impacted beneficial users, including DACs, small water systems, and domestic wells, to mitigate potential future adverse impacts.

The GSP should also explicitly demonstrate whether and how the stakeholder input from DACs was considered in the development of URs, MOs, and MTs.

We recommend that the sustainability goal explicitly includes environmental beneficial uses of groundwater.

7. Management Actions and Costs

What does the GSP identify as specific actions to achieve the MOs, particularly those that affect the key BUs, including actions triggered by failure to meet MOs? What funding mechanisms and processes are identified that will ensure that the proposed projects and management actions are achievable and implementable?

Selected relevant requirements and guidance
GSP Element 4.0 Projects and Management Actions to Achieve Sustainability Goal (§ 354.44)
(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
(b) Each Plan shall include a description of the projects and management actions that include the following:
(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action.

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP identify benefits or impacts to DACs as a result of identified management actions?		X		The impacts to DACs are not explicitly discussed in the GSP. Recharge projects are noted in the GSP as expected to improve water quality.	6.3.3, Page 323
2. If yes: a. Is a plan to mitigate impacts on DAC drinking water users included in the proposed Projects and		X			

	Management Actions?					
	b. Does the GSP identify costs to fund a mitigation program?		X			
	c. Does the GSP include a funding mechanism to support the mitigation program?		X			
3. Does the GSP identify any demand management measures in its projects and management actions?		X			Section 6.3 and 6.4 provide potential P/MAs options that may be utilized by the GSAs. Table 6-1 to 6-4 in Section 6.5 list the P/MAs chosen for each GSA.	6.3, Page 317-330 6.4, Page 330-331 6.5, Page 331-334
4. If yes, does it include:	a. Irrigation efficiency program		X			
	b. Ag land fallowing (voluntary or mandatory)	X			Fallowing programs are identified by Mid-Kings River GSA, El Rico GSA, and South Fork Kings GSA. "The Subbasin may adopt a policy to incentive farmers to permanently fallow land. Policy will solicit volunteers first then look towards mandatory fallowing based on percentage reductions possibly on a rotation basis."	
	c. Pumping allocation/restriction	X			Groundwater allocation is listed as a potential management action in Section 6.4.	
	d. Pumping fees/fines	X			Pumping fees for groundwater allocation exceedances and groundwater extractions are listed as potential management actions in Section 6.4.	
	e. Development of a water market/credit system	X			Groundwater marketing and trade is listed as a potential management action in Section 6.4.	
	f. Prohibition on new well construction		X			
	g. Limits on municipal pumping		X		It is not clear if there would be limits on municipal pumping.	
	h. Limits on domestic well pumping		X		It is not clear if there would be limits on domestic well pumping.	
	i. Other	X			"Require new developments (non-de minimis extractors) to prove sustainable water supplies if land use conversion is not a conservation measure"	
5. Does the GSP identify water supply augmentation projects in its projects and management actions?		X			Section 6.3 and 6.4 provide potential P/MAs options that may be utilized by the GSAs. Table 6-1 to 6-4 in Section 6.5 list the P/MAs chosen for each GSA.	6.3, Page 317-330 6.4, Page 330-331 6.5, Page 331-334
6. If yes, does it include:	a. Increasing existing water supplies	X			"Each GSA is proposing to use their existing contract and rights for surface water as access to import more surface water into the Subbasin."	
	b. Obtaining new water supplies		X			
	c. Increasing surface water storage	X			Storage projects are identified by South Fork Kings GSA, El Rico GSA, and Tri-County Water GSA.	
	d. Groundwater recharge projects – District or Regional level	X			Recharge projects are identified by Mid-Kings River GSA and South Fork Kings GSA.	
	e. On-farm recharge	X			On-Farm Improvements project is identified by South Fork Kings GSA.	
	f. Conjunctive use of surface water	X			The recharge projects also involve conjunctive use of surface water.	
	g. Developing/utilizing recycled water		X			

h. Stormwater capture and reuse		X			
i. Increasing operational flexibility (e.g., new interties and conveyance)	X			The Mid-Kings River GSA plans to pursue improvement to conveyance systems and expanded surface water delivery system.	
j. Other		X			
7. Does the GSP include plans to fill identified data gaps by the first five-year report?	X			Section 5.4.1.3 discusses plans to fill data gaps in groundwater level monitoring network, including plans to collect well completion reports, perform a video inspection of wells to obtain construction information, construct a dedicated monitoring well, and replace monitor point with another alternate private well. Some P/MAs in Table 7-1 are also noted in the GSP as expected to help fill data gaps, including (1) Flood Flows (Spills into the Subbasin), include, Tule River, Deer Creek, Cross-Creeks and Kings River; (2) Registration of extraction facilities; (3) Require self-reporting of groundwater extraction, water level, and water quality data; and (4) Require well meters, sounding tubes, and water quality sample ports.	5.4.1.3, Page 286 Table 7-1, Page 343
8. Do proposed management actions include any changes to local ordinances or land use planning?	X			"Require new developments (non-de minimis extractors) to prove sustainable water supplies if land use conversion is not a conservation measure"	6.4, Page 330
9. Does the GSP identify additional/contingent actions and funding mechanisms in the event that MOs are not met by the identified actions?		X		"This section identifies the proposed project and management action targets envisioned to achieve sustainability. These preliminary amounts will be reevaluated, and conditions monitored while efforts are implemented. This will allow the GSA to compare the anticipated versus resulting change in groundwater levels as well as other sustainability criteria to determine if additional measures need to be employed to achieve sustainability." However, the GSP does not provide details on what projects and management actions will be implemented as additional measures.	6.5, Section 331
10. Does the GSP provide a plan to study the interconnectedness of surface water bodies?		X		"As discussed in Section 3.2.8, Interconnected Surface Water and Groundwater Systems, the Subbasin does not contain interconnected surface and groundwater systems based on review of groundwater potentiometric surface maps. Groundwater contours indicate the Kings River, Cross Creek, and Mill Creek are losing streams that directly recharge groundwater. Groundwater is not in contact with these streams and cannot contribute any base flow to them. Due to the lack of connected water systems, interconnected surface water will not be monitored or considered when making management decisions."	4.2.5, Page 240
11. If yes: a. Does the GSP identify costs to study the interconnectedness of surface water bodies?			X		
b. Does the GSP include a funding mechanism to support the study of interconnectedness surface water bodies?			X		

Summary/ Comments

The GSP should identify the potential impacts of the proposed projects or management actions on DACs. If impacts are expected, the GSP should include plans to monitor for, prevent, and/or mitigate against such impacts, provide the estimated costs, and identify the funding sources.

The GSP does not appear to include any plans to address impacts to domestic well users if water quality in these wells is degraded in the future. The GSP should include plan to

monitor for and mitigate impacts to DAC drinking water users.

Westlands Water District

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December 2, 2019

Southwest Kings Groundwater Sustainability Agency
Kings Subbasin
Basin Number 5-22.08
Transmitted via online submission at: info@swkgsa.org

Subject: Tulare Lake Subbasin Draft Groundwater Sustainability Plan

Dear Southwest Kings GSA Group:

Westlands Water District ("Westlands GSA") appreciates the opportunity to provide comments on the Tulare Lake Subbasin Draft Groundwater Sustainability Plan ("Draft GSP"). The Westlands Groundwater Sustainability Agency ("GSA") respectfully submits the following comments.

Finding 1 (Page 3-27): Figures 3-26 and 3-27, Table 3-6, and Section 3.2.2 of the GSP states with respect to groundwater flow in the unconfined aquifer that, "[i]n general, groundwater flowed into the Subbasin from the Kings, Kaweah, and Tule Subbasins and out of the Subbasin to the Westside Subbasin." This statement is supplemented by contours of unconfined potentiometric head developed by DWR from 1990 through 2016.

Westlands' Comment: The unconfined water level data are used to make inferences about general groundwater flow directions. As stated in Section 3.2.3 of the GSP, vertical gradients can exceed 50 feet per 100 feet suggesting that flow directions can be heavily dependent on the depth horizons that are selected and therefore, change considerably with depth. Model results provided in Appendix D also highlight how groundwater flow directions vary with depth.

DWR does not provide groundwater contours for the majority of the boundary shared between the Westside and Tulare Lake Subbasin. In fact, contours from 2005, 2010 and 2016 provide almost no overlap with the shared Subbasin boundary. As a result, there is no substantial evidence to support the statements regarding groundwater flows "out of the Subbasin to the Westside Subbasin."

The spatial information for wells used to develop the DWR water level contours are readily available for 2016 (DWR, 2019). Review of these data reveals that the majority of wells used by DWR to develop contours of unconfined potentiometric head within the Westside Subbasin are screened in the Lower Aquifer (**WWD Attachment: Figure 1**). Given that groundwater level readings can vary considerably between the Upper Aquifer and Lower Aquifer, water levels from the Lower Aquifer are unlikely to be representative of unconfined water levels (even in the Spring) and should not be used to support the GSP conclusions of subsurface flow in the unconfined aquifer between the Westside and Tulare Lake Subbasins.

Therefore, the analysis is not supported by substantial evidence and we respectfully disagree with the conclusion set forth in the GSP relating to groundwater conditions in the unconfined aquifer.

Finding 2 (Page 3-87): Figures 3-28b, 3-28c and 3-28d display wells within the Tulare Lake Subbasin with long term hydrographs.

Westlands' Comment: Figures 3-28b to 3-28d shows long term hydrographs for wells within the Tulare Lake Subbasin. Unfortunately, the data displayed by the hydrographs is pixelated, therefore unreviewable. Westlands GSA recommends revising the mentioned figures to display hydrographs using a higher resolution to allow the public to review.

Finding 3 (Page 3-93): Figures 3-30 through 3-32, and Section 3.2.5 describes groundwater quality data in the Tulare Lake and Westside Subbasins. With respect to TDS, the GSP cites reports from Davis et al., 1956 and Hansen et al., 2018.

Westlands Comments: Both reports highlight how depth significantly influences TDS concentrations. However, Figure 3-30 does not report the depth of the wells or the aquifer the TDS sample represents which can substantially influence how data is interpreted. Furthermore, none of the maps shows the time period being represented. With respect to the concentration of arsenic in groundwater, neither the most recent nor the maximum arsenic concentration in the data available from GeoTracker is as high as those shown in Figure 3-31 (**WWD Attachment: Figure 2 and 3**). Furthermore, the density of wells with available arsenic data in the Geotracker GAMA database is substantially less than that shown in Figure 3-31.

The concentration of nitrate in groundwater is shown in Figure 3-32. This map shows nitrate concentration exceeding the MCL in four locations adjacent to the Westside Subbasin boundary. A review of data available from Geotracker GAMA show that samples exceeding the MCL were measured in the mid to late-1980's and likely do not reflect the current ambient nitrate concentration at these locations.

We recommend that the draft GSP be revised to accurately convey groundwater quality data by aquifer and by the timeframe the data represents. In addition, we recommend that the groundwater quality data be reviewed for accuracy.

Finding 4 (Page 3-87): Figures 3-34 displaying historical subsidence in the San Joaquin Valley from 1949 – 2005.

Westlands' Comment: Figures 3-34 contains a legend that is incomplete and is unable to be reviewed. Westlands GSA recommends applying the corresponding color scheme to the vertical displacement legend to allow readers to be able to review the presented information.

Finding 5 (Page 4-18): Section 4.5.1.1 introduces the following sustainable management criteria for Groundwater Levels paraphrased as follows: The Sustainable Management Criteria for Groundwater Level (Section 4.5.1.1) proposes the Measurable Objective to be set at a groundwater level using Method 4, which forecasts water levels to 2035 and sets the 2035 water level as the Measurable Objective. Minimum Thresholds were based on assumed stability of groundwater levels between 2035 and 2040 and are designed to be a last-resort warning before more severe measures must be taken to protect groundwater resources. Section 4.4.3 (Selection Process of Minimum Thresholds to Avoid

Undesirable Results) establishes the Minimum Thresholds as "one standard deviation of all observed head data in compliance wells or modeled forecasted data." Figure 4-2 through 4-6 describe establishment of the Minimum Thresholds as "one standard deviation or 50 feet, whichever is greater."

Westlands' Comment: Sustainable Management Criteria, which includes the measurable objectives and the minimum thresholds, allows groundwater levels in the aquifer to decline past the Westside Subbasin's Measurable Objectives and Minimum Thresholds, set at 2015 groundwater levels, and may negatively impact the Westside Subbasin's ability to achieve sustainability by reducing net inflow into the Westside Subbasin and/or reversing the groundwater flow direction. More specifically, the proposed decline of groundwater levels in the Southwest Kings GSA may alter the groundwater conditions near the boundary between the Westside Subbasin and the Kings Subbasin and result in a lowering of groundwater levels in the Westside Subbasin. This action would have the effect of shifting the burden of SGMA compliance from the Southwest Kings GSA to Westlands GSA. This is not permissible. The GSP is devoid of substantial evidence and any explanation as to how the Minimum Thresholds will avoid a significant and unreasonable reduction in groundwater storage and significant and unreasonable land subsidence contributing to the impairment of surface uses within the Westside Subbasin.

Water Code section 10733, subdivision (c) provides in relevant part:

> "The department shall evaluate whether a groundwater sustainability plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin"

Further, we respectfully call your attention to Code of Regulations, title 23, section 355.4, subdivision (b)(7):

> "When evaluating whether a Plan is likely to achieve the sustainability goal for the basin, the Department shall consider . . . whether the Plan *will adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of its sustainability goal.*" (emphasis added)

and Code of Regulations, title 23, section 354.28, subdivision (b)(3):

> "The description of minimum thresholds shall include . . . 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*." (emphasis added)

Moreover, the implementation of SGMA and a GSP cannot be used to override the protections afforded common law water rights. Overlying and appropriative uses of groundwater within the Westside Subbasin are entitled to legal and equitable protection against infringement by an action that deprives them of their historical subsurface inflows. (*City of Lodi v. East Bay Municipal Utility District* (1936) 7 Cal.2d 316, 344 [protecting groundwater levels against lowering from another party's pumping]; *Trussell v. City of San Diego* (1959) 172 Cal.App.2d 593, 611 [enjoining a party for lowering water table by interrupting surface flow].)

Practically speaking, proposing a continued decline of groundwater levels in the Lower Aquifer is not supported by substantial evidence because the GSP acknowledges that it does not have enough data to support its finding that there will be no impact to historical boundary flow conditions between the

Subbasins. The potential for curtailing historic underflow into the Westside Subbasin may be a substantial factor in contributing to significant and unreasonable subsidence and frustrate the Westlands' GSA ability to achieve the sustainability goal.

Finding 6 (Page 4-21): Section 4.5.33 Land Subsidence references Table 4-2: *Lemoore-Average Land Subsidence Interim Milestones based on Measurable Objectives for the Subbasin,* which displays modeled subsidence rates and interim milestones for those subsidence rates. The Tulare Lake Subbasin also proposes a minimum threshold of 16 ft by 2040 in Section 4.4.1.3.

Westlands' Comment: Westlands GSA is concerned that allowing subsidence rates as proposed may impact critical infrastructure such as roads, railroads, and may increase flood risks to existing land uses, especially near Corcoran where subsidence rates are critical, in the Westside Subbasin and other neighboring subbasins. Westlands GSA strongly recommend selecting Measurable Objectives and Minimum Thresholds to subsidence rates that will not negatively impact infrastructure in neighboring subbasins. The GSP fails to reference any substantial evidence that the minimum threshold will avoid significant and unreasonable land subsidence that impairs surface uses in the Westside Subbasin.

Finding 7 (Appendix D): The information provided in the GSP suggests a conceptual error leading to flows between the Westside Subbasin and Tulare Lake Subbasin to be misrepresented in the numerical model and GSP. Figure D5-5 in Appendix D shows the average model simulated net lateral subsurface flow of 158,405 AFY from the Lower Aquifer to the general head boundary (GHB) in the Westside Subbasin. Contours of simulated Lower Aquifer groundwater levels from 2015 in Figure D5-3 show a cone of depression along the GHB in the Westside Subbasin. Figure D5-5 shows pumping from the Lower Aquifer is a net positive suggesting that intraborehole flow from the Upper Aquifer to the Lower Aquifer is greater than the amount extracted from wells, suggesting the GHB is driving the flow across the boundary between the Westside and Tulare Lake Subbasins and out of the Westside Subbasin.

Westlands' Comment:
Lower Aquifer contours developed from water level data at the end of the 2014 irrigation year (one year before the simulated contour data provided) do not show a cone of depression in the location of the GHB (**WWD Attachment: Figure 4**). These contours also cannot be interpreted to suggest that groundwater flow is from the Tulare Lake Subbasin to the Westside Subbasin. Furthermore, it is unclear what physical process would cause a localized cone of depression to form in this location, especially considering that the groundwater model simulates positive net pumping from the Lower Aquifer in the Westside Subbasin.

The analysis is not supported by substantial evidence and for the reasons set forth above, Westlands recommends reanalyzing the water level contour data from the numerical model and GSP.

Lastly, the Westlands GSA identified the following reporting discrepancies within the text of the GSP and Appendix D that should be reviewed:

1. Total lateral subsurface inflow into the Westside Subbasin shown in Figure D5-5 averages 72,296 AFY (67,347 from the Tulare Lake Subbasin and 4,948 AFY from the Kings Subbasin). Table 3-6 of the GSP shows average annual subsurface flow from the Tulare Lake Subbasin to the Westside Subbasin of 41,390. What is the source of this discrepancy?

2. In the graphic depicting aquifer specific fluxes in Figure D5-5, the sum of the "Net GW Flux" (which presumably is lateral subsurface flow between adjacent subbasins) totals 4,936 AFY while the total in the table shown in Figure D5-5 is 72,296 AFY. What is the source of this discrepancy?

3. Figure numbers in the Appendix D text do not correspond to the correct figures. Figure D5-10 is titled "Simulated Subsidence 1990-2016". Figure D5-8 shows "Groundwater Mass Balance Tule Subbasin".

Westlands' General Comment: The GSP Regulations include a provision authorizing GSAs in adjacent basins to enter into interbasin agreements. The interbasin agreements can "establish compatible sustainability goals" and be included in GSPs 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." (Code Regs., tit. 23, § 357.2.)[1] The interbasin agreements may also address: (1) "an estimate of groundwater flow across basin boundaries;" (2) how the GSAs will reconcile differing minimum thresholds and measurable objectives in the basins to avoid undesirable results; and (3) a process for resolving conflicts between the GSAs. (*Id.*) Given the potential reduction of historical cross-boundary flow attributable to the planned operation with the Tulare Lake Subbasin Draft GSP, Westlands strongly recommends that we meet and confer at the earliest opportunity to determine whether an interbasin agreement can be reached. Our intention is to reach a cooperative resolution of these important issues that will enable coordinated sustainable management in our GSAs.

If you have any questions or concerns, regarding these comments, please contact Kiti Campbell by email at kcampbell@wwd.ca.gov or by phone at (559) 241-6226. Thank you for the opportunity to provide comments on the Tulare Lake Subbasin Draft GSP.

Sincerely,

Russ Freeman

Russ Freeman, P.E.
Deputy General Manager – Resources
Westlands Water District

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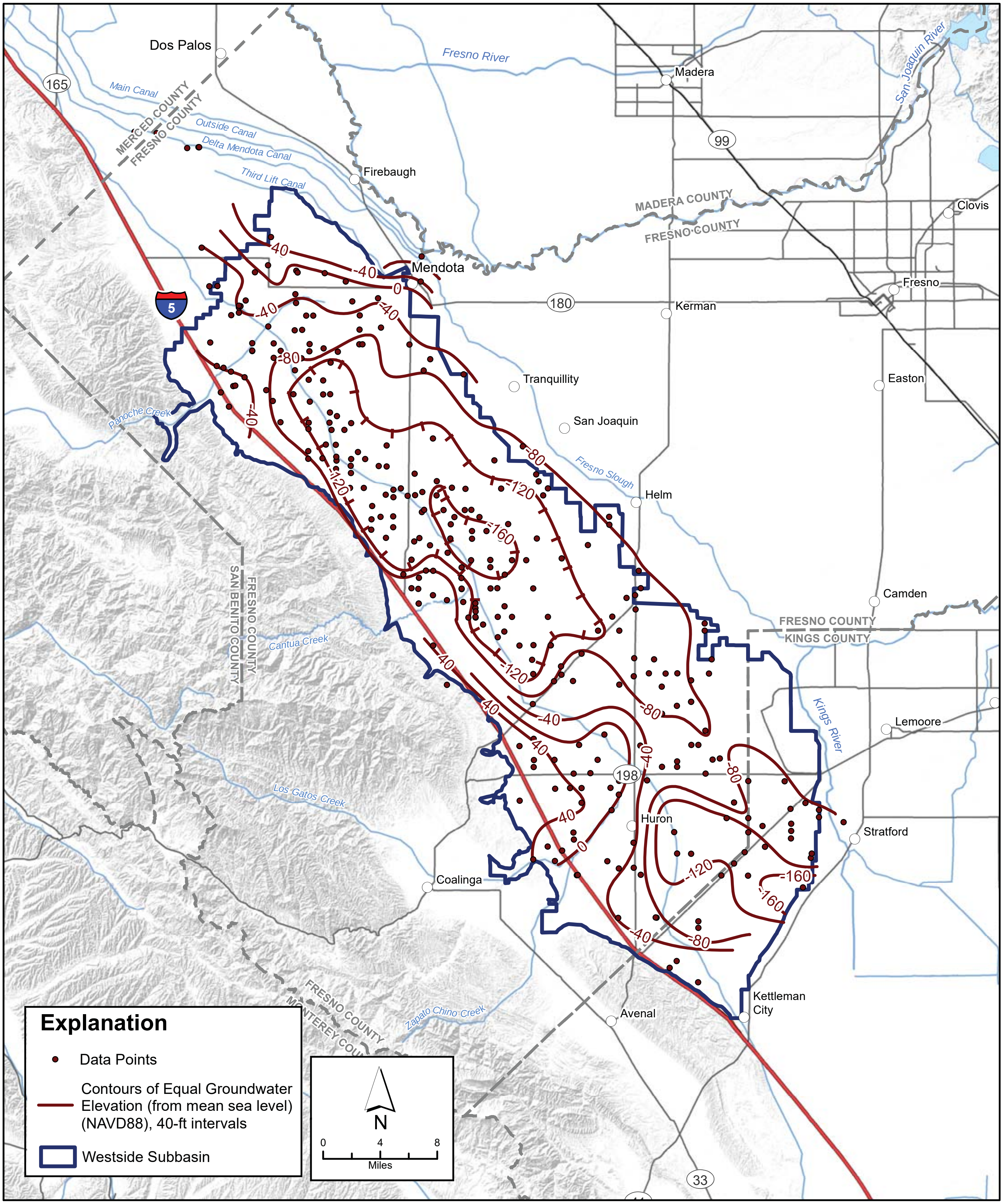
[1] See Appendix A for the complete text of the provisions of SGMA and the GSP Regulations (Code Regs., tit. 23, § 350, *et seq.*) cited herein.

Figure 4



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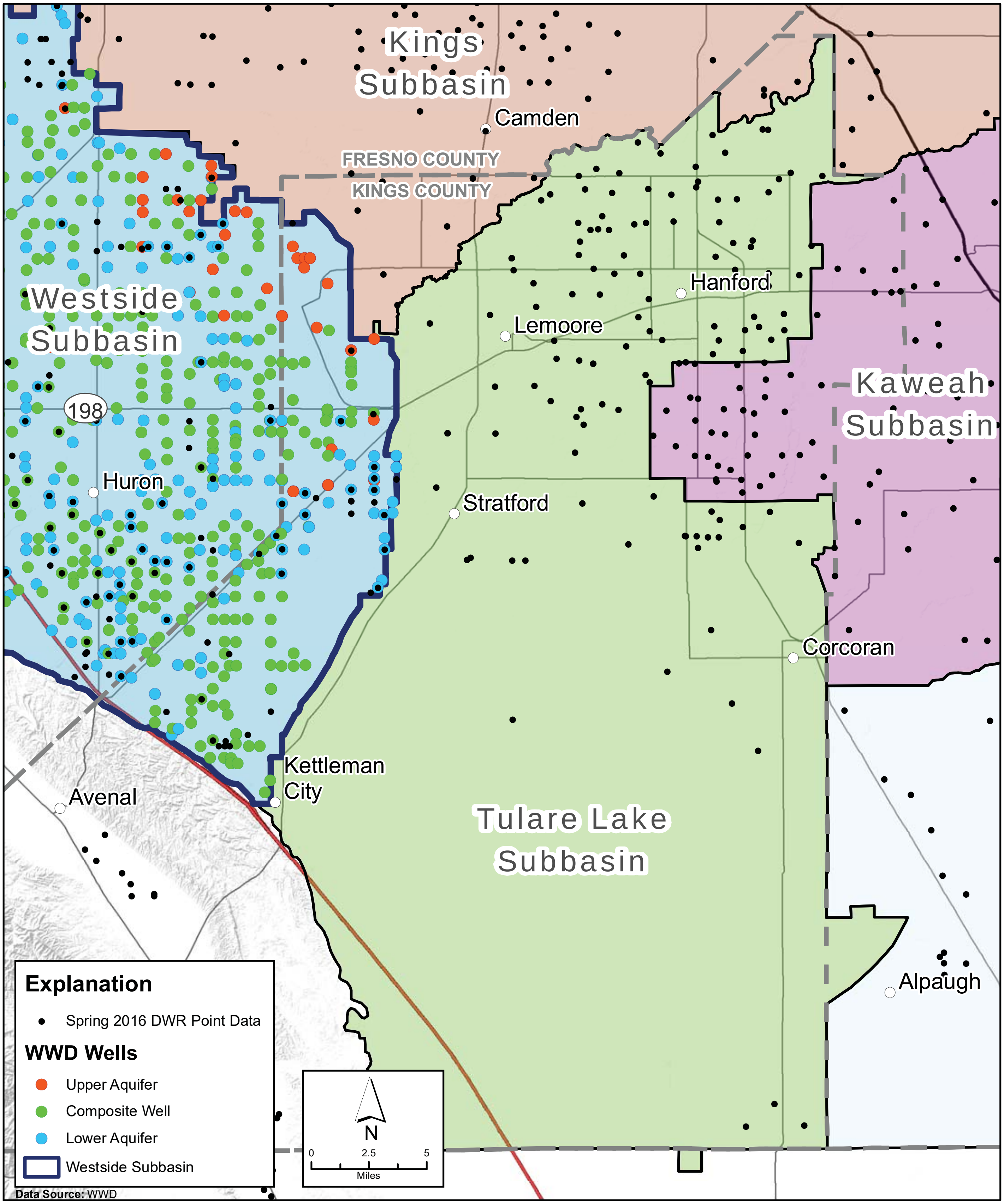
Consulting Engineers

FIGURE 2-40
Contours of Equal Groundwater Elevation
Lower Aquifer, Winter 2014/2015

Groundwater Sustainability Plan
Westside Subbasin



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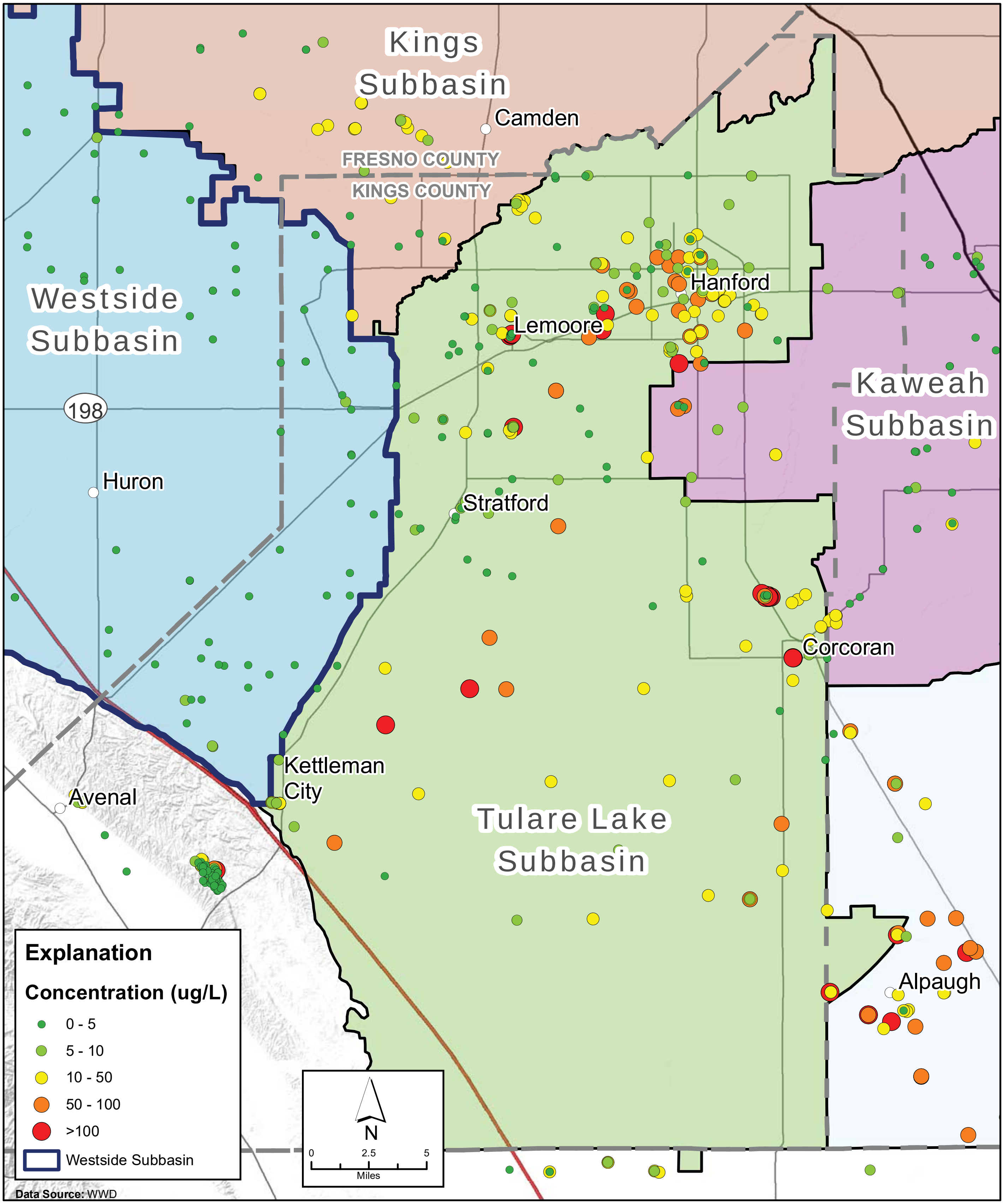
Luhdorff & Scalmanini Consulting Engineers

FIGURE 1

DWR Point Data Used to Develop Contours of the Unconfined Aquifer vs Westlands Well Construction

Groundwater Sustainability Plan
Westside Subbasin



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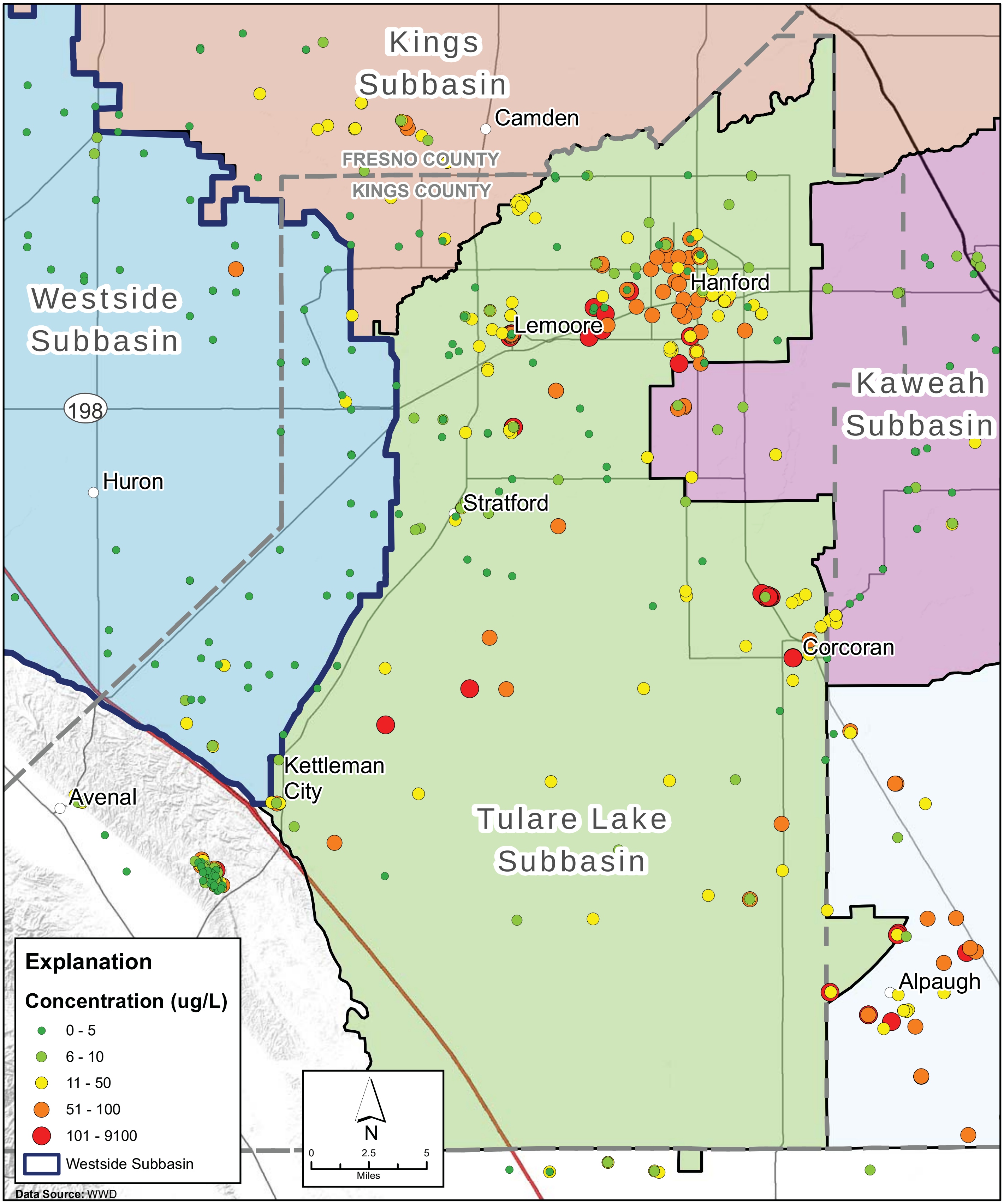
Luhdorff & Scalmanini
Consulting Engineers

FIGURE 2

Arsenic Concentration in Groundwater Wells Most Recent Reported Value

Groundwater Sustainability Plan
Westside Subbasin



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Luhdorff & Scalmanini
Consulting Engineers

FIGURE 3
Arsenic Concentration in Groundwater Wells Maximum Reported Value
Groundwater Sustainability Plan
Westside Subbasin

Westlands Water District
3130 N. Fresno Street, P.O. Box 6056, Fresno, California 93703-6056, (559) 224-1523, FAX (559) 241-6277

December 2, 2019

South Fork Kings Groundwater Sustainability Agency
Kings Subbasin
Basin Number 5-22.08
Transmitted via online submission at: comments@southforkkings.org

Subject: Tulare Lake Subbasin Draft Groundwater Sustainability Plan

Dear South Fork Kings GSA Group:

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Moreover, the implementation of SGMA and a GSP cannot be used to override the protections afforded common law water rights. Overlying and appropriative uses of groundwater within the Westside Subbasin are entitled to legal and equitable protection against infringement by an action that deprives them of their historical subsurface inflows. (*City of Lodi v. East Bay Municipal Utility District* (1936) 7 Cal.2d 316, 344 [protecting groundwater levels against lowering from another party's pumping]; *Trussell v. City of San Diego* (1959) 172 Cal.App.2d 593, 611 [enjoining a party for lowering water table by interrupting surface flow].)

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Sincerely,

Russ Freeman

Russ Freeman, P.E.
Deputy General Manager – Resources
Westlands Water District

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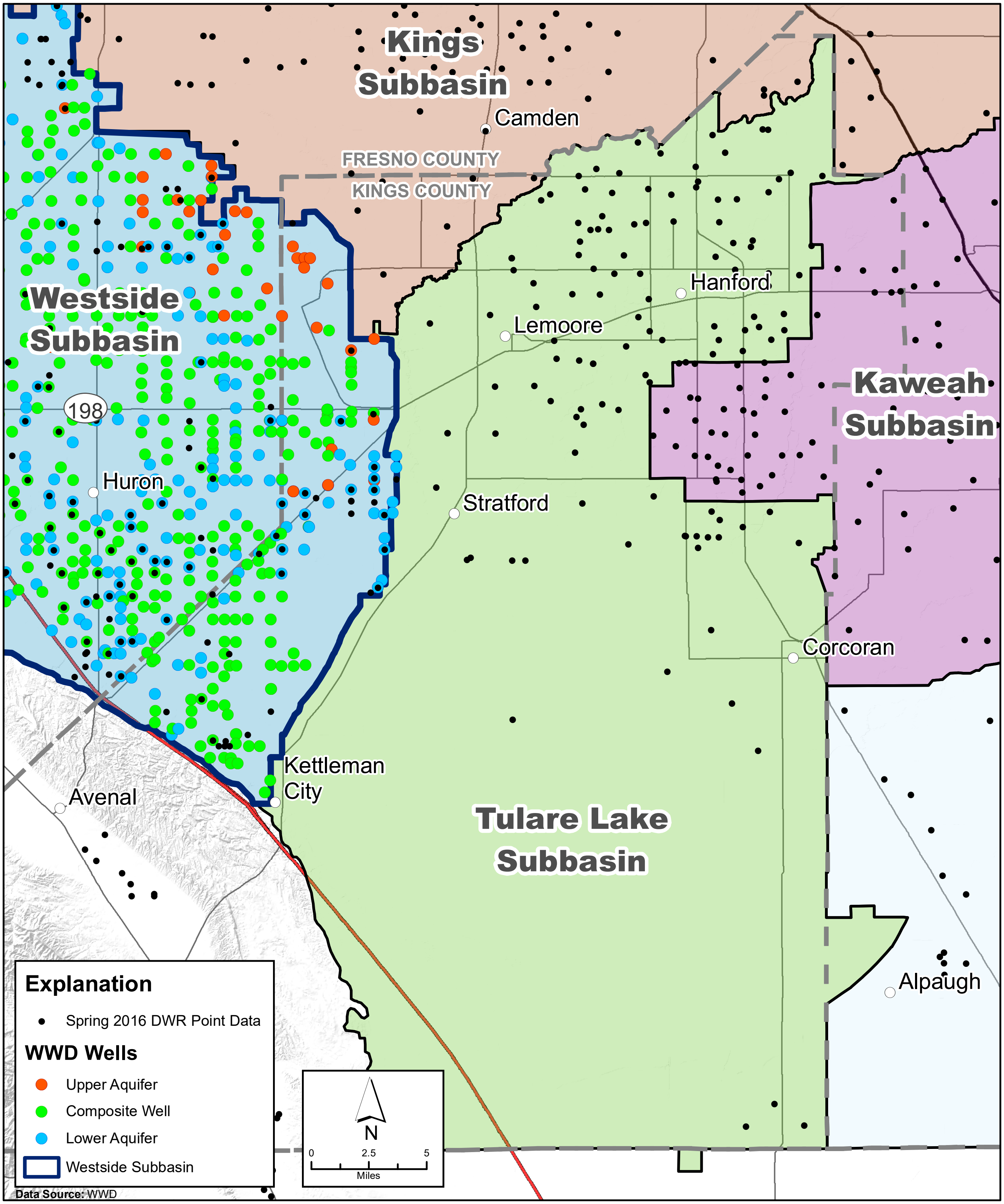

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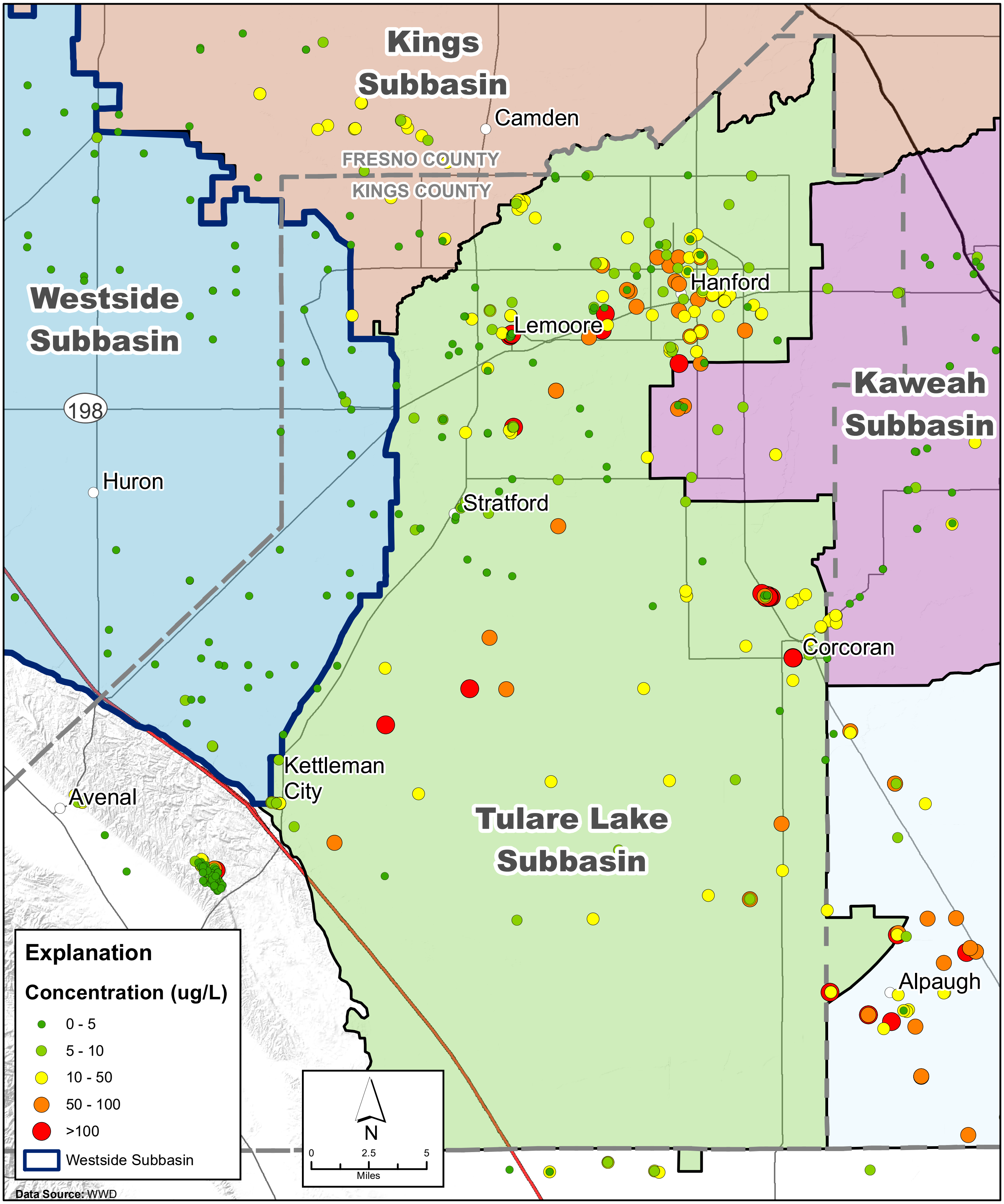
Luhdorff & Scalmanini
Consulting Engineers

FIGURE 1

DWR Point Data Used to Develop Contours of the Unconfined Aquifer vs Westlands Well Construction

Groundwater Sustainability Plan
Westside Subbasin



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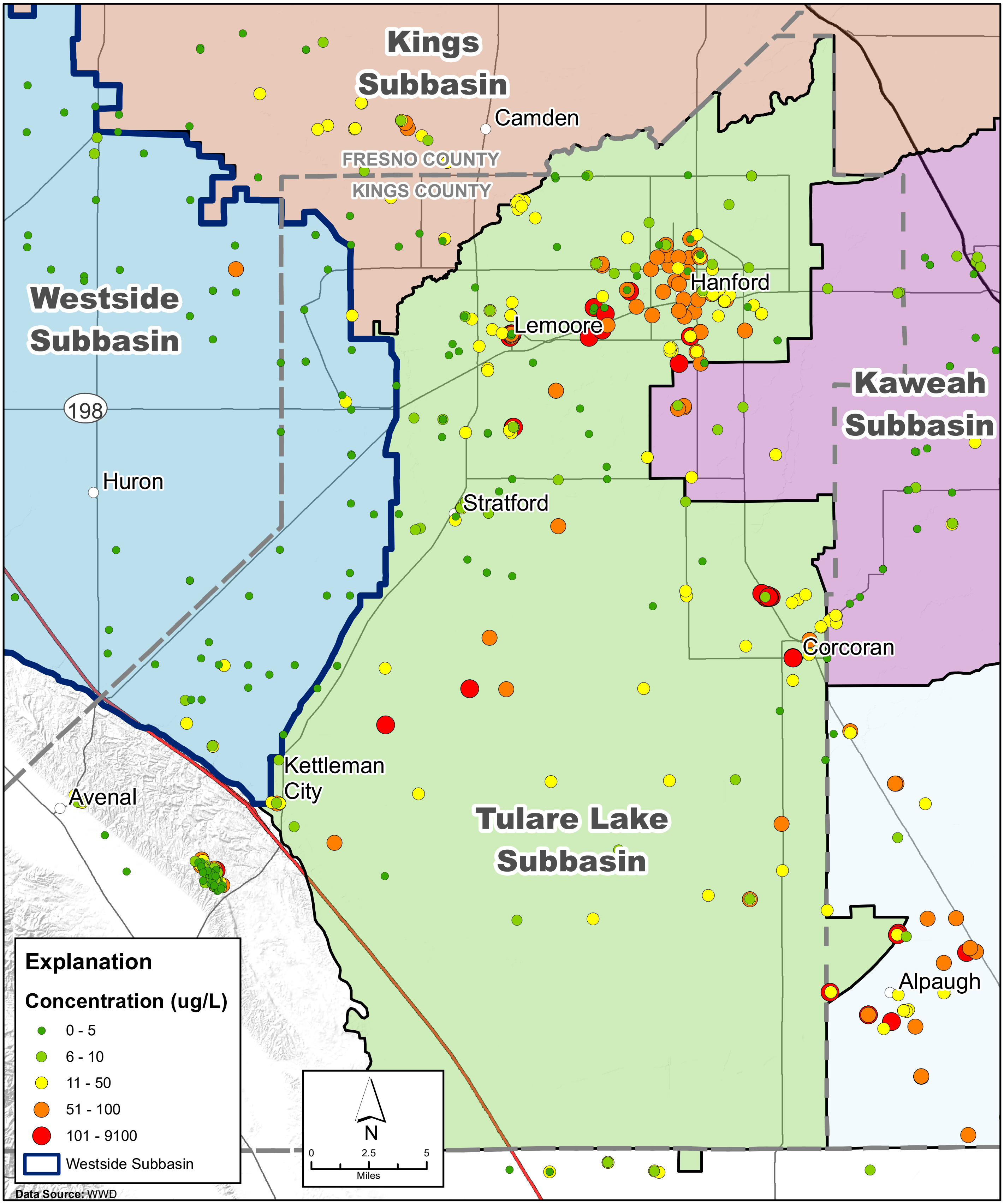
Luhdorff & Scalmanini
Consulting Engineers

FIGURE 2
Arsenic Concentration in Groundwater Wells
Most Recent Reported Value
Groundwater Sustainability Plan
Westside Subbasin



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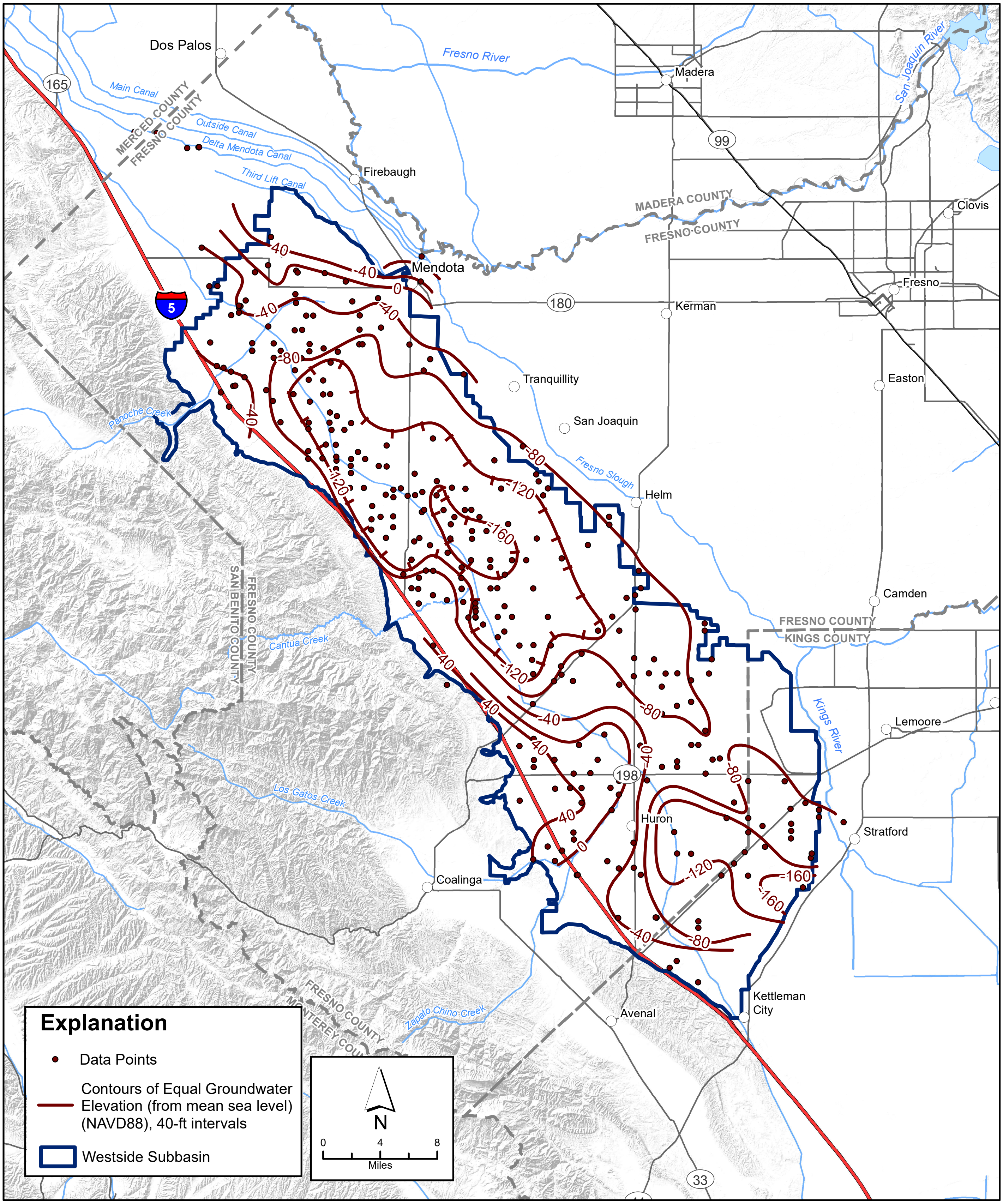
Luhdorff & Scalmanini
Consulting Engineers

FIGURE 3
Arsenic Concentration in Groundwater Wells
Maximum Reported Value

Groundwater Sustainability Plan
Westside Subbasin

Figure 4



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Luhdorff & Scalmanini
Consulting Engineers

FIGURE 2-40
Contours of Equal Groundwater Elevation Lower Aquifer, Winter 2014/2015

Groundwater Sustainability Plan Westside Subbasin

DOUG VERBOON
Supervisor
District 3

BOARD OF SUPERVISORS
Kings County Government Center
Hanford, CA 93230
Phone (559) 852-2366
Fax (559) 585-8047

December 2, 2019

Via Hand Delivery

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Re: Comments on the Tulare Lakes Subbasin Groundwater Sustainability Plan

Dear Messrs. and Madams:

I am writing as a duly elected Supervisor for the County of Kings (the "County") and not on behalf of the Board of Supervisors. I am also writing on behalf of the other signatories to this letter, who care as deeply as I do about the issues raised in the Tulare Lakes Subbasin Groundwater Sustainability Plan (the "GSP") that has been proposed and is subject to this public hearing. I am submitting my comments and proposed changes in writing so that they may be incorporated into the GSP prior to its submission to the State Department of Water Resources ("DWR") by January 31, 2020.

Procedural Defects

The Groundwater Sustainability Agencies addressed above ("GSAs") issued a notice on September 3, 2019 for the December 2, 2019 public hearing to comment on the GSP. The narrative part of the GSP – approximately 500 pages – was not issued until three days later, on September 6, 2019. The Appendix D to the GSP – the Water Modeling Report – and the Water Model itself were not released to the public for review until October 17th, 2019, a month and half later. Even though the County requested to, and did, coordinate with the GSAs on Wednesday, November 6th, the GSAs' delay in getting the complete GSP out for the full 90-day review period set out in Section 10728.4 of the Water Code impeded any serious review and feedback on the GSP.

Under Section 10728.4, you were required to provide the County – and, consequently, the public – with at least 90-days written notice of the public hearing at which you planned to adopt the GSP. When the GSAs were told their "notice" was inadequate because of the lengthy delay in issuing the entire GSP, the responses have typically been two-fold: First, they claim the statute is ambiguous as to what it meant by "notice" of the public hearing. In other words, the statute does not say with specificity that the GSP had to be released at the same time as the notice. The second response has been, "Well, you'll get to comment at the State level once the GSP is lodged with the State in January, so it shouldn't matter whether you had adequate opportunity to comment now." Neither of these responses excuses the GSAs from giving the County and its water users a full opportunity to review and comment on the draft GSP.

For public notice to be effective, it must satisfy the requirements of administrative due process. Federal and California courts have ruled over the last half-century that adequate notice must be "reasonably calculated, under all the circumstances, to apprise the interested parties of the pendency of the action and afford them an opportunity to present their objections . . . ." (*Mullane v. Cent. Hanover Bank & Trust Co.* (1950) 339 U.S. 306, 314.) Furthermore, the notice must "convey the required information" within "a reasonable time for those interested" to be heard "at a meaningful time and in a meaningful manner." (See *id;* see also *Mathews v. Eldridge* (1976) 424 U.S. 319, 333.) From these cases and others, it is clear that the September 3rd notice needed to include at least 90-days written notice of the date, time, and location of the public hearing, as well as service of the entire GSP.

Second, regardless of whether the County or anyone else has an opportunity to comment to the State on the final GSP submission, it was the legislature's intent that all interested parties have a meaningful opportunity to comment *before* it was submitted to the State. At least the legislature believed that the GSAs should be given the benefit of substantive input on the GSP before they submitted it. Unfortunately, the GSAs' delay in getting the draft GSP prepared in time for any substantive review, feedback and opportunity to revise the draft GSP in response to the public's comments has compromised the successful adoption and implementation of the GSP.

Project Vagueness

One of the most important parts, in my view, of a successful GSP is convincing the State that the GSAs are committed to creating a sustainable source of groundwater for the region and that they can be trusted to implement an approved GSP. I am concerned that the purported "projects" set out in the GSP are too vague and non-committal and, consequently, won't convince the State to defer to the GSAs when it comes to groundwater sustainability. If the State rejects the GSP as being too vague – or for any other reason – the Sustainable Groundwater Management Act ("SGMA") makes clear that the State will take over our groundwater management and local control of that essential water resource will be history.

I attended the October 22nd, 2019, Board of Supervisors meeting when Dennis Mills addressed the Board and stated openly that the GSAs had made a judgment decision to keep the description of the GSP's proposed projects vague; he said the GSAs didn't want to commit to any specific projects in case, on further review, it was determined a project was not viable. I was also part of the delegation from the County that met with the GSAs on November 6th to consult on the draft GSP. As we discussed whether the GSAs had considered certain elements of certain projects, such as CEQA requirements, Dennis stated that none of the GSA Boards had committed to any of the projects in the GSP. The fact that the GSA Boards haven't committed to doing anything (other than perhaps a groundwater monitoring program) as part of the GSP process is not going to instill confidence in the State and I'm concerned it could lead to the State's rejection of the GSP. The "projects" that have been proposed in the GSP should be firmed up as much as possible before the plan is submitted in January.

Land Fallowing Project

Finally, and most importantly, I am very concerned about the GSP proposal to fallow significant amounts of land within the County so as to cut agricultural demand for groundwater by at least 25 percent in 12 years. When we spoke with the GSAs during the November 6th consultation meeting, Jeof Wyrick confirmed that the GSP model incorporated an assumption that two percent (2%) of the land in the subbasin – not even spread out over the entire County – would be fallowed each year until we met the 2040 compliance deadline. If that is pursued, it would result in approximately 220,000 acres of agricultural land being fallowed. A good portion of that fallowed land would have to be permanent tree crops, which would result in the destruction of a significant amount of the value of the land (as they have to be irrigated every year) as well as the County's tax base.

During our consultation meeting, Jeof said that the water model consultants had erroneously incorporated the two percent (2%) assumption into the model, thus, overstating the amount of land to be fallowed as a result of GSP implementation. He said the GSP was going to be revised to incorporate an assumption of one percent (1%) per year fallowing that would result in "only approximately 100,000 acres" in the GSAs' boundaries being fallowed. I have no idea whether that has been done already or if it actually will be done before the GSP is submitted to the State. That amount of fallowed land is certainly less by half than what was previously projected, but when there are only approximately 420,000 acres of agricultural land within the GSAs' boundaries, that is an unacceptable level of fallowing both to the farmers whose land would be fallowed and, I believe, to the residents of the County. This 25 percent of total agricultural land fallowing is consistent with representations that the GSAs made publicly at the public outreach meeting in Lemoore, California, on October 15, 2019.

I was also surprised when Jeof said at our consultation meeting that implementation of the GSP was really "farmer versus farmer warfare" and that what was going to happen is "private adjudication of water rights in a public forum" (*i.e.*, before the GSAs). We all know what's going to happen when the few large farm and agricultural interests in the County go after the small, family-owned farms: The small farms are going to lose. I'm going to do everything in my power as a member of the Board of Supervisors to make sure that doesn't happen.

For this reason alone, the GSP should be revised to clarify that land fallowing in Kings County will be deployed only as a last resort after every other possible means of demand reduction and water recharge have been fully implemented and only at the minimal levels absolutely necessary to achieve sustainability. It is important to have survivability for the small farmer so that he can be competitive with the large corporate famers when it comes to ground water pumping. The Tulare Lake Subbasin will never achieve sustainability if the exported ground water from the subbasin to surrounding areas in the region is left unaddressed.

I am available to answer questions and discuss these concerns.

Sincerely,

Doug Verboon

DOUG VERBOON
Supervisor

Name: Jerome Warmerdam
Business: Warmerdam Walnut Co.

Name: [illegible]
Business: Casaca Vineyards

Name: Stanley Neves
Business: Golden Valley Farms

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Memorandum

To:	Tulare Lake Subbasin GSAs' Managers and Technical Team
From:	Trilby Barton, Public Outreach Coordinator, Provost & Pritchard
Subject:	Tulare Lake Subbasin GSAs' Groundwater Sustainability Plan Public Hearing Comments
Date:	December 2, 2019

December 2, 2019 Draft GSP Public Hearing Recap

The Tulare Lake Subbasin Groundwater Sustainability Agencies (GSAs) held a public hearing on the Draft Groundwater Sustainability Plan (GSP) on December 2, 2019. The hearing was held in the County of Kings Board of Supervisors' Chambers, and was called to order at 10:01 a.m. by Mid-Kings River GSA Manager, Dennis Mills.

Mr. Mills introduced himself and the other four GSA managers: Deanna Jackson with Tri-County Water Authority, Dale Melville with Southwest Kings GSA, Jeof Wyrick with El Rico GSA, and Charlotte Gallock with South Fork Kings GSA. Mr. Mills also introduced Trilby Barton, public outreach consultant with Provost & Pritchard Consultant Group. Mr. Mills and Ms. Barton explained the process for the public hearing, and Mr. Mills opened the floor for public comments.

Twenty stakeholders were in attendance, and one public comment was provided:

- **Bill Toss, Grower in Mid-Kings River GSA**
  "Reading through the plan that is available, the only thing that really struck out to me was the 25 percent set aside for reduction. That of course is most likely very damaging, and would not be sustainable economically here for Kings County or for us as growers. I hope that there is a change to that, and to make sure that is not the status quo."

Upon seeing that no other stakeholders wanted to provide oral comments, Mr. Mills thanked everyone for attending and closed the public hearing at 10:06 a.m.

Appendix D
2020 GSP Groundwater Model Report

Tulare Lake Subbasin Hydrologic Model for Groundwater Sustainability Plan Development: Calibration and Predictive Simulations

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Prepared for:
Mid-Kings River Groundwater Sustainability Agency
Hanford, California

January 8, 2020
Project FR18161220

Tulare Lake Subbasin Hydrologic Model for Groundwater Sustainability Plan Development: Calibration and Predictive Simulations

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Prepared for:

Mid-Kings River Groundwater Sustainability Agency
200 North Campus Drive
Hanford, California 93230

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.
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January 8, 2020
Project FR18161220

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STATE OF CALIFORNIA

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Abbreviations and Acronyms

%	percent
AF	acre-feet
AF/D	acre-feet per day
AF/M	acre-feet per month
AF/Y	acre-feet per year
bgs	below ground surface
CID	Corcoran Irrigation District
CT	Critical Thresholds
CVHM	United States Geological Survey Central Valley Hydrologic Model
CVP	Central Valley Project
DWR	California Department of Water Resources
ER GSA	El Rico Groundwater Sustainability Agency
ETc	Crop Evapotranspiration
ft/d	feet per day
ft^2/d	square feet per day
ft/m	feet per month
GHB	General Head Boundary
GSAs	groundwater sustainability agencies
GSP	Groundwater Sustainability Plan
GUI	Graphic User Interface
GWV	Environmental Simulations Inc.'s Groundwater Vistas™ Version 7 simulation code GUI
HCM	hydrogeologic conceptual model
K	hydraulic conductivity
f_c	coarse fraction
KCWD	Kings County Water District
K_h	horizontal hydraulic conductivity
K_v	vertical hydraulic conductivity
MKR GSA	Mid-Kings River Groundwater Sustainability Agency
MO	Monitoring Objective
MODFLOW	USGS Modular finite-difference family of numerical simulation codes
NRMS	Normalized root mean square error
MNW2	Version 2 of the MODFLOW multi-node well package
msl	mean sea level
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RMS	root mean square
SFK GSA	South Fork Kings Groundwater Sustainability Agency
SSR	sum of the square of the residuals
S_s	specific storage
S_y	specific yield
Subbasin	Tulare Lake Subbasin
SGMA	Sustainable Groundwater Management Act of 2014
SWK GSA	Southwest Kings Groundwater Sustainability Agency
SWP	State Water Project
TCWA GSA	Tri-County Water Authority Groundwater Sustainability Agency
TLSBHM	Tulare Lake Subbasin Hydrologic Model
USGS	United States Geological Survey
WD	Water District
Wood	Wood Environment & Infrastructure Solutions, Inc.

1.0 Introduction

Wood Environment & Infrastructure Solutions, Inc. (Wood), has been retained by the Mid-Kings River Groundwater Sustainability Agency to prepare and document a hydrologic flow model of the Tulare Lake Subbasin (Subbasin) to aid local agencies in compliance with the Sustainable Groundwater Management Act of 2014 (SGMA). The Subbasin is located primarily in Kings County, within the Tulare Lake Hydrologic Region of the San Joaquin Valley, California (Figure D1-1). This project is a cooperative effort among five Groundwater Sustainability Agencies (GSAs) within the Subbasin including: Mid-Kings River GSA (MKR GSA), El Rico GSA (ER GSA), South Fork Kings GSA (SFK GSA), Southwest Kings GSA (SWK GSA), and Tri-County Water Authority GSA (TCWA GSA). Although the Subbasin is the primary focus of this modeling study, the modeling effort encompasses portion of adjacent California Department of Water Resources (DWR)-defined groundwater subbasins including the Kings, Kaweah, Tule, Kern, and Westside subbasins.

1.1 Background

Included as part of SGMA was a requirement that the DWR identify groundwater basins and subbasins in conditions of critical overdraft. As defined by DWR, overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft can include land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels. DWR Bulletin 118 defines critical overdraft as "when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

Based on this criterion and a formal evaluation of groundwater basins across the state, the DWR found much of the Tulare Lake Hydrologic Region to be one of the most critically over-drafted regions of the state. The Subbasin sits at the lowest point of the Tulare Lake Hydrologic Region and receives both surface water inflows from several rivers and streams (including Kings River, Kaweah River, Tule River, and Deer Creek) and the State Water Project (SWP), but also irrigation return flows (tailwater) draining from irrigated lands. Nonetheless, in most years, especially during frequent drought cycles, agricultural water demand exceeds the surface water inflows, leading to the drilling of wells to develop the groundwater resources to fulfill that unmet demand. In fact, under recent historical conditions, the average annual demand on groundwater resources significantly exceeds the average existing recharge to the groundwater system, leading the DWR to declare the Subbasin critically over drafted, triggering the need to develop a Groundwater Sustainability Plan (GSP) by January 31, 2020, per SGMA requirements.

The Tulare Lake Subbasin Hydrologic Model (TLSBHM) developed for this project provides a quantitative tool for development and evaluation of alternative water management scenarios considered for the GSP. Additional model development and calibration will occur throughout the implementation of the GSP as additional data are collected.

1.2 Modeling Objectives

The objectives of the current modeling efforts were to:

1. Prepare a three-dimensional numerical surface water/groundwater flow model of the Subbasin and portions of adjoining subbasins.

2. Calibrate the surface water/groundwater flow model for the period 1990-2016, with a focus on the "normal hydrology" period 1998 through 2010, for initial calibration using available groundwater elevation observations and stream flow observations.
3. Provide a Baseline Forecast from 2017-2070 assuming continued recent land use and continued 1998 through 2010 "normal hydrology" conditions modified to account for climate change. This forecast was utilized to establish Critical Thresholds (CT) and Monitoring Objectives (MO) throughout the Subbasin.
4. Provide a Projects Forecast from 2017-2070 assuming continued recent land use, continued 1998 through 2010 "normal hydrology" conditions as modified to account for climate change, and additional Surface Water Supply and Aquifer Recharge resulting from several projects assumed to be implemented throughout the Subbasin and adjoining subbasins.
5. Compare the Baseline and Projects forecasts and estimate what additional projects and management actions (such as land fallowing) may be required to obtain sustainability by 2040 and thereafter.

2.0 Hydrogeologic Conceptual Model

A hydrogeologic conceptual model (HCM) is a simplified description of the groundwater flow system, frequently in the form of a block diagram or cross-section with an accompanying narrative description of the function and interaction of the various components that comprise the hydrogeologic system (Anderson et al., 2015). The nature of the HCM determines the dimensions of the numerical model and the design of the grid, the distribution of the hydrogeologic properties, and the definition and distribution (over space and time) of external and internal stresses and boundary conditions. The purpose of the HCM is to establish an initial understanding of the groundwater system and organize the associated data and information so that the system can be analyzed more effectively.

Figure D2-1 presents block diagrams that schematically represents key aspects of the HCM for the TLSBHM under both pre-development and current conditions. Details related to this HCM for the project include: (1) description of the model domain, (2) delineation of the hydrostratigraphic units within the model domain, (3) definition of sources and sinks and estimation of the water budget, and (4) narrative description of the flow system. Each of these items are discussed in the following subsections.

2.1 Basin Location and Study Area

The Subbasin is located primarily in Kings County in the Tulare Lake Hydrologic Region of the San Joaquin Valley, California (Figure D2-2). The Subbasin covers an area of approximately 535,869 acres or about 837 square miles (DWR, 2016b). The Subbasin in bounded by the Kings Subbasin to the north, the Kaweah Subbasin to the northeast, the Tule Subbasin to the southeast, the Kern Subbasin to the south, the Kettleman Plain Subbasin to the southwest, and the Westside Subbasin to the northwest.

As shown on the figure, the study area extends beyond the official Subbasin boundaries (as delineated by the DWR) from 3 to 6 miles into adjacent subbasins to better evaluate interactions with groundwater in those adjacent areas. The study area includes approximately 151,880 acres (~237.3 square miles) of the Kaweah Subbasin, approximately 119,360 acres (~186.5 square miles) of the Kings Subbasin, approximately 126,600 acres (~197.8 square miles) of the Tule Subbasin, approximately 81,760 acres (~127.8 square miles) of the Westside Subbasin, and approximately 78,000 acres (~121.8 square miles) of the Kern Subbasin.

The vertical extent of the study area is the freshwater hydrogeologic system, based on the United States Geological Survey (USGS) Central Valley Hydrologic Model (CVHM; Faunt et al., 2009), and modified to be consistent with the findings of Tulare Lake Bed de-designation studies (RWQCB, 2017). The depth zones that comprise the freshwater hydrogeologic system extend to a depth of about 3,000 feet below ground surface (bgs), but not reaching down into the deeper confined saline groundwater below.

2.2 Topography

The Subbasin and surrounding area is generally located in the lowest portion of the San Joaquin Valley (Figure D2-3). Ground surface gently rises to the northeast from about 180 feet above mean sea level (msl) at the Tulare Lake bottom to about 300 feet above msl near Kingsburg. To the southwest, ground surface rises rapidly from the Tulare Lake bottom to about 500 feet near the Kettleman Hills. To the south, ground surface gently rises from the lake bottom to about 220 above msl at the Kern County line.

2.3 Geology

The Subbasin is located in the south-central portion of the greater San Joaquin Valley. The valley was formed generally as a structural trough subsiding between two uplifts: the tectonically driven tilted block of the Sierra Nevada and the thrust belts of the Coast Ranges created by crustal shortening east of the San Andreas fault.

Episodic intrusion of the Pacific Ocean through land gaps along the northern and southern boundaries of the San Joaquin Valley occurred during Miocene and Pliocene times, allowing deposition of marine sediments to accumulate in the subsiding shallow sea environment of the San Joaquin basin. These deposits were subjected to deformation as the Sierra Nevada rose on the east and Coastal Range rose to the west and the valley trough subsided. The marine deposits are exposed in the west-side thrust belts, which typically reach elevations of 2,000 feet or less. Beneath the San Joaquin Valley, the top of the marine deposits are typically 3,000 feet or more below the valley floor, rising on the southeastern portion of the valley to cap the igneous rocks of the uplifted Sierra foothills.

As the land gaps closed in the mid-Pliocene, the continued uplift of the Sierra Nevada and Coast Ranges shed continental deposits to the San Joaquin Valley. These continental deposits, typically assigned to the Plio-Pleistocene Tulare Formation, have filled the valley trough in places with more than 3,000 feet of sediments. Where Pleistocene geologic features periodically cut off the route of major rivers and tributaries to the sea, wide spread and sometimes extreme thicknesses of lacustrine sediments were deposited. Significant examples of these lacustrine deposits are the Tulare Lake Bed clays, the Buena Vista clays, and the Corcoran Clay (sometimes referred to as the E-Clay or modified E-Clay).

2.3.1 Tulare Formation – Continental Deposits

Various investigators in the San Joaquin Valley have assigned ages and names to what they have identified as formations in their respective study areas. The Plio-Pleistocene Tulare Formation, which has its type section on the eastern slope of the North Dome of the Kettleman Hills (Woodring et al., 1940), has been correlated stratigraphically with other valley formations such as the Laguna Formation in the northeast portion of the valley (Woodring et al., 1940) and Kern River formations in the southeast portion of the valley (Bartow, 1991).
In the Subbasin, the primary stratigraphic units containing usable groundwater include the Tulare Formation, older alluvium, and younger alluvium. The Tulare Formation is by far the thickest of these three. The bottom of the Tulare Formation has been defined by Woodring et al. (1940) as occurring just above the Mya interval of the primarily marine San Joaquin Formation, over which it conformably lies on

the North Dome, just northwest of the Tulare Lake bed. The Tulare Formation/San Joaquin Formation contact dips steeply eastward from the Kettleman Hills, lying more than 3,000 feet beneath the trough in the Tulare Lake area (Croft and Gordon, 1968). Woodring et al. (1940) have defined the Tulare as the uppermost continental deposits deformed by the folding associated with the Kettleman Hills. However, as noted by Davis et al. (1959), the upper contact of the Tulare Formation with younger continental deposits (older and younger alluvium) is not easily discerned because "at many places along the valley border the dips increase westward so gradually that only a rough separation can be effected between the valley alluvium and the Tulare Formation. Separation of the alluvium from the Tulare Formation beneath the valley is virtually impossible because of their lithologic similarity."

2.3.2 Lacustrine, Marsh, and Flood Deposits

In the Subbasin, Croft & Gordon (1968) identified a number of lacustrine clays in the subsurface that they correlated to lacustrine clays identified by Woodring et al. (1940) in the Tulare Formation in Kettleman Hills. Croft & Gordon (1968) identified these in geophysical logs and named them the A- through F-Clays, with the E-Clay being equivalent to the diatomaceous Corcoran Clay. Though the A- through D-Clays may be important locally in restricting downward movement of groundwater, by far the most important is the EC-Clay, which has been identified as a spatially extensive (about 3,500 square miles, Croft, 1972) and thick clay that separates regionally confined and unconfined groundwater zones in the southern San Joaquin Valley (Figure D2-4). The E-Clay has been age-dated as mid-Pleistocene and is considered part of the Tulare Formation (Croft & Gordon, 1968). Beneath the Tulare Lake bed, there is a thick, nearly homogeneous deposit of lacustrine clays from ground surface to the San Joaquin Formation, including the E-Clay. However, the E-Clay extends far beyond the shoreline of Tulare Lake (Croft, 1972).

2.3.3 Older and Younger Alluvium

The other continental deposits that have been identified in published reports as containing groundwater are the older and younger alluvium (Croft & Gordon, 1968). In the Tulare Lake area, these deposits are primarily Sierran in origin, being deposited by the major stream channels emanating from the Sierra Nevada. Some sediments may have Coast Range origin, but the axis of Tulare Lake bed is close to the Kettleman Hills, which leaves little room for Coast Range sediment deposition on the west side. The older alluvium is widespread throughout the San Joaquin Valley and in other areas represents deposition from both the Coast Ranges on the west side of the valley and the Sierra on the east. It typically overlies the Tulare Formation, though as mentioned earlier, there is no way to differentiate between the two in the subsurface. It is considered Pleistocene to Recent in age. Most of the groundwater withdrawn from the Subbasin comes from the older alluvium/Tulare Formation complex.

The younger alluvium is generally thinner than the older alluvium and is present in current stream channels and as a veneer over the older alluvium as the deposits stretch to the west. The younger alluvium is primarily arkosic and contains groundwater only ephemerally or where underlying clays tend to restrict downward movement of recharging water. It is considered of Recent age.

2.3.4 Tulare Lake Bed

The Tulare Lake bed is the prominent sedimentary feature in the Subbasin. It was a natural lake bed fed by streams from the east and south. Its elongate shape to the northwest reflects the subsidence of the valley trough east of the Kettleman Hills. Geologic cross sections through the Tulare Lake bed (Croft, 1972; Croft & Gordon, 1968; Davis et al., 1959) illustrate the thick and continuous nature of the clay deposits beneath the lake bed (Figure D2-5).

Cross-section A-A′ (Plate 4, Croft & Gordon, 1968) indicates uninterrupted lacustrine deposits from the surface to at least 2,200 feet bgs beneath the central portion of the lake. Cross-sections B-B′ and C-C′ (Plates 5 and 6, Croft & Gordon, 1968) illustrate the interfingering of the coarser sediments and the thinner clay zones along the periphery of the lake with the thick clay deposits beneath the lake. Though Croft & Gordon (1968) did not carry the E-Clay through the lake deposits, Davis et al. (1959, Plate 10, Section G-G′, Diatomaceous Clay) and Croft (1972, Plate 3, Section G-G′, E-Clay) felt they had enough evidence to map it beneath the lake. Davis et al. (1959) show it as being warped downward along the axis of the lake with a maximum thickness of 150 to 175 feet. These cross sections indicate the Tulare Lake deposits form a clay "plug" across the center of the San Joaquin Valley that may be 15 miles wide, 8 miles long, and over ½ mile deep at its maximum dimensions.

2.4 Hydrogeology

The hydrogeology of the Subbasin is complex in that the only physical boundaries are the Kings River and the Kettleman Hills on the southwest edge of the Subbasin. The remaining edges of the Subbasin are based on political and water management areas. The Corcoran Clay under lies most of the Subbasin, and essentially subdivides the Subbasin into two aquifer systems: an unconfined to semi-confined aquifer system above the Corcoran Clay and a confined aquifer system below the Corcoran Clay.

The Kings River appears to be a natural groundwater divide separating the Subbasin and Kings Subbasin. The Kings River is also the primary source of surface water diversion into the Subbasin. As such, the Kings River hydrologic year has a significant influence on groundwater levels in the Subbasin. In the unconfined aquifer, groundwater outflow from the Kings Subbasin into the Subbasin is primarily due to leakage from the Kings River. However, this groundwater predominantly flows along the course of the Kings River and therefore does not remain exclusive to the Subbasin. In the confined aquifer, groundwater outflow from the Kings Subbasin into the Subbasin is also due to leakage from the Kings River in the northeast portion of the Subbasin where the Corcoran Clay is not present. This groundwater has a strong downward vertical component which creates steep southward hydraulic gradients beneath the Corcoran Clay. This groundwater tends to remain resident in the Subbasin confined aquifer.

The groundwater flow system for these two aquifer systems is summarized in the following subsections.

2.4.1 Unconfined Aquifer

The unconfined and semi-confined upper portion of the regional fresh-water aquifer are found above the Corcoran Clay. This upper portion of the regional freshwater aquifer is generally comprised of coarse- to medium-grained sediments (i.e., sand and gravel) with silt and clay interbeds.

Groundwater beneath the Subbasin and surrounding areas is typically found between depths from 30 to 250 feet bgs, depending on location and time. A review was conducted of available DWR groundwater elevation contour maps of the unconfined aquifer from 1960 to 2010 and briefly described below (DWR, 2018). The maps show a persistent, large data gap beneath the Tulare Lake bed where there are few observations of groundwater levels due to a lack of wells.

- In 1990, a dry hydrologic year on the Kings River, groundwater was at an elevation of about 260 feet msl near Kingsburg, decreasing toward the Tulare Lake bottom (Figure D2-6a). Groundwater elevations beneath Hanford were about 170 feet msl, and about 140 feet msl near Corcoran. There were several cones of depression in the water table near Hanford, north and south of Corcoran, and around Alpaugh. The Kings River appears to be a natural groundwater divide. In general, the potentiometric surface map indicates that groundwater was flowing into the Subbasin from the Kern, Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin.

- In 1995, a wet hydrologic year on the Kings River, groundwater was at an elevation of about 260 feet msl near Kingsburg, decreasing toward the Tulare Lake bottom (Figure D2-6a). Groundwater elevations beneath Hanford were about 150 feet msl and about 110 feet msl near Corcoran. The cone of depression in the water table between Hanford and Corcoran has merged into a single large depression. The Kings River continues to be a natural groundwater divide. In general, the potentiometric surface map indicates that groundwater was flowing into the Subbasin from the Kern, Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin.

- In 2000, an average hydrologic year on the Kings River, groundwater was at an elevation of about 250 feet msl near Kingsburg, decreasing toward the Tulare Lake bottom (Figure D2-6a). Groundwater elevations beneath Hanford were about 150 feet msl and less than 100 feet msl near Corcoran. The Kings River continues to be a natural groundwater divide. In general, the potentiometric surface map indicates that groundwater was flowing into the Subbasin from the Kings, Kaweah, and presumably the Kern subbasins and out of the Subbasin to the Tule and Westside subbasins.

- In 2005, a wet hydrologic year on the Kings River, groundwater was at an elevation of about 260 feet msl near Kingsburg, decreasing toward the Tulare Lake bottom. Groundwater elevations beneath Hanford were about 140 feet msl, about 10 feet lower than in 2000 (Figure D2-6b). Throughout the Subbasin, groundwater levels were about 10 or more feet lower than in 2000. The Kings River continues to be a natural groundwater divide. In general, the potentiometric surface map indicates that groundwater was flowing into the Subbasin from the Kings, Kaweah, and Tule subbasins and out of the Subbasin to the Westside Subbasin.

- In 2010, an average hydrologic year on the Kings River, groundwater was at an elevation of about 250 feet msl near Kingsburg, decreasing toward the Tulare Lake bottom. Groundwater elevations beneath Hanford were about 130 feet msl and less than 10 feet msl near Corcoran (Figure D2-6b). Throughout the Subbasin, groundwater levels were about 10 or more feet lower than in 2005. The Kings River continues to be a natural groundwater divide. In general, the potentiometric surface map indicates that groundwater was flowing into the Subbasin from the Kings, Kaweah, Tule, and presumably the Kern subbasins and out of the Subbasin to the Westside Subbasin.

- In 2016, a dry hydrologic year on the Kings River, groundwater was at an elevation of about 230 feet msl near Kingsburg, decreasing toward the Tulare Lake bottom. In the Hanford area, groundwater levels were about 110 feet msl, about 20 feet lower than in 2010. Cones of depression in the water table west, north, and southeast of Corcoran are still present and becoming deeper (-40 feet msl). The Kings River no longer is a natural groundwater divide. In general, the potentiometric surface map indicates that groundwater was flowing into the Subbasin from the Kings and Kaweah subbasins and out of the Subbasin to the Kern, Tule, and Westside subbasins.

2.4.2 Confined Aquifer

The sediments below the Corcoran Clay comprise the lower confined portion of the regional fresh-water aquifer. This lower portion of the regional freshwater aquifer is generally comprised of clay, silt, sandy silt and clay, sand, silty/clayey sand, gravel, and sandy, silty and clayey gravel (Page, 1983).

There are few available maps showing groundwater elevations in the confined aquifer beneath the Subbasin and surrounding areas (Harder, 2017). In fall 1998 and spring 1999, a wet hydrologic year on the Kings River, groundwater was at an elevation of about 100 feet msl near Corcoran, decreasing to the south towards an apparent pumping center near Alpaugh. In general, the potentiometric surface map (Harder, 2017) indicates that groundwater was flowing into the Subbasin from the Kaweah Subbasin and out of the Subbasin to the Tule Subbasin.

In fall 2010, an average hydrologic year on the Kings River, groundwater was at an elevation of about -50 feet msl near Corcoran, decreasing towards an apparent pumping center southwest of Corcoran. In general, groundwater was flowing into the Subbasin from the Kaweah and Tule subbasins.

2.4.3 Subsidence

Land subsidence due to groundwater drawdown associated with heavy groundwater pumping has affected large areas of the San Joaquin Valley since the 1920s, including the Subbasin (AFW, 2018). Between 1926 and 1970, there was approximately 4 feet of cumulative subsidence near Corcoran, 4 to 6 feet of subsidence near Hanford, and as much as 12 feet of subsidence near Pixley (Figure D2-7). Following the completion of the SWP and Central Valley Project (CVP), surface water became readily available and groundwater extraction was reduced and subsidence due to groundwater drawdown was temporarily slowed or stopped.

In the past 10 to 25 years, groundwater pumping has once again been increasing, with associated resumption and acceleration of groundwater drawdown and associated subsidence. The subsidence was exacerbated during a moderate to severe drought from 2007 through 2009, and a severe to exceptional drought from 2012 through 2016. A Jet Propulsion Laboratory study of subsidence between June 2007 and December 2010 (JPL, 2012) indicated subsidence rates were as high as 8.5 inches per year in the vicinity of Corcoran (Figure D2-7). A more recent study by Jet Propulsion Laboratory (JPL, 2017) indicted that subsidence rates accelerated in some areas during the recent drought, with annual subsidence rates of 1 to 1.5 feet near Corcoran in 2015-2016 (Figure D2-8). Groundwater pumping and drawdown, and consequent subsidence, are anticipated to continue into the future at least until sustainable groundwater pumping is achieved. Due to inelastic soil behavior, subsidence is mostly irreversible even if groundwater pumping decreases and groundwater level recovers.

2.5 Surface Water Occurrence

Historically, river runoff from the Sierra Nevada collected in terminal lakes on the basin floor in the San Joaquin Basin creating vast regions of Tule marshes and woodland wetlands (Figure D2-9a). Tulare Lake, the largest terminal lake, received runoff from four major rivers, the South Fork Kings, Kaweah, Tule, and Kern Rivers (ECORP, 2007). These rivers formed broad deltaic and alluvial fans as they emerged from the Sierra foothills forming multiple channels and sloughs that shifted periodically especially during flooding events (ECORP, 2007). The natural hydrology of the Tulare Lake Basin has been extensively altered over the last 130 years for flood control, irrigation, land reclamation, and water conservation. Concerns about water supplies led to the construction of large dams and reservoirs on each of the four major rivers and channelization of the rivers for flood control and water banking have further modified the Tulare Basins hydrography (ECORP, 2007). The surface water sources that supply the Subbasin are primarily from man-made canals and diverted rivers.

2.5.1 Tulare Lake

Tulare Lake was the largest freshwater lake west of the Mississippi River estimated to encompass 790 square miles at its highest overflow lever of 216 feet in 1862 and 1868 (Figure D2-9a) (ECORP, 2007). The lake was very shallow and had no natural outlet when the water levels was below 207 feet (ECORP, 2007). However, at 207 feet, the water could flow north into the San Joaquin River Basin. Increased diversion of water from the rivers and tributaries that previously flowed into Tulare Lake resulted in the lake drying up in the late 1800s except when occasionally flooded.

2.5.2 Kings River

The Kings River is a 133-mile-long river, the largest river draining the southern Sierra Nevada. The Kings River has three main tributaries, the North Fork, Middle Fork and South Fork, with the North and Middle forks flowing north to the San Joaquin River and the South Fork flowing south to the old Tulare Lake bed. Significant water development structures including the Pine Flat Dam were constructed in the last century to control and modified the rivers flow. The Kings River lies along the boundary between the Subbasin and Kings Subbasin, a portion of the boundary between the Subbasin and Westside Subbasin, and a portion of the boundary between the Subbasin and Kaweah Subbasin (Figure D2-9b). Leakage of water from the Kings River and distributary canals provides significant groundwater recharge in the Kings, Kaweah, Westside, and Tulare Lake subbasins, resulting in complex groundwater flow patterns between the subbasins.

2.5.3 Kaweah River

The Kaweah River is a 100-mile-long river in Tulare County and drains the southern Sierra Nevada (Figure D2-9a). The Kaweah River begins as four forks in Sequoia National Park, then flows in a southwest direction to Lake Kaweah – the only major reservoir on the river – and into the San Joaquin Valley, where it diverges into multiple channels across an alluvial plain around Visalia. The lower course of the river and its many distributaries – including the St. John's River and Mill Creek – form the Kaweah Delta, a productive agricultural region in the Kaweah Subbasin. Before the diversion of its waters for irrigation, the river flowed into Tulare Lake.

2.5.4 Tule River

The Tule River is a 71-mile-long river in Tulare County and drains the southern Sierra Nevada (Figure D2-8c). The Tule River has three main tributaries, the North Fork, Middle Fork and South Fork, that in the past flowed into Tulare Lake. Currently, water in the Tule River now flows into Lake Success, a reservoir constructed in 1961 near Porterville, California, and only in times of above normal precipitation or snow melt is water released onto the dry Tulare Lake bed.

2.5.5 Canals and Pipelines

There are 34 rivers, streams, canals, and diversions entering and within the Subbasin that deliver surface water to the Subbasin (Figures D2-9b-d).

Water is imported into the Subbasin using facilities of the SWP located west of the Subbasin and the CVP. Water can also be exported out of the Subbasin using the SWP and CVP facilities in combination with facilities developed by local water districts (ECORP, 2007). The CVP imports San Joaquin River water into the Subbasin through the Friant-Kern Canal and Delta water through the Delta-Mendota and San Luis Canals.

The Friant-Kern Canal is operated and maintained by the Friant Water Authority and is used to convey water from the San Joaquin River to Kern County. The canal originates at the Friant Dam, which is operated by the United States Bureau of Reclamation. The Friant-Kern Canal flows southeasterly along the western flank of the Sierra Nevada foothills through Fresno, Tulare, and Kern counties. The Friant-Kern Canal has a capacity of approximately 5,300 cubic feet per second or about 10,510 acre-feet per day (AF/D), which decreases to about 2,500 cubic feet per second or about 4,960 AF/D as demand decreases toward its end in the Kern River, near Bakersfield, California (AFW, 2018).

2.6 Climate

The climate in the Subbasin is semi-arid characterized by hot, dry summers and cool moist winters and is classified as Mediterranean steppe climate (Köppen climate classification). The wet season occurs from November through March with 80 percent (%) of precipitation falling during this time frame (ECORP, 2007). The valley floor often receives little to no rainfall in the summer months. Precipitation typically occurs from storms that move in from the northwest off the Pacific Ocean and occasionally storms from the southwest that contain warm sub-tropical moisture can produce heavy rains especially during El Nino episodes.

Historical annual precipitation at the Hanford weather Station from 1899 to 2017 (Hanford, 2017) has ranged from a low of 3.37 inches in 1947 to a maximum of 15.57 inches in 1983 (Table D2-1). Monthly precipitation in the area ranges between 0 and 6.69 inches per month and averages about 8.28 inches per year. This results in an estimated 2 inches per year of infiltration into the unconfined aquifer. Figure D2-10 provides a chart of the annual precipitation at the Hanford station from 1940 to 2017.

2.7 Land Use

Land use in the Subbasin and surrounding areas is predominately agricultural with smaller urban areas. Land use was evaluated using DWR land use maps for 1990 through 2006 (DWR, 2016a) and annual CropScape maps from 2006 through 2016 (USDA, 2016). These maps were provided in Geographic Information System formats, allowing for aggregation of similar land uses (i.e., crop types) to simplify analysis (Figure D2-11a-d). A total of 33 land uses were identified and evaluated (Table D2-2). Of these land uses, 27 were assumed to be irrigated, while 6 land uses (open water, forests, etc.) were assumed to only receive precipitation.

The Subbasin covers an area of approximately 535,869 acres or about 837 square miles (DWR 2016b). Between 1990 and 2016, the Subbasin had an average of approximately 310,800 acres of crops, 7,110 acres of riparian or open water, 137,110 acres of fallow or non-developed land, and 22,130 acres of urban and industrial development (Table D2-2, Appendix D1). The mix of crops grown and fallow lands has changed over time as agricultural practices changed in response to agricultural markets and drought conditions. A chart of area by land use shows that fallow acreage increased significantly during the 2010-2016 drought, while riparian, cotton, and pasture acreage all decreased during the drought (Figure D2-12). Cotton showed the most change with a decrease of over 85,000 acres between 1995 and 2016. The data also show that the was an overall increase in permanent crops over time, with increases in young and mature almonds from approximately 7,680 acres in 1995 to 42,300 acres in 2016. The total acreage of pistachios also increased from 4,700 to 26,900 acres between 1995 and 2016; however, there was a loss of 4,220 acres of mature pistachios with a concurrent increase of 26,400 acres of young pistachios.

Annualized tables and charts of land use for the Subbasin GSAs and the portions of the Westside, Kings, Kaweah, Tule, and Kern subbasins within the model domain are presented in Appendix D1.

2.8 Basin Water Budget

The basin water budget describes the inflows to and outflows from the Subbasin hydrogeologic system. Inflow and outflow can occur from the hydraulic boundaries of the system, from various sources within the model domain such as rainfall, lakes, and leakage from rivers and canals, and from the exit points or sinks such as wells or drainage systems. The boundaries, sources, and sinks identified within the model domain are discussed below.

2.8.1 Inflows

Inflows consist of precipitation, surface water diversions for irrigation, imported groundwater for irrigation, intentional recharge, and leakage from streams and conveyances.

2.8.1.1 Precipitation

Precipitation can be a significant source of water to the Subbasin and surrounding area. Given the large areal extent of the Subbasin and surrounding area, it was determined that using a single weather station to estimate precipitation would be inadequate to represent the entire Subbasin. Instead, the Parameter-elevation Regression on Independent Slopes Model (PRISM) database maintained by the Oregon State University was used to estimate monthly precipitation from January 1990 through December 2016 across the model domain (PRISM, 2017). The PRISM database contains monthly total precipitation for the entire United States using a 4-kilometer grid. The monthly precipitation values are statistically derived values based on local weather stations and corrections for topographic variations. A total of 304 PRISM data sets were downloaded for the model domain. The monthly precipitation data were summed by Subbasin area to estimate the potential annual precipitation volume for each subbasin (Figure D2-13a). Maps of average monthly rainfall across the model domain for the months of January, March, May, July, September, and November shows that precipitation also varies spatially across the model domain (Figure D2-13b).

Not all rainfall is available for use by crops – some fall on impervious surface, some is taken up by dry soils, some is intercepted by foliage and on evaporates before it can infiltrate, and some deep percolates and recharges groundwater. Monthly effective precipitation was estimated by multiplying the monthly PRISM data sets by the Precipitation / Effective Precipitation ratios presented in FAO 56 (Chapter 3, Table 6; Allen et al., 1998) and shown on Figure D2-14. A table and chart summarizing annual effective precipitation by subbasin within the model domain is presented on Figure D2-15. This shows that between 1990 and 2016, effective precipitation provided as little as 9,320 acre-feet (AF) in a dry year (2013) to 501,030 AF in a wet year (2010) and averaged approximately 214,720 acre-feet per year (AF/Y) of water across the model domain.

2.8.1.2 Surface Water Diversions

Surface water diversion from external sources are the most significant source of water to the Subbasin and surrounding area. There are 34 rivers, streams, canals, and diversions entering and within the Subbasin that have recorded diversions (Figure D2-9a-c). Two primary data sources were employed for the surface water inflows and deliveries to the farms within the model domain:

- For lands within the Subbasin itself, surface water delivery and diversion records were obtained by via direct contacts with the various GSAs (and member water management agencies within the

GSAs) within the Subbasin proper (Table D2-3). Those records were relatively complete from 1990 through 2016 for diversions off the Kings system and SWP. As shown on Table D2-3, during the period 1998 through 2010, the Kings River had six below normal water years, four average water years, and three above average water years. Over the 1998-2010 period is Kings River water years average 96% of normal, making this a "normal hydrology" period.

- For deliveries to lands located within the model buffer area (between the boundaries of the Subbasin as defined by the DWR and the TLSBHM model domain boundaries), a combination of data gathered for GSAs whose footprint extended into the Subbasin proper, and data mined from the C2VSIM (Brush et al., 2016) model for those GSAs and water management districts that lay completely outside the official Subbasin boundary were utilized. The C2VSIM model surface water data covered from the beginning of the TLSBHM model period through the end of 2011 and was extended through the end of 2016 by correlation of those inflows with Kings River deliveries at Peoples weir. In general, inflows into this area from Kaweah and Tule Rivers, and Deer Creek were reconstructed from a variety of disparate data.

A table and chart summarizing annual surface water diversions by subbasin within the model domain is presented on Figure D2-16. Monthly surface water diversions by subbasin by GSA and subbasin are provide in Appendix D2. This shows that between 1990 and 2016, surface water diversions provided an average of 948,370 AF/Y of water across the model domain and as much as 1,696,540 AF of water in wet years.

The surface water diversions are not delivered uniformly across the model domain spatially or temporally (Figure D2-17). During the 1990-2016 period, there are several areas that historically have not received any surface water diversions or have received intermittent deliveries of surface water (Figure D2-17).

2.8.1.3 Imported Groundwater Supply

One unique feature of the Subbasin is the importation of groundwater supplies from adjacent subbasins. The ER GSA and TCWA GSA operated well fields in the adjacent Tule Subbasin and import the pumped groundwater into the Subbasin as an additional water supply. Between 1990 and 2016, ER GSA operated up to 52 wells in the Creighton Ranch well field, which delivered up to 68,730 AF in a dry year (2014) and as little as 0 AF in wet years (1996-1999) and averaged approximately 39,320 AF/Y in non-wet years (Table D2-4). The TCWA GSA operated up to 51 wells in the Angiola Water District (WD) well field, which delivered groundwater to TCWA GSA lands in both the Subbasin (about 60%) and Tule Subbasin (about 40%). Between 1990 and 2016, the Angiola WD well field delivered up to 23,100 AF in a dry year (2009) and as little as 0 AF in wet years (1996-1999) and averaged approximately 15,950 AF/Y in non-wet years (Table D2-4).

2.8.1.4 Lake Bottom Water Storage

Another unique feature of the Subbasin is the utilization of certain portions of the historical lake bottom for storage of the excess surface water inflows that were not diverted by others. This stored surface water is later used as an irrigation supply. In some years, sufficient water can be stored in the lake bottom to eliminate the need for supplemental groundwater pumping to meet the irrigation demand.

As observed in historical aerial imagery, the area occupied and the locations of water storage changes from year to year, although certain areas to the south appear to be more regularly utilized by storage (Figure D2-18). This can result in significant volumes of stored water in some years. Permanent lakebed storage facilities have the capacity to store approximately 70,000 AF at any given time. During flood events, as an example of conjunctive use, some fields can be flooded allowing for the storage of significant volumes of water, in some years up to 450,000 AF in the ER GSA management area (Figure D2-18). When available, the storage water is typically utilized to supplement surface water deliveries in lieu of groundwater pumping. The importance of this conjunctive management capability is illustrated by the fact that the cumulative excess inflow stored in the lake bottom allowed lake bottom farmers to completely turn off their groundwater well fields between January 1995 and June 1999 (Table D2-4).

2.8.1.5 Intentional Recharge

Groundwater recharge in the Subbasin also occurs from intentional percolation of surface water in infiltration ponds and water banks. The Corcoran Irrigation District (CID) has operated nine intentional recharge basins covering approximately 2,760 acres since the 1980s (Figure D2-19). Aerial photograph analysis shows that only one or two basins are typically utilized each year between March and September when surface water is available, percolating an estimated average of 23,500 AF/Y of surface water. The other ponds are typically dry except in extremely wet years such as 2005-2006, 2010-2011, and 2017 when as much as 147,700 AF of water has been estimated to be percolated. During the 1990-2016 simulation period, the CID Ponds percolated an estimated 616,100 AF of excess surface water.

Kings County Water District (KCWD) has been infiltrating Kings River flood waters along the Old Kings River channel since the 1940s (referred to as Condition 8). Condition 8 water is surface water that naturally would have infiltrated along the Old Kings River channel during high river flow years had the river not been diverted for irrigation. Between 1990 and 2016, Condition 8 recharge has ranged from as little as 0 AF in most years and as much as 36,800 AF in flood years (1995) and averaged approximately 30,370 AF/Y in wet years (Figure D2-20).

In addition, KCWD operates 25 recharge basins totaling about 720 acres within the MKR GSA and also began operating a water bank on the Old Kings River Channel in 2002. Since 2002, approximately 73,600 AF of water has been recharged via percolation through approximately 50 acres of ponds through the water bank, and approximately 48,500 AF has been recovered utilizing five recovery wells. This leaves a positive balance of approximately 25,100 AF in the unconfined aquifer system as of 2016.

In the Chamberlain Ranch area of the ER GSA, 640 acres has been utilized for percolation basins. In 2017, approximately 5,000 AF was recharged. Immediately adjacent to the eastern boundary of the ER GSA in the Tule Subbasin, there are recharge basins that are operated by ER GSA landowners.

2.8.1.6 River and Canal Seepage

Seepage losses from river and canals provide another source of water to the Subbasin and surrounding areas. There are over 290 miles of major streams and canals within the Subbasin, in addition to many more miles of small distribution ditches on individual farms (Figures D2-9b-d). Most to the stream and canals are unlined and can have significant seepage losses. Ownership of canal and river seepage is to be determined. There was little available information on seepage losses in the Subbasin, although anecdotal reports indicate the Old River Channel, Peoples Ditch, and Lakeland Canal all have substantial losses near the head gates at Peoples Weir (personal communication, Dennis Mills).

2.8.2 Outflows

Outflows consist of evapotranspiration, agricultural pumping, municipal pumping, and agricultural drains.

2.8.2.1 Evapotranspiration

Crop evapotranspiration (ETc) or crop demand use is the largest outflow of water from the Subbasin. ETc data are based on spatial distributions of different types of crops, as well as estimated rates of evapotranspiration for the Subbasin area. Crop data comes from DWR data sets for the counties of Fresno, Kern, Kings, and Tulare (surveyed intermittently between 1990-2006) and from CropScape datasets (surveyed annually from 2007-2016). Monthly ETc varies by crop type and by season, typically peaking during the summer months. ETc rates were estimated from published ITRC rates (ITRC, 2003) under normal year conditions for the region (Table D2-5).

Annual crop demand was calculated for each crop type on a 40-acre basis as follows:

Annual Crop Acres (Acres) * *Annual Crop ETc* (Feet/Acre) = *Irrigated Crop Demand* (AF/Y)
(Table D2-2) (Table D2-5) (Table D2-6)

Note: some crop types do not receive irrigation water and thus have zero irrigated crop demand.

Between 1990 and 2016, the total irrigated crop demand in the Subbasin ranged from 564,120 AF in 2015 to 1,072,440 AF in 2007 and had an average irrigated crop demand of approximately 879,020 AF/Y (Table D2-6).

The mix of crops grown and fallow lands has changed over time as agricultural practices changed in response to agricultural markets and drought conditions. A chart of annual crop acreage shows that total crop acreage has generally decreased since 2010 (Figure D2-12). Crop demand shows a similar pattern, generally decreasing from 2009 through 2015 (Table D2-6). Cotton showed the most change with a decrease of crop demand over 50% between 1995 and 2016. The data also show that during the 2011-2016 drought, there was an overall increase in row crop demand including tomatoes, peppers, small vegetables, onion, garlic, grain, and hay. In addition, the data show a large increase in ETc demand from almonds, pistachios, and stone fruits. Annualized tables and charts of crop demand for the Subbasin GSAs and the portions of the Westside, Kings, Kaweah, Tule, and Kern subbasins within the model domain are presented in Appendix D3.

2.8.2.2 Specified Agricultural Well Field Pumping

Agricultural pumping is typically not recorded over much of California, including the Subbasin. However, there are 455 wells with reported production in 6 agricultural well fields within the model domain. A wellfield consists of a group of wells generally located in the same area and operated a single entity to provide a reliable groundwater supply. The agricultural wellfields include: ER GSA (99 wells), Creighton Ranch (52 wells), CID (98 wells), Angiola Water District (51 wells), Westlands Water District (150 wells), and Apex Ranch (5 wells) (Figure D2-21). The ER GSA and CID well fields service local areas in the Subbasin. The Creighton Ranch and Angola Water District well fields, located in the Tule Subbasin, service the Tule Subbasin and also export significant amounts of groundwater to the Subbasin. The Westlands Water District well field only services the Westside Subbasin. The specified pumping from the agricultural well fields has varied significantly over time, ranging from 23,470 AF (1998) to 370,880 AF (2016) and averaging about 202,750 AF/Y (Figure D2-22). The reduction in annual pumping coincides with the availability of surface flood waters (Figure D2-18). Appendix D4 presents an annualized summary of reported pumping by agricultural well fields within the model domain.

2.8.2.3 Specified Municipal Well Field Pumping

Municipal pumping of groundwater occurs in the Subbasin by the cities of Hanford, Lemoore, Stratford, and Corcoran (Figure D2-21). Specified pumping from the 30 identified municipal well fields has been slowly increasing over time but has remained relatively consistent (Figure D2-22). Between 1990 and 2016, reported municipal pumping has ranged from 9,110 AF (1991) to 26,700 AF (2002) and averaged 14,910 AF/Y over this 26-year period. The municipal pumping demand varies seasonally, peaking in the summer months. As noted in Section 2.4, municipal pump has created persistent cones of depression in the potentiometric surface near the cities of Hanford and Corcoran. Appendix D4 presents an annualized summary of pumping by municipal wells within the model domain as reported by the cities.

2.8.2.4 Estimated Agricultural Pumping

As noted above, agricultural pumping is typically not recorded over much of California, including the Subbasin. However, agricultural pumping by subbasin can be estimated using a simple water balance approach where:

Irrigated Crop Demand (AF/Y)- *Effective Precipitation* (AF/Y) */ Irrigation Efficiency* (%) = *Farm Demand* (AF/Y)

and

Farm Demand (AF/Y) – *Surface Water Supplies* (AF/Y) = *Estimated Agricultural Pumping Demand* (AF/Y) (Figure D2-23)

Note: Surface Water Supplies include Surface Water Deliveries, imported groundwater, and lake bottom water storage

Although this simple water balance approach does not account for subtleties in the areal distribution of effective precipitation, irrigation efficiency, and surface water deliveries, it does provide a reasonable gross estimate of agricultural pumping on the subbasin scale. Based on this analysis, gross agricultural pumping demand in the Subbasin from 1990 through 2016 has ranged from 24,730 AF (1995) to 785,260 AF (1991) and averaged approximately 469,560 AF/Y (Figure D2-23).

2.8.2.5 Agricultural Drains

Agricultural drains are used in several areas across the model domain to keep soil from becoming waterlogged in the root zone. Typically, a tile or French drain system is used, with tiles buried approximately 4 to 6 feet bgs draining to sumps. Subsurface drainage collected in the sumps is pumped via pipeline to evaporation basins. Figure D2-24 shows the approximate location of known subsurface drains within the Subbasin.

3.0 Simulation Code

In order to meet the model objectives discussed in Section 1.3, the groundwater flow model code must meet the following criteria:

- be able to simulate three-dimensional groundwater flow within the model domain,
- be well documented and verified against analytical solutions for specific flow scenarios,
- be accepted by regulatory agencies,
- be readily understandable and usable by others for simulation of future groundwater conditions, and
- have a readily available technical support structure.

The groundwater flow model codes MODFLOW2005-NWT (Niswonger et al., 2011) and MODFLOW-OWHM (Hanson et al., 2014) are two distinct versions from the well-known MODFLOW family of groundwater simulation codes. These codes were used to develop the Subbasin model.

MODFLOW is a modular, finite-difference computer code developed by the USGS to simulate three-dimensional groundwater flow (McDonald and Harbaugh, 1988, Harbaugh, A. W., 2005). The use of the MODFLOW family of codes is well documented in technical literature and is a de facto standard for groundwater flow modeling worldwide.

MODFLOW2005-NWT is a particular version of MODFLOW that implements the Newton method for handling non-linearities in flow equations, which allows for very efficient solution of the flow equation including complexities such as unsaturated zone flow, eliminated the cell draining and re-wetting problems of earlier versions of MODFLOW (Niswonger et al., 2011). MODFLOW-OWHM is a relatively new version of MODFLOW (still under development) specifically developed to provide a flexible and robust approach to simulate conjunctive management of surface water and groundwater resources in an agricultural crop production setting (Boyce et al., 2016).

3.1 Model Code Selection

Once the decision was made to develop a model using the MODFLOW family of codes, the initial plan was to develop both a MODFLOW2005-NWT model and a MODFLOW-OWHM model to provide independent, yet complementary, methods for model development. This was planned due to the fact that both codes will share many of the same input files, only differing in how the farm irrigation pumping is specified. For the NWT model, the farm irrigation pumping requirement would be calculated externally in a de-coupled modeling approach, whereas with OWHM, the farm irrigation pumping is calculated internally as a dynamic component.

The MODFLOW-NWT (“MF-NWT”) code would be employed to develop a “de-coupled” model of conjunctive surface water – groundwater management in the Subbasin. In the de-coupled approach, the following four-step procedure is used to build surface boundary processes (irrigation, crop water use, return flows, etc.), build the irrigation well pumping file, and run the model to simulate system response:

- the crop ETc demand calculated externally on a model cell-by-cell basis based on cropping patterns, crop coefficients, and reference ETc;
- effective precipitation and specified surface water deliveries are also calculated on a model cell-by-cell basis, irrigation pumping demand is calculated as the ETc demand – effective precipitation - surface water supplies;
- the resulting cell-by-cell irrigation pumping demand is subsequently summed by area, and assigned to a hypothetical pumping well in the center of the area in the de-coupled model; and
- the model is run to simulate groundwater-system response (drawdown, loss of storage, subsidence) to the stresses (including municipal and irrigation pumping, natural recharge, intentional artificial recharge, recharge from stream and canal leakage, recharge from irrigation return flows.

The MODFLOW-OWHM (“MF-OWHM”) code was investigated as a tool to dynamically simulate conjunctive management of surface water and groundwater resources in the Subbasin. The MF-OWHM model employs basically the same input data sets used to calculate the ETc and irrigation pumping demands externally for the de-coupled MF-NWT model, but the MF-OWHM simulations are dynamic in the sense that the ETc and irrigation pumping are calculated internally within the model allowing for "feedback loops" between these two key stressors on the groundwater system. The MF-NWT de-coupled model does not address these types of feedback loops that actually can be occurring in the field.

The MF-OWHM, the code is currently undergoing enhancements (from to its capabilities and numerical methods. In January 2019, the USGS indicated that updated version of the model code (OWHM v2) would be available in March 2019. The most recent communication with the USGS indicated that the updated model code might not be ready until the end of October 2019, too late for the GSP schedule. Thus, further development of the OWHM was suspended at the end of March and efforts were directed at completing the de-coupled MF-NWT model for the Subbasin within the project schedule. The remainder of this report focusses on the de-coupled model development, application, and results.

3.2 Code Assumptions and Limitations

There are certain model code assumptions and limitations that must be considered when developing, applying, and interpreting a numerical model. Some key assumptions and limitations that may affect the site models are briefly discussed below.

Porous Media: The MODFLOW family of codes is limited simulation of saturated and unsaturated flow in porous media. It does not simulate flow through fractures or relatively impermeable bedrock.

Layer Continuity: MODFLOW requires that all layer extend from edge-to-edge of the model domain. This limits the ability to explicitly simulate formation pinch-outs or unconformities. Instead these features may be simulated using a hydraulic conductivity contrast.

Unsaturated Flow: The MODFLOW Unsaturated Zone Flow (UZF1) package can simulate flow in the unsaturated zone using an approximation to Richards' equation to simulate vertical unsaturated flow. The approach is limited in that unsaturated flow occurs in response to gravity, and there must be uniform hydraulic properties in the unsaturated zone for each vertical column of model cells. This limits the ability of the MODFLOW to simulate different properties of the thick unsaturated zone. The Brooks-Corey function is used to define the relation between unsaturated hydraulic conductivity and water content. Variables used by the UZF1 Package include initial and saturated water contents, saturated vertical hydraulic conductivity (Kv), and an exponent in the Brooks-Corey function. Residual water content is calculated internally by the UZF1 Package on the basis of the difference between saturated water content and specific yield (Sy).

The UZF1 Package is also substitution for the Recharge (RCH) and Evapotranspiration (ET) Packages of MODFLOW-2005. The UZF1 Package differs from the RCH Package in that an infiltration rate is applied at land surface instead of a specified recharge rate directly to ground water. The applied infiltration rate is further limited by the saturated Kv. The UZF1 Package differs from the ET Package in that evapotranspiration losses are first removed from the unsaturated zone above the evapotranspiration extinction depth, and if the demand is not met, water can be removed directly from ground water whenever the depth to ground water is less than the extinction depth. The UZF1 Package also differs from the ET Package in that water is discharged directly to land surface whenever the altitude of the water table exceeds land surface. Water that is discharged to land surface, as well as applied infiltration in excess of the saturated Kv, may be routed directly as inflow to specified streams or lakes if these packages are active; otherwise, this water is removed from the model similar to the Drain (DRN) Package.

Stress Periods: MODFLOW requires that temporally variable data be consistent within each stress period. This results in some temporally averaging of data. For example, stream flow or municipal pumping may vary hourly or daily in response to demand, while agricultural well field may pump nearly continuously for several months in a row. The averaging of transient stress into consistent monthly stress period tends to smooth out the hydraulic impacts of the transient stresses.

3.3 Graphic Pre/Post-Processor

To facilitate the preparation and evaluation of each model simulation, Wood utilized the graphics pre/post processor GWVistas® Version 7 (GWV) by Environmental Simulations, Inc. (ESI, 2017). GWV is a Windows® program that utilizes a graphic user interface (GUI) to build and modify a database of model parameters. The model grid, hydraulic properties, and boundary conditions are input using the GUI, and then GWV creates the necessary MODFLOW and MT3DMS data input files. The input files generated by GWV are generic (standard) files compatible with USGS MODFLOW-NWT and MT3DMS. Wood also utilized some in-house utilities and Microsoft EXCEL spreadsheets to generate standard MODFLOW data input files for selected simulations and for post-processing simulation results. For example, PYTHON scripts were utilized to add and subtract the large matrices containing 27 years of monthly data worth of effective precipitation, surface water deliveries, and crop demand to estimate agricultural pumping. Similarly, an Excel spreadsheet was created to allocate the estimated agricultural pumping demand to hypothetical wells, and export file formatted for importation into GWV.

GWV was also utilized to post-process the model simulations. GWV can display the simulated head results as plan views and cross-sections. In plan view, the contour intervals and labels specified by the user and dry cells are denoted by a different color. In cross-section view, the water table surface is also plotted. Most outputs to the screen can be saved in a number of formats (DXF, WMF, PCX, SURFER, etc.) for utilization in other graphics programs.

4.0 Model Design

The following sections describe the numerical groundwater flow model for the TLSBHM. The model construction was based on the HCM presented in Section 2.0, with each of the key features described in that Section represented numerically in the TLSBHM. This modeling effort is a revision to the preliminary groundwater model of the Subbasin (Kings Model) developed in 2016-2018 on behalf of the Kings County Community Development Agency (AFW, 2018).

4.1 Model Domain/Grid

As described in Section 2.1, the TLSBHM model domain is centered on the Subbasin and extends beyond the Subbasin several miles, overlapping adjacent subbasins within the Tulare Lake Hydrologic Region (Figure D2-2). The model domain was extended beyond the Subbasin so that model boundary conditions are sufficiently far away the area of interest in the Subbasin; these areas beyond the extent of the Subbasin henceforth are referred to as the “buffer areas” (Figure D2-2). The buffer areas extend approximately 3 miles beyond the DWR-defined Subbasin boundaries on the north, south, and east sides; on the west and southwest sides, however, a large buffer area is not included because the alluvial groundwater basin is truncated by low-permeability geologic units on those side. The active model grid covers an area of approximately 1,091,320 acres (about 1,705 square miles) and is orientated due north to align the model grid with the predominant direction State Plane coordinate system of Township/Range/Sections.

The preliminary Kings Model (AFW, 2018) exhibited some boundary condition interference along the eastern edge of the model. Hence the TLSBHM model grid was extended further east approximately

2.5 miles. In addition, some of the active model grid edges were modified to yield straighter lines to simplify specified boundary conditions. The resulting TLSBHM model grid consists of 281,750 active cells with uniform dimensions of 1,320 x 1,320 feet (¼ mile x ¼ mile, or 40-acres) (Figure D4-1). The complete model grid consists of 230 rows, 175 columns, and 7 layers.

4.2 Model Layers

The purpose of model layers is to represent the hydraulic influence of stratigraphy at a scale appropriate to the model objectives. One way to think of "hydraulic influence" is how finer-grained deposits present resistance to flow, both laterally and vertically, and it is only through multiple model layers that one can simulated the vertical resistance to flow. It is understood that stratigraphic variations occur at scales that are both smaller and larger than that characterized for this model.

- Those hydrostratigraphic variations that are of the same scale or larger than the numerical grid cell size, for example the Corcoran Clay, are captured explicitly in model property variations.
- Those hydrostratigraphic variations that are much smaller than the model cell size are not treated explicitly in the model, but rather their effect is incorporated into the model via appropriate assignment of large scale "effective" properties for the model cell as described above in Section 2.1.1. For example, say three 1- to 2- foot thick clay layer or lenses extend across a large portion of the 1,320-foot x 1,320-foot plan view area of a 50-foot thick model cell. To capture the hydraulic effect of those layers in the 50-foot thick model cell requires significantly reducing the Kv as guided by this conceptual model and application of the harmonic average as a lower bracket for significantly reducing Kv compared to what is in the CVHM model data that was provided to the TLSBHM modeling team by the USGS.

In addition to direct import of the CVHM hydraulic conductivity fields (based on the USGS sediment texture study) as the starting point for the model, refinements to the conceptual and numerical models of the site were based on consideration of several types of information. Supplement information considered included both recent and older USGS literature (Croft, 1972; Page, 1986), monitoring well perforation intervals in sub-areas of the site, and qualitative and quantitative information obtained directly from the GSAs.

The initial basis for the TLSBHM model layering scheme was based on a modified version of the CVHM (AFW, 2018). The modified CVHM model had 13 layers including 5 layers above the Corcoran Clay, 3 layers representing the Corcoran Clay, and 5 layers below the Corcoran Clay. The TLSBHM layering scheme was reduced from 13 layers to 7 layers to simplify the model and make it more consistent with the 3- to 4-layer models being developed for the Tule and Kaweah subbasins. The TLSBHM layer count was reduced by combining several thin layers into a single, thicker layer. For example, the 3 layers representing the Corcoran Clay in the CVHM model were combined into a single layer in the TLSBHM. Layer elevations and thicknesses were also modified in some areas based on local information. The resulting Cross-sections showing the model layering scheme and initial hydraulic conductivity distribution are shown on Figures D4-2 and D4-3.

4.3 Model Duration and Stress Periods

The TLSBHM simulates the period from 1990 through 2016 using 324 monthly stress periods (Table D4-1). The model simulates the period from 1990 to 1995 as a "run-up" period to stabilize the model hydraulics prior to the 1998-2010 focused calibration period. The model continues from 2010 through 2016 to bring the model up to date with current hydraulic conditions as required under SGMA.

4.4 Model Hydraulic Parameters

The initial hydraulic properties assigned to the TLSBHM were extracted from CVHM. The hydraulic parameters were only modified as necessary during the model calibration process to improve the fit between simulated and observed heads. As such, the model contains no more complexity than is justified by the available data, the model objectives, and the model results to date. Section 4.4.1 briefly describes how the USGS used textural information from thousands of boring logs to develop three-dimensional maps of the hydraulic properties.

The range of final hydraulic properties, hydraulic conductivity, Kv, storage, Sy, and porosity used as a result of the calibration process are briefly summarized in the following subsections.

4.4.1 Hydraulic Conductivity

Geologically speaking, the Central Valley is a large structural trough filled with sediments of Jurassic to Holocene age. These sediments reach thicknesses on the order of 15,000 feet in the San Joaquin Valley, and as much as 30,000 feet in the Sacramento Valley. In general, the Sacramento Valley is predominantly fine-grained and reflects more fine-grained volcanic-derived sediments, and in the San Joaquin Valley the areas of coarse-grained texture are more widespread than the areas of fine-grained texture and occur along the major rivers, especially on the eastern side.

The texture (particle size) of these sediments and how that texture varies spatially strongly impacts how groundwater flows in response to recharge and discharge stresses on the system. Therefore, the textural distribution of the basin-fill sediments was used to define the initial vertical and lateral hydraulic conductivity and storage property distributions for the TLSBHM domain.

To characterize the Central Valley basin-fill deposits, scientists from the USGS developed a geologic texture model to describe the coarseness or fineness of basin-fill materials that make up the hydrogeologic system, and then used it to estimate hydraulic properties (hydraulic conductivity and storage properties) for every cell in the model grid. To create a sediment texture model for the Central Valley, the USGS compiled and analyzed data and information from approximately 8,500 drillers' logs of boreholes ranging in depth from 12 to 3,000 feet below land surface (Faunt el al., 2009). The textural characterization focused on the variability and spatial distribution of the fraction of coarse sediments (f_c) over 50-foot depth intervals. Figure D4-4 presents the f_c for several of the model layers, and Figure D4-5 presents an oblique view of f_c for the San Joaquin Valley, with the TLSBHM study area outlined in red. In general, there are two key aquifer systems, the upper unconfined and semi-confined aquifer and the deeper confined aquifer system, separated by the Corcoran Clay aquitard. On Figures D4-4 and D4-5, the Corcoran Clay horizon is found in model layers 6 through 8, with the unconfined and semi-confined shallow aquifer system in model layers 1 through 5 and the deeper confined aquifers in model layers 9 through 13.

The USGS generated estimates of hydraulic properties from their texture model developed for the CVHM. These values were imported directly into the TLSBHM to use as initial values prior to beginning model calibration. The initial hydraulic conductivity distribution utilized in the TLSBHM is shown on Figure D4-6.

Beneath the Subbasin study area, previous studies have identified extensive deposits of fine-grained materials consisting of lacustrine and marsh sediments (Croft and Gordon, 1968; Croft, 1972; Page, 1986, Williamson et.al., 1989). A cumulative thickness of as much as 3,000 feet of these fine- grained deposits have been identified and include laterally extensive clay layers (A – F Clays). The A-, C-, and E-Clays (i.e., Corcoran Clay) cover much of the TLSBHM domain. During the calibration process, these studies and input from the GSAs were utilized to adjust hydraulic properties derived from the USGS texture model to be more representative of the Tulare Lake bed and surrounding area (Figure D4-7). The following subsections provide a summary of the hydraulic properties for each of these depth intervals.

4.4.1.1 Unconfined and Semi-Confined Aquifer Zones above the Corcoran Clay

Above the Corcoran Clay is the unconfined to semi-confined upper portion of the regional fresh-water aquifer. This upper portion of the regional freshwater aquifer is generally comprised of coarse- to medium-grained sediments (i.e., sand and gravel) with silt and clay interbeds.

According to the USGS CVHM, the grid-block-scale horizontal hydraulic conductivity (K_h), ranges from 8 to 75 feet per day (ft/d). These values span the lower range of a “good aquifer” as defined by Bear (1972). Figure D4-4 presents the K_h distribution derived from the USGS texture study for selected model layers. On Figure D4-4 (as well as Figure D4-6), a broad swath of lower permeability (low sand fraction) deposits is evident that run from the northwest side of the model domain trending to the southeast toward the southeast corner of the model domain. In this zone, the hydraulic conductivities derived from the CVHM are in the 5 to 25 ft/d range, which is closer to the range of a “poor aquifer” (Bear, 1972), and which appear to be lower than values obtained from pumping tests in these areas (P&P, 2009). In fact, the averaging of sediment texture (f_c) over 50-foot depth intervals leads to “smoothing out” of permeability contrasts.

As described previously, it is important to recognize that even in the zones with a higher fraction of coarse textured sediments, clayey layers and lenses are found throughout the profile. This is especially important for estimating effective horizontal-to-vertical anisotropy of hydraulic conductivity for a numerical model layer thickness of 50 feet, which is the scale of vertical averaging that the USGS employed in their sediment texture study. For example, say the fraction of coarse-materials over a 50-foot depth interval is 90%; if the remaining 10% consists of a fine fraction that is concentrated in a few clay layers on the order of a foot thickness, then the effective K_v should tend toward the harmonic average of a clay and a sand (Freeze and Cherry, 1979). If the sand has a K_h of 90 ft/d and the clay layers have a K_h of 0.01 ft/d, then the effective K_v for that grid cell could be estimated using a layer-thickness weighted harmonic average as:

$$K_v \approx [50 / ((5/0.01) + (45/90))] = [50/500.5] \approx 0.1 \text{ ft/d}$$

The effective K_h can be estimated as the layer-thickness weighted arithmetic average:

$$K_h \approx [(45x90) + (5x0.01)] / 50 \approx 90* (45/50) = 81 \text{ ft/d}$$

These simple calculations indicate that it would be reasonable to expect very high anisotropy ratios (very low effective K_v), and indeed that is what was found during the model calibration process (see Section 5.0).

The storage properties above the Corcoran Clay do not vary nearly as much as the hydraulic conductivity in this portion of the aquifer. The S_y of the sediments above the Corcoran Clay (Layers 1 through 3) range from 0.08 to 0.3, while the specific storage (S_s) ranges between 1.5x10-5/feet and 7.3x10-3/feet.

4.4.1.2 Corcoran Clay Aquitard

The lateral extent and thickness of the Corcoran Clay are shown on Figure D2-4. While it is sometimes considered a continuous layer of low permeability sediments spanning across the San Joaquin Valley, in fact comparing these figures to the CVHM hydraulic conductivity maps for model layers 4 through 10 (Figures D4-4 through D4-6) clearly shows that the Corcoran Clay grades into coarse materials laterally, as well as above and below. They also show that some clay lenses exist above and throughout areas characterized as relatively "coarser" in the USGS texture study. Recognizing that the texture maps were developed from averaging f_c over 50-foot depth intervals, this impacts the effective Kv used in the TLSBHM as described in the previous section.

This is consistent with recent investigations by the USGS in the San Joaquin Valley, which indicate that the groundwater conditions grade from unconfined, or water-table, at the shallowest depths to semi-confined with increasing depth, eventually grading into fully confined conditions beneath the Corcoran Clay. Geophysical well logs indicate that the Corcoran Clay, although probably the largest single confining bed, constitutes only a small percentage of the total cumulative thickness of clay layers in the fresh-water bearing unconsolidated sediments in the Subbasin. Thus, it is more accurate to consider the confinement as the result of numerous overlapping clay lenses and beds. Further, the difference in hydraulic head directly above and below the Corcoran Clay is relatively small when compared to head differences between larger intervals of the deeper parts of the aquifer system. Again, rather than to explicitly simulate each of these thin clay layers and lenses discretely in the model, their impact on the flow system is simulated through the high anisotropy in hydraulic conductivity (very low Kv).

Hydraulic conductivity (K_h) values of the Corcoran Clay cells in the model domain from the USGS CVHM range from 0.5 to 10 ft/d, which is rather high for an aquitard material, and especially high considering that the harmonic average should be the guide for effective K_v. As mentioned in Section 4.4.1, hydraulic conductivity values at the depth horizon of the Corcoran Clay were adjusted during model calibration to improve the fit between the simulated and observed hydraulic heads over time.

In addition, as discussed in Section 2.3.4, Croft & Gordon (1968) identified uninterrupted lacustrine (clay) deposits from the surface to at least 2,200 feet bgs beneath the central portion of the Tulare Lake bed (Figure D2-5). These lacustrine deposits interfinger with coarser sediments and the thinner clay zones along the periphery of the lake with the thick clay deposits beneath the lake bed itself. The Corcoran Clay (E-Clay) has been identified as extending beneath the lake bed (Davis et al., 1959). show it as being warped downward along the axis of the lake with a maximum thickness of 150 to 175 feet. These cross sections indicate the Tulare Lake deposits form a clay "plug" across the center of the San Joaquin Valley that may be 15 miles wide, 8 miles long, and ½ mile deep at its maximum dimensions. This was incorporated into the TLSBHM (Figure D4-7).

Again, the storage properties do not vary as much as the hydraulic conductivity, with S_s of the Corcoran Clay and other sediments in this depth horizon ranging between 4.5x10-4/feet and 1.2x10-3/feet, with the S_y ranging from 0.10 to 0.15 where unconfined. Storage values were adjusted during model calibration to improve the fit between the simulated and observed hydraulic heads over time.

4.4.1.3 Confined Aquifer Beneath the Corcoran Clay

Hydraulic conductivities initially assigned to the model layers beneath the Corcoran Clay horizon were derived from the USGS CVHM. Conductivity values generally ranged from 20 to 40 ft/d, except for two broad regions of lower permeability. One of the areas with a predominance of low-K_h materials at depth is in the Westside Subbasin to the west, and the other is beneath the southeast buffer areas near where Deer Creek enters the model domain. Again, the storage properties do not vary as much as the hydraulic conductivity, with Ss of the sediments below the Corcoran Clay ranging between $6.8x10^{-4}$/feet and $1.5x10^{-3}$/feet. Storage values were adjusted during model calibration to improve the fit between the simulated and observed hydraulic heads over time.

The TLSBHM groundwater model was initially assigned variable K_h values that ranged between $4.0x10^{-4}$ ft/d for aquitard clay units to 91 ft/d for aquifers, with the spatial distribution of the properties derived from the CVHM. These values were modified as necessary during the calibration process to improve the model fit to observed groundwater elevations (Figure D4-7).

4.4.2 Storage

The TLSBHM groundwater model was initially assigned S_s values from the USGS CVHM. Initial S_s values ranged between $1.5x10^{-5}$ to $7.3x10^{-3}$ feet-1. These values are within the published range of values for the silty to sandy sediment types (Spitz and Moreno, 1996). S_s values were modified over a limited range during the model calibration process.

4.4.3 Specific Yield

The TLSBHM groundwater model was initially assigned S_y values from the USGS CVHM. Initial S_y values ranged between $7.9x10^{-2}$ to $3.0x10^{-1}$. These values are within the published range of values for the silty to sandy sediment types (Spitz and Moreno, 1996). S_y values were modified over a limited range during the model calibration process.

4.4.4 Porosity

The TLSBHM groundwater model was initially assigned porosity values from the USGS CVHM. Initial porosity values ranged between $9.1x10^{-2}$ to $2.9x10^{-1}$. These values are within the published range of values for the silty to sandy sediment types (Spitz and Moreno, 1996). Porosity values were modified over a limited range during the model calibration process.

4.5 Model Boundary Conditions

Significant hydraulic boundaries (sources and sinks) within the model domain that must be considered in the site numerical model include the inflows and outflows from surrounding subbasins, inflows and outflows of surface water, return flows and intentional recharge, and groundwater pumping. These boundaries are discussed in the following subsections.

4.5.1 General Head Boundaries

The MODFLOW General Head Boundary (GHB) package was utilized to simulate the north, south, and east edges of the model domain and represent the aquifer system beyond the model domain (Figure D4-8). For the TLSBHM, the GHBs were developed based on historical water level observations in well located within 2 miles of the model domain boundary. Figure D4-8 shows the locations of wells evaluated to develop the GHB boundary conditions. The GHBs were developed as a series of 20 GHB reaches. The GHB heads at the ends of each reach were interpolated on a monthly basis from the available hydrograph data. The GHB heads for each cell within a reach were then linearly interpolated between the end points. This resulted in a relative smooth variation in GHB heads along the length of each reach.

The GHB conductance term, which governs how much water can flow through the GHB, was calculated as:

Conductance = KLW/M in square feet per day (ft^2/d), where:

K is the hydraulic conductivity of the sediments (assumed to be 25 ft/d),
L is the GHB length or distance to the head value (assumed to be 1,320 feet),
W is the GHB width (assumed to be 1,320 feet), and
M is the saturated thickness of GHB layer (assumed to be 100 feet).

4.5.2 River and Canal Boundaries

As noted above, several rivers and streams deliver surface water to irrigated lands within the model domain. The most important of these is the Kings River, which enters the model domain on the northeast side, and it flows westward near the top of the model domain before turning southwest then southward in the western portion of the model domain. Other major surface water inflows are provided by the Kaweah River, the Tule River, Deer Creek, and Poso Creek. Figure D4-9 shows the locations of each of these surface water features; also shown are the major distributary canals that take the deliveries from the streams and rivers and distribute that water to the irrigation farmlands.

The MODFLOW River (RIV) package was utilized to simulate all the stream and canals that deliver water to irrigated lands. The streams were developed as a series of 23 RIV reaches, where each RIV reach is composed on many model cells. The RIV package is a head dependent boundary and will allow water to enter groundwater via seepage (losing stream) or exit groundwater (gaining stream) based on river stage (Head) and a steam bed conductance term:

Conductance = KLW/M in ft^2/d, where:

K is the hydraulic conductivity of the sediments (assumed to be 1 to 10 ft/d),
L is the length of the river reach (variable in feet),
W is the river width (assumed to be 10 to 40 feet), and
M is the thickness of the river bed (assumed to be 10 feet).

The rivers were assumed to leak anytime there were surface water diversions down a particular river reach. Throughout the Subbasin, almost all river are disconnected from groundwater and are losing rivers. Appendix D2 presents an annualized summary of river flow by reach within the model domain.

4.5.3 Agricultural Drains

The MODFLOW Drain (DRN) package was utilized to simulate the agricultural drains within the model domain (Figure D2-24). The DRN package is a head dependent boundary condition that only collects groundwater above a specified elevation. Similar to GHBs, the rate of removal is governed by a conductance term:

Conductance = KLW/M in ft^2/d, where:

K is the hydraulic conductivity of the sediments (assumed to be 100 ft/d),
L is the length of the drain (assumed to be 1,320 feet),
W is the width of the drain (assumed to be 1,320 feet), and
M is the thickness of the drain bed (assumed to be 1 foot).

In areas where drains were simulated, if simulated groundwater rose to within 4 feet of ground surface, then groundwater was collected by the drains and assumed to be discharged to evaporation basins where it evaporated and was removed from the model domain.

4.5.4 Groundwater Extraction

Groundwater extraction for municipal, industrial, and agricultural demand was simulated using the MODFLOW Multi-Node Well (MNW2) package. The MNW2 package is a powerful enhancement to the original MODFLOW well package in that it allows for simulation of wells screened across multiple model layers (aquifers). Thus, the MNW2 package will calculate inflows from each model layer within the screened interval as well as the calculating flow within the well casing, including flows from one layer to another when the well is not being pumped. In addition, the MNW2 package will automatically increase pumping from deeper intervals as shallower aquifers become dewatered until the pumping level in the well approaches a specified elevation (such as a pump setting).

4.5.4.1 Specified Pumping Wells

As discussed in Sections 2.8.2.2 and 2.8.2.3, there are 485 known municipal, industrial, recovery, and agricultural wells that have data on well construction as well as reported pumping rates over time (Figure D2-21). The pumping rates were specified for the municipal wells based on monthly historical pumping data obtained from the cities of Corcoran, Hanford, Lemoore, and Stratford (Table D2-3), or reported monthly pumping data from irrigation districts such as CID, ER GSA, Westlands Water District, and reported pumping from well fields like Creighton Ranch and Angiola well fields (Table D2-6).

4.5.4.2 Hypothetical Agricultural Irrigation Wells

As discussed in Section 2.8.2.4, agricultural pumping is not typically recorded throughout most of the Subbasin. As such agricultural pumping had to be estimated based on available cropping data using a water balance method. Recognizing that many more wells exist in the Subbasin than those 485 known wells, an additional 1,091 hypothetical irrigation wells were uniformly distributed across the model domain on approximately 1-mile centers for those areas with unknown well completion intervals, resulting in the final well distribution as shown on Figure D4-10. The hypothetical wells were specified to be screened in the upper (above Corcoran) or lower (below Corcoran) aquifer zones based on statistics of well completions for 238 known irrigation wells in the Subbasin. In addition, approximately 25% of the hypothetical irrigation wells were specified to be completed across the Corcoran, producing groundwater from permeable intervals both above and below the aquitard, consistent with the completion statistics for the 238 known irrigation wells in the Subbasin.

Crop Evapotranspiration Rates

Field crops (alfalfa, row crops, corn, cotton, etc.) are assigned on an annual basis in the model. For example, if the annual DWR crop survey/CropScape data (DWR, 2016a) indicate that corn was present in a particular model cell, then it was assumed that corn was the only crop within that cell for the full calendar year (12 stress periods). The applied evapotranspiration rates for that cell were assigned based on the monthly ETc rates for corn.

Permanent crops including vineyards, almonds, pistachios, pomegranates, and stone fruit (tree crops) are assumed to be fully mature at the beginning of the simulation in 1990 (based on 1994-1996 DWR crop data). As the model progresses forward in time, the available crop data changed, and the spatial distribution of crops also changed, with a recent trend to more permanent tree crops being planted. As the permanent crop grows from seedling to full maturity, the evapotranspiration rate was assumed to increase as well. The presence of a crop within a specific space in a cell was tracked over time by assigning crop IDs that reflect the number of years of maturity for each tree crop and using the intersect tool in ArcMap to see specific areas of overlap between year n tree crops and year n+1 tree crops. If an intersected area of the domain has almonds in year n and in year n+1, it is assumed that the almonds have matured in that particular portion of the cell.

The crop data for the Subbasin indicates that there was a substantial increase in the number of acres planted in tree crops during the 2010-2016 period (Section 2.8.2.1, Table D2-2). Rather than assuming full maturity and peak evapotranspiration rates for these new areas of tree crops, the ET rates for these areas are assumed to be a fraction of the mature ET rates.

For example, almonds are assumed to mature over a 5-year period, so the first year that almonds are present in a portion of a model cell they are assigned ET rates that are 1/5th of the mature rate. If those almonds are still in the same area the next year, then they are assigned an ET rate of 2/5$^{\text{ths}}$ of the mature rate, and so on. If almonds are in the same spot for 5 years, they are assumed to have the full ET rates of a mature almond tree. Anything beyond 5 years, up to 25 years, uses the full maturity ET rates. For instances where almonds have been in a portion of a cell more than 25 years, the almond trees are assumed to have been replanted, and start over at the 1-year, 1/5$^{\text{th}}$ mature ET rates.

Almonds were assumed to mature over a 5-year period and were assumed to be replanted after 25 years. Pistachios were assumed to mature over a 13-year period and are assumed to remain in place for 100 years once they are planted. Pomegranates were assumed to mature over a 19-year period and were assumed to be replanted after 44 years. Stone fruits were assumed to mature over a 5-year period and were assumed to be replanted after 25 years.

Irrigated Areas/Irrigated Fractions

Area fractions within cells were used to compute an area-weighted average for crop ET values within each cell and to determine the irrigated areas of each cell for use with surface water delivery matrix processing. The crop distributions for each stress period were intersected with the active domain grid in ArcMap. Each cell containing crops was subdivided into multiple pieces, one for each crop type within the cell. The areas of each crop type within the cells were calculated for each stress period. The ET demand for a single cell is computed as the area of the crop type times the rate of ET for that crop, divided by the total area of the cell.

Irrigated areas also play a part in the surface water delivery preprocessing. Surface water deliveries were assumed to be spread evenly across the entire irrigated area of each GSA Area (or farm). Not all cells within a GSA may be fully irrigated; there may be a portion of a cell which is fallow, or contains non-irrigated land uses (winter wheat, native vegetation, urban areas). Therefore, the irrigated area of a cell can be used as a weighting factor against the full area of the cell to adjust the effective rates of surface water delivered within a specific cell in a GSA.

For example, if a GSA has a surface water delivery of 30,000 AF in the month of September and the total irrigated area of the GSA is 10,000 acres, then the nominal rate of surface water delivery is 30,000 AF / 30 days = 1,000 AF/D over an irrigated area of 10,000 acres. Going a step further, this becomes (1,000 AF/D) / (10,000 acres) = 0.1 ft/d rate of surface water delivery. For a cell where only half of the area is irrigated, the weighted surface water delivery rate for that cell would be 0.05 ft/d.

Agricultural Irrigation Pumping Demand

Monthly pumping rates for the hypothetical irrigation wells were computed based on crop ETc demand (Section 2.8.2.1) minus the sum of effective precipitation (Section 2.8.1.1), surface water deliveries (Section 2.8.1.2) and Lake Bottom Water Storage (Section 2.8.1.3). The logic behind the calculation of the hypothetical irrigation well pumping rates is summarized below.

For each monthly stress period and each 40-acre model cell:

- Area Weighted Crop Acreage (acres) x Crop ETc (feet per month [ft/m]) = ET Demand (acre-feet per month [AF/M])
- [-ET Demand (AF/M) + Effective Precipitation (ft/m)] / Irrigation Efficiency = -Farm Demand (AF/M)

  (*Note: over most of the model domain, Irrigation Efficiency was assumed to be 75% from 1990 to 2000 and then increase to 85% from 2000 through 2016. Irrigation Efficiency from the lake bottom area was assumed to be 95% from 1990 through 2016. Approximately 50% of excess Effective Precipitation was assumed to infiltrate and 50% was assumed lost to evaporation. Farm Demand is the volume of water needed to irrigate a field and meet crop demand due to inefficiencies in irrigation methods*)
- -Farm Demand (AF/M) + Surface Water Deliveries (AF/M) + Lake Bottom Storage Water (AF/M) = -Unmet Demand (AF/M) and +Tailwater Flow (AF/M)

  (Note: monthly Surface Water Deliveries were summed by GSA and applied to irrigated areas within each GSA. Lake Bottom Water Storage typically occurred only during and following very wet years and was an additional water supply for the ER GSA and TCWA GSA)
- -Unmet Demand (AF/M) + Avg Tailwater Flow/GSA (AF/M) = -Ag Pumping Demand (AF/M) and +Excess Applied Water (AF/M)

  (Note: Tailwater Flows were assumed to stay within each GSA. The monthly Average Tailwater Flow/GSA (AF/M) = Sum of Tailwater flow per GSA (AF/M) divided by GSA irrigated area. Approximately 75% of excess Applied Water was assumed to infiltrate and 25% was assumed lost to evaporation.)

Typically, each hypothetical agricultural irrigation well was assigned a service area (or farm) consisting of 16 model cells totaling 1-square mile (Figure D4-11). The sum of the monthly Ag Pumping Demand (AF/M) for the 16 model cells was assigned to each hypothetical agricultural irrigation well. For some hypothetical agricultural irrigation well the cell count was more or less than 16 model cells due to boundaries no-flow boundaries or to eliminate hypothetical wells servicing only 1 or 2 cells.

In addition, there are several large areas (ER GSA, CID, SWK GSA, TCWA GSA, and Westlands Water District) that were assumed to be operated as single service areas (or farms) with equal access to surface water and pumped groundwater within the service area. Several of the service areas supplied groundwater by wells located within the service area and/or by external well fields outside of the service area. For example, ER GSA is supplied groundwater from wells within the GSA and by the Creighton Ranch well field in the Tule Subbasin. Likewise, both SWK GSA and TCWA GSA are supplied groundwater from a few wells inside the GSAs and by the Angiola well field in the Tule Subbasin. CID and Westlands Water District are assumed to be supplied groundwater from the wells within each service area.

4.5.5 Deep Percolation and Intentional Recharge

Groundwater recharge occurs within the Subbasin from deep percolation of applied water and intentional recharge. Intentional recharge occurs at specific locations including Apex Ranch, CID ponds, and the Old Kings River (Section 2.8.1.4). Deep percolation of applied water occurs almost everywhere in the TLSBHM where there is active irrigation due to inefficient irrigation practices. There are three components to deep percolation including Farm Demand, Excess Applied Water, and Intentional Recharge. Deep percolation is estimated for each monthly stress period and each 40-acre model cell or farm as follows:

- [+Farm Demand (AF/M) / (1-1/Irrigation Efficiency)] + Excess Applied Water (AF/M) + APEX/CID/Condition 8 Intentional Recharge (AF/M) = Deep Percolation (AF/M)

  (*Note: over most of the model domain 75% of Excess Applied Water was assumed to percolate and 25% was assumed to evaporate*)

Deep percolation is applied to the TLSBHM for each stress period and each model cell using the RCH Package.

4.5.6 Subsidence

Land subsidence due to extraction of groundwater was simulated using the MODFLOW Subsidence (SUB) package. The SUB Package simulates elastic (recoverable) compaction and expansion, and inelastic (permanent) compaction of compressible fine-grained beds (interbeds) within the aquifers. The compaction of the interbeds is caused by head or pore-pressure changes (changes in effective stress) within the interbeds. If the stress is less than the pre-consolidation stress of the sediments, the deformation is elastic; if the stress is greater than the pre-consolidation stress, the deformation is inelastic.

The SUB package parameters of:

Sk_e skeletal storage elastic,

Sk_i skeletal storage in elastic,

b_{equiv} combine thickness of delay interbeds within a model layer, and

n_{equiv} combine thickness of non-delay interbeds within a model layer

were derived from CVHM and modified during calibration to approximate observed subsidence during the simulation period.

5.0 Model Calibration

Calibration of a groundwater flow model is a process through which the model is demonstrated to be capable of simulating the field-measured heads and flows that comprise the calibration targets. Calibration is accomplished by selecting a set of model parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field measurements within a pre-established range of error. Because of the multiplicity of parameters involved in the calibration process, a unique solution (e.g., one set of parameters) cannot be achieved. A brief discussion of the calibration of the groundwater flow model for the site is presented in the following subsections.

5.1 Model Calibration Criteria

The quantitative fit of the model to observed water level measurements is conducted through statistical analysis of the residuals, (the difference between observed and simulated water levels or heads) at specified observation locations, and in the case of transient calibration, with time. The residual is calculated as the observed value minus the simulated value; thus, a positive residual indicates that the simulated head value is less than the observed value, and vice-versa. The principal statistical measures of the residuals of all data points combined include the following:

- the mean of the residuals,
- the mean of the absolute value of the residuals,
- the standard deviation of the residuals,
- the sum of the square of the residuals (SSR),
- the root mean square (RMS) error of the residuals,
- the min and max of the residuals,
- the range of the observed values, and
- normalized root mean square error (NRMS) (e.g., the root mean square error divided by the range of observed values or the standard deviation divided by the range in observed values).

There is no industry standard for determining when a numerical model is adequately calibrated. However, a commonly used rule of thumb criterion for acceptable calibration is a normalized RMS error of less than 10% (Anderson et al., 2015). The RMS is the square root of the SSR divided by the number of observations throughout the model divided by the range of observed water level measurements. In addition, a plot of observed versus computed head values should track close to a 45-degree line and generally fall within one standard deviation of the mean error.

A common qualitative (visual) measure of goodness of fit in numerical modeling is a comparison of observe and simulated values using hydrographs for individual wells. In addition, a map view plot of the average residuals may be used to help identify targets or areas where the residuals in the model domain are largest. Clusters or patterns of gradation of positive or negative residuals may suggest areas where model parameters need to be adjusted further.

5.2 1990-2016 Transient Model Calibration

The transient TLSBHM simulated the period January 1990 through December 2016 using 324 monthly stress periods (Table D4-1). The TLSBHM was calibrated to two data sets, one data set covering the 1990-2016 period and a second data set limited to the 1998-2010 “normal hydrology” period.

The 1990-2016 calibration period included 16,468 groundwater level observations collected from 593 observation wells across the model domain. The 1998-2010 “normal hydrology” calibration period included 7,028 groundwater level observations collected from 544 observation wells across the model domain. Most of the observation wells had little or no completion interval information, making it difficult to assign the observations to a particular model layer. Wells with known completion intervals includes 81 wells above the Corcoran Clay and 69 wells below the Corcoran Clay. The other observation wells were assigned to model layers based on the similarity of observations with nearby known wells. Although additional observation wells with groundwater elevation measurements are available, many were determined to have too short a record, too many spurious observations, or uncertain completion intervals and hence were not utilized.

Numerous model iterations were needed to calibrate the TLSBHM model. Various hydraulic parameters (K_h, K_v, S_s, S_y) and boundary conditions (RCH, GHB heads, RIV conductance) were incrementally modified using the manual trial and error method.

The calibration statistics for the entire 1990-2016 historical simulation period include a residual mean of -4.98 feet, a RMS error of 50.85 feet, a range of 575.33 feet, and a NRMS of 8.84 %, meeting the calibration criteria of a NRMS of <10% (Figure D5-1a). A scattergram of observed and simulated values shows that many values fall within one standard deviation of the perfect 45-degree fit. A residual distribution chart shows that the residual error approximates a gaussian distribution with a slight bias to over predicting heads.

The calibration statistics for 1998-2010 "normal hydrology" calibration period include a residual mean of 2.26 feet, a RMS error of 46.26 feet, a range of 545.16 feet, and a NRMS of 8.50 %, slightly better than for the 1990-2016 period, and meeting the calibration criteria of a NRMS of <10% (Figure D5-1b). A scattergram of observed and simulated values shows that most values are closer to the perfect 45-degree fit compared to the 1990-2016 period. A residual distribution chart shows that the residual error approximates a gaussian distribution with a slight bias to over predicting heads.

A qualitative comparison of observed and simulated heads in selected monitoring wells using hydrographs shows a reasonable fit for several wells, and poor fits for others (Figures D5-2a through D5-2g). In general, the hydrographs show that simulated heads are slightly under predicted above the Corcoran Clay (Figures D5-2a to D5-2c). Within the Corcoran Clay, the hydrographs show that simulated heads tend to start out lower than observed during the ramp-up period but end up with a relatively good fit after 1998 (Figure D5-2d). Below the Corcoran Clay, the hydrographs show that simulated heads are generally on trend with the observed, although seasonal variations are not simulated very well (Figures D5-2e to D5-2g). Observed and simulated heads in selected all monitoring wells used for model calibration are provided in Appendix D5.

Simulated potentiometric surface maps with groundwater flow vectors from above and below the Corcoran Clay show how the general direction of groundwater flow between the subbasins for December 2015 (Figure D5-3). In general, above the Corcoran Clay, simulated groundwater flow is entering the Subbasin from the north, east, and south, and leaving the Subbasin to the west. Below the Corcoran Clay, simulated groundwater flow is also entering the Subbasin from the north. The simulation results also show consistent cones of depression above the Corcoran Clay around pumping centers beneath the cities of Hanford, Lemoore, and Corcoran. There is also a large, persistent cones of depression beneath CID and lake bottom well fields southeast of the City of Corcoran and along the border between the Tulare Lake and Tule subbasins.

The maps also show that there is a large area in the lake bottom area where groundwater appears to be mounding slightly and the groundwater flow vectors show little movement of groundwater above and below the Corcoran Clay (Figure D5-3). This area has been described as being under lain by an extensive sequence of lacustrine and marsh deposits (i.e., Tulare Lake bed "clay plug") which are relatively impervious. Thus, the apparent mounding may result from a zone of residual high heads that are draining more slowly than surrounding areas as groundwater levels are being drawn down due to pumping, recharge to the lake bottom, or it could result as a combination of both.

5.3 1990-2016 Water Balance Calculations

The calibrated transient TLSBHM was used to estimate the groundwater flows that occur between the Subbasin and the adjoining subbasins (Figure D2-2). The following subsection present water balances 1990-2016 simulation period and the 1998-2010 “normal hydrology” period for the Subbasin itself, as well as for each adjoining subbasin, and net flows between the Subbasin can be extracted from these results. Note that the protrusion of the Kaweah Subbasin boundary into the Subbasin and the presence of large wellfields near subbasin boundaries complicate the assessment of inter-basin flows.

5.3.1 Tulare Lake Subbasin

The 1990-2016 annualized net water balance for the Subbasin shows that overall there is a long-term net outflow of groundwater from the Subbasin to the Kings, Kaweah and Tule subbasins (Table D5-1, Figure D5-4), while there is a long-term net inflow of groundwater from the Westside and Kern subbasins. These overall results can be disaggregated to subbasin interactions above and below the Corcoran Clay. Above the Corcoran Clay, there is a net outflow of groundwater from the Subbasin to the Kings, Kaweah, and Tule subbasins, and a net inflow of groundwater from the Westside and Kern subbasins. Below the Corcoran Clay, there is a net outflow of groundwater from the Subbasin to the Westside, Kings, Kaweah and Tule subbasins and a net inflow of groundwater from the Kern Subbasin. The inflows and outflows of groundwater from below the Corcoran Clay are greater than those from above the Corcoran Clay.

The change in storage in the Subbasin has varied from year to year depending on the water year type. Between 1990 and 2016, the estimated change in storage has ranged from -392,280 AF (2015) to 361,230 AF (2011) and averaged -85,690 AF/Y. During 1990-2016, the estimated cumulative change in storage was about -2,313,740 AF. During the 1998-2010 “normal hydrology” period, the estimated change in storage has ranged from about -220,650 AF (2006) to -296,280 AF (2008) and averaged -73,770 AF/Y. During the 1998-2010 period, the estimated cumulative change in storage was about -958,940 AF.

5.3.2 Westside Subbasin

Annualized net water balance for the portions of the Westside Subbasin within the model domain shows that there is a long-term net outflow from the Westside Subbasin to the Tulare Lake and Kings subbasins (Figure D5-5). In general, the long-term outflow from the Westside Subbasin to the Subbasin is greater than that from the Kings Subbasin above the Corcoran Clay, while the long-term inflow to the Westside Subbasin from the Subbasin is less than that from the Kings Subbasin below the Corcoran Clay. The potentiometric surface maps (Figure D5-3) show that the outflow of groundwater from the Subbasin is due to both pumping in the Westside Subbasin and leakage from the South Fork of the Kings River.

The change in storage for the portions of the Westside Subbasin within the model domain has varied from year to year depending on the water year type. Between 1990 and 2016 the estimated change in storage has ranged from -425,290 AF (1990) to 103,573 AF (1998) and averaged -84,070 AF/Y. During 1990-2016 the estimated cumulative change in storage was about -2,269,800 AF. During the 1998-2010 “normal hydrology” period the estimated change in storage has ranged from -177,600 AF (2008) to 103,573 AF (1998) and averaged about -47,080 AF/Y. During the 1998-2010 period the estimated cumulative change in storage was about -612,040 AF.

5.3.3 Kings Subbasin

Annualized net water balance for the portions of the Kings Subbasin within the model domain shows that there is a long-term net groundwater inflow to the Kings Subbasin from the Tulare Lake, Westside, and

Kaweah subbasins (Figure D5-6). In general, the groundwater inflow to the Kings Subbasin from the Tulare Lake and Kaweah subbasins is from both above and below the Corcoran Clay, while there is a net outflow from the Kings Subbasin to the Westside Subbasin below the Corcoran Clay. The potentiometric surface maps (Figure D5-3) show that above the Corcoran Clay, the outflow of groundwater from the Subbasin is primarily due to leakage from the Kings River. Below the Corcoran Clay, the outflow of groundwater from the Subbasin to the Kings Subbasin is due to leakage from the Kings River (where the Corcoran Clay is not present).

The change in storage for the portions of the Kings Subbasin within the model domain has varied from year to year depending on the water year type. Between 1990 and 2016, the estimated change in storage has ranged from -229,310 AF (2015) to 74,030 AF (1998) and averaged -68,220 AF/Y. During 1990-2016, the estimated cumulative change in storage was about -1,841,980 AF. During the 1998-2010 "normal hydrology" period, the estimated change in storage has ranged from -162,950 AF (2004) to 74,030 AF (1998) and averaged about -66,520 AF/Y. During the 1998-2010 period, the estimated cumulative change in storage was about -864,720 AF.

5.3.4 Kaweah Subbasin

Annualized net water balance for the portions of the Kaweah Subbasin within the model domain shows that there is a long-term net groundwater inflow to the Kaweah Subbasin from the Tulare Lake and Tule subbasins and a long-term net groundwater outflow to the Kings Subbasin (Figure D5-6). In general, the groundwater outflow from the Tule Subbasin is greater than that from the Subbasin above the Corcoran Clay, while the outflow from the Subbasin is greater than that from the Tule Subbasin below the Corcoran Clay. The potentiometric surface maps (Figure D5-3) show that a portion of the Kaweah Subbasin protrudes into the Subbasin. This complicates the calculation of inter-basin groundwater flow because there is both inflow and outflow between the Tulare Lake and Kaweah subbasins through this area. In addition, there is outflow of groundwater from the Kaweah Subbasin to the Subbasin due to well field pumping in the area near the City of Corcoran.

The change in storage for the portions of the Kaweah Subbasin within the model domain has varied from year to year depending on the water year type. Between 1990 and 2016, the estimated change in storage has ranged from -317,310 AF (2014) to 31,300 AF (2011) and averaged -156,640 AF/Y. During 1990-2016, the estimated cumulative change in storage was about -4,229,350 AF. During the 1998-2010 "normal hydrology" period, the estimated change in storage has ranged from -239,860 AF (2004) to -2,110 AF (1998) and averaged about -128,390 AF/Y. During the 1998-2010 period, the estimated cumulative change in storage was about -1,669,020 AF.

5.3.5 Tule Subbasin

Annualized net water balance for the portions of the Tule Subbasin within the model domain shows that there is a log-term net groundwater inflow to the Tule Subbasin from the Tulare Lake and Kern subbasins and a log-term net groundwater outflow from the Tule Subbasin to the Kaweah Subbasin (Figure D5-8). In general, the flow from the Subbasin is greater than that from the Kaweah Subbasin both above and below the Corcoran Clay, with greater groundwater flow below the Corcoran Clay. The potentiometric surface maps (Figure D5-8) show that the outflow of groundwater from the Subbasin is primarily due to pumping wellfields southeast of the City of Corcoran and a pumping center east of the model domain in the vicinity of the City of Pixley.

The change in storage for the portions of the Tule Subbasin within the model domain has varied from year to year depending on the water year type. Between 1990 and 2016, the estimated change in storage has ranged from -247,850 AF (1990) to -1,820 AF (2011) and averaged -143,770 AF/Y. During 1990-2016, the estimated cumulative change in storage was about -3,881,750 AF. During the 1998-2010 "normal hydrology" period, the estimated change in storage has ranged from -224,920 AF (2008) to -46,570 AF (2006) and averaged about -140,900 AF/Y. During the 1998-2010 period, the estimated cumulative change in storage was about -1,831,680 AF.

5.3.6 Kern Subbasin

Annualized net water balance for the portions of the Kern Subbasin within the model domain shows that there is a long-term net groundwater outflow from the Kern Subbasin to the Tulare Lake and Tule subbasins (Figure D5-9). In general, the outflow from the Kern Subbasin to the Subbasin is greater than that to the Tule Subbasin both above and below the Corcoran Clay, with greater groundwater flow below the Corcoran Clay. The potentiometric surface maps (Figure D5-3) show that the outflow of groundwater above the Corcoran Clay from the Subbasin to the Kern Subbasin. Starting in the mid-2000s, the groundwater flow filed above the Corcoran Clay reversed and there was a net inflow from the Kern Subbasin to the Subbasin. Below the Corcoran Clay, the water balance charts and potentiometric surface maps show a general decline in the outflow of groundwater from the Subbasin to the Kern Subbasin.

The change in storage for the portions of the Kern Subbasin within the model domain has varied from year to year depending on the water year type. Between 1990 and 2016, the estimated change in storage has ranged from -97,940 AF (2013) to 64,860 AF (2011) and averaged -17,490 AF/Y. During 1990-2016, the estimated cumulative change in storage was about -472,140 AF. During the 1998-2010 "normal hydrology" period, the estimated change in storage has ranged from -84,350 AF (2008) to 64,860 AF (1999) and averaged about -10,950 AF/Y. During the 1998-2010 period, the estimated cumulative change in storage was about -141,330 AF.

5.3.7 Groundwater Storage

The change in storage in the Subbasin has varied from year to year depending on the water year type. Between 1990 and 2016, the estimated change in storage has ranged from -392,280 AF (2015) to 361,230 AF (2011) and averaged -85,690 AF/Y. During the 26-year 1990-2016 simulation period, the estimated cumulative change in storage was about -2,313,740 AF (Table D5-1, Figure D5-4). During the 1998-2010 "normal hydrology" period, the estimated change in storage has ranged from about -220,650 AF (2006) to -296,280 AF (2008) and averaged -73,770 AF/Y. During the 13-year 1998-2010 "normal hydrology" period, the estimated cumulative change in storage was about -958,940 AF.

The simulated groundwater mass balance data were used to estimate the change in groundwater storage in the Subbasin on an annual basis for the simulation period. The simulation results indicate that between 1990 and 2016, the estimated annual change in storage averaged -85,690 AF/Y while during the 1998-2010 "normal hydrology" period, the estimated annual change in storage averaged -73,770 AF/Y or about 14 % less than the 1990-2016 period. Likewise, the estimated net cumulative change in storage for the 26-year 1990-2016 period was about -2,313,740 AF while the estimated net cumulative change in storage for the 13-year 1998-2010 period was about –958,940 AF or almost 60% less than during the 1990-2016 period. Note that following the wet years of 1995-1998, 2005-2006, and 2010-2011, there was a small net increase in groundwater storage in the Subbasin (Table D5-1, Figure D5-4). This indicates that the Subbasin is relatively sensitive to water year type, and that during wet years, there can be a significant increase in the amount of groundwater in storage. Likewise, as shown on Figure D5-4, extended drought periods (like 2011-2016) can results in a significant loss of groundwater in storage.

5.3.8 Subsidence

Simulated cumulative land subsidence due to extraction of groundwater was simulated for the period 1990-2015 (Figure D5-10). Throughout most of the Subbasin, simulated cumulative subsidence was less than 2 feet. However, in the vicinity of the wellfields southeast of Corcoran in the Tule Subbasin, simulated subsidence was over 9 feet. The simulation results also indicate up to 4 feet of subsidence in the Westside, Kaweah, and Kern subbasins. Charts of simulated subsidence over time was also calculated for the major municipal and agricultural wellfields in the TLSBHM (Figure D5-11). These charts show that there was 1 to 2 feet of cumulative subsidence in the vicinity of Hanford, Lemoore, and Stratford, while there was about 5 feet of subsidence at Corcoran, and up to 9 feet of subsidence at the Angiola and Creighton Ranch well fields in Tule Subbasin. The charts also show a small seasonal pattern of elastic subsidence rebound. During the early simulation period (1990-1992), the simulated subsidence occurred at all locations and then stabilized from 1993 through 2001. Simulated subsidence at that time started to increase again after 2002 in a series of steps. Additional calibration of the model to subsidence is needed as more data are collected.

6.0 Sensitivity Analysis

A sensitivity analysis was conducted to evaluate the sensitivity of the model to a change in the estimated hydraulic conductivity and storage parameters. These values in the model were systematically modified over the plausible range of values for the sediment types present beneath the site, and the model was re-run. The sensitivity model run results were compared to the calibration model result to estimate the change in model calibration due to the change in the model parameter.

The sensitivity analysis results indicate that the aquifers above and below the Corcoran Clay are relatively sensitive to changes in K_h, while the Corcoran Clay is not sensitive, as shown by the change (delta) in the sum of square residual (Figure D6-1). The results indicate that little improvement in calibration could be expected by modifying the K_h parameters.

The model sensitivity is reversed with respect to K_v, with the Corcoran Clay heads relatively sensitive to changes in K_v, while the aquifers above and below the Corcoran Clay are relatively insensitive (Figure D6-1). The results indicate that a small improvement in calibration could be obtained by decreasing the K_v above the Corcoran Clay.

The sensitivity analysis results indicate that the model is also relatively sensitive to changes in aquifer S_s, with the change in sum of squares error increasing with lower values of storage (Figure D6-1). A small improvement in calibration could be obtained by decreasing the S_s above the Corcoran Clay.

The sensitivity analysis results indicate that the model is also relatively in sensitive to changes in the Sy of the unconfined aquifer above the Corcoran Clay, with the change in sum of squares error decreasing with lower values of S_y (Figure D6-1).

7.0 Predictive Simulations

The calibrated groundwater flow model was modified to develop two 54-year transient predictive simulations from 2017 through 2070: (1) a Baseline Forecast to evaluate potential undesirable impacts from maintaining the recent land use under "normal hydrology" conditions (i.e., the status quo); and

(2) a Projects Forecast to evaluate potential impacts of implementing alternative land uses and projects to obtain groundwater sustainability. Both forecast models consist of 649 monthly stress periods starting with December 2016 and ending with December 2070. The SGMA requires that any forecast model start with current conditions. The models were started in December 2016 to permit the importation of the calibration simulations results as the start for the forecast models. The forecast models assume multiple repeating 14-year cycles of "normal hydrology" (e.g., precipitation, stream flow, surface water deliveries, and boundary conditions) from 1998 to 2010 (Figure D7-1), starting with using 2011 hydrology as an analog for 2017, which was a wet year. A summary of the forecast year and associated "normal hydrology" analog year is presented on Table D7-1. The forecast models were developed as described in the following subsections.

7.1 Baseline Forecast Scenario

The TLSBHM Baseline Forecast model represents conditions that assume land use recovering from the 2010-2015 drought conditions to "normal hydrology" conditions in the first few years of the simulation and maintaining these "normal hydrology conditions for the duration of the simulations. The Baseline Forecast model were developed as described below.

7.1.1 Baseline Forecast Land Use

A review of historical land use shows that major cropping acreage patterns have changed significantly over the past decades (Table D2-6, Figure D2-12). Acreage of cotton, pasture, and dairy fodder decreased, especially during the 2011-2016 drought. During this same period, acreage of almonds, pistachios, pomegranates, and fallow land increased. Note that the more recent plantings of almonds, pistachios, pomegranates have not yet reached maturity and associated increased water demand (Section 4.5.4.2).

During this early Baseline Forecast stress period, the acreage of corn and cotton that had been fallowed during the drought was assumed to be replanted, except for the acreage that had been converted to permanent crops. In addition, the water demand of more recently planted acreage of almonds, pistachios, and pomegranates was assumed to increase as the trees matured as discussed in Section 4.5.4.2.

For crop maturation, tree crops are assumed to continue to mature on a 25-year cycle (except for pistachios which can produce for over 100 years) and continuously mature forward in time. All other crops/land use is assumed to revert to whatever the land use was in the seed year for that particular forecast year. For example, assume there is a new patch of almonds planted in 2016 (crop zone 201). In 2021, it will be in its sixth year of existence, so it's assigned the ET rate of 6-year old almonds (crop zone 206). The other crops around this patch of almonds will revert to whatever was planted there in 2001, since 2001 is the seed year for the forecast year 2021. Three years from then, the patch of almonds is now mature and assigned an ET rate for mature almonds (crop zone 209), while the nearby crops are represented by seed year 2004 (corresponding to 2024). Further into the forecast, the almonds will be in their 25th year of existence in 2041 (crop zone 225), while the surrounding crops will be represented by seed year 2007. That same patch of almonds will be replaced, cycle back to being represented by 1st year almond ET rates (crop zone 201), and since it is 2042, the other crops are represented by whatever was planted in 2008. A chart of Baseline Forecast crop acreage is presented on Figure D7-2. Note that the crop acreage chart shows a repeating cycle of replanting of permanent tree crops.

7.1.2 Baseline Forecast Municipal Pumping

Baseline Forecast municipal water demand for the cities of Hanford, Lemoore, and Corcoran were assumed to vary seasonally at the average of 2011-2015 pumping rates. Municipal pumping was assumed to increase slowly with populations growth at a rate of 0.35% per year from about 25,060 AF (2017) to about 30,160 AF (2070).

7.1.3 Baseline Forecast Hypothetical Irrigation Pumping

As discussed in Section 4.5.4.2, the calibration model utilized the available groundwater pumping data for the individual wells and well fields servicing the ER GSA, CID, SWK GSA, TCWA GSA, and Westlands Water District, which allowed these areas to be treated as individual service area or “farms” (Figure D4-11). In the rest of the model domain, the agricultural pumping demand was calculated on approximately 40-acre spacing and assigned to hypothetical agricultural wells on approximately a 1-miles spacing. A similar process was utilized for the forecast models with a few modifications as described below.

For the forecast models, the service area or “farm” concept was extended throughout model domain by dividing the model by subbasin and GSAs into 10 services areas or “farms” (Figure D7-3). For each service area, the monthly agricultural pumping demand was calculated as follows:

- Service Area Weighted Crop Acreage (acres) x Crop ETc (ft/m) = Service Area ET Demand (AF/M)
- [-Service Area ET Demand (AF/M) + Effective Precipitation (ft/m)] / Irrigation Efficiency = -Service Area Farm Demand (AF/M)

  (*Note: over most of the model domain, Irrigation Efficiency was assumed to be 85% from 2017 to 2070. In the lake bottom area Irrigation Efficiency from was assumed to be 95% from 2017 through 2070. Approximately 50% of excess Effective Precipitation was assumed to infiltrate and 50% was assumed lost to evaporation).*
- -Service Area Farm Demand (AF/M) + Service Area Surface Water Deliveries (AF/M) + Service Area Lake Bottom Storage Water (AF/M) +Service Area Project Water (AF/M) = -Service Area Ag Pumping Demand (AF/M)

  (Note: when monthly Service Area water supplies exceeded monthly Service Area Farm Demand the excess water supply was assumed to carry over as available water supply in the following month).

The resulting service area agricultural pumping demand was then divided equally amongst the wells and well fields suppling groundwater to each servicing area. However, pumping from the Westlands Water District, CID, ER GSA, Creighton Ranch, and Angiola wells fields was limited to the maximum historical pumping from each well field (although not necessarily for each well). While this approach many not replicate the individual historical pumping from each well in a service area, it does provide a reasonable approach to allocate forecast groundwater agricultural pumping in each service area and thus a reasonable estimate of groundwater system demand.

7.1.4 Baseline Forecast GHBs

As shown on Table D7-1, the Baseline Forecast uses historical years as analogs for the hydrology conditions in the forecast. For example, 2019 is assumed to have hydrology similar to 1999. However, the GHB heads in 1999 are many feet higher than those in 2016 when the Baseline Forecast model starts. To correct for this head discrepancy, the general head boundaries for the Baseline Forecast model were developed by calculating the difference in monthly heads for each stress period of the calibration simulation, and then adding that difference to the forecast GHB head from the previous month. This allows the Baseline Forecast GHBs to have a similar change in heads between stress periods as the calibration model, but from a different initial (2016) elevation. For example, the Baseline Forecast GHB heads for simulation year 2019 are based on the heads difference for the analog year 1999. If the head difference for GHB cell 1001 between December 1998-January 1999 was 0.55 feet in the calibration model, then 0.55 feet was added to the GHB cell 1001 head for the December 2018 to yield the January 2019 GHB head. Thus the resulting Baseline Forecast GHBs exhibit a change in heads similar to that for the calibration model analog year, but from a different initial condition.

7.1.5 Baseline Forecast of Climate Change

The SGMA guidelines require that climate change be considered in any forecasts of future land uses. The California Natural Resources Association (CNRA) has developed a set of tools that can apply change factors to historical precipitation, ET demand, and surface water delivery data to make historical data consistent with forecasted conditions under climate change. The CNRA has developed two climate change factor data sets, one for 2030 and one for 2070.

7.1.5.1 Effective Precipitation

The Baseline Forecast monthly effective precipitation data set was processed through the CNRA python script/ArcGIS tool. The tool takes monthly data and processes it using change factors, which vary temporally and spatially. For model cells that cross multiple change factor grid cells, an area-weighted average change factor is applied. The change factors for a 2030 forecast were used for the forecast period January 2017-Dececember 2030 (stress periods 2 – 169) while the change factors for a 2070 forecast were used for the forecast period January 2031-December 2070 (stress periods 170 – 649).

7.1.5.2 Crop Evapotranspiration

The Baseline Forecast monthly ETc data set was processed through the CNRA python script/ArcGIS tool. The tool takes monthly data and processes it using change factors, which vary temporally and spatially. Since the "normal hydrology" Baseline Forecast scheme rotates through a series of years from 1997 to 2010 (with a 2011-based year for 2017), each ET distribution for the Baseline Forecast is unique when accounting for tree crop maturation. For model cells that cross multiple change factor grid cells, an area-weighted average change factor is applied. The change factors for a 2030 forecast were used for the forecast period January 2017-December 2030 (stress periods 2 – 169) while the change factors for a 2070 forecast were used for the forecast period January 2031-December 2070 (stress periods 170 – 649).

7.1.5.3 Surface Water Deliveries

The Baseline Forecast surface water delivery data set incorporates a reduction in historical surface water allocations to SWK GSA and TCWA GSA due the sale of water rights. The Baseline Forecast surface water delivery data set all GSAs outside of the Subbasin were not modified. CNRA change factors for surface water deliveries do not vary spatially, and are simply a multiplier applied to the historical surface water delivery volume. Different change factors are available for 2030 and 2070 climate change forecasted conditions. Like the effective precipitation and ETc data sets, the 2030 change factors were used for the forecast period January 2017-December 2030 (stress periods 2 – 169) while the change factors for a 2070 forecast were used for the forecast period January 2031-December 2070 (stress periods 170 – 649). The Baseline Forecast of surface water deliveries is shown on Figure D7-4.

7.1.6 Baseline Forecast Simulation Results

A comparison of simulated potentiometric surface maps from above and below the Corcoran Clay for December 2015 (Figure D5-3) with simulated Baseline Forecast potentiometric surface maps from above and below the Corcoran Clay for June 2040 (Figure D7-5) show that the groundwater elevations beneath the Subbasin above and below the Corcoran clay are projected to decline about 25 feet and 50 feet, respectively during the 25-year simulation period. Dewatered areas in the upper aquifer on the east side of the model domain (mostly in the Kaweah and Tule subbasins) are projected to expanded and migrate into deeper intervals. The cones of depression above and below the Corcoran Clay in the Lemoore, Creighton Ranch, and Angiola Water District well field areas are projected to become more pronounced.

Simulated Baseline Forecast potentiometric surface maps from above and below the Corcoran Clay for December 2070 (Figure D7-6) show that the groundwater elevations beneath the Subbasin above and below the Corcoran clay are projected to decline about 50 feet and 150 feet, respectively, during the 54-year simulation period. Dewatered areas in the upper aquifer in the Kaweah and Tule subbasins are projected to expanded significantly and migrate into deeper intervals. The cones of depression above and below the Corcoran Clay in the Westside Subbasin, Creighton Ranch, and Angiola well field areas are projected to become much more pronounced.

Simulated Baseline Forecast hydrographs for selected compliance wells in the vicinity of the cities of Corcoran, Hanford, and Lemoore show a continued gradual decline in groundwater elevations in the unconfined aquifer above and below the Corcoran Clay, with seasonal variations much greater below the Corcoran Clay (Figure D7-7). Over the 54-year simulation period, the hydrographs above the Corcoran Clay show approximately 100 feet of decline in the Corcoran area, about 90 feet of decline in the Hanford area, and about 100 feet of decline in the Lemoore area. Over the same period, the hydrographs below the Corcoran Clay show about 100 feet of decline in the Corcoran area, about 100 feet of decline in the Hanford area, and about 100 feet of decline in the Lemoore area.

The Baseline Forecast simulation results indicate that subsidence will continue over the next 54 years under continued existing conditions. A map of cumulative subsidence from 2017-2040 shows that the is about 0 to 4 feet of additional subsidence over most of the Subbasin, with up to 6 feet of additional subsidence in the Lemoore area and Angiola and Creighton Ranch wells fields in the Tule Subbasin (Figure D7-8). Baseline Forecast subsidence in the lake bottom area are minimal. A map of cumulative subsidence from 2017-2070 shows that the is about 0 to 8 feet of additional subsidence over most of the Subbasin, with up to 10 feet of additional subsidence in the Lemoore area and over 10 feet of subsidence in the Angiola and Creighton Ranch wells fields in the Tule Subbasin (Figure D7-8).

Simulated Baseline Forecast subsidence hydrographs for continuous GPS compliance point near the cities of Corcoran and Lemoore wells show that under continued existing conditions, subsidence rate remain consistent during the forecast period (Figure D7-8). The minimum threshold for subsidence was specified as 11.5 feet, which was the maximum simulated subsidence within the TLSBHM domain in 2070.

The Baseline Forecast simulation groundwater mass balance data were used to estimate the change in groundwater storage in the Subbasin on an annual basis for the 54-year forecast simulation period (Figure D7-9). Similar to the 1998-2010 "normal hydrology" period in the calibration model, the period 2040-2048 represents a "normal" or "hydrologically balanced" period in the forecast model. Under the Baseline Forecast assumptions described above, the 2040-2408 "hydrologically balanced period" annual change in groundwater storage averaged about -149,430 AF/Y. During the 2017-2070 period, the annual change in groundwater storage averaged about -142,990 AF/Y, and as much as -7.72 million AF of cumulative storage depletion from the Subbasin.

In summary, the Baseline Forecast simulation results indicate continued overdraft conditions in the Subbasin, with chronic lowering of groundwater levels, continued reduction of groundwater in storage, continued land subsidence, and possibly degraded groundwater quality. Thus, the Baseline Forecast indicates that sustainable groundwater conditions in the Subbasin cannot be achieved without changes in groundwater usage and management.

7.2 Forecast Project Simulations

Multiple Projects Forecast simulations were created iteratively by modifying the Baseline Forecast and incorporating various potential projects and management actions developed by the GSAs for the Subbasin and surrounding subbasins (see Section 7.6) (Figure D7-10). The objectives of the projects and management actions are to obtain groundwater sustainability (defined as stable groundwater elevations with minimal changes in storage, land subsidence, and water quality degradation over time) by 2040 through a combination of increase water supplies and demand reduction.

Potential projects and management actions considered include:

- Above ground surface water storage projects,
- Intentional recharge basins,
- On-Farm Recharge,
- Aquifer Storage and Recovery (ASR), and
- Agricultural pumping limits in surrounding subbasins.

The combined projects were assumed to provide an annual average of 40,500 AF/Y of increases water supply and 38,000 AF/Y of groundwater recharge for a total of about 78,500 AF/Y of new water supply (Table D7-2, Figure D7-11). This is slightly more than the average overdraft (-73,760 AF/Y) observed during the 1998-2010 “normal hydrology” period and about 92% of the 1990-2016 average overdraft (-85,690 AF/Y). In addition, land use changes resulting from construction of the projects are anticipated to reduce agricultural demand by approximately 26,900 AF/Y. In total, the proposed project may yield an average of up to 104,400 AF/Y of additional water supply to the Subbasin. The proposed projects are described below by Subbasin GSAs.

Mid-Kings River Groundwater Sustainability Agency

The Mid-Kinks River GSA has proposed constructing several 40-80 acre groundwater recharge facilities in the GSA. For modeling purposes, the proposed recharge facility was assumed to be constructed on about 1,500 acres of land in the northeast portion of the GSA (Figure D7-10). The simulated facility was implemented in four 5-year phases starting in 2020. Full build out would be completed in 2035. Due to conversion of irrigated crop land to recharge basins, the recharge facility construction is estimated to result in a permanent annual agricultural demand reduction of about 4,500 AF once completed. The facility was assumed to recharge Kings River flood waters with an assumed percolation rate of approximately 1-foot per day for a 150-day period from March through July when flood waters are typically available based on the historical hydrology cycles used to construct the forecast (Figure D7-11). Flood water were assumed to be available about every 6 to 7 years. Total recharge capacity would increase in 5-year phases from an initial 50,000 AF to an estimated 200,000 AF during flood years when fully built out. Annual average project yield is estimated to be about 38,000 AF/Y over the simulation period, and about 44,440 AF/Y over the hydrologically balanced 2040-2048 period (Table D7-2). Intentional recharge was simulated in the Projects Forecast using the RCH package.

El Rico Groundwater Sustainability Agency

The ER GSA has proposed constructing an intermittent surface water storage facility to store Kings River flood water when available (Figure D7-10). The proposed surface water storage facility was assumed to be constructed by 2030 using raised 6-foot berms to enclose approximately 6,400 acres of land. The land would continue to be farmed during non-flood years, so the net average agricultural demand reduction is estimated to be about 8,400 AF/Y. The surface water storage facility was assumed to store approximately 40,000 AF of Kings River flood waters at a rate of about 8,000 AF/M during a 150-day period from March through July when flood water are typically available based on the historical hydrology cycles used to construct the forecast (Figure D7-11). Because of the clayey nature of the Lake Bottom sediments, infiltration of storage water was assumed to be de minimis. Annual average project yield is estimated to be about 8,780 AF/Y over the simulation period, and 8,890 AF/Y over the hydrologically balanced 2040-2048 period (Table D7-2). This additional surface water supply was added to the Baseline Forecast surface water deliveries for the ER GSA.

South Fork Kings Groundwater Sustainability Agency

The SFK GSA has proposed a number of small projects including aquifer storage and recovery (ASR) wells, new surface water storage facilities, and land fallowing. The potential projects for SFK GSA were very conceptual in nature. The location of the potential ASR well field(s) and potential recharge and recovery rates has not been identified. The locations of potential surface water storage facilities and land fallowing areas were also undefined. Hence, for forecast modeling purposes, a single large surface water storage facility was assumed to be constructed in the southeast portion of the GSA (Figure D7-11). The simulated surface water storage facility was assumed to be constructed by 2030 using raised 6-foot berms to enclose approximately 10,000 acres of land. Approximately half of this land was assumed to already be fallow, so the net agricultural demand reduction is estimated to be about 15,000 AF/Y after 2030. Because of the clayey nature of the sediments in this area, infiltration of storage water was assumed to be de minimis. The surface water storage facility was assumed to store approximately 60,000 AF of Kings River flood waters at a rate of about 12,000 AF/M from March through July when flood water are typically available based on the historical hydrology cycles used to construct the forecast (Figure D7-11). Annual average project yield is estimated to be about 13,170 AF/Y over the simulation period, and 13,330 AF/Y over the hydrologically balanced 2040-2048 period (Table D7-2). This additional surface water supply was added to the Baseline Forecast surface water deliveries for the SFK GSA.

Tri-County Water Authority Groundwater Sustainability Agency

The TCWA GSA has proposed constructing a new surface water storage facility over the middle portion of the GSA (Figure D7-11). The simulated surface water storage facility was assumed to be constructed by 2030 using raised 6-foot berms to enclose approximately 13,340 acres of fallow land, so there was no net agricultural demand reduction. Because of the clayey nature of the sediments in this area, infiltration of storage water was assumed to be de minimis. The surface water storage facility was assumed to store approximately 80,000 AF of Kings River flood waters at a rate of about 16,000 AF/M from March through July when flood water are typically available based on the historical hydrology cycles used to construct the forecast (Figure D7-11). Annual average project yield is estimated to be about 17,561 AF/Y over the simulation period, and 17,780 AF/Y over the hydrologically balanced 2040-2048 period (Table 7-2). This additional surface water supply was added to the Baseline surface water deliveries for the TCWA GSA and SWK GSA.

Surrounding Subbasins Projects

As shown on Figure D2-2, the Subbasin is surround by the Westside, Kings, Kaweah, Tule, and Kern subbasins. It was assumed that these surrounding subbasins would also implement projects similar in scope and yield as those proposed for the Subbasin in order to obtain groundwater sustainability. Since all the surrounding subbasins were developing potential projects as part of their GSPs, there was insufficient time to coordinate with the surrounding subbasins and implement their proposed projects into the TLSBHM Projects Forecast model. Therefore, for simplicity, it was assumed that each surrounding subbasins would implement projects that would yield additional surface water supplies similar to what is proposed for the Subbasin, or approximately 75% of the 1990-2016 annual average change in storage estimated for that portion of each subbasin within the TLSBHM (Figures D5-4 through D5-9). It was further assumed, for simplicity, that the surrounding subbasin projects would be implement outside of the TLSBHM model domain and that the additional water supply would be imported into the TLSBHM domain as addition surface water deliveries. The assumed surrounding subbasin additional water supplies include:

- Westside Subbasin 60,330 AF/Y
- Kings Subbasin 50,960 AF/Y
- Kaweah Subbasin 114,400 AF/Y
- Tule Subbasin 104,220 AF/Y
- Kern Subbasin 35,720 AF/Y

This additional surface water supply was added to the Baseline surface water deliveries for each of the surrounding subbasins.

Surrounding Subbasins Pumping Limits

Another management option under consideration by the surrounding subbasins is a limitation of groundwater pumping to a prescribed number of acre-feet per acre of irrigated land. Based on review of draft GSPs and discussions with other GSA the pumping limits under consideration include:

Subbasin	GSA	Irrigated Acres in Model	Pumping Limit (af/ac)	Agricultural Pumping (AF/Y)
Kaweah	All	127,870	2.00	255,740
Kings	Central Kings	16,170	1.13	18,275
Kings	Kings River East	15,800	0.73	11,530
Kings	North Fork Kings	41,864	1.10	46,050
Kern	--	36,190	1.00	36,190
Tule	--	79,920	0.54	43,160
Westside	--	62,920	0.60	37,750

The prescribed pumping limit volumes were assumed to be uniformly distributed between all agricultural wells in each subbasin within the model domain.

7.2.1 Projects Forecast Land Use

Land use under the Projects Forecast is identical to that used in the Baseline Forecast with the exception that lands utilized for most of the Subbasin projects was assumed to go out of production as the projects are built out over time, resulting in a step-wise decrease in agricultural demand (Figure D7-10).

Land fallowing in the surrounding subbasins resulting from implementation of pumping limits was not explicitly simulated in the model. Only the reduction in agricultural pumping was specified in the forecast model.

7.2.2 Projects Forecast Municipal Pumping

The Project Forecast municipal water demand for the cities of Hanford, Lemoore, and Corcoran is identical to that used in the Baseline Forecast. Municipal pumping was assumed to increase slowly with populations growth at a rate of 0.35% per year from about 25,060 AF (2017) to about 30,160 AF (2070).

7.2.3 Projects Forecast Hypothetical Irrigation Pumping

The Projects Forecast of agricultural irrigation pumping was calculated in an identical manner as for the Baseline Forecast, assuming increased surface water deliveries from the projects and pumping limits in the surrounding subbasins. The available surface water supplies were increased by the proposed project yields as described in Section 7.2.1. During flood events, additional stored surface water was assumed to be available to supplement surface water deliveries the month following storage, less evaporative losses. For example, the volume of water stored in the proposed SFK GSA surface water pond during March 2031 (about 1.2 feet over 10,000 acres) would be available to be redistributed as additional surface water supply to SFK GSA in April 2013 minus open water evaporation for March (about 0.38 feet). This assumption allows the proposed project surface water storage to be depleted in a timely manner by both evaporation and re-use.

7.2.4 Projects Forecast GHBs

The Projects Forecast GHBs were calculated in an identical manner as for the Baseline Forecast with one modification. As described in Section 7.1.4, the general head boundaries for the Baseline Forecast model were developed by calculating the difference in monthly heads for each stress period of the calibration simulation, and then adding that difference to the forecast GHB head from the previous month. This allows the forecast GHBs to have a similar change in heads between stress periods as the calibration model, but from a different initial (2016) elevation. This same process was used for the Projects Forecast GHBs with the addition of a head change factor that assumes projects were implemented in the subbasins surrounding the Subbasin resulting in a gradual stabilization (or "soft landing") of heads around 2040. The head change factor had a value of 100% from 2017 through 2026, and then decreased by 5% per year until 2040 where the head change factor was fixed at 25% for the duration of the simulation. The resulting Projects Forecast GHBs show a more gradual decrease in the rate of decline compared to the Baseline GHBs (Figure D7-12).

7.2.5 Projects Forecast of Climate Change

The SGMA guidelines require that climate change be considered in any forecasts of future land uses. The same CNRA climate change factor data sets for 2030 and 2070 used in the Baseline Forecast were applied to the Projects Forecast ET demand, and surface water delivery data. The CNRA corrected effective precipitation results remained identical to the Baseline Forecast.

7.2.6 Projects Forecast Simulation Results

As discussed in Section 7.2, multiple Projects Forecast simulations were created iteratively by modifying the Baseline Forecast and incorporating various potential projects and management actions developed by the Subbasin GSAs and surrounding subbasins. The Projects Forecast scenarios evolved as follows:

1. Projects Forecast Scenario 1: The Baseline Forecast was modified by added projects and associated land fallowing in the Subbasin only (discussed below). The simulation results showed a continued lowering of groundwater levels, reduction of groundwater in storage, continued land subsidence, and increased outflow to surrounding subbasins.
2. Projects Forecast Scenario 2: The Projects Forecast was further modified with GHBs that caused an asymptotic flatting (i.e., soft landing) of the GHB heads in 2040, representing the effects of assumed projects in other subbasins. The modification of the GHBs simulation results showed only a slight reduction of groundwater level declines compared to Projects Forecast Scenario 1, with continued reduction of groundwater in storage, continued land subsidence, and continued outflow to surrounding subbasins.
3. Projects Forecast Scenario 3: The Projects Forecast was further modified by assuming each surrounding subbasin implemented projects that would yield additional surface water supplies similar to what is proposed for the Subbasin, or approximately 75% of the 1990-2016 annual average change in storage estimated for that portion of each subbasin within the TLSBHM. The simulation results showed a substantial reduction of groundwater level declines over time compared to Projects Forecast Scenarios 1 and 2, but with continued declining groundwater levels, reduction of groundwater in storage, continued land subsidence, and continued outflow to surrounding subbasins, after 2040.
4. Projects Forecast Scenario 4: The Projects Forecast was further modified by implementing agricultural pumping limits in the surrounding subbasins. The simulation results showed a substantial reduction of groundwater level declines over time compared to Projects Forecast Scenarios 1 through 3, resulting in stable groundwater elevations throughout most of the Subbasin and surrounding subbasins, with significantly reduced reduction of groundwater in storage, and significantly reduced land subsidence. These results are presented below.

A comparison of simulated potentiometric surface maps from above and below the Corcoran Clay for the Baseline Forecast for June 2040 (Figure D7-5) with simulated Projects Forecast Scenario 4 (hereafter referred to simply as the Projects Forecast) potentiometric surface maps from above the Corcoran Clay for June 2040 (Figure D7-13) show that the simulated groundwater elevations beneath the Subbasin above the Corcoran Clay are about 10 feet higher under the Projects Forecast compared to the Baseline Forecast. Simulated groundwater elevations in the surrounding subbasins are substantially higher with groundwater elevation increases ranging from 20 to 30 feet in Kaweah, Kings, and Tule subbasins. The Westside Subbasin showed groundwater elevations increases in the 10 to 20 foot range, while there was little increase in the Kern Subbasin.

Simulated groundwater elevations for June 2040 beneath the Subbasin below the Corcoran Clay are about 20 to 30 feet higher under the Projects Forecast compared to the Baseline Forecast. In the Kaweah and Kings subbasins, simulated heads are 20 to 40 feet higher compared to the Baseline Forecast. In the Tule Subbasin in Creighton Ranch and Angiola well field areas, simulated heads are as much as 130 feet higher compared to the Baseline Forecast. The Westside Subbasin showed groundwater elevations increases in the 40- to 100-foot range, while the heads in the Kern Subbasin increased as much as 50 feet.

A comparison of simulated potentiometric surface maps from above and below the Corcoran Clay for the Baseline Forecast for December 2070 (Figure D7-5) with simulated Projects Forecast potentiometric surface maps from above the Corcoran Clay for December 2070 (Figure D7-14) show that the simulated groundwater elevations beneath the Subbasin above the Corcoran Clay are about 10 to 30 feet higher under the Projects Forecast compared to the Baseline Forecast. Simulated groundwater elevations in the surrounding subbasins are substantially higher with groundwater elevation increases ranging from 20 to 40 feet in Kaweah and Kings subbasins, and as much as 80 feet in the Tule Subbasin. The Westside Subbasin showed groundwater elevations increases in the 10 to 20 to 60 foot range, while the heads in the Kern Subbasin increased as much as 40 feet.

Simulated groundwater elevations for December 2070 beneath the Subbasin below the Corcoran Clay are about 30 to 40 feet higher under the Projects Forecast compared to the Baseline Forecast. In the Kaweah and Kings subbasins, simulated heads are 30 to 60 feet higher compared to the Baseline Forecast. In the Tule Subbasin in Creighton Ranch and Angiola well field areas, simulated heads are as much as 160 feet higher compared to the Baseline Forecast. The Westside Subbasin showed groundwater elevations increases in the 50-to 130-foot range, while the heads in the Kern Subbasin increased as much as 90 feet.

Simulated Projects Forecast hydrographs for selected compliance wells in the vicinity of the cities of Corcoran, Hanford, and Lemoore show a gradual stabilization of groundwater elevations in the unconfined aquifer above and confined below the Corcoran Clay, with seasonal variations much greater below the Corcoran Clay (Figure D7-15). Over the 54-year simulation period, the hydrographs above the Corcoran Clay show approximately 15 feet of decline in the Corcoran area, about 25 feet of decline in the Hanford area, and about 60 feet of decline in the Lemoore area. Over the same period, the hydrographs below the Corcoran Clay show about 30 feet of decline in the Corcoran area, about 25 feet of decline in the Hanford area, and about 20 feet of decline in the Lemoore area.

The Projects Forecast simulation results indicate that subsidence will continue over the next 54 years under the assumed forecast conditions. A map of cumulative subsidence from 2017-2040 shows that the is about 0 to 2 feet of additional subsidence over most of the Subbasin, with up to 2 feet of additional subsidence in the Lemoore area (Figure D7-16). Subsidence in the Angiola and Creighton Ranch wells fields in the Tule Subbasin is significantly less compared to the Baseline Forecast (Figure D7-7). Projects Forecast subsidence in the lake bottom area in minimal. A map of cumulative subsidence from 2017-2070 shows that the is about 2 to 4 feet of additional subsidence over the northern portion of the Subbasin, with up to 2 feet of additional subsidence in the Angiola and Creighton Ranch wells fields in the Tule Subbasin (Figure D7-16).

Simulated Projects Forecast subsidence hydrographs for continuous GPS compliance point near the cities of Corcoran and Lemoore wells show that under project conditions, the subsidence continues to occur (Figure D7-17), but at significant reduced rates compared to the Baseline Forecast (Figure D7-8).

The Projects Forecast simulation groundwater mass balance data were used to estimate the change in groundwater storage in the Subbasin on an annual basis for the 54-year forecast simulation period (Figure D7-18). Under the Projects Forecast assumptions described above, between 2017 and 2070, there would continue to be an annual average of about -36,200 AF/Y of groundwater storage depletion (a reduction of 75% compared to the Baseline Forecast), and as much as -7.72 million AF of cumulative storage depletion from the Subbasin. Most of the remaining overdraft in the Subbasin appears to result from the continued outflow of groundwater to the surrounding subbasins, which average approximately -58,610 AF/Y over the 2017-2070 simulation periods (Figure D7-18).

As discussed in Section 7.2, for simulation purposes it was assumed that the surrounding subbasins would implement projects and management actions that would increase surface water supply and decrease agricultural demand. However, until the magnitude and timing of actual projects and management actions to be implemented in the surrounding subbasins can be incorporated into the TLSBHM, the model forecasts will have a degree of uncertainty regarding future water balance and overdraft estimates.

In summary, the Projects Forecast simulation results indicate that overdraft conditions in the Subbasin will be mostly eliminated, with stable groundwater levels by 2040. While there continues to be some reduction of groundwater in storage, the forecast that groundwater levels remain relatively stable through 2070 indicates that the continued reduction in groundwater in storage is also sustainable. Likewise, although some land subsidence will continue over time, the forecast that groundwater levels remain relatively stable through 2070 indicates that the continued subsidence is also sustainable. Thus, the Projects Forecast indicates that sustainable groundwater conditions in the Subbasin can be achieved by 2040 with implementation of the proposed projects and management actions in the Subbasin and assumed projects and management actions in the surrounding subbasins.

7.2.7 Historical vs. Projects Forecast Simulation Comparison

A comparison of the 1990-2016 historical model, 2017-2070 Baseline Forecast, and 2017-2070 Projects Forecast was made using the annual average groundwater balance data for each simulation (Table D7-3). The Baseline and Projects forecast models both assume that land fallowed during the 2011-2016 drought would be put back into production, and that overall crop demand would increase due to the maturation of permanent crop as described in Section 7.1.1. The increase in ET demand was also exacerbated by climate change. Furthermore, the forecasts also assume that groundwater levels would continue to decline at historical rates for 10 or more years prior to project implementation. As a result, for the even though the Baseline Forecast 2017-2070 average annual pumping, recharge, and river leakage are similar to the Calibration 1990-2016 average values, the net change in storage increased from -85,690 AF/Y to -142,990 AF/Y because there was more interbasin outflow from the Subbasin into the surrounding subbasins. The annual average values for 1998-2010 and 2040-2048 “normal hydrology” periods have similar results, where the net change in storage increased from -73,760 AF/Y to -149,430 AF/Y.

The Projects Forecast shows a different trend. With implementation of the projects, the 2017-2070 average annual pumping decreases, groundwater recharge increases, and interbasin flow decreases. As a result, the net change in storage decreased from -85,690 AF/Y to -36,200 AF/Y (nearly a 60% decrease). The results are similar for the 1998-2010 and 2040-2048 “normal hydrology” periods, where the net change in storage decreased from -73,760 AF/Y to -19,390 AF/Y.

The results of the Projects forecast simulation indicate that under the assumed forecast conditions, implementation of the proposed projects to increase surface water supply and recharge coupled with agricultural demand reductions in the surrounding subbasins can significantly reduce overdraft to sustainable levels in the Subbasin as evidenced by the stabilization of groundwater levels throughout most of the subbasins (Figure D7-15, GSP Appendix G) and the reduction of subsidence (Figure 7-17).

8.0 Data Limitations

Groundwater models are designed to estimate changes over time in groundwater levels, flow directions, and storage given a set of inflows (precipitation, surface water, under flow in, etc.) and outflows (evapotranspiration, pumping, underflow out, etc.). Prior to the SGMA there were no requirements to manage or report groundwater usage. As a result, most GSAs do know the location, construction, and pumping history of many pumping wells within their GSAs. Furthermore, most GSAs often do not have a good historical accounting of which parcels have received surface waters and at what rates. Hence, these inputs and outputs need to be approximated by other means than direct measurement.

The data utilized for construction and calibration of the TLSBHM were provided by various private parties, public agencies, and data extracted from existing numerical models of the area including DWR's 2014 release of C2VSim in the Coarse Grid version, USGS CVHM, the Kaweah Delta Water Conservation District model (Fugro West, 2005), and the preliminary Tule Subbasin and Westside Subbasin models. Other numerical models adjacent to and/or covering portions of the TLSBHM are known to exist, but were unavailable for this effort. The data gathering effort also occurred before many GSAs were organized, so it is likely that some data were unavailable at the time the model was developed. It is anticipated that as the TLSBHM is reviewed and utilized that some corrections of input data will be necessary and that additional data, unavailable at the time, will need to be incorporated into the model.

Much of the hydrologic data used to construct and calibrate the TLSBHM are based on estimates or inferred from multiple data sources. As noted above, most GSAs do not know the historical delivery of surface water to various parcels within the GSAs. Hence it was necessary to assume that all irrigated parcels received some surface water allotment. Likewise, the location, construction, and pumping history of most of the irrigation wells in the TLSBHM domain are not known. Hence hypothetical irrigation well locations were assumed to be distributed with relatively uniform spacing across the model domain. The hypothetical irrigation wells were also assumed to have completion intervals and frequency similar to that of a small subset of wells with known constructions. Hypothetical irrigation wells pumping was estimated based on a water balance method using estimated agricultural demand based on reported crop type minus the assumed distribution of surface water supplies. While these simplifying assumptions and estimates are reasonable given the sparseness of measurements, they add uncertainty to the model.

Overtime, under the SGMA, more accurate spatial and temporal groundwater pumping, and surface water delivery data should be collected and utilized to construct and update groundwater models of the Subbasin. As the models are populated with actual measurement instead of estimate, the models will become more useful tool for managing groundwater in the Subbasin.

9.0 Summary of Model Reliability and Peer Review

The TLSBHM is an approximation of existing conditions beneath and in the vicinity of the Subbasin. It covers a large area with very dynamic hydrologic conditions that have significant changes over the simulation period. Due to a lack of historical data, much of the data utilized to construct the model had to be inferred from alternative data sets. Given the uncertainty of these estimates, the model can approximate on average, but not completely reproduce, all observations across the entire site area under all conditions. Overall, the TLSBHM can reliably predict groundwater elevations in response to various hydrologic conditions within the calibration period based on the available data and estimates. However, forecast simulations with extreme ranges in hydrologic conditions (i.e., severe drought conditions or extreme flooding) may produce less reliable results.

The TLSBHM was submitted for peer review to Dr James T McCord of GeoSystems Analysis, Inc. Dr. McCord has over 30 years of experience in hydrology, hydrogeology, and water resource investigations, with emphasis on characterization of groundwater and surface water systems, numerical modeling of hydrologic systems. He has authored numerous consulting reports and technical peer-reviewed papers, and co-authored the textbook, Vadose Zone Processes (CRC Press, 1999). He has served as an Adjunct Professor of Earth Science at New Mexico Technical University since 1991, as well as Adjunct

Professor of Civil Engineering at the University of New Mexico and of Civil and Environmental Engineering at New Mexico Tech since 2007. Dr. McCord's per review in include in Appendix D6.

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Table D2-1

Historical Precipitation - Hanford, California[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1899	M	M	M	M	M	M	M	M	0	0.67	M	0.87	M
1900	1.38	0	1.18	1.04	M	M	M	M	M	M	M	M	M
1901	M	M	M	M	M	M	M	T	1.04	T	M	0.15	M
1902	0.4	2	1.78	0.47	0.09	M	0	M	0	0.36	1.67	0.56	M
1903	1.31	0.38	1.71	0.5	0	0	0	0	0	0.05	0.47	0.15	4.57
1904	0.52	2.03	2.05	0.72	0	0	0	0	2.48	0.84	0.31	1.16	10.11
1905	1.28	1.09	2.1	0.56	0.65	0	0	0	0.07	0	1.16	0.23	7.14
1906	1.59	1.92	4.05	0.62	2.06	0.02	0	0	0	0	M	M	M
1907	M	M	M	M	M	M	M	M	M	M	M	M	M
1908	M	M	M	M	M	M	M	M	M	M	M	0.31	M
1909	M	M	M	M	M	M	M	M	M	M	M	M	M
1910	M	M	M	M	M	M	M	M	M	M	M	M	M
1911	M	M	M	M	M	M	M	M	M	M	M	M	M
1912	M	0.02	3.24	1.52	0.27	0	0	0	0	0	0.61	0.21	M
1913	1.26	1.55	0.34	0.78	0.76	0.06	0.08	0	M	M	M	1.35	M
1914	4.36	1.25	0.37	0.11	M	1.06	0	0	0	0	0.02	M	M
1915	M	M	0.3	1.37	M	M	M	M	M	M	M	M	M
1916	4.68	M	M	M	0.16	M	M	0.28	0.47	1.09	M	1.35	M
1917	M	M	M	M	0.31	M	M	M	M	M	M	M	M
1918	M	4.5	3.43	M	M	M	M	M	0.88	0.12	M	M	M
1919	M	M	1.01	0.15	0.1	M	M	M	M	M	M	M	M
1920	M	2.72	3.05	0.24	M	M	M	M	M	M	M	M	M
1921	M	0.89	M	M	0.87	M	M	M	M	M	M	M	M
1922	M	M	M	M	M	M	M	T	M	M	M	M	M
1923	M	M	M	2.43	M	M	M	M	M	M	M	0.22	M
1924	M	M	1.86	M	0	M	M	T	0	0.65	M	2.12	M
1925	M	M	1.58	M	M	M	0	M	0	M	M	M	M
1926	0.82	1.44	0.2	2.67	T	0	0	0	0	0.76	3.67	0.65	10.21
1927	1.33	2.52	2.04	0.18	0.06	T	0	0.04	T	1.67	1.63	0.78	10.25
1928	0.09	0.96	1.55	0.08	0.1	0	0	0	0	T	1.47	1.69	5.94
1929	0.81	0.61	1.4	0.81	0	0.24	T	0	0.03	0	0	0.42	4.32
1930	1.66	1	1.66	0.15	0.37	0	0	0.02	0.38	0.07	0.67	0.3	6.28
1931	2.32	0.72	0.07	0.91	0.2	1.12	0	0.08	0.08	0	1.36	2.54	9.4
1932	1.85	1.52	0.47	0.71	0.13	0	0	0	0	0	0.28	0.93	5.89
1933	3.12	0.16	0.72	0.28	0.41	0.07	0	0	0	0.15	0	1.01	5.92
1934	0.17	1.53	0.05	0	0.22	0.14	0	0	0	1.06	2.15	1.84	7.16
1935	2.5	1.77	2	2.05	0	0	0.03	0	0.06	0.51	0.4	0.89	10.21
1936	0.66	4.7	0.97	0.55	T	T	0	0	0	1.84	0	2.87	11.59
1937	1.95	2.46	2.23	0.22	0	0	0	0	0	0.11	0.21	2.16	9.34
1938	1.76	3.51	4.59	1.15	0.11	0.17	0.07	0	0.13	0.19	0.19	1.42	13.29
1939	1.54	0.77	1.44	0.82	T	0.12	0	0	0.04	0.57	0.06	0.22	5.58
1940	3.53	3.61	0.99	0.18	T	T	0	0	0	0.85	T	3.61	12.77

Table D2-1

Historical Precipitation - Hanford, California[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1941	1.51	3.9	2.05	2.41	T	T	0	T	0	0.9	0.57	3.11	14.45
1942	1.21	0.88	0.94	1.19	0.16	0	0	M	0	0	0.43	1.1	M
1943	2.73	1.14	3.35	0.87	0	0	0	0	0	0.03	0.22	1.03	9.37
1944	1.28	2.97	0.22	0.86	0.28	0.23	0	0	0.02	0.23	2.25	0.97	9.31
1945	0.26	2.71	1.81	0.16	0.1	0.17	0	0	T	0.71	1.15	1.51	8.58
1946	0.34	1.53	2.56	0.07	0.41	0	0.11	0	0	1.33	1.1	2.06	9.51
1947	0.41	0.49	0.56	0.11	0.41	0	0	0	T	0.59	0.29	0.51	3.37
1948	0	0.44	1.46	1.55	0.54	0	0	0	0	0.03	0.01	0.99	5.02
1949	0.51	0.85	1.94	0.07	0.53	0	0	T	0	0	0.6	0.68	5.18
1950	1.93	1.13	1.1	0.4	0	0	0.08	0	0	0.34	0.63	1.06	6.67
1951	1.24	0.76	0.22	1.17	0.07	0	0	0	0	0.08	1.11	2.39	7.04
1952	3.08	0.27	2.18	0.79	0.01	0.02	T	0	0.17	0.05	0.65	2.96	10.18
1953	1.1	0.27	0.34	0.83	0.29	0.02	T	0	0	0.02	1.01	0.09	3.97
1954	1.89	0.78	2.21	0.52	0.34	0.08	0	0	0	0	0.66	1.61	8.09
1955	3.25	1.31	M	M	0.9	0	0	M	0	0.02	0.92	4.67	M
1956	1.2	0.38	0.1	0.73	0.83	0	0	0	0	0.72	0	0.15	4.11
1957	1.39	1.17	0.56	0.67	0.63	0	0	0	0	0.2	1.39	1.41	7.42
1958	1.85	2.3	3.92	2.04	0.24	0	0	T	0.88	0	0.23	0.16	11.62
1959	0.86	1.9	0.11	0.52	T	0	0	T	0.11	0	0	0.17	3.67
1960	0.8	1.71	0.61	0.57	0	0	0.02	0	0	0.53	2.61	0.03	6.88
1961	1.34	0.22	0.67	0.22	0.37	0	0	0	0	0	1.11	1.28	5.21
1962	0.71	4.88	1.06	0	0.11	0	0	0	0.01	0.1	0	0.19	7.06
1963	1.19	1.68	1.37	2.88	0.56	0.17	0	0	0.33	0.75	1.23	0.29	10.45
1964	0.61	0.02	0.94	0.64	0.2	0	0	0.34	0	0.95	1.31	1.44	6.45
1965	1.18	0.33	0.33	1.6	0	0	0	0.05	0.07	0.05	2.15	1.97	7.73
1966	0.63	0.71	0.1	0	0.07	0.06	0.04	0	0.29	0	1.28	2.57	5.75
1967	1.41	0.05	2.42	2.95	0.07	0.23	0	0	0.31	0	1.99	0.5	9.93
1968	0.57	0.64	1	0.5	0.08	0	0	0	0	1.33	0.98	1.64	6.74
1969	6.69	4.54	0.79	0.85	0.32	0.21	0.07	0	0.15	0.05	0.51	0.7	14.88
1970	1.6	1.33	1.42	0.16	0	T	T	0	0	T	2.4	1.23	8.14
1971	0.35	0.19	0.23	0.4	1.44	0	0	T	0.04	0.06	0.41	1.87	4.99
1972	0.04	0.35	0	0.23	0	0	0	0	0.24	0.21	2.9	0.65	4.62
1973	M	2.29	2.2	0.12	M	M	0	0	0	M	M	M	M
1974	2.97	0.11	1.75	0.03	0	0	0	0	0	0.65	0.24	1.4	7.15
1975	0.09	2.26	M	0.49	0	0	0	0	0.96	M	0.05	0.22	M
1976	T	2.94	0.19	1.47	0.03	0.51	0	0.22	1.47	0	1.15	0.96	8.94
1977	0.59	0.03	0.43	0	0.91	0.07	0	0	0	0.05	0.66	2.85	5.59
1978	2.22	5.05	4.12	1.71	0	0	0	0	1.1	0	0.79	0.5	15.49
1979	2.19	1.61	1.16	0.03	0	0	0.04	0	0.08	0.41	0.62	0.41	6.55
1980	2.9	2.71	1.28	0.05	0.04	0	0	0	0	0.09	0	0.2	7.27
1981	1.77	0.86	2.1	0.68	0.17	0	0	0	0	0.76	1.08	0.29	7.71
1982	0.84	0.38	3.52	1.75	0	0.45	0.18	0	0.64	1.03	2.15	0.71	11.65
1983	3.74	2.59	3.39	1.63	0.04	0	0	0.05	0.82	0.43	1.66	1.22	15.57
1984	0.01	0.42	0.27	0.18	0	0	0	0	0	M	M	M	M
1985	0.59	M	0.7	0.12	0	0	M	0	T	M	2.11	0.66	M

Table D2-1

Historical Precipitation - Hanford, California[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1986	1.46	2.6	3.43	0.5	0	0	T	T	0.15	0	0.21	0.77	9.12
1987	1.77	2.07	2.02	0.06	0.13	0.05	0	0	0	0.58	0.47	1.7	8.85
1988	1.37	0.4	0.93	1.99	0.07	0	0	0	0	0	1.31	2.29	8.36
1989	0.17	1.04	0.85	0.02	0.39	0	0	T	0.67	0.32	0.2	0	3.66
1990	1.66	1.1	0.3	0.97	0.87	0	T	T	T	0.01	0.22	0.15	5.28
1991	0.31	0.12	6.62	0.19	T	0.12	0	0	0.11	0.41	0.14	M	M
1992	1.4	2.82	0.85	0.1	T	0	0.01	0.01	T	0.58	T	2.62	8.39
1993	3.88	2.48	2.16	0.07	0.08	0.3	0	0	0	0.24	0.64	0.66	10.51
1994	0.94	1.45	1.02	0.72	0.66	0	T	0	1.06	0.35	1.54	0.33	8.07
1995	4.7	0.51	4.77	0.65	0.87	0.04	T	0	T	0	T	1.59	13.13
1996	1.68	2.89	2.27	0.85	0.1	T	0	0	0	2.43	0.69	3.27	14.18
1997	3.02	0.12	0.21	0	0	T	T	0	0.06	0.09	1.96	1.8	7.26
1998	2	4.05	2.63	1.68	1.31	0.44	0	0	T	0.68	0.63	0.65	14.07
1999	3.01	0.56	0.43	1.37	0	0	0	T	0.01	0	0.15	T	5.53
2000	1.8	3.28	1.59	0.97	0.48	0.35	0	0	0.03	1.31	T	0.05	9.86
2001	1.98	1.48	1.24	1.12	0	0	0.09	0	T	0.18	1.84	1.99	9.92
2002	0.87	0.31	1.04	0.03	0.01	0.82	0	0	0	0	1.42	1.14	5.64
2003	0.24	1.08	1.01	1.5	0.62	0	T	0.07	0	0	0.49	2	7.01
2004	2	2.18	0.29	0.02	0.01	0	0	0	0	2.06	0.52	2.23	9.31
2005	2.63	1.58	2.24	0.71	0.83	0	0	T	0.01	0.01	0.19	2.07	10.27
2006	3.54	0.55	2.72	3.39	0.53	0	0	0	0	0.06	0.22	1.01	12.02
2007	0.65	0.89	0.26	0.33	0.01	0	0	0.12	0.37	0.35	0.12	1.32	4.42
2008	2.18	1.18	T	0	0.11	0	0	0	0	0.15	1.04	1.49	6.15
2009	0.8	1.86	0.2	0.02	0.41	0.22	0	0	0.18	1.32	0.28	1.42	6.71
2010	2.64	1.91	0.34	1.65	0.17	0	0	0	0	0.64	1.32	6.46	15.13
2011	1.52	1.53	2.87	0.3	0.4	1.04	0	0.08	0.01	0.55	0.8	0.06	9.16
2012	M	M	M	1.39	0.03	M	T	0	0	0.28	0.49	1.9	M
2013	0.22	0.48	0.79	0.08	0.17	0	0	0	0.01	T	0.33	0.16	M
2014	0.3	1.38	0.27	0.35	T	0	0	0	0.03	0	0.94	2.52	5.79
2015	0.08	0.72	0.02	0.77	0.1	0	0.45	0	0	0.38	0.91	1.4	4.83
2016	2.56	0.58	1.99	0.57	0.02	0.09	0	0	0	0.76	0.4	1.6	8.57
2017	3.7	2.8	0.31	1.02	0.36	0.01	0	0.01	0.17	0.06	0.21	0.08	8.73
Mean	1.59	1.5	1.47	0.75	0.25	0.09	0.01	0.01	0.15	0.38	0.82	1.24	8.28
Min	6.69 1969	5.05 1978	6.62 1991	3.39 2006	2.06 1906	1.12 1931	0.45 2015	0.34 1964	2.48 1904	2.43 1996	3.67 1926	6.46 2010	15.57 1983
Max	0 1948	0 1900	0 1972	0 2008	0 2018	0 2015	0 2017	0 2016	0 2016	0 2014	0 1980	0 1989	3.37 1947

1. From: https://w2.weather.gov/climate/xmacis.php?wfo=hnx
   M = missing data and T = trace amount of precipitation.

wood.

Table D2-2

Historical Land Use

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Tulare Lake Subbasin[1]	1990-1995 (acres)	1996-1998 (acres)	1999-2006 (acres)	2007 (acres)	2008 (acres)	2009 (acres)	2010 (acres)	2011 (acres)	2012 (acres)	2013 (acres)	2014 (acres)	2015 (acres)	2016 (acres)	Average (acres)
Alfalfa Hay and Clover	41,604	32,564	54,301	72,459	80,600	71,504	69,685	38,789	42,131	49,318	35,820	29,665	24,245	**45,987**
Almonds (Adolescent)			2,908			5,127	7,927	3,222	4,464	7,476	6,526	6,222	5,365	**2,470**
Almonds (Mature)	7,682	5,241	4,550	12,897	11,825	9,826	8,374	10,140	10,818	11,441	12,876	15,046	15,105	**7,852**
Almonds (Young)		3,278	9,290	16,538	25,966	14,678	20,887	13,968	14,564	20,341	17,678	16,983	21,576	**9,557**
Berries	20								1	2		0		**5**
Carrot Single Crop								11	5	12	2	2	16	**2**
Citrus (no ground cover)			25		13	14	4	120	29	100	89	22	9	**21**
Corn and Grain Sorghum	14,280	38,896	29,349	39,271	31,762	34,643	23,031	33,780	29,175	27,566	22,638	18,826	17,400	**25,404**
Cotton	159,534	180,960	124,764	109,605	88,304	72,441	98,167	105,541	88,993	89,317	63,385	44,532	73,720	**118,794**
Dairy Single Crop*	3,816	4,077	4,385											**2,438**
Fallow Land*	193,695	138,392	89,606	65,169	85,144	99,688	90,192	152,391	172,697	172,486	195,172	237,790	200,972	**136,159**
Forest*	420	809	2,955	6	5	46	5			1		4	0	**952**
Grain and Grain Hay	28,708	48,533	62,962	19,266	27,870	27,406	25,980	7,758	9,968	11,194	12,213	21,196	19,069	**34,833**
Melons	250	56	284				14	2	11	7	797	18	86	**170**
Misc. field crops	17,116	12,819	51,311		2			0			2			**18,531**
Onions and Garlic	457	479	770			7	1,358	411	302	94	502	149	644	**483**
Open Water*	5,568	9,092	8,968	5,576	4,296	4,049	5,434	7,703	5,443	5,045	6,824	5,919	5,435	**6,637**
Pasture and Misc. Grasses	2,500	5,029	5,615	50,688	44,232	66,944	53,080	14,680	13,368	15,355	33,551	15,744	13,743	**14,473**
Pistachio (Adolescent)								170	218	370	882	3,575	3,836	**335**
Pistachio (Mature)	4,694	3,808	3,804	6,096	1,907	934	404	394	380	348	330	485	469	**2,888**
Pistachio (Young)		1,580	4,390	4,351	4,259	8,527	8,083	12,985	14,676	15,878	19,195	22,678	22,570	**6,247**
Pomegranates (Adolescent)											3	16	27	**2**
Pomegranates (Young)				61	1,705	545	256	5,012	804	1,395	2,207	1,312	3,111	**608**
Potatoes, Sugar beets, Turnip etc..	5,736	1	209	6		3		9		41		2	2	**1,331**
Riparian*		668	1,120	517	134	398	615	226	138	313	239	248	194	**477**
Small Vegetables	1,599	647	4,518	20	2	13	212	142	133	244	165	78	198	**1,643**
Stone Fruit (Adolescent)			1,478			14	66	100	125	69	47	191	170	**412**
Stone Fruit (Mature)	7,070	4,985	3,854	1,314	544	168	18	3	23	41	23	27	39	**3,206**
Stone Fruit (Young)		1,827	4,185	672	1,609	1,573	2,502	1,077	712	1,641	1,340	1,183	713	**1,770**
Tomatoes and Peppers	5,634	1,627	14,676	117	2	110	12	21,482	23,670	7,114	11,922	19,211	23,420	**9,203**
Urban, Industrial*	12,654	17,391	19,875	33,427	34,711	44,471	32,218	32,091	28,576	29,366	33,901	30,530	30,930	**22,128**
Wine Grapes with 80% canopy	2,948	3,226	5,779	5,588	3,499	2,240	2,746	5,361	9,228	4,655	6,472	4,672	10,985	**4,565**
Winter Wheat*				72,238	67,458	50,451	64,526	48,212	45,118	44,530	30,950	19,420	21,690	**17,207**
Tulare Lake Subbasin Irrigated Crop Acreage	**299,832**	**345,557**	**389,021**	**338,951**	**324,102**	**316,717**	**322,806**	**275,156**	**263,796**	**264,018**	**248,665**	**221,837**	**256,519**	**310,792**
Tulare Lake Subbasin Total Crop Acreage	**515,986**	**515,986**	**515,931**	**515,883**	**515,849**	**515,821**	**515,796**	**515,779**	**515,768**	**515,759**	**515,751**	**515,747**	**515,741**	**496,788**

1. Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year

Table D2-3
Historical Kings River Diversions

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Kings River Water Years	Diversion	Peoples Canal- MKRGSA Total	Last Chance Canal- MKRGSA Total	Lakeside IWD	Imported Water	Mid Kings	Stratford Canal	Empire West Side ID total from SWP	Empire West Side Canal	Westlake Canal	Lemoore Canal	Imported Water	South Fork Kings River
	GSA	Mid-Kings River					South Fork Kings						
	Agency	Peoples Ditch Company	Last Chance Water Ditch Company				Stratford Irrigation District	Empire West Side Irrigation District			Lemoore Canal & Irrigation Company		
		(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)
71%	1966	107,763	50,356	-	-	158,119	2,158	-	4,770	3,604	96,079	-	106,612
197%	1967	136,889	78,468	-	-	215,358	3,947	-	9,622	5,861	109,323	-	128,753
49%	1968	75,809	31,878	-	-	107,688	3,540	1,780	13,636	12,718	91,478	-	123,153
256%	1969	107,636	61,339	-	-	168,975	1,139	50	2,878	6,056	87,537	-	97,659
78%	1970	76,723	38,772	-	-	115,495	1,884	3,548	5,359	7,305	93,441	-	111,538
69%	1971	86,815	35,321	-	-	122,137	4,376	5,391	4,665	10,280	96,498	-	121,210
50%	1972	51,631	38,190	-	-	89,820	4,062	5,216	6,188	5,133	80,465	-	101,065
125%	1973	139,667	62,672	-	-	202,339	4,411	5,233	5,964	6,543	86,382	-	108,534
122%	1974	137,406	68,454	-	-	205,860	4,082	4,085	9,291	10,508	102,115	-	130,081
92%	1975	109,458	43,937	-	-	153,395	4,570	5,803	8,763	10,939	104,388	-	134,463
32%	1976	37,828	2,255	-	-	40,083	4,284	5,811	5,915	5,004	70,925	-	91,940
23%	1977	43,393	9,542	-	-	52,935	2,203	2,120	1,598	557	42,067	-	48,545
201%	1978	125,769	71,577	-	-	197,346	2,859	409	10,627	9,312	80,567	-	103,774
101%	1979	125,680	64,463	-	-	190,143	6,434	1,565	15,449	9,523	107,578	-	140,549
178%	1980	101,388	64,365	-	-	165,753	3,981	805	16,100	11,566	103,714	-	136,165
61%	1981	89,091	47,482	-	-	136,572	4,435	7,966	7,841	9,437	89,111	-	118,790
181%	1982	127,200	65,413	-	-	192,613	4,479	4,379	9,396	20,983	100,153	-	139,389
261%	1983	60,994	48,013	-	-	109,007	3,808	0	6,097	10,389	58,631	-	78,926
115%	1984	97,831	53,649	-	-	151,480	2,533	0	2,801	3,800	99,362	-	108,496
73%	1985	105,362	39,583	-	-	144,944	4,869	4,677	5,209	6,827	103,148	-	124,731
190%	1986	111,962	62,457	-	-	174,419	7,329	2,070	7,345	16,723	87,761	-	121,227
45%	1987	70,406	24,792	-	-	95,198	5,177	3,961	4,959	10,982	90,541	-	115,620
48%	1988	60,312	21,844	-	-	82,156	3,953	3,128	4,457	2,949	76,554	-	91,041
53%	1989	60,579	19,935	-	-	80,514	0	2,700	0	-	56,519	-	59,219
40%	1990	53,292	9,909	-	-	63,201	0	2,979	0	-	34,465	-	37,444
63%	1991	45,654	18,622	-	-	64,276	1,760	199	1,006	964	31,492	-	35,420
41%	1992	49,394	9,361	-	-	58,755	1,759	1,219	0	0	37,968	-	40,945
149%	1993	147,363	53,498	-	-	200,860	5,070	2,467	4,314	8,612	91,166	-	111,629
50%	1994	69,510	30,738	-	-	100,248	2,997	1,499	3,808	6,811	76,550	-	91,666
202%	1995	143,785	102,300	-	-	246,085	6,123	1,468	6,419	1,410	85,049	-	100,469
122%	1996	166,765	95,338	-	-	262,103	6,774	1,681	5,576	5,778	105,398	-	125,206
155%	1997	133,158	85,505	20,657	-	239,321	7,460	0	8,239	2,079	89,117	-	106,896
181%	1998	141,107	77,863	29,871	-	248,841	5,578	488	4,596	8,447	75,590	-	94,698
74%	1999	101,773	62,938	12,119	-	176,830	4,971	2,858	6,135	3,624	95,504	-	113,092
90%	2000	108,835	82,526	13,181	-	204,541	4,598	1,619	2,184	4,566	99,074	-	112,041
59%	2001	73,419	31,031	7,017	-	111,467	4,959	1,674	1,993	2,680	58,979	-	70,285
67%	2002	99,376	52,020	5,354	-	156,751	4,104	1,265	1,364	2,202	74,196	-	83,131
83%	2003	104,545	54,735	13,325	-	172,605	4,356	1,292	752	3,362	63,511	-	73,273
61%	2004	79,743	27,306	5,667	-	112,717	2,019	3,206	1,650	1,480	58,257	-	66,611
148%	2005	131,193	54,799	24,547	-	210,539	5,619	3,451	2,664	1,946	98,279	-	111,958
172%	2006	129,571	65,459	24,718	-	219,748	6,065	2,954	5,417	2,368	96,857	-	113,661
40%	2007	84,144	20,918	3,312	-	108,374	4,836	1,876	3,810	4,727	70,288	-	85,536
72%	2008	81,364	29,000	6,764	-	117,128	2,037	852	1,470	1,081	59,988	-	65,428
79%	2009	85,743	30,617	5,829	-	122,189	2,047	148	1,811	1,771	49,297	-	55,074
121%	2010	113,146	42,817	16,103	-	172,066	4,318	2,545	3,644	2,900	90,694	-	104,101
180%	2011	163,801	79,589	23,764	-	267,154	4,979	1,364	4,625	4,947	109,605	-	125,519
49%	2012	80,025	30,309	4,595	-	114,929	4,203	1,151	4,594	2,289	71,207	-	83,443
41%	2013	49,246	12,881	110	-	62,236	0	536	0	0	43,206	-	43,741
32%	2014	27,801	8,824	0	-	36,626	0	158	0	0	17,905	-	18,062
21%	2015	12,430	-	0	-	12,430	0	326	0	0	14,759	-	15,085
75%	2016	67,310	20,567	2,986	-	90,863	0	-	0	0	42,532	-	42,532
204%	2017	-	-		-	-	-	-	-	-	-	-	-
	Annual Averages	93,943	44,985	4,312		143,240	3,669	2,156	4,804	5,315	77,554		93,499

Kings River Water Years	Diversion	Blakeley Canal-Kings River & Lateral A	TLBWSD Lateral C, T203	Dudley Ridge State Turnout (DR-1), T201	Dudley Ridge State Turnout (DR-1B), T202	Dudley Ridge State Turnout (DR-1A), T204	Dudley Ridge State Turnout (DR-2), T205	Dudley Ridge State Turnout (Paramount), T207	Dudley Ridge State Turnout (DR-3), T208	Imported Water, Angiola/Green Valley Well Fields, City of Lemoore and Westlands RD 761	Southwest Kings
	GSA	Southwest Kings									
	Agency			Dudley Ridge Water District-Monthly Diversions Assumed							
		(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)
71%	1966	20,559	-	-	-	-	-	-	-	-	20,559
197%	1967	29,187	-	-	-	-	-	-	-	-	29,187
49%	1968	19,692	0	3,312	949	2,372	11,388	9	5,694	-	43,416
256%	1969	534	0	3,942	1,130	2,824	13,554	11	6,777	-	28,771
78%	1970	0	0	5,077	1,455	3,637	17,456	15	8,728	-	36,366
69%	1971	10,521	0	5,158	1,478	3,695	17,735	15	8,867	-	47,469
50%	1972	20,920	0	5,333	1,528	3,820	18,335	15	9,168	-	59,119
125%	1973	22,249	0	4,429	1,269	3,172	15,228	13	7,614	-	53,973
122%	1974	37,966	0	8,390	2,404	6,010	28,849	24	14,425	-	98,069
92%	1975	36,603	0	10,191	2,920	7,300	35,040	29	17,520	-	109,602
32%	1976	22,247	0	7,770	2,226	5,566	26,716	22	13,358	-	77,906
23%	1977	8,903	0	3,633	1,041	2,603	12,493	10	6,246	-	34,930
201%	1978	26,094	0	7,455	2,136	5,340	25,632	21	12,816	-	79,494
101%	1979	52,496	0	9,685	2,775	6,938	33,302	28	16,651	-	121,876
178%	1980	53,639	0	10,061	2,883	7,207	34,594	29	17,297	-	125,710
61%	1981	42,806	0	9,213	2,640	6,599	31,677	26	15,839	-	108,800
181%	1982	41,213	0	6,968	1,997	4,992	23,960	20	11,980	-	91,130
261%	1983	22,250	0	7,026	2,013	5,033	24,157	20	12,078	-	72,577
115%	1984	10,003	0	8,116	2,326	5,814	27,907	23	13,954	-	68,144
73%	1985	34,288	0	7,791	2,232	5,581	26,788	22	13,394	-	90,096
190%	1986	27,361	0	6,427	1,841	4,604	22,098	18	11,049	-	73,398
45%	1987	28,582	0	5,816	1,666	4,166	19,996	17	9,998	-	70,242
48%	1988	21,261	0	6,030	1,728	4,319	20,733	17	10,367	-	64,456
53%	1989	13,458	0	7,168	2,054	5,134	24,645	21	12,323	-	64,802
40%	1990	6,485	0	4,606	1,320	3,299	15,836	13	7,918	14,540	54,016
63%	1991	5,941	0	1,670	479	1,196	5,743	5	2,871	8,181	26,085
41%	1992	6,003	0	1,696	486	1,215	5,831	5	2,915	6,095	24,245
149%	1993	30,546	0	2,917	836	2,090	10,031	8	5,016	6,480	57,925
50%	1994	26,295	0	3,834	1,099	2,747	13,184	11	6,592	11,642	65,404
202%	1995	34,039	0	5,715	1,637	4,094	19,650	16	9,825	8,131	83,107
122%	1996	41,813	0	6,886	1,973	4,933	23,677	20	11,839	14,505	105,645
155%	1997	25,259	0	7,895	2,262	5,655	27,146	23	13,573	11,319	93,132
181%	1998	17,157	3,528	6,955	1,993	4,982	23,916	20	11,958	11,348	81,857
74%	1999	25,132	0	7,958	2,280	5,701	27,363	23	13,681	10,280	92,418
90%	2000	21,426	0	7,397	2,119	5,299	25,433	21	12,717	10,299	84,711
59%	2001	11,377	0	6,030	1,728	4,319	20,732	17	10,366	10,306	64,875
67%	2002	13,083	0	6,930	1,986	4,964	23,828	20	11,914	10,291	73,016
83%	2003	8,256	0	6,657	1,907	4,768	22,888	19	11,444	10,359	66,299
61%	2004	12,382	0	6,383	1,829	4,572	21,946	18	10,973	10,072	68,176
148%	2005	24,480	0	7,366	2,111	5,276	25,327	21	12,663	11,115	88,360
172%	2006	34,147	0	7,766	2,225	5,563	26,702	22	13,351	11,115	100,891
40%	2007	25,308	0	6,090	1,745	4,363	20,940	17	10,470	9,975	78,909
72%	2008	10,209	0	5,292	1,516	3,791	18,195	15	9,097	10,016	58,131
79%	2009	7,997	0	3,982	1,141	2,852	13,691	11	6,846	12,178	48,699
121%	2010	17,655	0	4,144	1,187	2,969	14,249	12	7,125	42,300	89,641
180%	2011	43,781	0	3,373	966	2,416	11,597	10	5,799	34,012	101,953
49%	2012	22,689	0	2,775	795	1,988	9,543	8	4,771	51,435	94,006
41%	2013	3,284	0	3,591	1,029	2,572	12,346	10	6,173	19,602	48,606
32%	2014	567	0	2,136	612	1,530	7,345	6	3,672	23,852	39,720
21%	2015	184	0	3,271	937	2,343	11,247	9	5,623	31,718	55,333
75%	2016	-	-	-	-	-	-	-	-	34,248	34,248
204%	2017	-	-	-	-	-	-	-	-	-	-
	Annual Averages	20,737	68	5,535	1,586	3,965	19,033	16	9,516	8,734	69,598

Table D2-3
Historical Kings River Diversions

Tulare Lake Subbasin Hydrologic Model
Kings County, California

	GSA	El Rico												Tri-County										
	Agency																							
Kings River Water Years	Diversion	***Empire Weir No. 2 (over #2 weir to river extension, River Water) Modified Total-(Empire Weir No. 2 minus Tri County Kings River Water)***	***TLBWSD Lateral B, T206 (State Water)-Modified Total-(SWP Total for Lateral B minus Tri County Entitlement)***	Lakelands Canal-Total	Tulare Lake Canal	***Melga Canal-Diversion of Peoples Canal, El Rico GSA Total***	Kern River	***Deer Creek-30% of Deer Creek Total***	Tule River-El Rico	Kaweah River	***Loan Oak/New Deal- Diversion of Last Chance, El RicoGSA Total***	Imported Water	El Rico	Poso Creek	***TLBWSD Lateral A, T200 (State Water)-Assumed Full Entitlement-25% to Lateral A***	***TLBWSD Lateral B, T206 (State Water)-Assumed Full Entitlement-75% to Lateral B***	Tule River-Tri County	***Deer Creek-70% of Deer Creek Total***	White River	Kings River-Tri County	Other Water	Imported Water	Tr-County	**Annual Totals**
		(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)	(AF/Y)
71%	1966	2,404	-	14,225	17,831	71,842	-	-	-	-	21,581	-	127,884	-	-	-	-	-	-	-	-	-	0	413,173
197%	1967	82,883	-	71,671	42,476	91,260	-	-	-	-	33,629	-	321,919	-	-	-	-	-	-	-	-	-	0	695,217
49%	1968	4,673	10,256	17,218	49,218	50,540	-	-	-	-	13,662	-	151,775	-	923	2,768	-	-	-	-	-	-	3,690	429,722
256%	1969	196,219	2,893	40,568	0	71,757	-	-	-	-	26,288	-	339,477	-	260	781	-	-	-	-	-	-	1,041	635,924
78%	1970	0	0	52,483	0	51,149	-	-	-	-	16,617	-	120,248	-	0	0	-	-	-	-	-	-	0	383,648
69%	1971	0	47,329	28,610	490	57,877	-	-	-	-	15,138	-	178,091	-	4,257	12,771	-	-	-	-	-	-	17,028	485,935
50%	1972	1,099	103,195	0	7,305	34,420	-	-	-	-	16,367	-	224,849	-	9,282	27,846	-	-	-	-	-	-	37,128	511,981
125%	1973	530	45,583	19,101	31,948	93,111	-	-	-	-	26,860	-	244,723	-	4,100	12,300	-	-	-	-	-	-	16,400	625,968
122%	1974	14,906	56,123	55,482	28,336	91,604	-	0	-	-	29,337	-	309,845	0	5,157	15,472	1,402	0	0	0	0	-	22,032	765,886
92%	1975	11,905	89,737	41,833	53,125	72,972	-	0	-	-	18,830	-	342,042	0	7,224	21,671	224	0	0	2,642	0	-	31,760	771,261
32%	1976	0	47,863	3,493	45,170	25,219	-	0	-	-	967	-	151,071	0	3,541	10,624	0	0	0	9,154	0	-	23,320	384,320
23%	1977	1,732	21,197	0	4,003	28,929	-	0	-	-	4,090	-	71,762	0	635	1,905	0	0	0	950	0	-	3,490	211,662
201%	1978	33,029	3,073	31,904	49,511	83,846	-	3,000	-	-	30,676	-	237,179	1,500	624	1,873	2,476	7,000	1,000	11,956	0	-	26,430	644,222
101%	1979	2,523	97,690	34,336	32,856	83,787	-	0	-	-	27,627	-	334,337	0	4,271	12,814	185	0	0	6,575	0	-	23,846	810,750
178%	1980	41,353	34,131	37,277	29,258	67,592	-	1,800	-	-	27,585	-	259,729	900	3,163	9,488	2,611	4,200	600	2,819	0	-	23,780	711,136
61%	1981	8,761	140,237	9,180	19,710	59,394	-	0	742	78,485	20,349	-	415,677	0	5,033	15,099	223	0	0	8,983	0	-	29,338	809,178
181%	1982	45,602	36,788	54,659	77,268	84,800	-	5,660	63,476	171,808	28,034	-	589,793	2,830	2,598	7,793	3,090	13,207	1,887	12,547	0	-	43,951	1,056,876
261%	1983	238,616	522	21,919	1,333	40,663	-	12,150	193,800	114,301	20,577	-	644,159	6,075	0	0	340	28,350	4,050	0	0	-	38,815	943,484
115%	1984	17,704	1,917	42,516	0	65,220	-	19,804	17,566	120,846	22,992	-	309,830	9,902	303	909	0	46,210	6,601	0	0	-	63,925	701,875
73%	1985	16,118	84,042	20,108	29,821	70,241	-	0	367	73,859	16,964	-	361,048	0	5,881	17,644	826	0	0	1,586	0	-	25,937	746,756
190%	1986	28,395	41,528	50,896	51,205	74,641	-	5,144	43,384	71,918	26,767	-	417,043	2,572	1,269	3,806	1,701	12,004	1,715	11,054	0	-	34,121	820,207
45%	1987	18,250	60,441	27,104	57,023	46,938	-	0	0	44,445	10,625	-	299,874	0	3,517	10,550	0	0	0	9,366	0	-	23,432	604,366
48%	1988	8,209	40,544	18,863	17,816	40,208	-	0	0	25,873	9,362	-	184,264	0	2,207	6,622	0	0	0	984	0	-	9,814	431,730
53%	1989	0	75,859	7,458	0	40,386	-	0	0	24,550	8,544	-	200,939	0	4,605	13,814	150	0	0	0	1,580	-	20,149	425,623
40%	1990	0	37,168	15,114	0	35,528	-	0	0	39,853	4,247	-	153,181	0	1,810	5,430	0	0	0	0	4,556	-	11,796	319,638
63%	1991	344	2,855	6,143	2,870	30,436	-	0	0	28,897	7,981	-	81,060	0	16	49	604	0	0	1,604	0	-	2,274	209,115
41%	1992	0	35,181	0	0	32,930	-	279	0	23,442	4,012	-	115,532	140	1,156	3,469	0	652	93	0	0	-	5,510	244,987
149%	1993	25,174	58,745	66,990	44,555	68,050	-	101	0	108,379	22,928	-	426,703	50	565	1,694	1,155	235	34	6,919	2,575	-	13,226	810,344
50%	1994	15,625	28,204	0	49,718	38,072	-	0	0	28,376	-	-	175,829	0	990	2,970	0	0	0	6,098	0	-	10,058	443,205
202%	1995	51,722	59,720	52,969	48,240	75,670	-	2,285	13,777	149,232	-	-	487,891	1,142	3,032	9,095	6,040	5,331	762	4,902	0	-	30,303	947,854
122%	1996	33,027	107,966	61,767	36,006	81,522	-	1,847	236	139,238	-	-	521,635	924	3,055	9,165	1,913	4,311	616	2,219	0	-	22,202	1,036,790
155%	1997	19,089	2,107	32,557	25,047	65,232	-	9,220	40,122	66,638	-	-	265,690	4,610	1,895	5,684	1,701	21,513	3,073	4,729	0	-	43,206	748,244
181%	1998	4,514	17,487	32,918	16,707	75,570	-	5,590	26,731	58,340	-	-	243,601	2,795	1,057	3,171	2,083	13,042	1,863	50	0	-	24,061	693,058
74%	1999	4,359	140,451	8,184	13,492	49,810	-	0	2,235	51,184	-	-	329,217	0	95	286	274	0	0	167	0	-	822	712,379
90%	2000	16,796	86,346	35,062	33,304	56,416	-	871	2,900	48,050	-	-	319,674	435	3,935	11,804	1,166	2,032	290	0	0	-	19,663	740,630
59%	2001	21,146	39,067	2,122	38,045	38,433	-	0	8	20,131	-	-	180,610	0	1,027	3,082	0	0	0	3,044	3,000	-	10,154	437,390
67%	2002	14,150	33,324	46,842	7,942	45,043	-	0	490	73,770	-	-	242,267	0	2,004	6,011	124	0	0	0	190	-	8,329	563,493
83%	2003	13,153	44,894	36,750	45,168	48,228	-	0	1,748	49,413	-	-	254,241	0	2,152	6,455	790	0	0	6,652	160	-	16,209	582,626
61%	2004	17,145	42,460	40,917	16,768	40,719	-	0	1,106	59,030	-	-	241,003	0	265	795	559	0	0	0	5,293	-	6,912	495,419
148%	2005	73,872	75,546	42,290	64,243	67,430	-	1,767	2,372	86,750	-	-	442,024	884	116	347	1,680	4,123	589	10,632	1,235	-	19,605	872,486
172%	2006	70,800	52,463	80,614	74,920	69,623	-	2,392	17,135	171,601	-	-	561,992	1,196	126	378	795	5,581	797	14,253	0	-	23,126	1,019,418
40%	2007	21,586	39,927	17,889	31,676	46,218	-	0	153	39,474	-	-	217,420	0	50	149	0	0	0	18,083	63	-	18,345	508,584
72%	2008	9,553	11,833	8,051	5,282	41,851	-	0	158	37,662	-	-	123,545	0	156	468	828	0	0	4,756	0	-	6,208	370,440
79%	2009	855	13,750	22,036	99	43,482	-	0	1,383	62,389	-	-	152,859	0	7	21	0	0	0	0	0	-	28	378,849
121%	2010	34,789	32,026	38,210	37,297	55,771	-	0	5,059	102,754	-	-	315,091	0	2	7	1,676	0	0	10,587	282	-	12,555	693,453
180%	2011	89,121	25,964	88,052	78,409	83,250	-	0	11,316	140,553	-	-	530,567	0	68	205	-	0	0	0	-	-	273	1,025,466
49%	2012	24,964	43,921	3,483	15,977	39,616	-	0	200	60,683	-	-	205,755	0	57	170	-	0	0	0	-	-	227	498,360
41%	2013	0	13,062	58,140	0	27,281	-	-	-	-	-	-	109,253	0	58	174	-	0	0	0	-	-	232	264,069
32%	2014	0	3,681	41,472	0	12,461	-	-	-	-	-	-	59,473	0	38	115	-	0	0	0	-	-	154	154,035
21%	2015	0	0	21,076	0	2,493	-	-	-	-	-	-	24,175	0	45	0	-	0	0	0	-	-	45	107,068
75%	2016	0	-	32,114	0	27,677	-	-	-	-	-	-	59,791	0			-	0	0	0	-	-	0	227,433
204%	2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual Averages	26,210	40,175	31,229	26,107	54,847	0	1,383	8,586	45,614	10,052		268,189	705	1,816	5,446	666	3,227	470	3,333	364		16,175	590,701

Table D2-3
Historical Kings River Diversions

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Notes:
1. Values highlighted have been modified.
2. Values with "0" indicate no surface water delivery to the best of our knowledge.
3. Values with "-" have no verified data.
4. Total flow from Peoples Canal is split 60% to Mid-Kings, 40% to Melga.
5. Last Chance Diversion is split 50% between Mid-Kings and El Rico.
6. Blakeley has added State Water from Lateral A for Southwest.
7. Total flow from Deer Creek split 30% to El Rico, 70% to Tri-County.
8. Tule River for El Rico includes the total of Elk Bayou and TID Spill.
9. SWP from TLBWSD Split Through out Tri-County and Southwest Kings.
10. Kings River water in Tri-County was subtracted from the total in Empire Weir No. 2. 1976 and 2010 are 0 for Empire Weir No. 2 because of negative values.
11. Lakeside is a portion of Kaweah River, Reduced Total Kaweah River between Mid-Kings and El Rico.
12. Additional Tule River flow data added for Tri-County.
13. Empire Westside Irrigation District total from SWP reduce annual totals by 10%.
14. Dudley Ridge Water District reduce annual totals by 10%.
15. Lateral A (T200) & Lateral B (T206) reduce annual totals by 18% for El Rico & Tri-County.
16. Modifications to Peoples Canal and Last Chance as a result of discussions with Mid-Kings River GSA on 2/14/19.

Key
Wet Year
Dry Year
Average Precipitation
GSA Annual Totals
Kings River Watershed Total

Average Annual
690,714
494,326
649,938

Reduction in Entitlement	
Empire West Side ID Total from SWP	10%
Dudley Ridge State Turnouts	10%
Lateral A & B for El Rico & Tri County	18%

Table D2-4

Annual Specified Well Field Pumping[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Date	El Rico GSA Well Field (AF/Y)	Creighton Ranch Well Field (AF/Y)	Corcoran ID Well Field (AF/Y)	Angiola Well Field (AF/Y)	Westlands Well Field (AF/Y)	Municipal Well Fields (AF/Y)	Apex Ranch Well Field (AF/Y)
1990	70,716	27,222	87,977	34,500	67,131	9,370	--
1991	57,509	38,484	84,438	23,396	98,656	9,109	--
1992	80,012	27,255	72,348	33,494	98,344	9,666	--
1993	11,395	4,035	14,248	5,956	44,056	10,208	--
1994	48,043	17,986	78,297	16,389	72,674	10,928	--
1995	2,897	905	7,145	-	27,589	10,775	--
1996	-	-	20,261	-	28,516	12,719	--
1997	-	-	15,586	-	27,000	12,775	--
1998	-	-	2,484	-	20,988	11,555	--
1999	-	-	33,406	-	37,185	13,087	--
2000	14,910	2,849	40,672	6,784	43,392	13,421	--
2001	89,799	41,120	64,353	23,244	65,947	13,895	--
2002	68,933	35,843	64,736	26,537	66,530	26,701	--
2003	32,420	10,856	62,246	22,429	40,841	19,349	526
2004	82,875	47,511	74,007	26,805	42,115	18,777	912
2005	-	468	20,138	662	14,744	16,536	--
2006	-	72	14,034	141	16,526	15,822	6,939
2007	69,863	40,266	85,434	32,894	40,373	17,221	6,319
2008	92,269	52,980	79,362	32,502	63,519	18,432	5,435
2009	78,097	45,292	81,493	37,798	69,904	16,354	7,677
2010	36,129	17,740	29,669	22,568	34,895	15,271	6,345
2011	606	314	7,328	11,336	15,509	17,042	--
2012	95,154	52,325	70,008	19,388	55,298	17,467	9,044
2013	100,275	66,005	78,175	30,528	70,940	18,411	4,970
2014	108,976	68,726	69,880	27,695	94,077	16,930	298
2015	116,254	61,050	67,982	30,220	90,723	16,146	--
2016	126,886	53,113	67,982	29,047	93,853	14,555	--
1990-2016 Average	**51,260**	**26,386**	**51,618**	**18,308**	**53,382**	**14,908**	**4,847**
1998-2010 Average	**43,484**	**22,692**	**50,156**	**17,874**	**42,843**	**16,648**	**4,879**
Well Count	**99**	**52**	**98**	**51**	**150**	**30**	**5**

1. GSA = Groundwater Sustainability Agency, ID = Irrigation District, and AF/Y = acre-feet per year.

wood.

Table D2-5

Reference Crop Evapotranspiration Values[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Crop Evapotranspiration	January (inches)	February (inches)	March (inches)	April (inches)	May (inches)	June (inches)	July (inches)	August (inches)	September (inches)	October (inches)	November (inches)	December (inches)
Reference ETo	0.82	2.22	4.5	6.73	8.52	8.23	8.34	7.62	5.8	4.2	1.28	0.84
Fallow Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Almonds	0.83	0.85	2.71	3.91	6.75	6.39	6.58	6.08	3.92	2.25	0.75	0.83
Pistachio	0.83	0.66	1.92	1.13	2.77	5.91	8.17	7.65	5.26	2.99	0.81	0.83
Grain and Grain Hay	0.89	2.09	4.67	6.86	3.84	0.14	0.20	0.09	0.08	0.38	0.84	0.89
Cotton	0.88	0.64	1.88	0.75	1.62	4.68	8.17	7.70	5.35	1.52	0.78	0.87
Corn and Grain Sorghum	0.88	0.64	2.89	1.16	2.83	7.00	8.06	5.12	0.38	0.38	0.78	0.87
Misc. field crops	0.88	0.64	2.89	1.16	2.77	7.32	7.56	3.03	0.08	0.38	0.78	0.87
Alfalfa Hay and Clover	0.88	2.12	4.31	5.78	7.25	7.02	7.01	6.34	4.80	2.01	1.33	0.91
Pasture and Misc. Grasses	0.89	1.64	3.37	5.17	7.83	7.64	7.74	7.00	5.32	3.25	1.18	0.87
Small Vegetables	0.88	1.29	4.07	1.25	0.02	0.11	0.18	1.08	1.54	1.84	1.61	0.90
Potatoes, Sugar beets, Turnip etc.	0.88	0.92	3.13	6.72	8.84	8.58	7.58	0.18	0.08	0.37	0.77	0.86
Onions and Garlic	0.88	1.88	4.10	5.48	4.80	0.56	0.18	0.08	0.08	0.37	1.34	0.88
Citrus (no ground cover)	0.83	1.98	3.96	4.69	5.54	5.76	5.72	5.24	3.91	3.14	1.47	0.86
Tomatoes and Peppers	0.88	0.63	2.57	0.70	4.39	8.12	7.42	0.78	0.08	0.37	0.77	0.86
Wine Grapes with 80% canopy	0.84	0.66	2.17	1.42	4.18	6.06	6.00	4.82	2.74	0.40	0.75	0.84
Dairy Single Crop	1.03	1.94	3.48	4.67	4.50	6.71	7.72	6.32	3.91	2.27	1.24	1.14
Carrot Single Crop	1.02	1.60	3.14	5.95	4.79	5.75	6.16	4.36	3.70	2.85	1.77	1.19
Carrot Double Cropping	0.54	1.40	2.93	4.41	5.84	3.59	2.71	3.53	3.12	2.60	1.41	1.12
Dairy Double Cropping	0.59	1.59	3.26	4.65	3.57	5.27	7.87	6.81	3.71	0.77	0.59	0.67
Urban, Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban, Industrial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Riparian	0.00	0.01	3.49	6.13	8.33	8.23	8.34	7.62	5.74	3.91	1.02	0.10
Open Water	0.82	2.22	4.50	6.73	8.52	8.23	8.34	7.62	5.80	4.20	1.58	0.84
Average All Crops	0.85	1.29	3.19	3.66	4.56	5.37	5.84	4.23	2.67	1.56	1.05	0.90

Table D2-5

Reference Crop Evapotranspiration Values[1]

Crop Evapotranspiration	January (ft/d)	February (ft/d)	March (ft/d)	April (ft/d)	May (ft/d)	June (ft/d)	July (ft/d)	August (ft/d)	September (ft/d)	October (ft/d)	November (ft/d)	December (ft/d)
Reference ETo	0.00220	0.00661	0.01210	0.01869	0.02290	0.02286	0.02242	0.02048	0.01611	0.01129	0.00356	0.00226
Fallow Land	0	0	0	0	0	0	0	0	0	0	0	0
Almonds	0.00223	0.00253	0.00728	0.01086	0.01815	0.01775	0.01769	0.01634	0.01089	0.00605	0.00208	0.00223
Pistachio	0.00223	0.00196	0.00516	0.00314	0.00745	0.01642	0.02196	0.02056	0.01461	0.00804	0.00225	0.00223
Grain and Grain Hay	0.00239	0.00622	0.01255	0.01906	0.01032	0.00039	0.00054	0.00024	0.00022	0.00102	0.00233	0.00239
Cotton	0.00237	0.00190	0.00505	0.00208	0.00435	0.01300	0.02196	0.02070	0.01486	0.00409	0.00217	0.00234
Corn and Grain Sorghum	0.00237	0.00190	0.00777	0.00322	0.00761	0.01944	0.02167	0.01376	0.00106	0.00102	0.00217	0.00234
Misc. field crops	0.00237	0.00190	0.00777	0.00322	0.00745	0.02033	0.02032	0.00815	0.00022	0.00102	0.00217	0.00234
Alfalfa Hay and Clover	0.00237	0.00631	0.01159	0.01606	0.01949	0.01950	0.01884	0.01704	0.01333	0.00540	0.00369	0.00245
Pasture and Misc. Grasses	0.00239	0.00488	0.00906	0.01436	0.02105	0.02122	0.02081	0.01882	0.01478	0.00874	0.00328	0.00234
Small Vegetables	0.00237	0.00384	0.01094	0.00347	0.00005	0.00031	0.00048	0.00290	0.00428	0.00495	0.00447	0.00242
Potatoes, Sugar beets, Turnip etc.	0.00237	0.00274	0.00841	0.01867	0.02376	0.02383	0.02038	0.00048	0.00022	0.00099	0.00214	0.00231
Onions and Garlic	0.00237	0.00560	0.01102	0.01522	0.01290	0.00156	0.00048	0.00022	0.00022	0.00099	0.00372	0.00237
Citrus (no ground cover)	0.00223	0.00589	0.01065	0.01303	0.01489	0.01600	0.01538	0.01409	0.01086	0.00844	0.00408	0.00231
Tomatoes and Peppers	0.00237	0.00188	0.00691	0.00194	0.01180	0.02256	0.01995	0.00210	0.00022	0.00099	0.00214	0.00231
Wine Grapes with 80% canopy	0.00226	0.00196	0.00583	0.00394	0.01124	0.01683	0.01613	0.01296	0.00761	0.00108	0.00208	0.00226
Dairy Single Crop	0.00276	0.00578	0.00936	0.01296	0.01211	0.01863	0.02076	0.01698	0.01085	0.00611	0.00344	0.00305
Carrot Single Crop	0.00274	0.00476	0.00844	0.01652	0.01288	0.01598	0.01657	0.01173	0.01027	0.00765	0.00490	0.00320
Carrot Double Cropping	0.00144	0.00416	0.00788	0.01226	0.01570	0.00998	0.00729	0.00950	0.00867	0.00700	0.00393	0.00301
Dairy Double Cropping	0.00158	0.00474	0.00877	0.01291	0.00958	0.01463	0.02115	0.01831	0.01029	0.00207	0.00165	0.00180
Urban, Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0.00000	0.00004	0.00938	0.01703	0.02240	0.02286	0.02242	0.02048	0.01595	0.01052	0.00284	0.00026
Open Water	0.00220	0.00661	0.01210	0.01869	0.02290	0.02286	0.02242	0.02048	0.01611	0.01129	0.00439	0.00226
Average All Crops	0.00229	0.00383	0.00858	0.01016	0.01227	0.01491	0.01569	0.01138	0.00742	0.00420	0.00293	0.00243

1. Grass reference ETo based on typical year, CIMIS Zone 16 monthly evapotranspiration. Irrigation Training and Research Center, California Polytechnic State University, San Luis Obispo.
   ft/d = feet per day.

Table D2-6
Historical Evapotranspiration Demand

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Tulare Lake Subbasin[1]	1990-1995 (AF/Y)	1996-1998 (AF/Y)	1999-2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)	Average (AF/Y)
Alfalfa Hay and Clover	172,519	135,032	225,167	300,041	333,752	296,086	288,555	160,621	174,457	204,219	148,325	122,839	100,395	**190,580**
Almonds (Adolescent)			8,113			11,218	19,864	8,127	10,631	18,529	16,937	15,155	13,714	**6,332**
Almonds (Mature)	26,791	18,278	15,869	47,030	43,122	35,832	30,537	36,976	39,450	41,720	46,956	54,869	55,084	**28,083**
Almonds (Young)		2,287	6,480	12,062	26,125	15,445	17,964	13,431	14,580	18,458	17,621	15,779	20,206	**8,292**
Berries	47								2	6		1		**11**
Carrot Single Crop								37	16	41	7	6	56	**6**
Citrus (no ground cover)			91		42	46	14	405	99	335	300	74	32	**74**
Corn and Grain Sorghum	36,877	100,450	75,793	101,418	82,027	89,467	59,478	87,236	75,344	71,190	58,462	48,619	44,935	**65,605**
Cotton	463,179	525,386	362,232	320,870	258,511	212,071	287,383	308,970	260,527	261,476	185,559	130,368	215,815	**345,645**
Dairy Single Crop*	14,290	15,268	16,421											**9,129**
Fallow Land*														**-**
Forest*														**-**
Grain and Grain Hay	50,167	84,811	110,025	33,572	48,563	47,755	45,271	13,518	17,369	19,505	21,282	36,934	33,228	**60,837**
Melons	413	92	468				21	3	16	10	1,182	27	128	**275**
Misc. field crops	40,450	30,296	121,265		5			1			4			**43,795**
Onions and Garlic	807	846	1,359			12	2,417	731	538	167	893	266	1,146	**854**
Open Water*														**-**
Pasture and Misc. Grasses	10,799	21,726	24,256	218,974	191,082	289,198	229,306	63,417	57,751	66,333	144,942	68,014	59,370	**62,524**
Pistachio (Adolescent)								213	315	559	1,290	4,713	5,704	**474**
Pistachio (Mature)	15,229	12,354	12,341	17,831	5,680	2,825	1,236	1,283	1,237	1,135	1,075	1,412	1,374	**9,256**
Pistachio (Young)		394	2,265	1,091	1,370	2,454	2,395	3,729	5,770	7,498	8,281	8,231	9,024	**2,477**
Pomegranates (Adolescent)											5	23	41	**3**
Pomegranates (Young)				11	303	99	52	901	210	376	537	567	746	**141**
Potatoes, Sugar beets, Turnip etc.	18,604	4	676	19		10		29		127		7	7	**4,317**
Riparian*														**-**
Small Vegetables	2,835	1,147	8,009	33	3	20	340	227	212	390	264	126	317	**2,905**
Stone Fruit (Adolescent)			4,238			28	138	232	291	171	106	414	425	**1,166**
Stone Fruit (Mature)	25,350	17,875	13,818	4,560	1,886	584	64	11	80	141	79	95	136	**11,485**
Stone Fruit (Young)		1,310	3,001	466	1,234	1,217	1,879	1,010	547	1,250	1,186	913	667	**1,308**
Tomatoes and Peppers	12,971	3,747	33,791	261	5	246	26	47,851	52,725	15,847	26,555	42,793	52,168	**20,892**
Urban, Industrial*														**-**
Wine Grapes with 80% canopy	7,586	8,301	14,872	14,203	8,893	5,692	6,980	13,625	23,455	11,832	16,450	11,874	27,920	**11,683**
Winter Wheat*														**-**
Tulare Lake Subbasin Irrigated ET Demand	**884,626**	**964,336**	**1,044,130**	**1,072,442**	**1,002,603**	**1,010,305**	**993,918**	**762,584**	**735,624**	**741,315**	**698,299**	**564,117**	**642,636**	**879,019**
Tulare Lake Subbasin GSA Total ET Demand	**898,916**	**979,604**	**1,060,551**	**1,072,442**	**1,002,603**	**1,010,305**	**993,918**	**762,584**	**735,624**	**741,315**	**698,299**	**564,117**	**642,636**	**888,148**

1. Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year. AF/Y = acre-feet per year, GSA = Groundwater Sustainability Agency, and ET = evapotranspiration.

Table D2-7
Historical Farm Demand[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Date	Other SB (AF/Y)	TLSB (AF/Y)	Westside (AF/Y)	Kings (AF/Y)	Kaweah (AF/Y)	Tule (AF/Y)	Kern (AF/Y)	Mid-Kings (AF/Y)	El Rico (AF/Y)	South Fork (AF/Y)	Southwest (AF/Y)	TCWA (AF/Y)
Jan-90	1,728,732	1,065,856	379,829	425,121	552,538	256,615	114,629	325,993	417,055	166,690	114,789	41,329
Jan-91	1,614,099	994,832	358,828	401,725	514,334	233,176	106,035	306,828	388,094	155,314	107,036	37,561
Jan-92	1,628,359	1,012,909	343,450	406,535	528,115	241,481	108,779	313,628	395,489	156,526	108,443	38,824
Jan-93	1,625,686	1,008,709	347,335	404,875	524,762	240,425	108,288	310,417	394,078	156,684	108,853	38,677
Jan-94	1,667,754	1,047,937	339,746	419,143	544,830	251,521	112,514	321,367	409,642	163,677	112,809	40,442
Jan-95	1,518,505	973,503	292,869	389,226	502,007	229,979	104,424	298,503	382,014	151,236	104,578	37,172
Jan-96	1,576,024	1,067,962	313,585	344,546	482,623	304,804	130,465	274,763	432,798	171,197	134,163	55,041
Jan-97	1,680,694	1,123,726	337,872	377,306	511,503	317,630	136,383	296,047	449,362	180,958	139,428	57,931
Jan-98	1,549,840	1,059,009	286,711	361,492	480,381	294,124	127,132	282,666	424,886	167,423	132,138	51,896
Jan-99	1,691,385	1,232,448	339,665	407,814	535,160	327,150	81,596	286,433	535,576	191,560	148,842	70,039
Jan-00	1,445,415	1,127,412	284,814	349,602	457,426	279,949	73,623	251,153	506,236	164,195	141,354	64,475
Jan-01	1,448,592	1,111,506	309,426	344,390	447,420	273,032	74,325	252,107	492,321	161,311	143,460	62,308
Jan-02	1,541,594	1,201,455	318,210	370,000	480,162	290,750	82,471	275,691	524,619	174,107	159,485	67,554
Jan-03	1,555,120	1,198,411	341,139	366,586	474,349	288,517	84,529	276,879	519,352	171,951	163,815	66,414
Jan-04	1,505,353	1,162,011	319,587	357,269	463,075	281,525	83,897	267,176	504,557	165,885	160,028	64,366
Jan-05	1,470,433	1,155,548	293,659	353,639	461,355	278,436	83,344	266,036	503,020	165,545	157,409	63,538
Jan-06	1,423,773	1,129,741	281,543	345,256	445,626	268,596	82,751	260,555	488,753	162,180	156,955	61,299
Jan-07	1,645,495	1,183,096	324,200	294,958	447,694	338,016	240,627	248,586	542,967	168,715	157,357	65,471
Jan-08	1,618,955	1,083,093	307,929	286,930	474,164	335,571	214,361	252,038	499,213	157,222	99,089	75,531
Jan-09	1,579,778	1,091,697	349,701	288,327	381,416	286,941	273,394	222,909	473,147	141,969	186,010	67,662
Jan-10	1,563,995	1,016,725	297,419	297,831	370,133	326,713	271,898	197,569	442,224	138,271	178,015	60,646
Jan-11	1,145,135	791,090	287,744	234,224	382,183	166,368	74,617	190,992	384,027	114,892	65,595	35,584
Jan-12	1,254,900	776,133	330,525	245,767	397,981	200,454	80,173	191,423	373,845	122,949	65,986	21,930
Jan-13	1,322,113	826,405	371,025	237,221	406,748	194,551	112,569	199,812	420,487	105,696	73,137	27,273
Jan-14	1,422,271	757,265	413,917	266,385	385,588	218,818	137,564	199,827	289,182	112,733	97,591	57,932
Jan-15	1,335,608	624,647	428,797	253,146	362,160	194,523	96,982	196,099	250,843	101,691	46,314	29,700
Jan-16	1,285,028	677,936	417,581	260,622	348,283	168,493	90,048	188,850	320,298	97,905	47,386	23,497
1990-2016 Average	**1,512,764**	**1,018,558**	**333,967**	**336,664**	**457,853**	**262,524**	**121,756**	**257,568**	**435,707**	**151,425**	**122,595**	**51,263**
1998-2010 Average	**1,541,517**	**1,134,781**	**311,846**	**340,315**	**455,259**	**297,640**	**136,457**	**256,907**	**496,682**	**163,872**	**152,612**	**64,707**

1. SB = subbasin, TLSB = Tulare Lake Subbasin, TCWA = Tri-County Water Agency, AF/Y = acre-feet per year.

Table D4-1
Tulare Lake Subbasin Hydrologic Model Stress Periods

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Date	Stress Period	Days	Date	Stress Period	Days
Jan-90	1	31	Mar-93	39	31
Feb-90	2	28	Apr-93	40	30
Mar-90	3	31	May-93	41	31
Apr-90	4	30	Jun-93	42	30
May-90	5	31	Jul-93	43	31
Jun-90	6	30	Aug-93	44	31
Jul-90	7	31	Sep-93	45	30
Aug-90	8	31	Oct-93	46	31
Sep-90	9	30	Nov-93	47	30
Oct-90	10	31	Dec-93	48	31
Nov-90	11	30	Jan-94	49	31
Dec-90	12	31	Feb-94	50	28
Jan-91	13	31	Mar-94	51	31
Feb-91	14	28	Apr-94	52	30
Mar-91	15	31	May-94	53	31
Apr-91	16	30	Jun-94	54	30
May-91	17	31	Jul-94	55	31
Jun-91	18	30	Aug-94	56	31
Jul-91	19	31	Sep-94	57	30
Aug-91	20	31	Oct-94	58	31
Sep-91	21	30	Nov-94	59	30
Oct-91	22	31	Dec-94	60	31
Nov-91	23	30	Jan-95	61	31
Dec-91	24	31	Feb-95	62	28
Jan-92	25	31	Mar-95	63	31
Feb-92	26	29	Apr-95	64	30
Mar-92	27	31	May-95	65	31
Apr-92	28	30	Jun-95	66	30
May-92	29	31	Jul-95	67	31
Jun-92	30	30	Aug-95	68	31
Jul-92	31	31	Sep-95	69	30
Aug-92	32	31	Oct-95	70	31
Sep-92	33	30	Nov-95	71	30
Oct-92	34	31	Dec-95	72	31
Nov-92	35	30	Jan-96	73	31
Dec-92	36	31	Feb-96	74	29
Jan-93	37	31	Mar-96	75	31
Feb-93	38	28	Apr-96	76	30

Table D4-1
Tulare Lake Subbasin Hydrologic Model Stress Periods

Date	Stress Period	Days	Date	Stress Period	Days
May-96	77	31	Oct-99	118	31
Jun-96	78	30	Nov-99	119	30
Jul-96	79	31	Dec-99	120	31
Aug-96	80	31	Jan-00	121	31
Sep-96	81	30	Feb-00	122	29
Oct-96	82	31	Mar-00	123	31
Nov-96	83	30	Apr-00	124	30
Dec-96	84	31	May-00	125	31
Jan-97	85	31	Jun-00	126	30
Feb-97	86	28	Jul-00	127	31
Mar-97	87	31	Aug-00	128	31
Apr-97	88	30	Sep-00	129	30
May-97	89	31	Oct-00	130	31
Jun-97	90	30	Nov-00	131	30
Jul-97	91	31	Dec-00	132	31
Aug-97	92	31	Jan-01	133	31
Sep-97	93	30	Feb-01	134	28
Oct-97	94	31	Mar-01	135	31
Nov-97	95	30	Apr-01	136	30
Dec-97	96	31	May-01	137	31
Jan-98	97	31	Jun-01	138	30
Feb-98	98	28	Jul-01	139	31
Mar-98	99	31	Aug-01	140	31
Apr-98	100	30	Sep-01	141	30
May-98	101	31	Oct-01	142	31
Jun-98	102	30	Nov-01	143	30
Jul-98	103	31	Dec-01	144	31
Aug-98	104	31	Jan-02	145	31
Sep-98	105	30	Feb-02	146	28
Oct-98	106	31	Mar-02	147	31
Nov-98	107	30	Apr-02	148	30
Dec-98	108	31	May-02	149	31
Jan-99	109	31	Jun-02	150	30
Feb-99	110	28	Jul-02	151	31
Mar-99	111	31	Aug-02	152	31
Apr-99	112	30	Sep-02	153	30
May-99	113	31	Oct-02	154	31
Jun-99	114	30	Nov-02	155	30
Jul-99	115	31	Dec-02	156	31
Aug-99	116	31	Jan-03	157	31
Sep-99	117	30	Feb-03	158	28

Table D4-1

Tulare Lake Subbasin Hydrologic Model Stress Periods

Date	Stress Period	Days	Date	Stress Period	Days
Mar-03	159	31	Aug-06	200	31
Apr-03	160	30	Sep-06	201	30
May-03	161	31	Oct-06	202	31
Jun-03	162	30	Nov-06	203	30
Jul-03	163	31	Dec-06	204	31
Aug-03	164	31	Jan-07	205	31
Sep-03	165	30	Feb-07	206	28
Oct-03	166	31	Mar-07	207	31
Nov-03	167	30	Apr-07	208	30
Dec-03	168	31	May-07	209	31
Jan-04	169	31	Jun-07	210	30
Feb-04	170	29	Jul-07	211	31
Mar-04	171	31	Aug-07	212	31
Apr-04	172	30	Sep-07	213	30
May-04	173	31	Oct-07	214	31
Jun-04	174	30	Nov-07	215	30
Jul-04	175	31	Dec-07	216	31
Aug-04	176	31	Jan-08	217	31
Sep-04	177	30	Feb-08	218	29
Oct-04	178	31	Mar-08	219	31
Nov-04	179	30	Apr-08	220	30
Dec-04	180	31	May-08	221	31
Jan-05	181	31	Jun-08	222	30
Feb-05	182	28	Jul-08	223	31
Mar-05	183	31	Aug-08	224	31
Apr-05	184	30	Sep-08	225	30
May-05	185	31	Oct-08	226	31
Jun-05	186	30	Nov-08	227	30
Jul-05	187	31	Dec-08	228	31
Aug-05	188	31	Jan-09	229	31
Sep-05	189	30	Feb-09	230	28
Oct-05	190	31	Mar-09	231	31
Nov-05	191	30	Apr-09	232	30
Dec-05	192	31	May-09	233	31
Jan-06	193	31	Jun-09	234	30
Feb-06	194	28	Jul-09	235	31
Mar-06	195	31	Aug-09	236	31
Apr-06	196	30	Sep-09	237	30
May-06	197	31	Oct-09	238	31
Jun-06	198	30	Nov-09	239	30
Jul-06	199	31	Dec-09	240	31

Table D4-1
Tulare Lake Subbasin Hydrologic Model Stress Periods

Date	Stress Period	Days	Date	Stress Period	Days
Jan-10	241	31	Jul-13	283	31
Feb-10	242	28	Aug-13	284	31
Mar-10	243	31	Sep-13	285	30
Apr-10	244	30	Oct-13	286	31
May-10	245	31	Nov-13	287	30
Jun-10	246	30	Dec-13	288	31
Jul-10	247	31	Jan-14	289	31
Aug-10	248	31	Feb-14	290	28
Sep-10	249	30	Mar-14	291	31
Oct-10	250	31	Apr-14	292	30
Nov-10	251	30	May-14	293	31
Dec-10	252	31	Jun-14	294	30
Jan-11	253	31	Jul-14	295	31
Feb-11	254	28	Aug-14	296	31
Mar-11	255	31	Sep-14	297	30
Apr-11	256	30	Oct-14	298	31
May-11	257	31	Nov-14	299	30
Jun-11	258	30	Dec-14	300	31
Jul-11	259	31	Jan-15	301	31
Aug-11	260	31	Feb-15	302	28
Sep-11	261	30	Mar-15	303	31
Oct-11	262	31	Apr-15	304	30
Nov-11	263	30	May-15	305	31
Dec-11	264	31	Jun-15	306	30
Jan-12	265	31	Jul-15	307	31
Feb-12	266	29	Aug-15	308	31
Mar-12	267	31	Sep-15	309	30
Apr-12	268	30	Oct-15	310	31
May-12	269	31	Nov-15	311	30
Jun-12	270	30	Dec-15	312	31
Jul-12	271	31	Jan-16	313	31
Aug-12	272	31	Feb-16	314	29
Sep-12	273	30	Mar-16	315	31
Oct-12	274	31	Apr-16	316	30
Nov-12	275	30	May-16	317	31
Dec-12	276	31	Jun-16	318	30
Jan-13	277	31	Jul-16	319	31
Feb-13	278	28	Aug-16	320	31
Mar-13	279	31	Sep-16	321	30
Apr-13	280	30	Oct-16	322	61
May-13	281	31	Nov-16	323	30
Jun-13	282	30	Dec-16	324	31

Table D5-1
Tulare Lake Subbasin Historical and Current Water Balance[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Land Surface Water Budget

			Inflows						Outflows				Net
Year	Kings River Flows	Year Type	Effective Precipitation (AF)	Applied Surface Water (AF)	Applied Pond Water (AF)	Imported Groundwater (AF)	Applied Groundwater (AF)	Total Inflows (AF)	Drain Outflow (AF)	Farm Demand Evapotranspiration (AF)	Deep Percolation (AF)	Total Outflows (AF)	Inflow-Outflow (AF)
1990	40%	D	19,958	319,870	10,310	48,885	609,474	1,008,496	0	1,065,856	132,933	1,198,789	-190,293
1991	63%	D	78,722	209,568	3,793	52,225	568,130	912,439	0	994,832	125,674	1,120,507	-208,068
1992	41%	D	64,818	245,345	8,619	46,926	587,328	953,036	0	1,012,909	126,365	1,139,274	-186,238
1993	149%	W	67,191	811,312	31,153	7,533	238,616	1,155,805	0	1,008,709	124,472	1,133,181	22,624
1994	50%	D	34,514	443,731	4,237	27,612	481,028	991,122	26	1,047,937	129,432	1,177,394	-186,272
1995	202%	W	95,479	948,773	42,079	905	177,847	1,265,083	82	973,503	116,897	1,090,481	174,601
1996	122%	N	100,745	1,038,046	26,566	0	182,868	1,348,225	251	1,067,962	127,604	1,195,817	152,408
1997	155%	W	58,885	749,117	54,380	0	265,952	1,128,333	1,392	1,123,726	143,342	1,268,459	-140,126
1998	181%	W	116,167	693,908	49,104	0	237,530	1,096,709	1,870	1,059,009	128,533	1,189,412	-92,703
1999	74%	D	34,039	713,206	39,371	0	325,154	1,111,771	7,376	1,232,448	151,647	1,391,471	-279,701
2000	90%	N	70,413	741,494	35,618	6,833	247,306	1,101,664	17,343	1,127,412	95,624	1,240,379	-138,714
2001	59%	D	94,963	437,871	8,911	54,771	453,432	1,049,949	13,351	1,111,506	90,933	1,215,791	-165,841
2002	67%	D	26,034	564,134	21,817	51,428	408,568	1,071,981	10,253	1,201,455	85,417	1,297,125	-225,143
2003	83%	N	40,108	583,124	4,687	24,029	366,253	1,018,201	8,170	1,198,411	95,332	1,301,914	-283,713
2004	61%	D	74,858	495,764	25,863	63,254	475,486	1,135,226	20,849	1,162,011	86,876	1,269,736	-134,510
2005	148%	W	80,390	873,425	36,085	857	200,953	1,191,709	5,413	1,155,548	101,553	1,262,513	-70,804
2006	172%	W	104,703	1,020,922	37,530	154	189,607	1,352,916	9,651	1,129,741	108,496	1,247,887	105,029
2007	40%	D	14,800	508,886	4,613	60,608	456,931	1,045,839	14,999	1,183,096	97,935	1,296,030	-250,191
2008	72%	D	35,836	371,231	9,331	72,842	497,113	986,354	13,795	1,083,093	89,622	1,186,511	-200,157
2009	79%	N	32,367	379,590	16,632	68,391	440,286	937,266	4,295	1,091,697	94,173	1,190,165	-252,899
2010	121%	N	88,203	694,592	51,406	31,531	234,505	1,100,238	2,440	1,016,725	78,915	1,098,080	2,158
2011	180%	W	52,937	1,026,568	21,035	7,241	60,638	1,168,420	4,486	791,090	83,959	879,535	288,885
2012	49%	D	45,317	498,937	20,785	64,173	339,834	969,046	3,226	776,133	62,058	841,417	127,629
2013	41%	D	2,800	264,515	1,725	84,661	437,315	791,017	8,381	826,405	65,687	900,473	-109,456
2014	32%	D	30,586	154,346	0	85,650	491,323	761,906	3,579	757,265	62,755	823,599	-61,693
2015	21%	D	15,085	107,212	0	79,517	508,193	710,008	829	624,647	49,756	675,231	34,777
2016	75%	D	41,890	227,755	0	70,864	413,868	754,377	2,497	677,936	53,544	733,977	20,400
1990-2016 Avg	**91%**	**--**	**56,363**	**560,120**	**20,950**	**37,440**	**366,501**	**1,041,375**	**5,724**	**1,018,558**	**100,353**	**1,124,635**	**-83,260**
1998-2010 Avg	**96%**	**--**	**62,529**	**621,396**	**26,228**	**33,438**	**348,702**	**1,092,294**	**9,985**	**1,134,781**	**100,389**	**1,245,155**	**-152,861**

Subsurface Water Budget

			Inflows							Outflows					Annual Change in Storage		
			Deep Percolation				Interbasin Inflow			Groundwater Pumping		Interbasin Outflow					
Year	Kings River Flows	Year Type	Precipitation Infiltration (AF)	Applied Water Infiltration (AF)	Stream Leakage (AF)	Intentional Recharge (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Total Inflows (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Total Outflows (AF)	Upper Aquifer (AF)	Lower Aquifer (AF)	Total Aquifer (AF)
1990	40%	D	17,012	132,933	222,466	1,021	60,944	120,265	554,640	363,970	254,873	52,493	58,787	730,124	-392,438	206,512	-185,926
1991	63%	D	10,310	125,674	149,106	0	59,832	104,657	449,578	351,785	225,455	44,466	68,123	689,829	-379,415	154,951	-224,464
1992	41%	D	13,215	126,365	122,515	0	58,304	102,535	422,934	345,307	251,686	43,733	75,762	716,488	-379,874	89,485	-290,389
1993	149%	W	43,499	124,472	178,243	61	51,892	77,023	475,190	239,755	9,069	42,526	80,157	371,507	-117,785	275,064	157,279
1994	50%	D	20,701	129,432	121,447	23,540	52,755	83,154	431,028	310,055	181,901	44,438	80,974	617,368	-255,820	87,113	-168,707
1995	202%	W	58,569	116,897	160,315	60,372	45,868	68,012	510,032	205,637	17,015	50,708	79,891	353,250	-23,977	255,398	231,421
1996	122%	N	78,864	127,604	161,750	32,081	42,064	60,065	502,429	184,321	11,265	47,154	88,966	331,705	-4,023	190,504	186,481
1997	155%	W	65,946	143,342	153,373	42,787	40,618	63,597	509,662	204,969	73,758	50,417	89,192	418,336	-15,247	116,032	100,786
1998	181%	W	75,095	128,533	152,395	61,425	38,754	67,063	523,264	191,289	57,797	55,626	78,577	383,288	17,175	136,362	153,536
1999	74%	D	47,885	151,647	180,710	0	41,389	79,296	500,928	227,049	111,192	47,970	93,144	479,355	-71,374	71,897	522
2000	90%	N	51,238	95,624	159,781	23,540	41,391	75,001	446,574	201,799	58,927	44,741	85,312	390,779	-76,900	120,539	43,638
2001	59%	D	26,775	90,933	124,376	0	44,167	84,217	370,468	264,888	202,438	45,556	85,202	598,085	-222,719	-20,340	-243,059
2002	67%	D	41,347	85,417	164,069	0	46,006	76,591	413,429	272,312	162,957	45,147	97,839	578,256	-174,685	-3,708	-178,393
2003	83%	N	36,128	95,332	174,955	23,540	45,798	78,735	454,487	255,270	130,332	46,552	94,198	526,352	-133,547	32,464	-101,083
2004	61%	D	40,008	86,876	148,458	10,700	46,099	79,299	411,440	279,593	214,670	46,854	90,221	631,339	-181,729	-49,393	-231,122
2005	148%	W	64,268	101,553	185,872	58,945	41,121	60,617	512,376	194,492	22,996	48,908	89,165	355,562	516	120,500	121,017
2006	172%	W	57,791	108,496	169,501	170,266	37,534	56,625	600,213	174,179	31,250	56,025	86,840	348,293	117,742	102,907	220,649
2007	40%	D	23,538	97,935	174,019	0	42,192	67,360	405,044	264,654	209,499	52,530	90,375	617,057	-177,972	-70,518	-248,490
2008	72%	D	26,373	89,622	137,369	0	43,266	76,606	373,236	283,431	232,114	49,766	93,253	658,564	-210,701	-85,575	-296,277
2009	79%	N	29,563	94,173	167,126	10,700	43,877	74,501	419,939	268,843	187,798	49,818	92,397	598,856	-170,773	-42,237	-213,010
2010	121%	N	67,953	78,915	145,364	23,540	37,974	63,446	417,193	187,770	62,006	47,711	91,016	388,504	-56,332	69,461	13,129
2011	180%	W	88,853	83,959	180,036	180,066	32,182	51,038	616,133	126,313	48,633	58,840	85,781	319,567	197,345	163,884	361,228
2012	49%	D	46,276	62,058	126,057	10,700	34,819	64,180	344,090	205,013	152,288	52,627	89,367	499,295	-137,135	-32,812	-169,947
2013	41%	D	23,005	65,687	123,434	0	38,673	66,410	317,209	252,639	203,087	50,934	92,285	598,945	-222,003	-83,604	-305,607
2014	32%	D	20,546	62,755	92,469	23,320	41,277	69,232	309,598	276,394	231,859	51,497	100,472	660,223	-247,305	-113,047	-360,352
2015	21%	D	25,814	49,756	74,156	23,540	41,875	72,128	287,269	283,699	240,639	50,653	90,840	665,831	-286,779	-105,501	-392,279
2016	75%	D	26,426	53,544	32,070	42,659	36,829	65,273	256,801	248,557	179,866	60,070	100,280	588,773	-234,011	-60,314	-294,325
1990-2016 Avg	**91%**	**--**	**41,740**	**100,353**	**147,460**	**30,474**	**43,981**	**74,331**	**438,340**	**246,814**	**139,458**	**49,547**	**86,978**	**522,797**	**-142,214**	**56,519**	**-85,694**
1998-2010 Avg	**96%**	**--**	**45,228**	**100,389**	**160,307**	**29,435**	**42,274**	**72,258**	**449,892**	**235,813**	**129,537**	**49,016**	**89,811**	**504,176**	**-103,177**	**29,412**	**-73,765**

1. AF = acre-feet, D = dry, W = wet, and N = normal.

Table D7-1

2017 – 2070 Forecast Model Hydrology Sequence[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

Stress Period	Forecast Year	Hydrology Conditions	Normal Kings River Flow (AF)	CNRA Change Factor	Kings River Flow CNRA (AF)
1	2017	2011	1,037,113	1.004167	1,041,434
2	2018	2010	706,083	1.016667	717,851
3	2019	1999	763,007	0.998333	761,735
4	2020	2000	777,871	1.010833	786,298
5	2021	2001	456,607	1.013333	462,695
6	2022	2002	582,769	1.015000	591,510
7	2023	2003	603,080	1.014167	611,624
8	2024	2004	515,426	1.038333	535,184
9	2025	2005	901,509	1.001667	903,011
10	2026	2000	777,871	1.010833	786,298
11	2027	2007	526,947	1.008333	531,338
12	2028	2008	379,491	1.001667	380,123
13	2029	2009	387,005	1.015000	392,810
14	2030	2010	706,083	1.016667	717,851
15	2031	1997	757,901	0.983333	745,269
16	2032	1998	704,676	0.989167	697,042
17	2033	1999	763,007	0.996667	760,463
18	2034	2000	777,871	1.021667	794,725
19	2035	2001	456,607	1.016667	464,217
20	2036	2002	582,769	0.974167	567,714
21	2037	2003	603,080	0.974167	587,500
22	2038	2004	515,426	1.002500	516,714
23	2039	2005	901,509	0.993333	895,499
24	2040	2000	777,871	1.021667	794,725
25	2041	2007	526,947	1.000833	527,386
26	2042	2008	379,491	1.002500	380,440
27	2043	2009	387,005	0.991667	383,780
28	2044	2010	706,083	1.012500	714,909
29	2045	1997	757,901	0.983333	745,269
30	2046	1998	704,676	0.989167	697,042
31	2047	1999	763,007	0.996667	760,463
32	2048	2000	777,871	1.021667	794,725
33	2049	2001	456,607	1.016667	464,217
34	2050	2002	582,769	0.974167	567,714
35	2051	2003	603,080	0.974167	587,500
36	2052	2004	515,426	1.002500	516,714

Table D7-1

2017 – 2070 Forecast Model Hydrology Sequence[1]

Stress Period	Forecast Year	Hydrology Conditions	Normal Kings River Flow (AF)	CNRA Change Factor	Kings River Flow CNRA (AF)
37	2053	2005	901,509	0.993333	895,499
38	2054	2000	777,871	1.021667	794,725
39	2055	2007	526,947	1.000833	527,386
40	2056	2008	379,491	1.002500	380,440
41	2057	2009	387,005	0.991667	383,780
42	2058	2010	706,083	1.012500	714,909
43	2059	1997	757,901	0.983333	745,269
44	2060	1998	704,676	0.989167	697,042
45	2061	1999	763,007	0.996667	760,463
46	2062	2000	777,871	1.021667	794,725
47	2063	2001	456,607	1.016667	464,217
48	2064	2002	582,769	0.974167	567,714
49	2065	2003	603,080	0.974167	587,500
50	2066	2004	515,426	1.002500	516,714
51	2067	2005	901,509	0.993333	895,499
52	2068	2000	777,871	1.021667	794,725
53	2069	2007	526,947	1.000833	527,386
54	2070	2008	379,491	1.002500	380,440

1. AF = acre-feet and CNRA = California Natural Resources Agency.

Table D7-2

2017 – 2070 Projects Forecast Model Project Development and Yields[1]

Tulare Lake Subbasin Hydrologic Model
Kings County, California

				Mid-Kings GSA	El Rico GSA		South Fork Kings GSA	TCWA GSA	New Project
	Kings River Hydrology			Proposed Recharge	Existing Ponds	Proposed 6,400 AC SW Pond	Proposed 10,000 AC SW Pond	Proposed 13,340 AC SW Pond	Total SW Supply
Year	% Normal Flows	Flood Years	Project Descriptions	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)
2017	180%			0	0	0	0	0	0
2018	121%			0	0	0	0	0	0
2019	74%			0	0	0	0	0	0
2020	90%		Construct 340 acres of Perc Basins	0	0	0	0	0	0
2021	59%			0	0	0	0	0	0
2022	67%			0	0	0	0	0	0
2023	83%			0	0	0	0	0	0
2024	61%			0	0	0	0	0	0
2025	148%	Flood		50,000	71,000	0	0	0	0
2026	90%		Construct 340 acres of Perc Basins	0	0	0	0	0	0
2027	40%			0	0	0	0	0	0
2028	72%		Construct 6,400, 10,000, and 13,400	0	0	0	0	0	0
2029	79%		acres of SW Ponds	0	0	0	0	0	0
2030	121%		Construct 340 acres of Perc Basins	0	0	0	0	0	0
2031	155%	Flood		150,000	71,000	40,000	60,000	80,000	180,000
2032	181%	Flood		150,000	71,000	40,000	60,000	80,000	180,000
2033	74%			0	0	0	0	0	0
2034	90%			0	0	0	0	0	0
2035	59%		Construct 340 acres of Perc Basins	0	0	0	0	0	0
2036	67%			0	0	0	0	0	0
2037	83%			0	0	0	0	0	0
2038	61%			0	0	0	0	0	0
2039	148%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2040	90%			0	0	0	0	0	0
2041	40%			0	0	0	0	0	0
2042	72%			0	0	0	0	0	0
2043	79%			0	0	0	0	0	0
2044	121%			0	0	0	0	0	0
2045	155%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2046	181%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2047	74%			0	0	0	0	0	0
2048	90%			0	0	0	0	0	0
2049	59%			0	0	0	0	0	0
2050	67%			0	0	0	0	0	0
2051	83%			0	0	0	0	0	0
2052	61%			0	0	0	0	0	0
2053	148%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2054	90%			0	0	0	0	0	0
2055	40%			0	0	0	0	0	0
2056	72%			0	0	0	0	0	0
2057	79%			0	0	0	0	0	0
2058	121%			0	0	0	0	0	0
2059	155%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2060	181%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2061	74%			0	0	0	0	0	0
2062	90%			0	0	0	0	0	0
2063	59%			0	0	0	0	0	0
2064	67%			0	0	0	0	0	0
2065	83%			0	0	0	0	0	0
2066	61%			0	0	0	0	0	0
2067	148%	Flood		200,000	71,000	40,000	60,000	80,000	180,000
2068	90%			0	0	0	0	0	0
2069	40%			0	0	0	0	0	0
2070	72%			0	0	0	0	0	0
			Project Annual Average	**38,043**	**15,435**	**8,780**	**13,171**	**17,561**	**40,500**
			2040-2048 Average	**44,444**	**15,778**	**8,889**	**13,333**	**17,778**	**40,000**

1. GSA = Groundwater Sustainability Agency, TCWA = Tri-County Water Authority, AC = acre, SW = southwest, SF = surface water, and AF = acre-feet.

Table D7-3

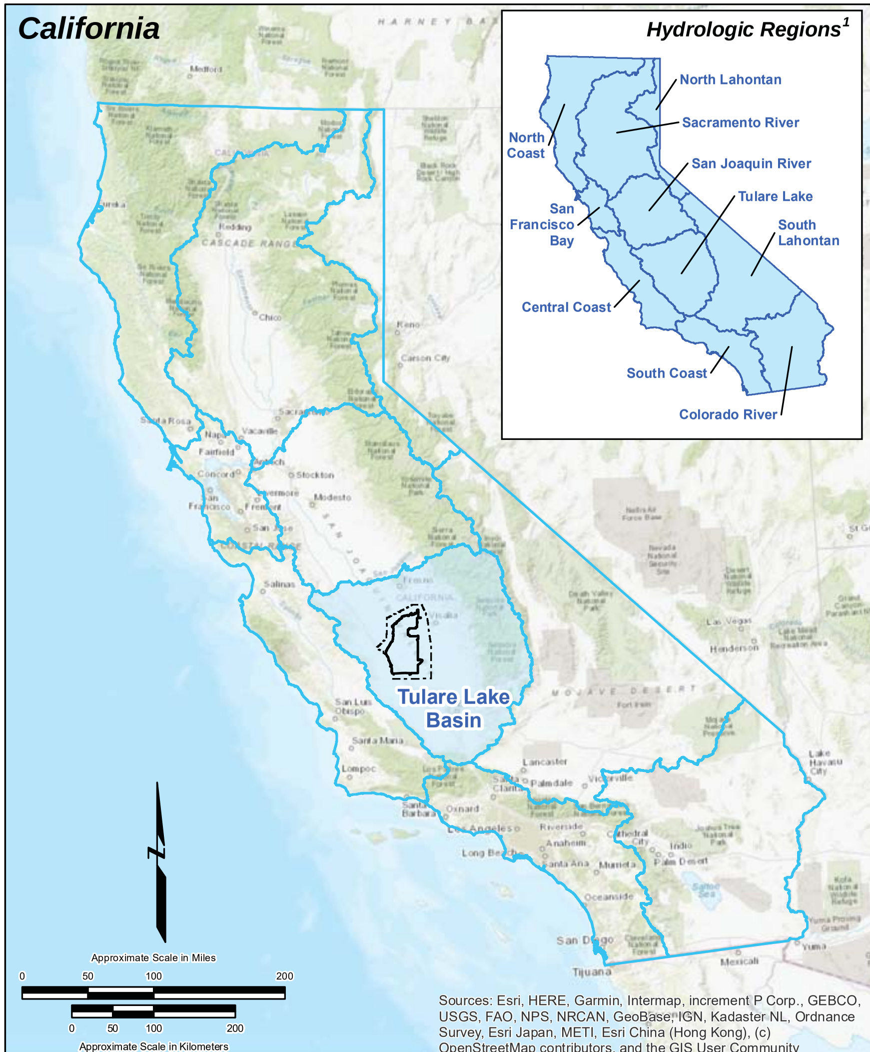
Historical and Forecasts Groundwater Balance Comparison[1]

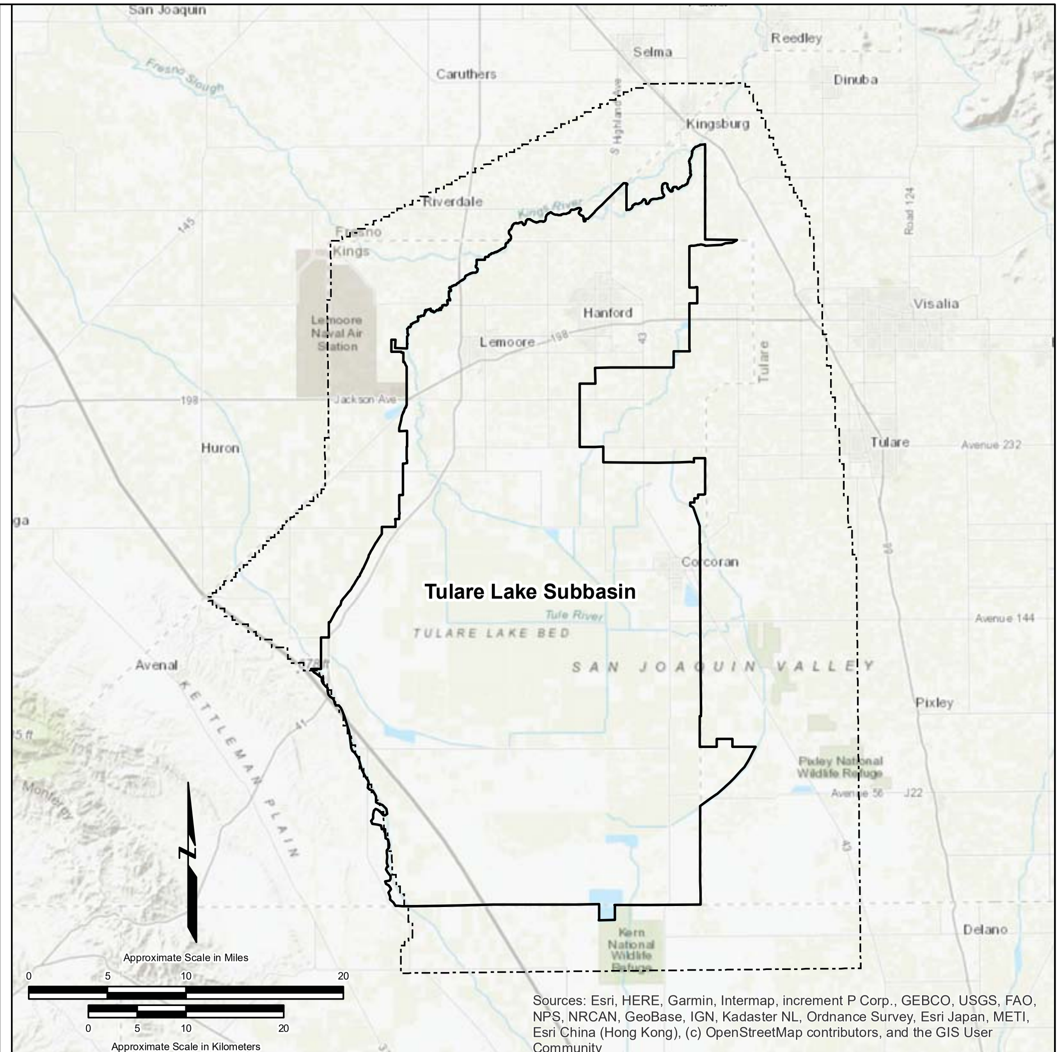
Tulare Lake Subbasin Hydrologic Model
Kings County, California

Simulation	Total Simulation Period	Tulare Lake Drain Net (AF/Y)	Tulare Lake Well Net (AF/Y)	Tulare Lake River Net (AF/Y)	Tulare Lake Recharge Net (AF/Y)	Tulare Lake Storage Net (AF/Y)	Tulare Lake Net Interbasin Flow (AF/Y)	Tulare Lake - Westside Net (AF/Y)	Tulare Lake - Kings Net (AF/Y)	Tulare Lake - Kaweah Net (AF/Y)	Tulare Lake - Tule Net (AF/Y)	Tulare Lake - Kern Net (AF/Y)
Above Corcoran Clay												
Calibration	1990-2016 Average	-5,724	-246,814	141,361	173,756	-142,214	-5,565	5,230	-5,566	-64	-6,678	1,514
Baseline Forecast	2017-2070 Average	-2,915	-233,018	148,209	172,329	-91,547	-30,438	1,288	-8,263	-8,955	-13,336	-1,172
Projects Forecast	2017-2070 Average	-3,919	-196,130	109,294	200,120	-29,931	-16,363	1,707	-4,390	-6,625	-6,988	-67
Below Corcoran Clay												
Calibration	1990-2016 Average	0	-134,595	0	0	56,519	-12,648	-1,269	-8,259	-19,363	-11,700	27,943
Baseline Forecast	2017-2070 Average	0	-90,714	0	0	-51,440	-108,636	-24,350	-25,894	-44,226	-35,198	21,032
Projects Forecast	2017-2070 Average	0	-89,353	0	0	-6,269	-42,250	-11,794	-4,500	-27,202	-6,599	7,845
Total Aquifer												
Calibration	1990-2016 Average	-5,724	-381,410	141,361	173,756	-85,694	-18,213	3,961	-13,826	-19,427	-18,379	29,457
Baseline Forecast	2017-2070 Average	-2,915	-323,732	148,209	172,329	-142,987	-139,074	-23,062	-34,157	-53,181	-48,534	19,860
Projects Forecast	2017-2070 Average	-3,919	-285,483	109,294	200,120	-36,200	-58,613	-10,086	-8,890	-33,827	-13,587	7,778

Simulation	Normal Hydrology Period	Tulare Lake Drain Net (AF/Y)	Tulare Lake Well Net (AF/Y)	Tulare Lake River Net (AF/Y)	Tulare Lake Recharge Net (AF/Y)	Tulare Lake Storage Net (AF/Y)	Tulare Lake Net Interbasin Flow (AF/Y)	Tulare Lake - Westside Net (AF/Y)	Tulare Lake - Kings Net (AF/Y)	Tulare Lake - Kaweah Net (AF/Y)	Tulare Lake - Tule Net (AF/Y)	Tulare Lake - Kern Net (AF/Y)
Above Corcoran Clay												
Calibration	1998-2010 Average	-9,985	-235,813	140,827	176,936	-103,177	-6,741	4,658	-5,640	-244	-7,131	1,616
Baseline Forecast	2040-2048 Average	-1,986	-231,248	141,765	170,054	-104,055	-34,749	965	-10,192	-9,468	-13,930	-2,124
Projects Forecast	2040-2048 Average	-3,288	-182,304	89,564	210,859	-25,079	-19,005	1,572	-6,346	-7,148	-6,743	-341
Below Corcoran Clay												
Calibration	1998-2010 Average	0	-129,537	0	0	29,412	-17,552	1,173	-10,299	-20,331	-14,158	26,063
Baseline Forecast	2040-2048 Average	0	-72,702	0	0	-45,379	-121,729	-29,706	-29,475	-46,470	-36,501	20,423
Projects Forecast	2040-2048 Average	0	-62,943	0	0	5,687	-53,972	-15,058	-8,292	-31,963	-6,195	7,536
Total Aquifer												
Calibration	1998-2010 Average	-9,985	-365,350	140,827	176,936	-73,765	-24,294	5,830	-15,939	-20,575	-21,289	27,680
Baseline Forecast	2040-2048 Average	-1,986	-303,950	141,765	170,054	-149,434	-156,477	-28,740	-39,667	-55,938	-50,431	18,299
Projects Forecast	2040-2048 Average	-3,288	-245,247	89,564	210,859	-19,392	-72,977	-13,485	-14,638	-39,111	-12,938	7,195

1. AF/Y = acre-feet per year.





Explanation

- Hydrologic region
- Subbasin boundary
- Model Domain

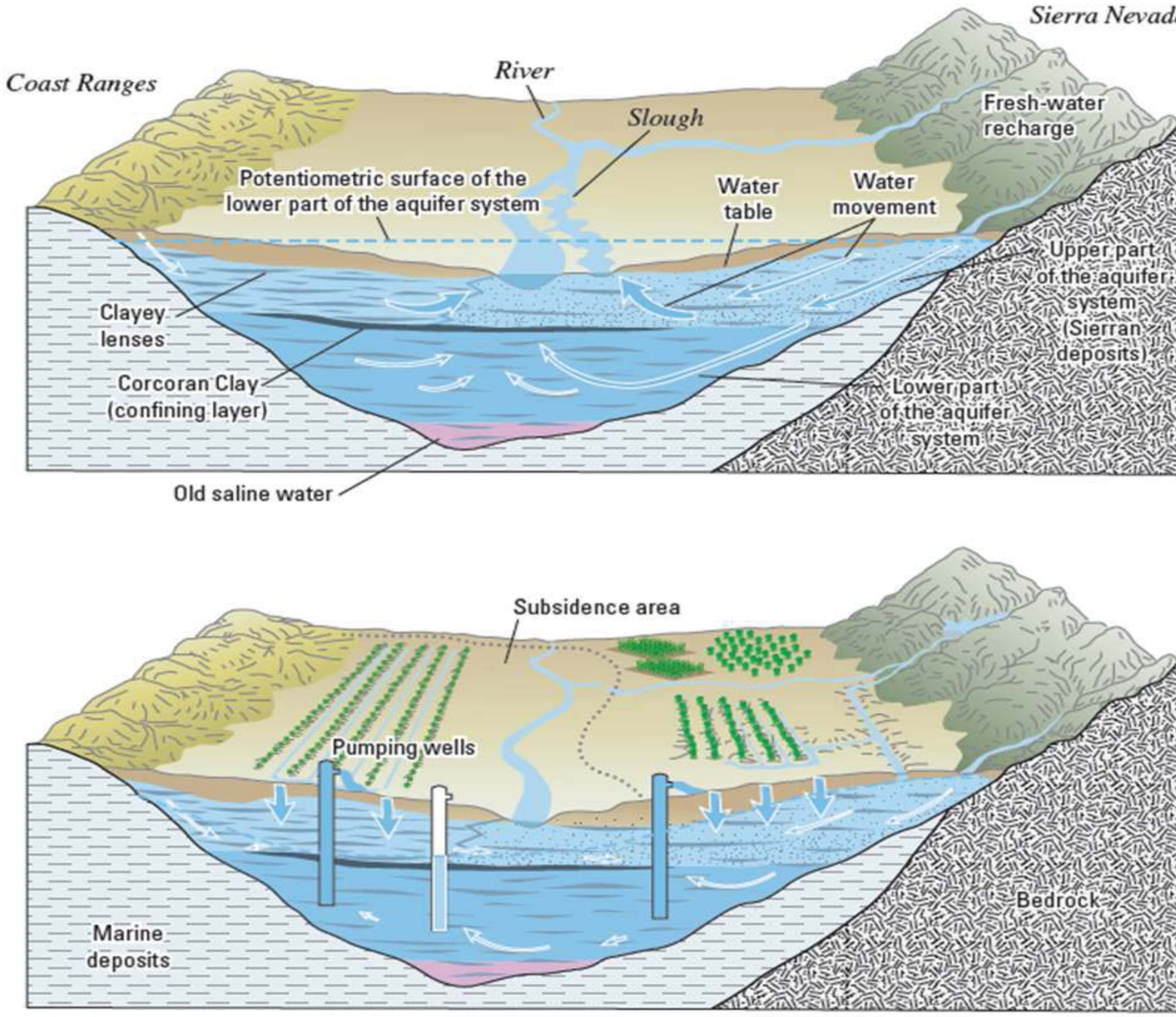
Note:
1) Hydrologic region dataset obtained from California Department of Water Resources (CA DWR), September 12, 2018.
https://data.ca.gov/dataset/hydrologic-regions

Site Location Map
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 12/12/2019	Project No.: FR18161220
	Figure	D1-1

Date: 12/12/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\Basin_Setting_fig3-1_SiteLocationMap.mxd

Pre-Development



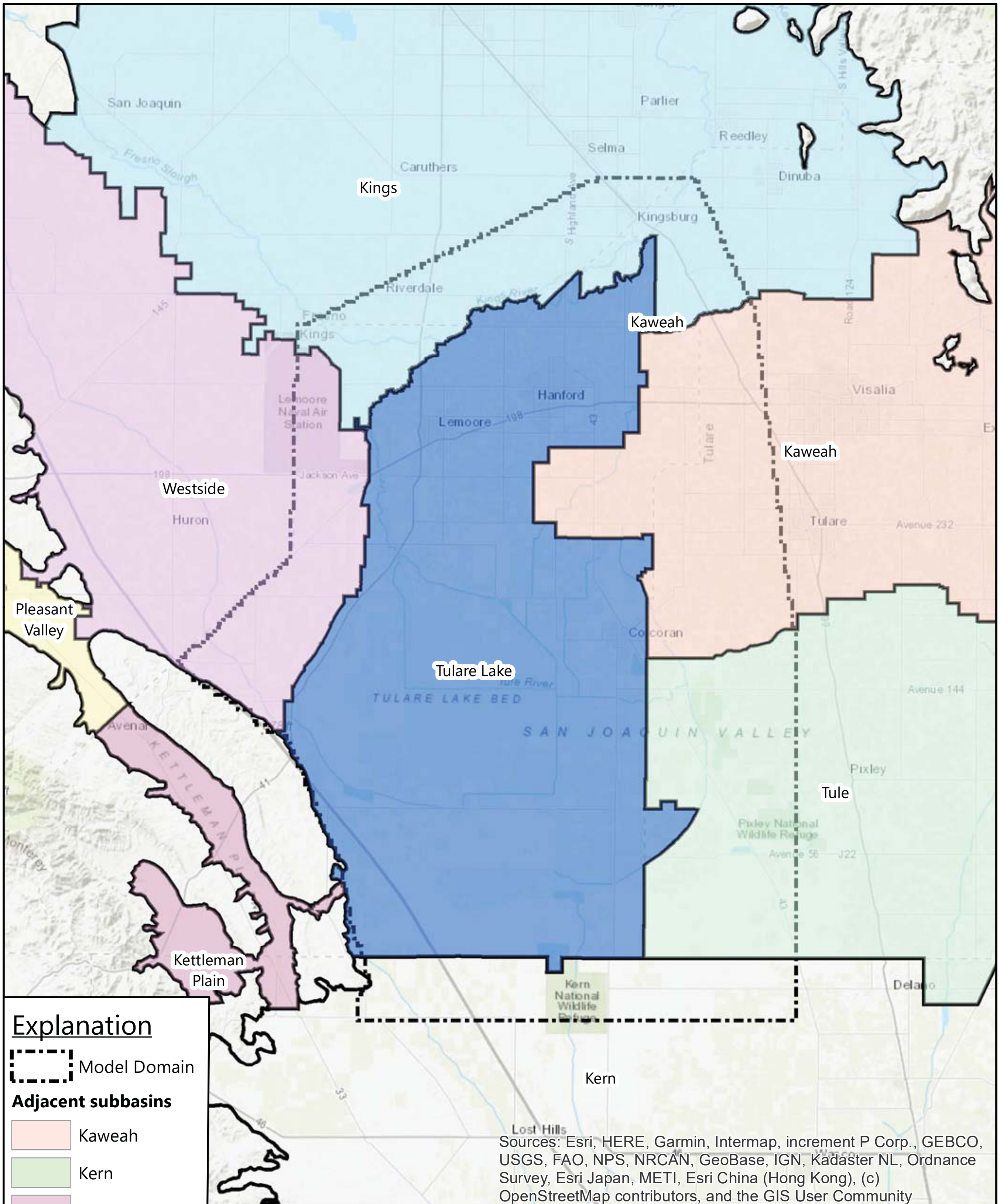
Post-Development

Pre-Development and Post-Development Hydrogeologic Conceptual Model for the San Joaquin Valley

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 08/26/2019	Project No.: FR18161220
		Figure **D2-1**

adapted from Fig. A9, USGS Prof. Paper 1766



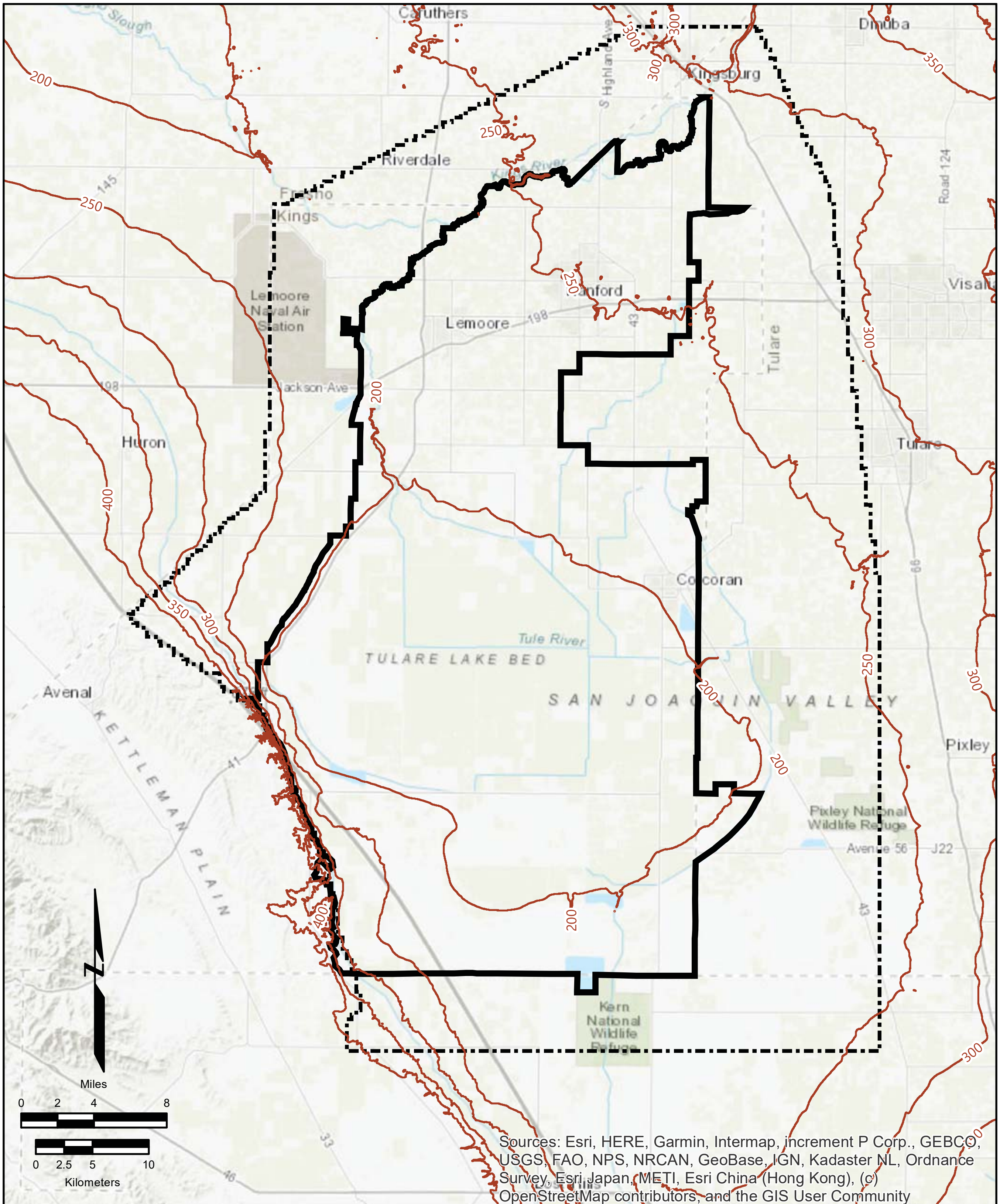
Subbasins Bounding The Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: EMC	Date: 1/7/2020	Project No.: FR18161220
		Figure **D2-2**

Date: 1/7/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-2_ModelDomain.mxd



Explanation

50ft elevation contour

Subbasin boundary

Model domain

Surface Topography

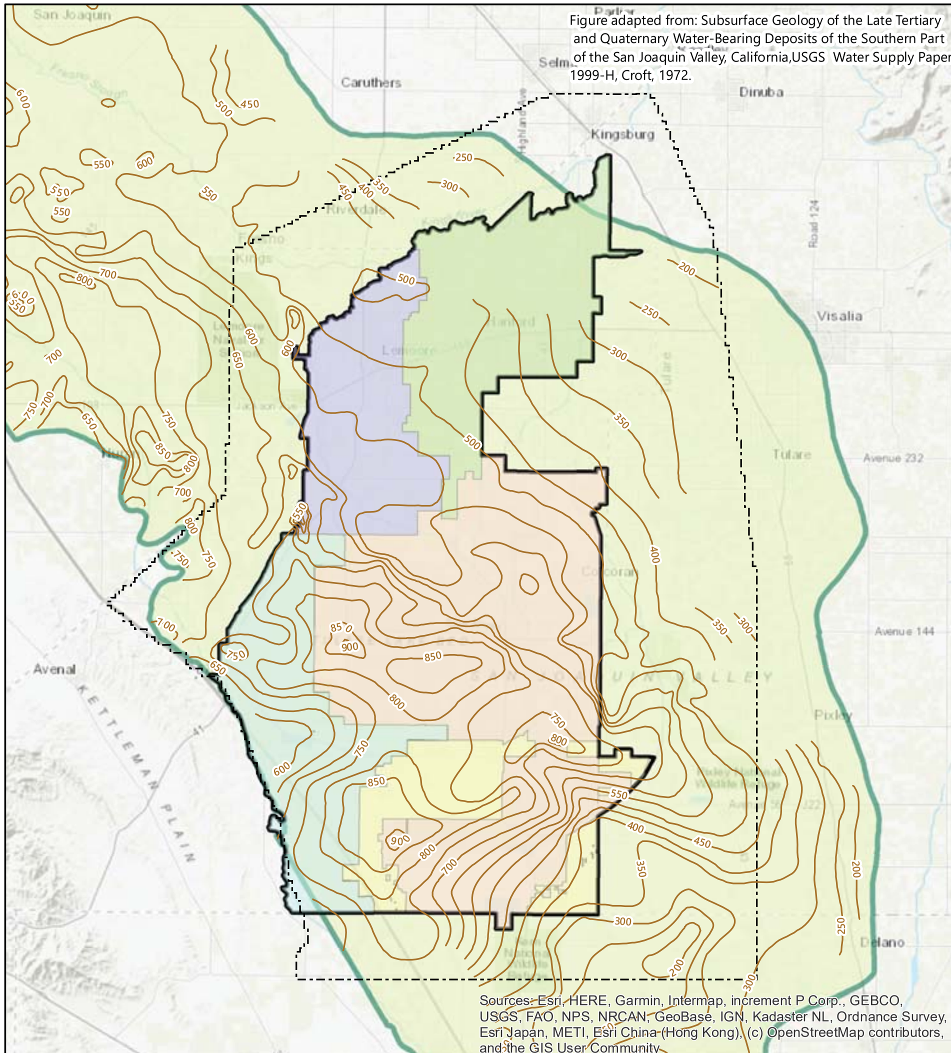
Tulare Lake Subbasin Groundwater Sustainability Plan

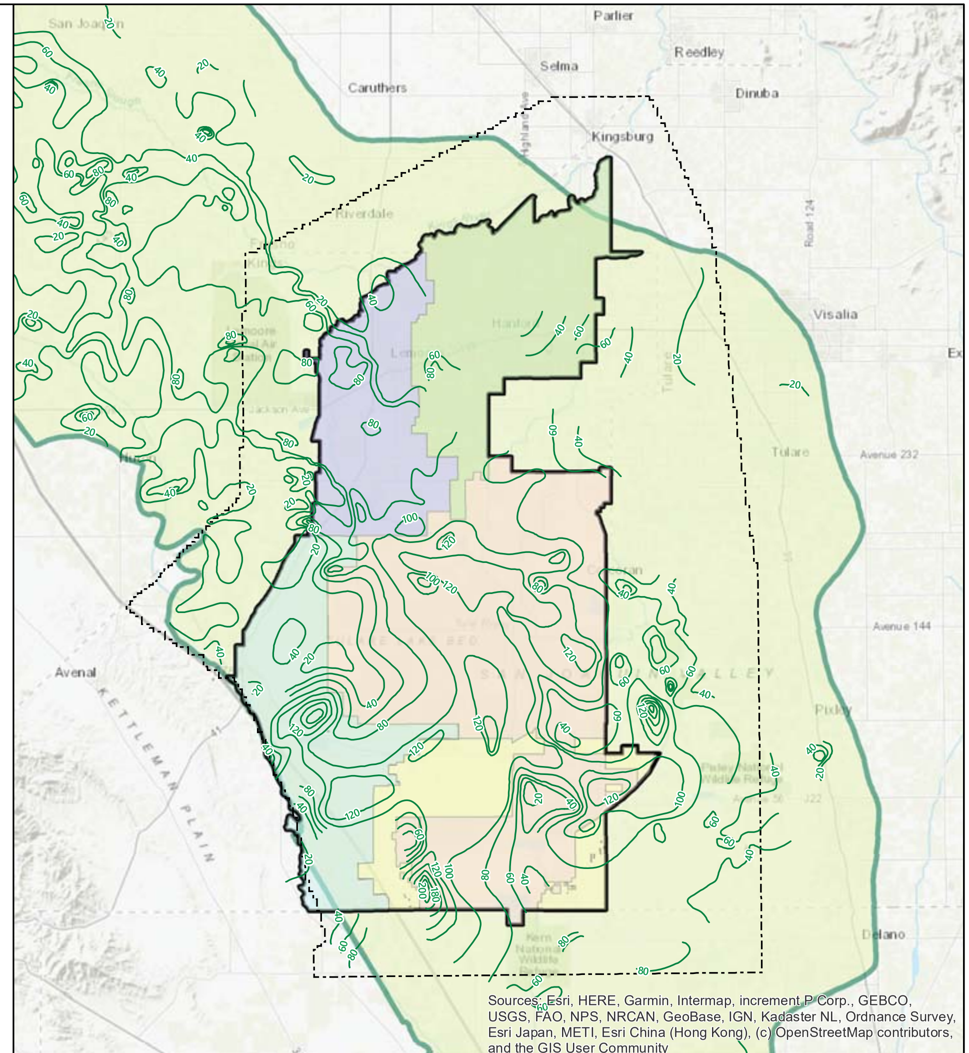
Kings County, California

By: EMC	Date: 12/12/2019	Project No.: FR18161220

Figure **D2-3**

Date: 12/12/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-3_Topography.mxd





Explanation

- Depth to top of E-Clay in feet
- Thickness of E-Clay in feet
- Model domain
- Subbasin boundary
- Extent of E-Clay

Groundwater Sustainability Areas (GSAs)

- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Approximate Scale in Miles: 0 4 8 16

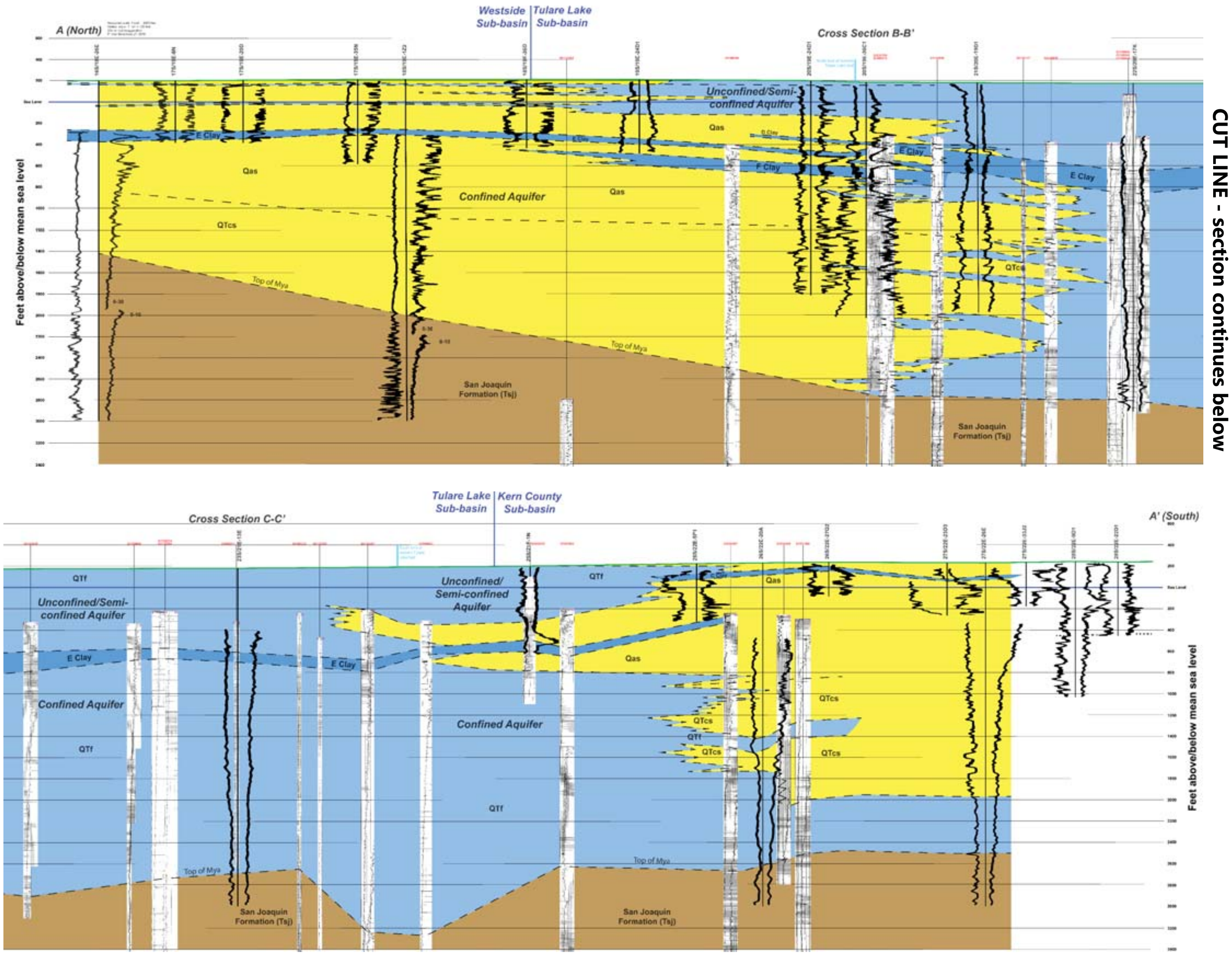
Approximate Scale in Kilometers: 0 4 8 16

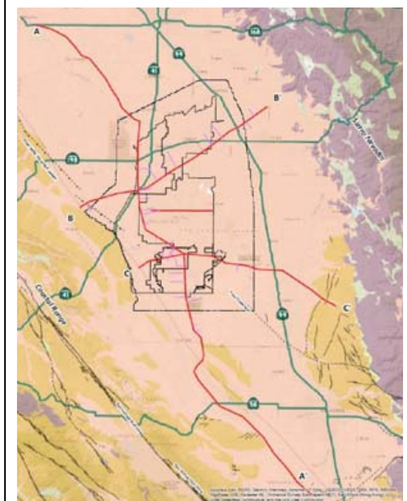
Lateral Extent Elevation and Thickness of E-Clay

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/7/2020	Project No.: FR16181220
		Figure **D2-4**

Date: 1/7/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-4_Corcoran Clay.mxd





Explanation

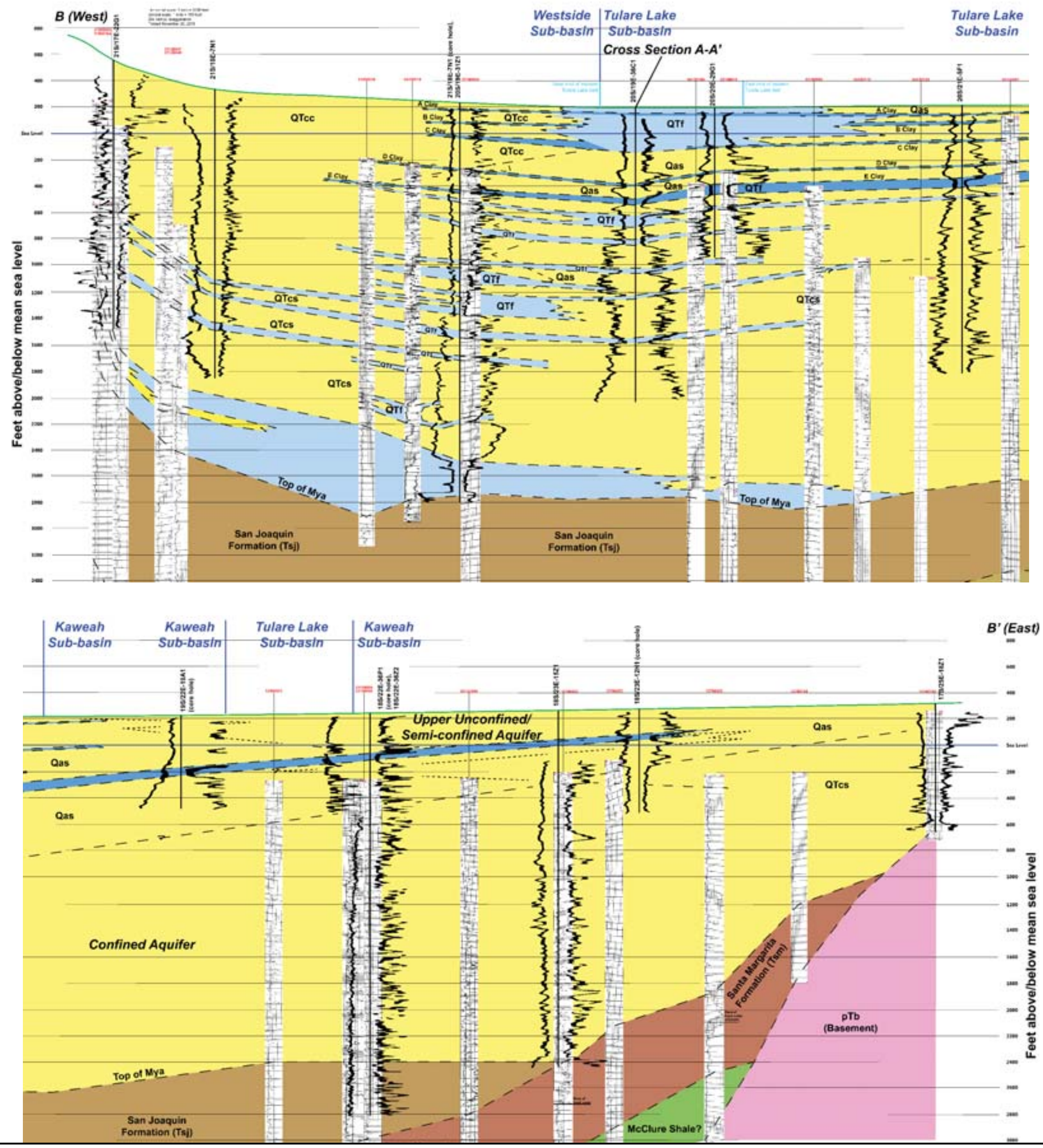
(yellow)	Coarse-grained alluvium / Tulare Formation
(brown)	San Joaquin Formation
(light blue)	Alluvium / Tulare Formation lacustrine sediments
(dark blue)	Regional clay marker beds as defined by Croft (1972)
25S/21E-1N	CA DWR well name
03120281	CA DOGGR well APN
0 30	Electric log resistivity scale (ohmmeters)

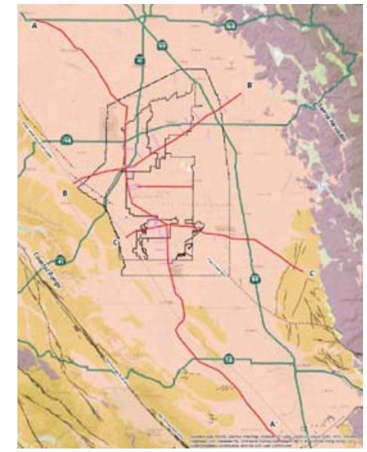
Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

North-South Geologic Cross-Section A-A'
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings county, California

By: EMC | Date: 12/13/2019 | Project No.: FR18161220

Figure **D2-5a**





Explanation

(yellow)	Coarse-grained alluvium / Tulare Formation
(brown)	San Joaquin Formation
(olive)	Etchegoin Formation
(red-brown)	Santa Margarita Formation
(light blue)	Alluvium / Tulare Formation lacustrine sediments
(blue)	Regional clay marker beds as defined by Croft (1972)
(pink)	Crystalline basement
25S/21E-1N	CA DWR well name
03120281	CA DOGGR well APN
0 30	Electric log resistivity scale (ohmmeters)

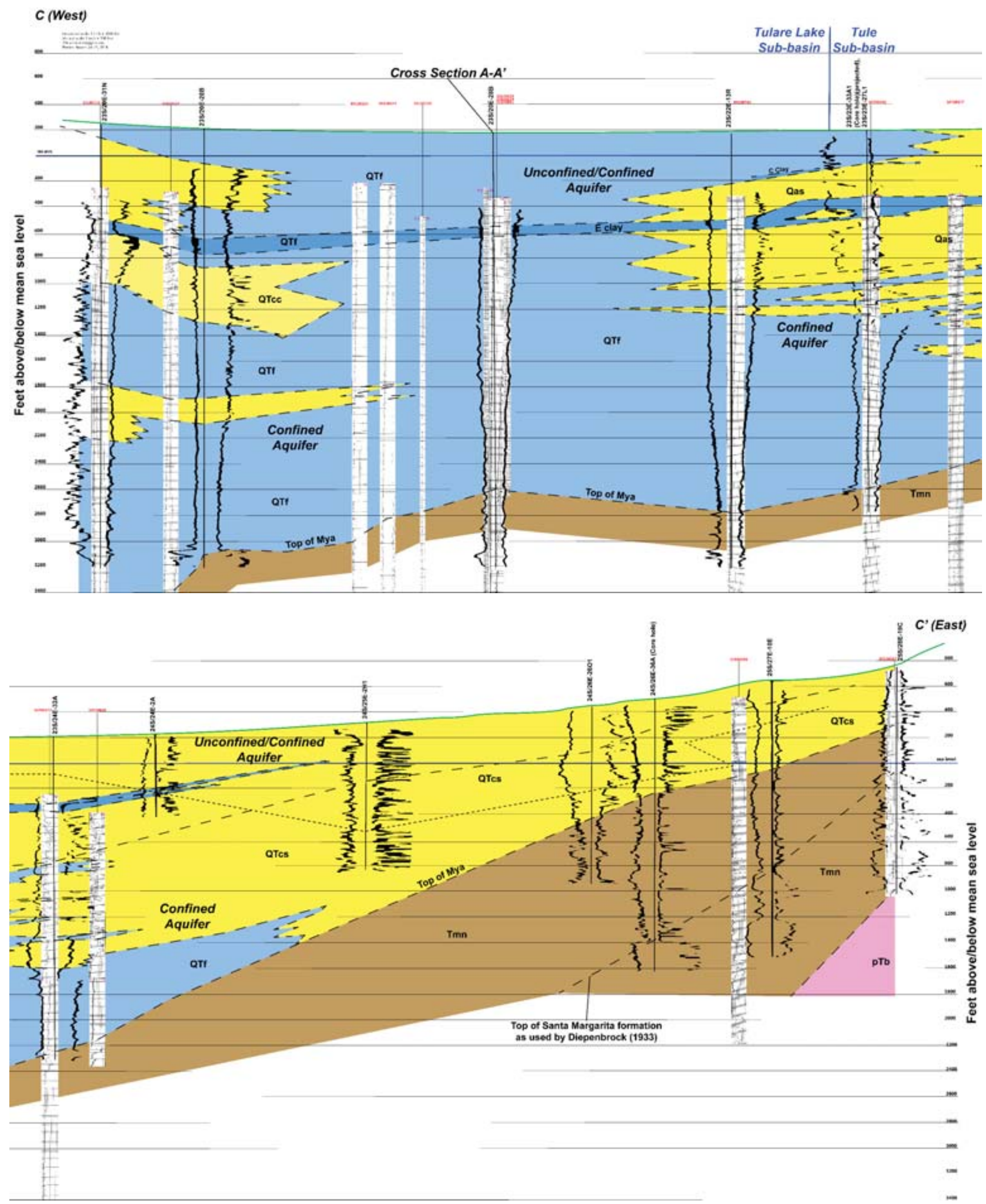
Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

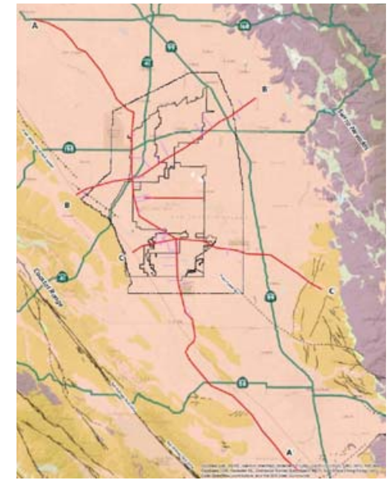
West-East Geologic Cross-Section B-B'
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC | Date: 12/13/2019 | Project No.: FR18161220

Figure **D2-5b**

Date: 12/13/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-5b_West-East Geologic Cross-Section B-B'.mxd





Explanation

(yellow)	Coarse-grained alluvium / Tulare Formation
(brown)	San Joaquin Formation
(light blue)	Alluvium / Tulare Formation lacustrine sediments
(blue)	Regional clay marker beds as defined by Croft (1972)
(pink)	Crystalline basement
25S/21E-1N	CA DWR well name
03120281	CA DOGGR well APN
0 30	Electric log resistivity scale (ohmmeters)

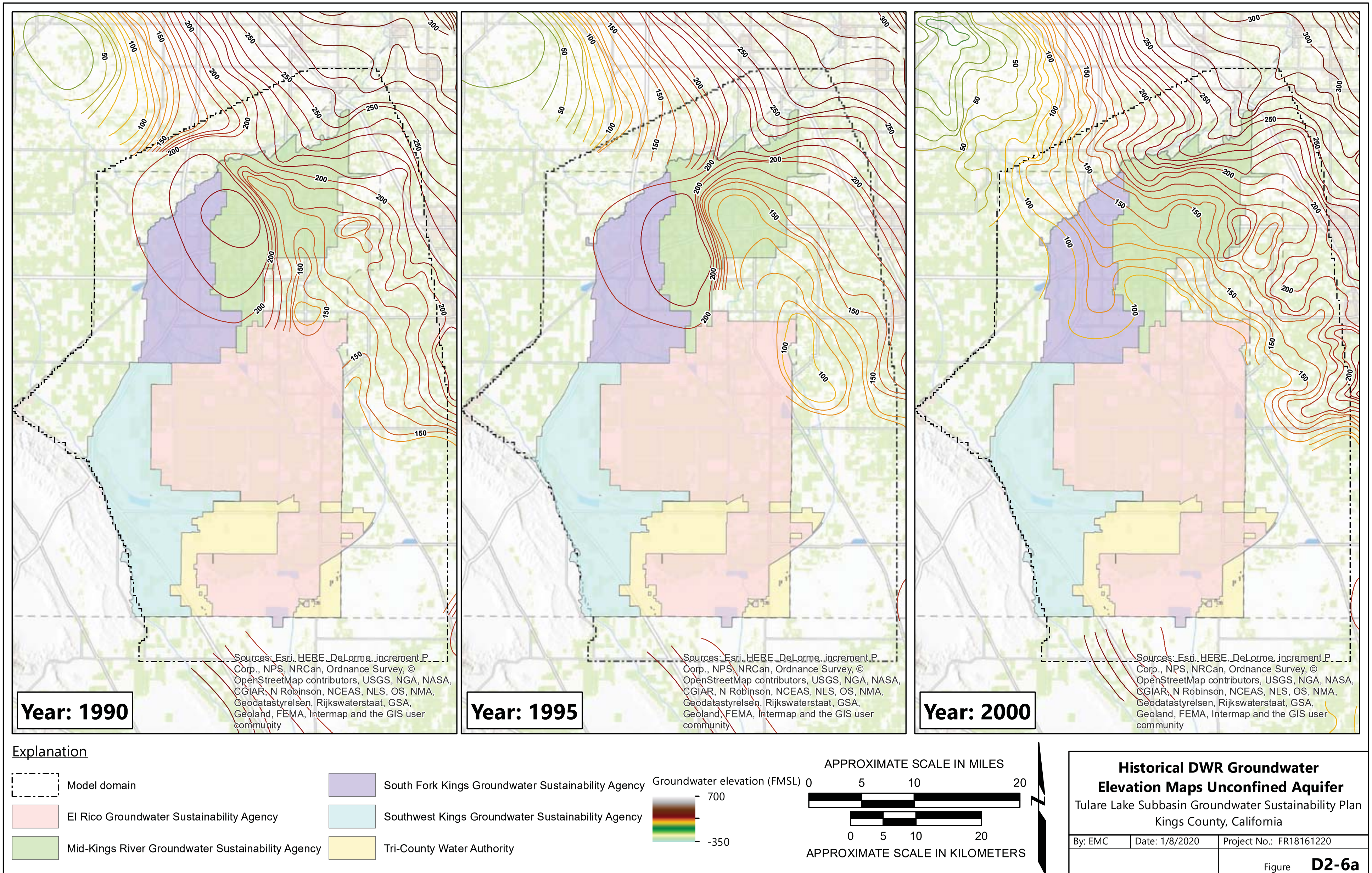
Notes:
1) Contacts dashed where inferred.
2) CA DWR = California Department of Water Resources.
2) CA DOGGR = Division of Oil, Gas, and Geothermal Resources, California Department of Conservation.

North - South Geologic Cross-Section Through the Tulare Lake Bed

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 12/13/2019	Project No.: FR18161220
		Figure **D2-5c**

Date: 12/13/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-5c_West-East Geologic Cross-Section C-C'.mxd

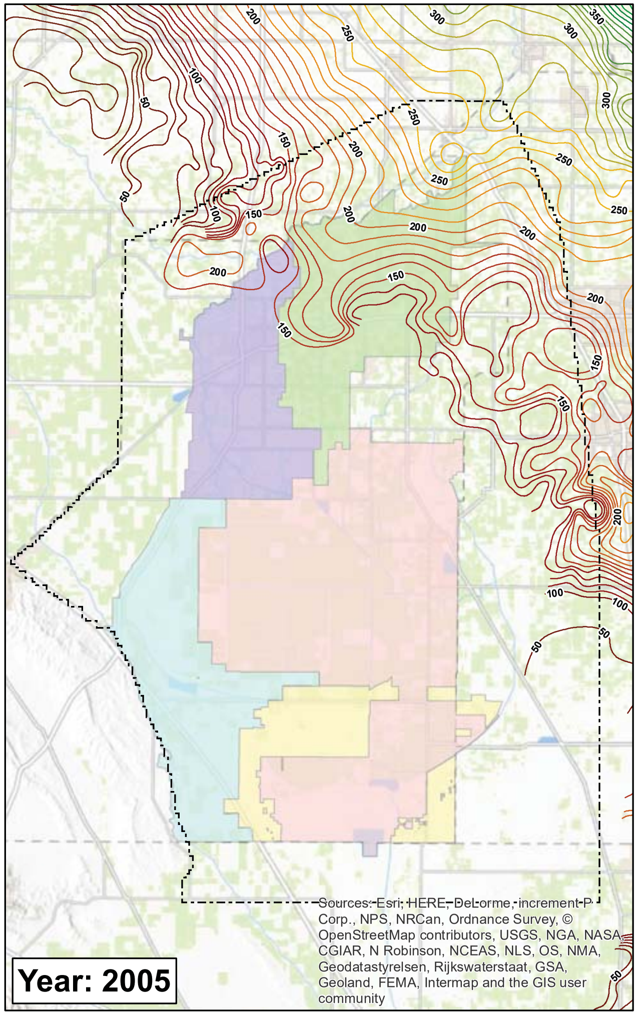


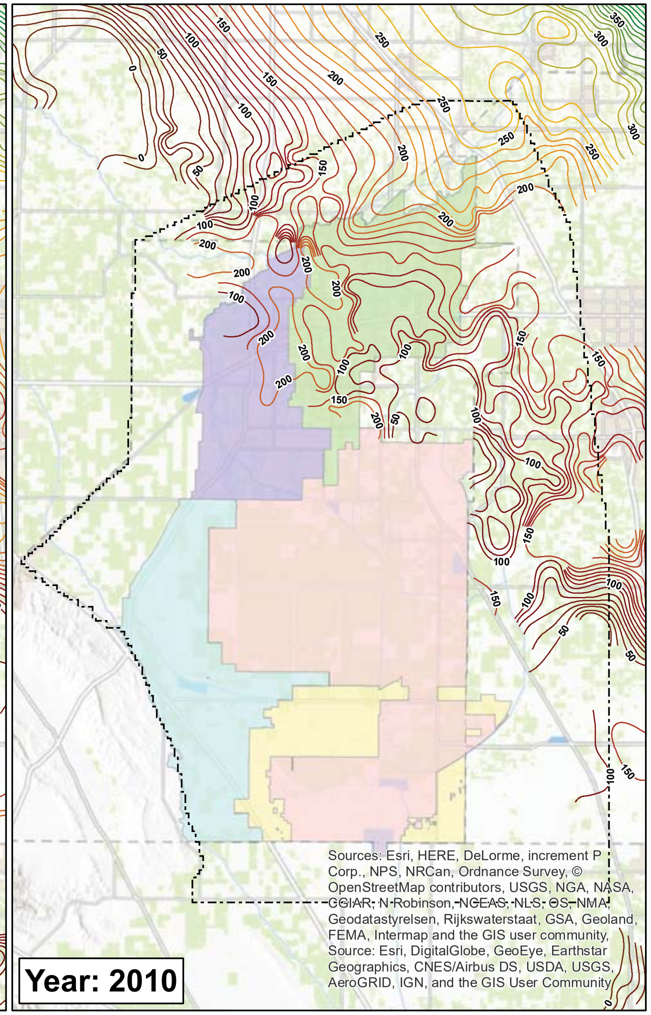
Historical DWR Groundwater Elevation Maps Unconfined Aquifer

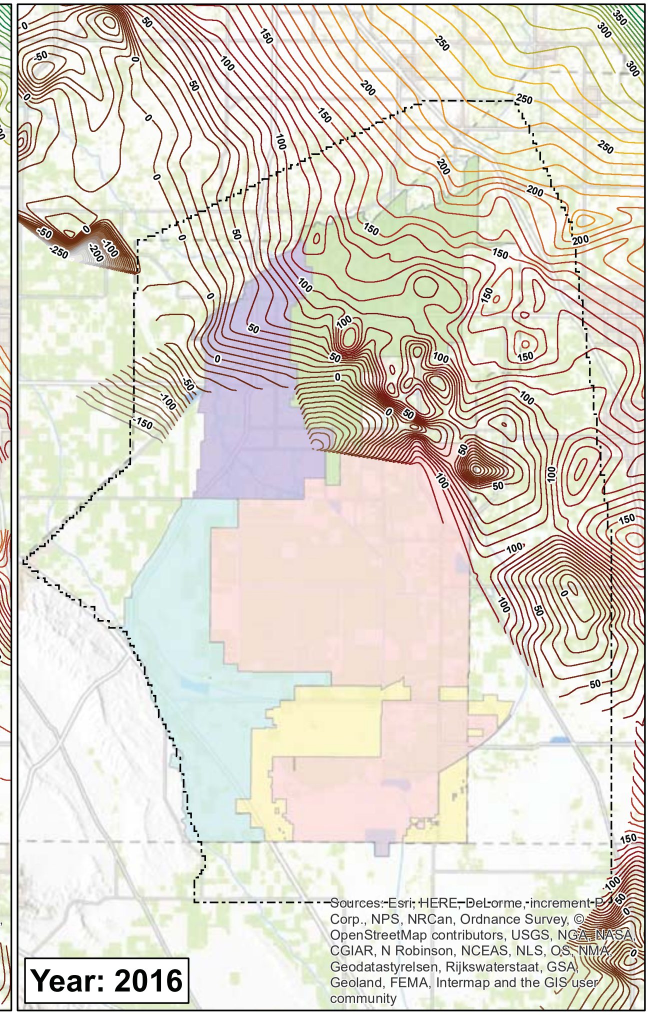
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D2-6a**

Date: 1/8/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-6a_RecentGroundwaterConditions_1990_1995_2000.mxd







Explanation

- Model domain
- El Rico Groundwater Sustainability Agency
- Mid-Kings River Groundwater Sustainability Agency
- South Fork Kings Groundwater Sustainability Agency
- Southwest Kings Groundwater Sustainability Agency
- Tri-County Water Authority

Groundwater elevation (FMSL)
-700
-350

APPROXIMATE SCALE IN MILES
0 5 10 20

0 5 10 20
APPROXIMATE SCALE IN KILOMETERS

NOTE:
1) Groundwater elevation data obtained from California Department of Water Resources (CA DWR), June 2018: https://databasin.org/datasets/b05820cda86b4921a515065fa1deffcc
2) FMSL = Feet above mean sea level.

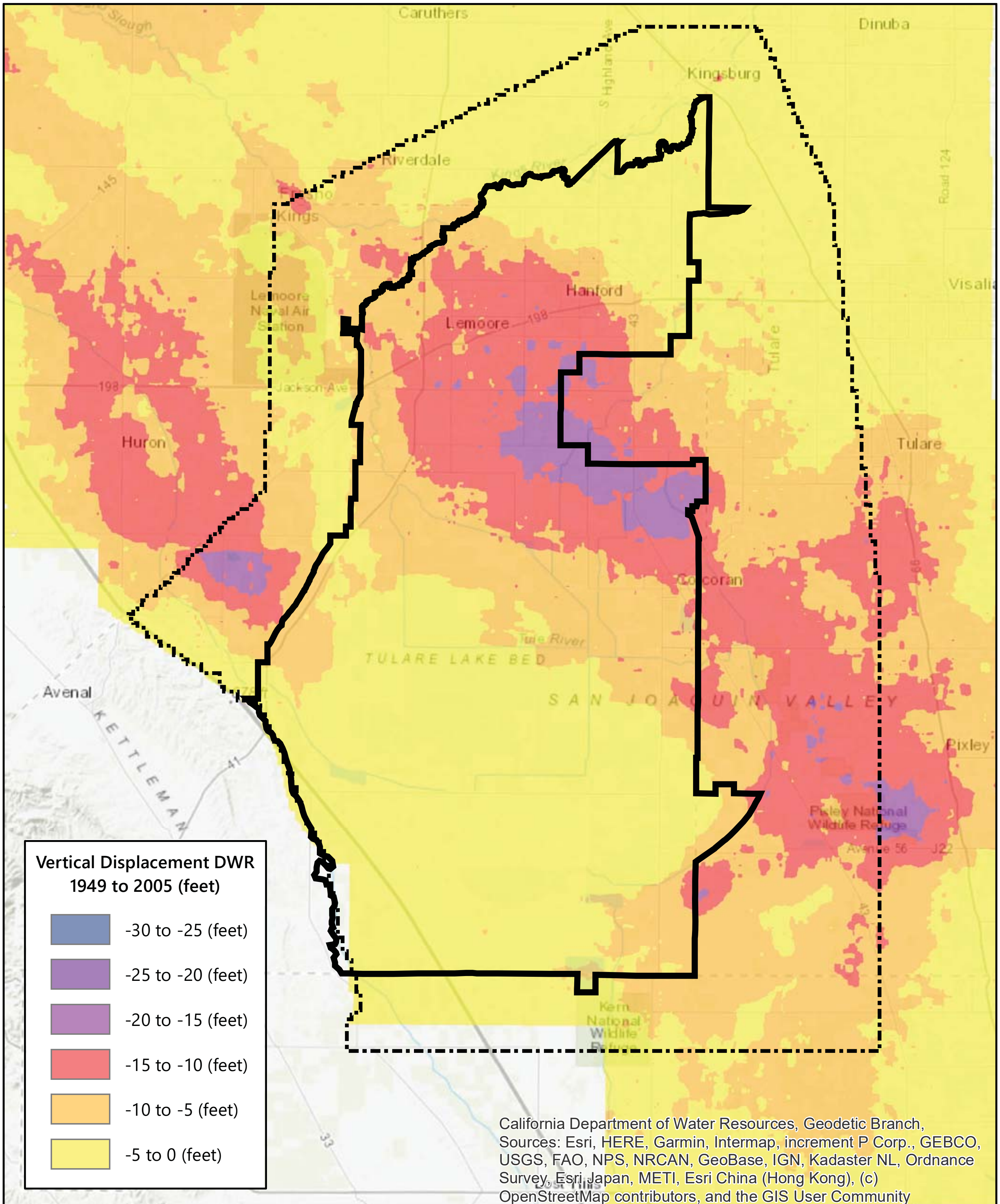
Historical DWR Groundwater Elevation Maps, Unconfined Aquifer

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 12/13/2019	Project No.: FR18161220

Figure **D2-6b**

Date: 12/13/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-6b_RecentGroundwaterConditions_2005_2010_2016.mxd



Explanation

Model domain

Subbasin boundary

Notes:

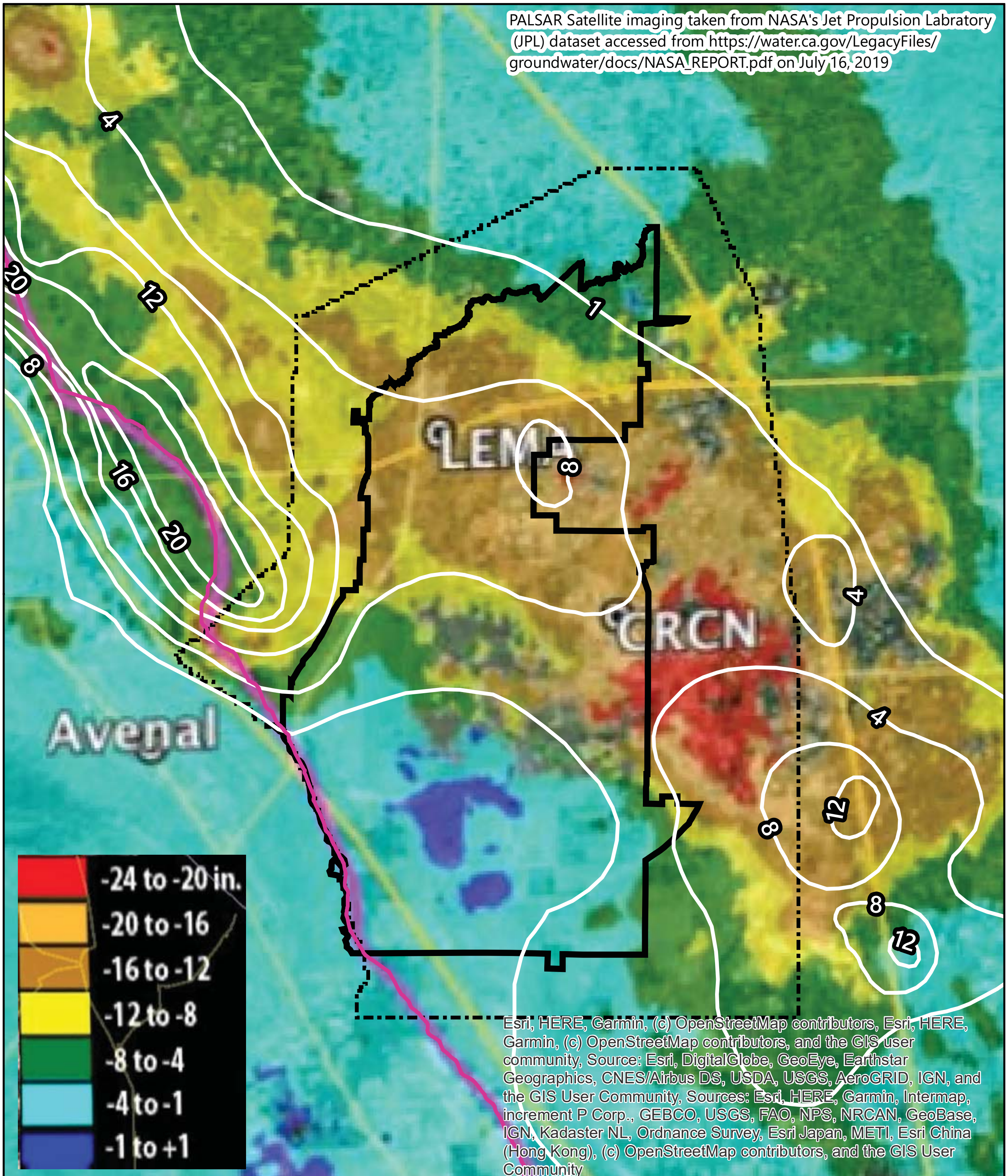
1. Vertical Displacement dataset taken from California Department of Water Resources (DWR) https://sgma.water.ca.gov/webgis. Accessed July 9, 2019.

Historical Subsidence of the Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 12/13/2019	Project No.: FR18161220
		Figure **D2-7**

Date: 12/13/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-7_Historical Subsidence TLSB8x11.mxd



Explanation

Subbasin boundary

Model domain

Edmund G. Brown California Aqueduct

White line shows historical subsidence data from 1926-1970 (ft.)

Miles: 0 2 4 8

Kilometers: 0 2.5 5 10

N

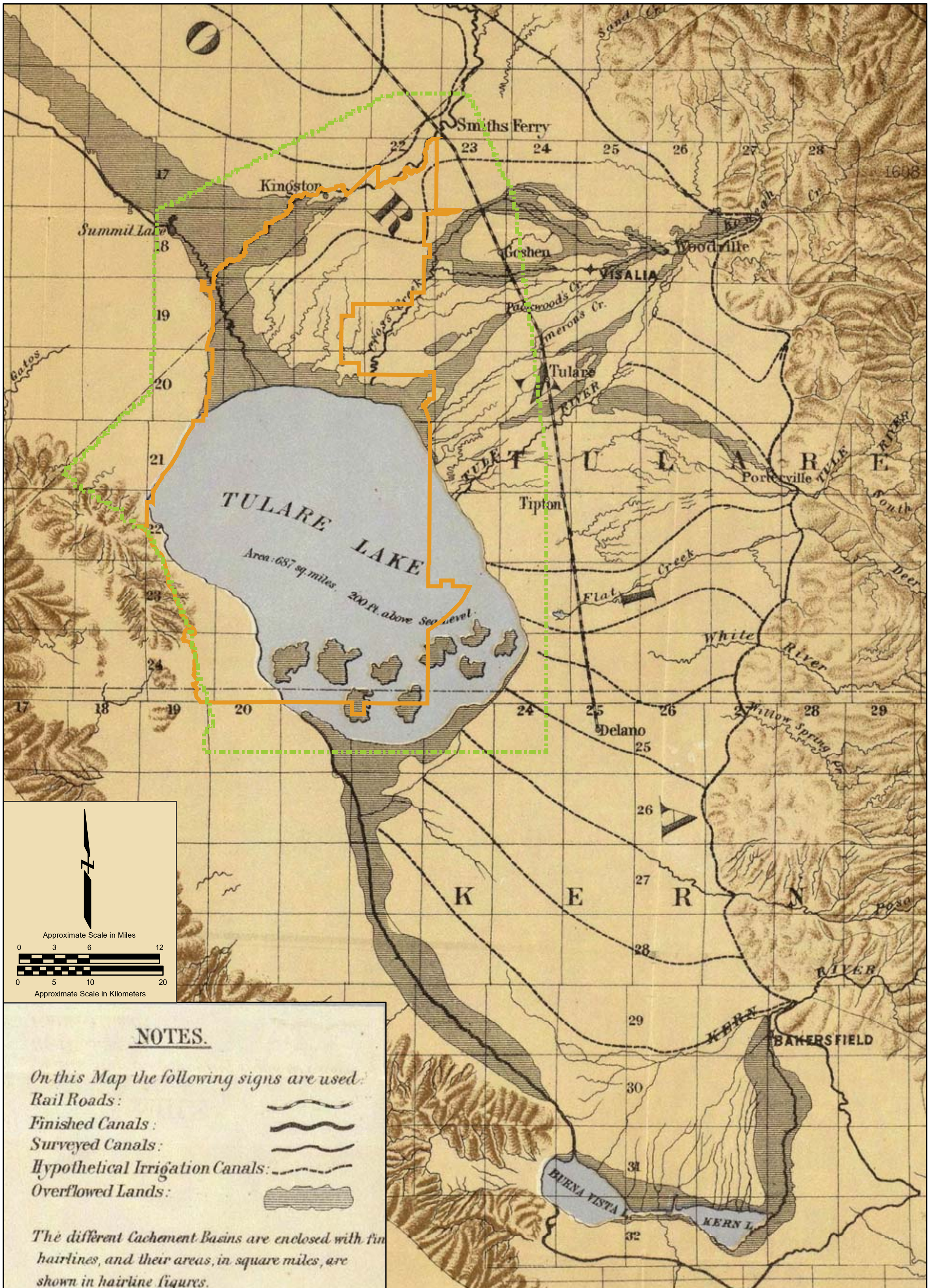
Subsidence in the Tulare Lake Subbasin 2007 to 2010

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 12/13/2019	Project No.: FR18161220
		Figure **D2-8**

Date: 12/13/2019 Printed by: shaina.price
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-8_Historical Subsidence TLSB8x11.mxd

Date: 12/12/2019 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-9a_Historic Surface Water Systems San Joaquin Valley.mxd



Explanation

Model domain

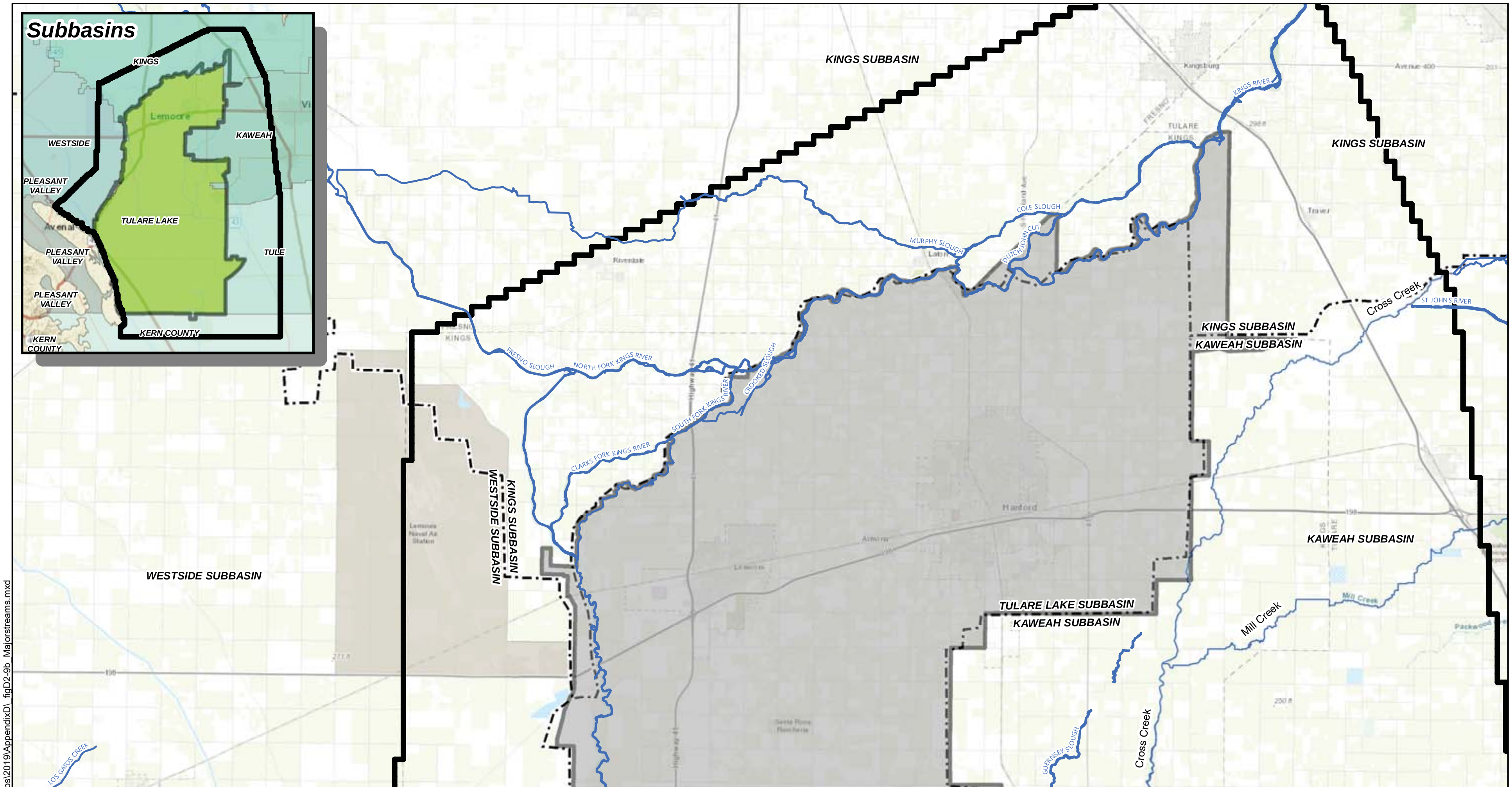
Subbasin boundary

Note:
Adapted from "Map of the San Joaquin, Sacramento and Tulare Valleys, State of California, Prepared Under The Direction of the Board of Commissioners on Irrigation, 1873"

Historic Drainage System
Tulare Lake Basin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: GLK	Date: 12/12/2019	Project No.: FR16181220

Figure **D2-9a**



Explanation

- River/Lake [1]
- Model Domain
- Tulare Lake subbasin boundary
- Boundaries of adjacent subbasins

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

APPROXIMATE SCALE IN MILES
0 1 2 4

0 1 2 4
APPROXIMATE SCALE IN KILOMETERS

N

Notes:
1. Data accessed from the National Hydrography Dataset (2018)

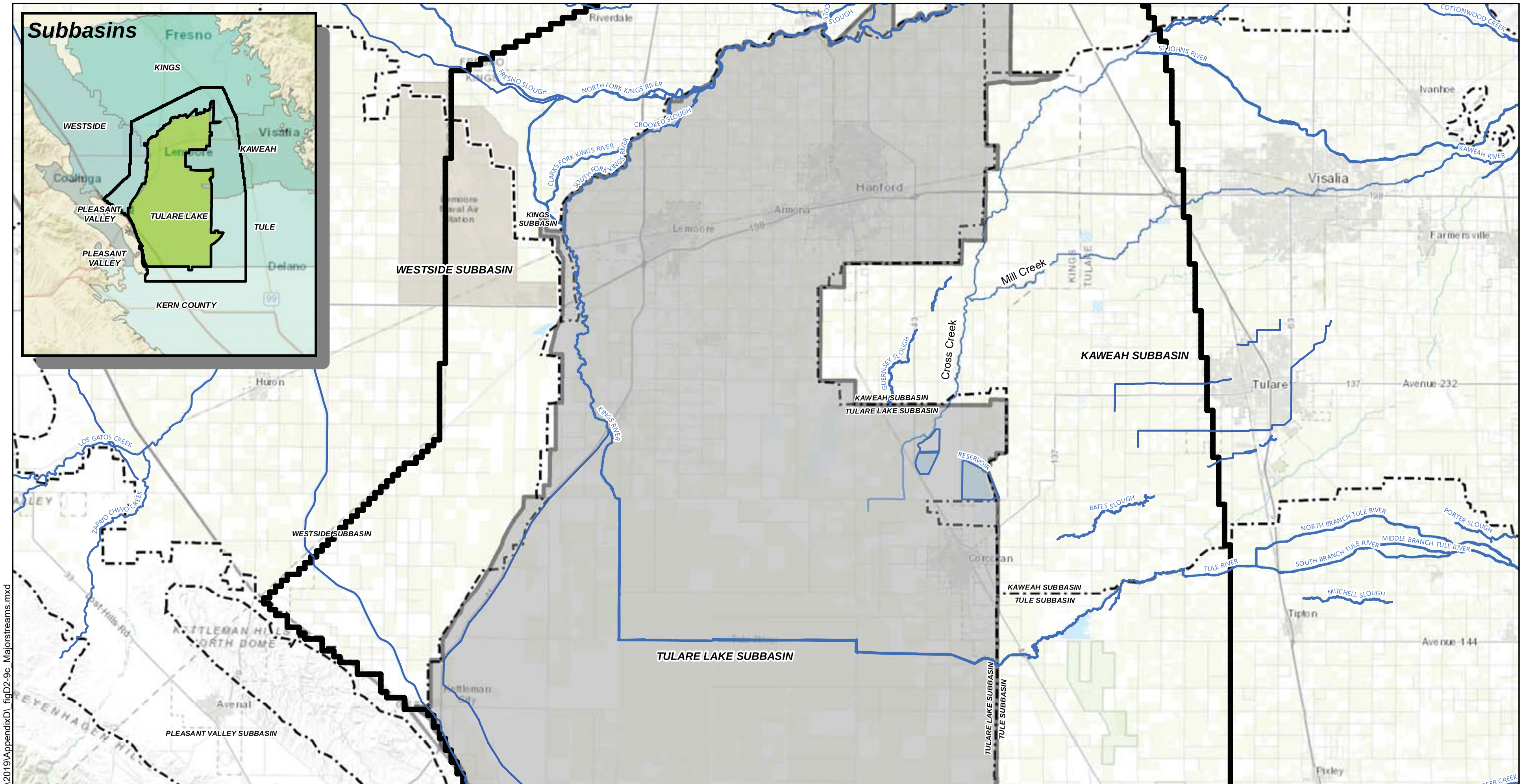
Simulated Major Streams and Distribution Channels

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 12/13/2019	Project No.: FR18161220

Figure **D2-9b**

N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-9b_Majorstreams.mxd



Explanation

- River/Lake [1]
- Model Domain
- Tulare Lake subbasin boundary
- Boundaries of adjacent subbasins

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

APPROXIMATE SCALE IN MILES
0 1 2 4

0 1 2 4
APPROXIMATE SCALE IN KILOMETERS

N

Notes:
1. Data accessed from the National Hydrography Dataset (2018)

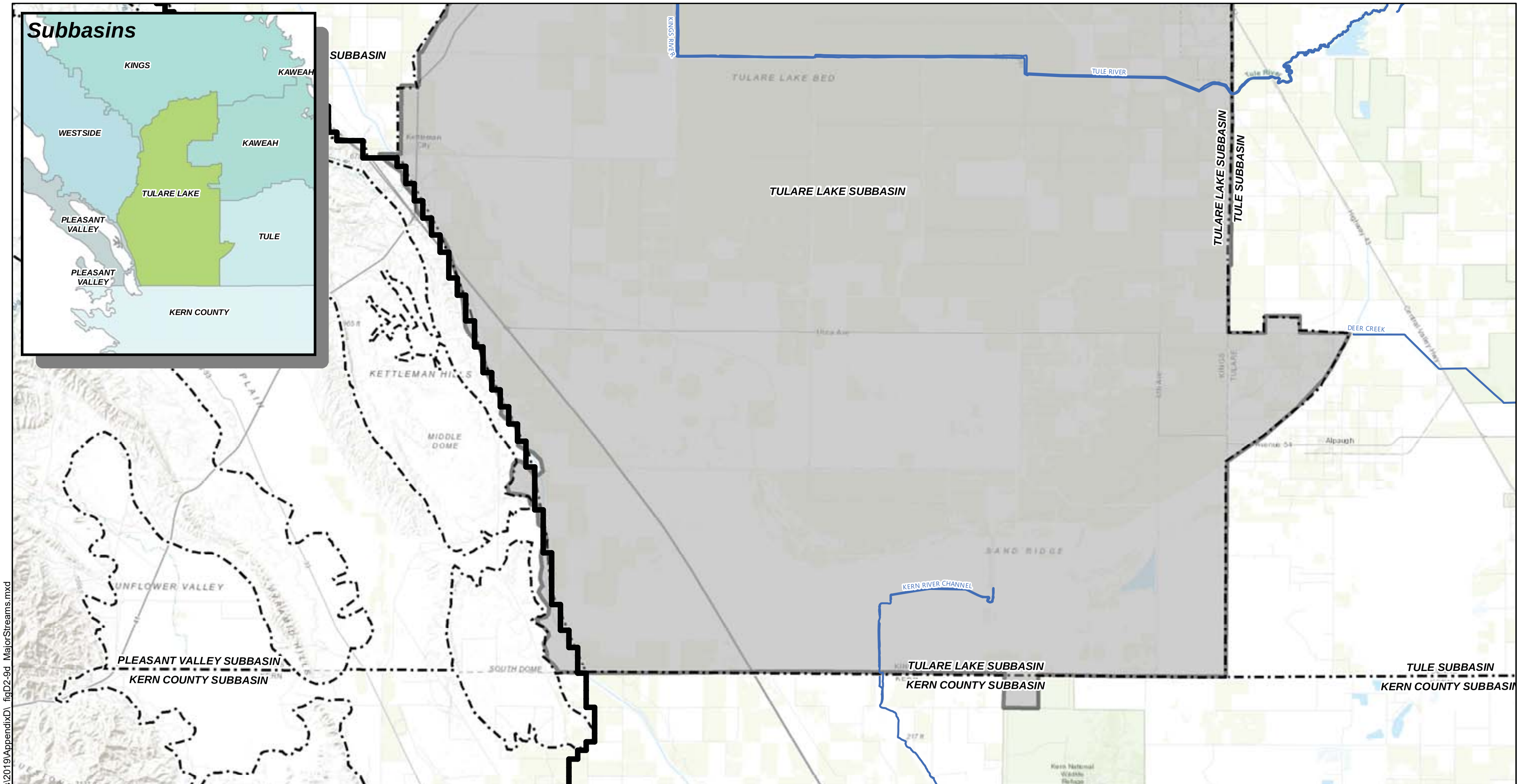
Major Streams and Distribution Channels

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/2/2020	Project No.: FR18161220

Figure **D2-9c**

N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-9c_Majorstreams.mxd



Explanation

- River/Lake [1]
- Model domain
- Subbasin boundary
- Boundaries of adjacent subbasins

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

APPROXIMATE SCALE IN MILES
0 1 2 4

0 1 2 4
APPROXIMATE SCALE IN KILOMETERS

N

Notes:
1. Data accessed from the National Hydrography Dataset (2018)

Major Streams and Distribution Channels

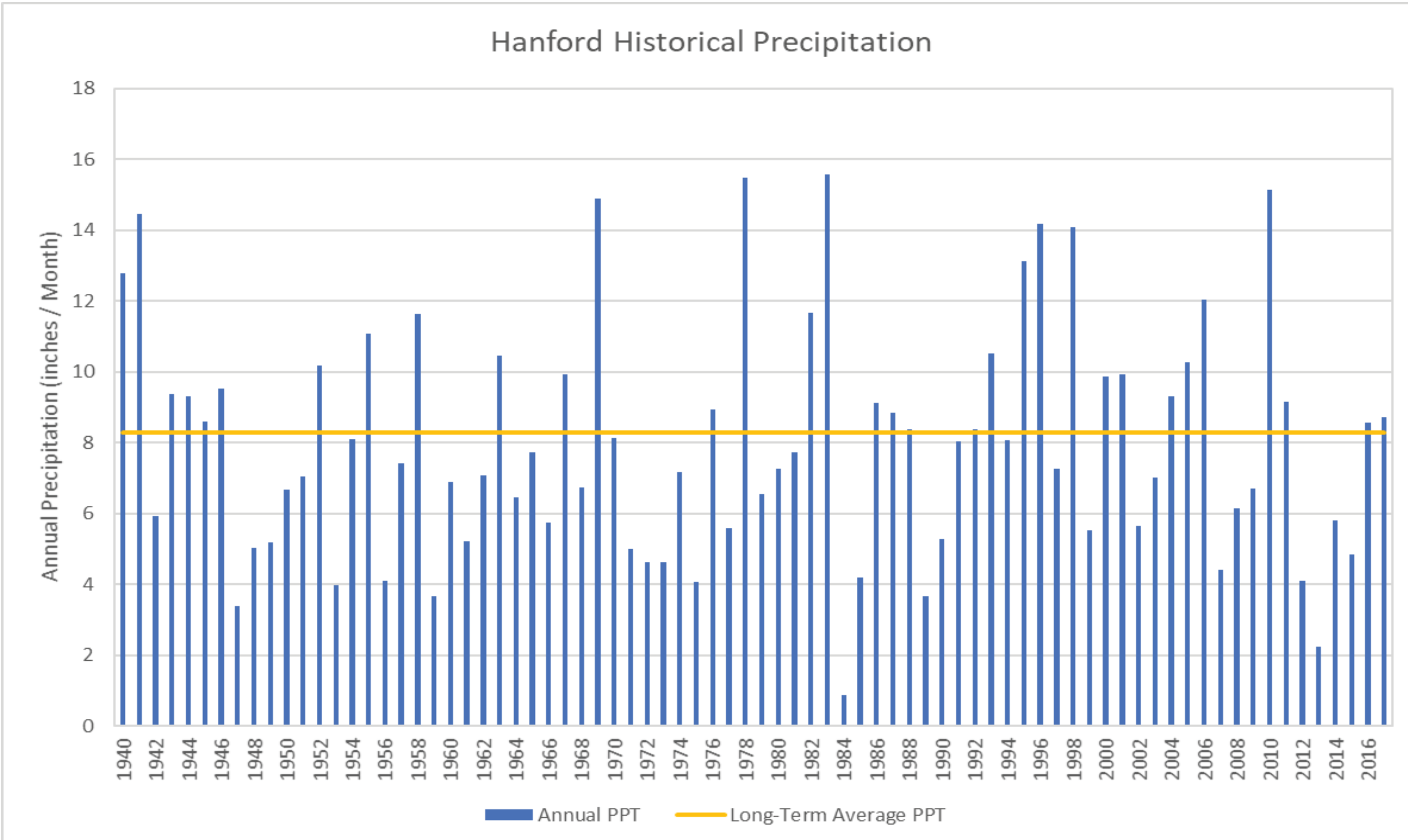
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC | Date: 12/13/2019 | Project No.: FR18161220

Figure **D2-9d**

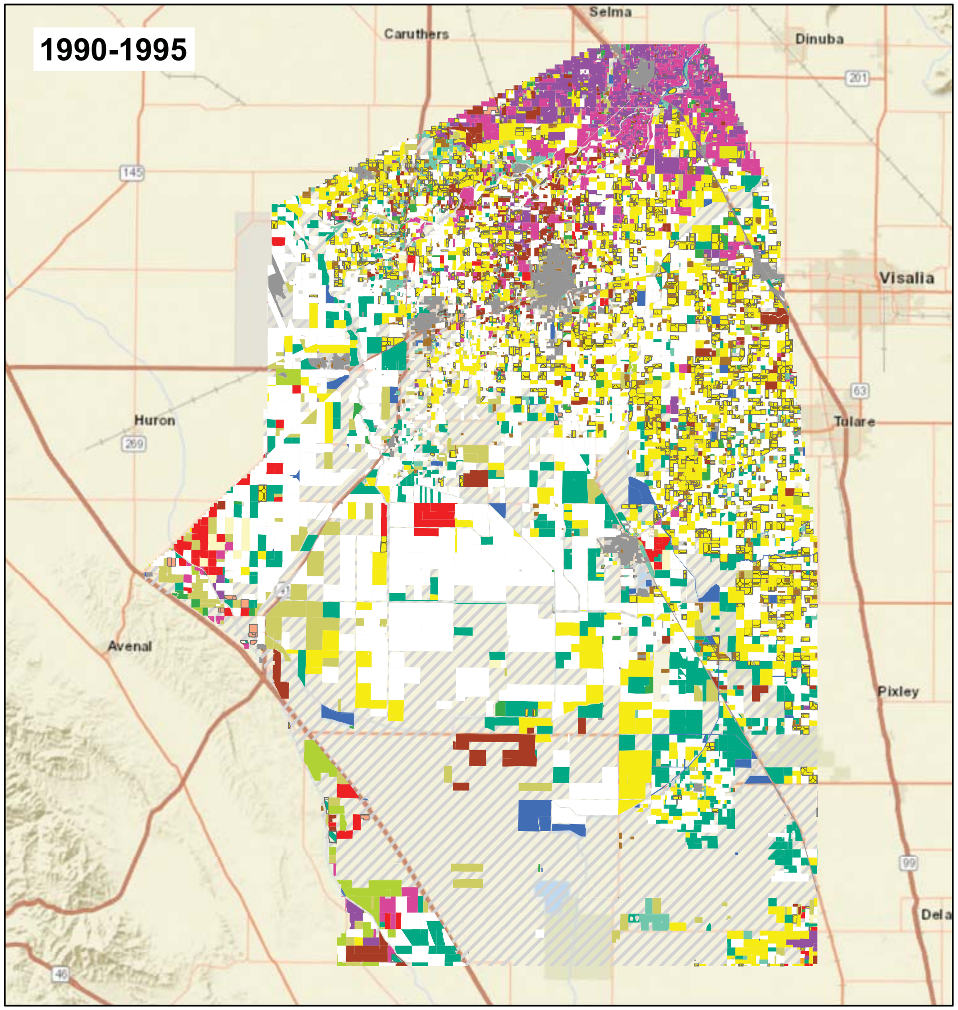
N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD2-9d_MajorStreams.mxd

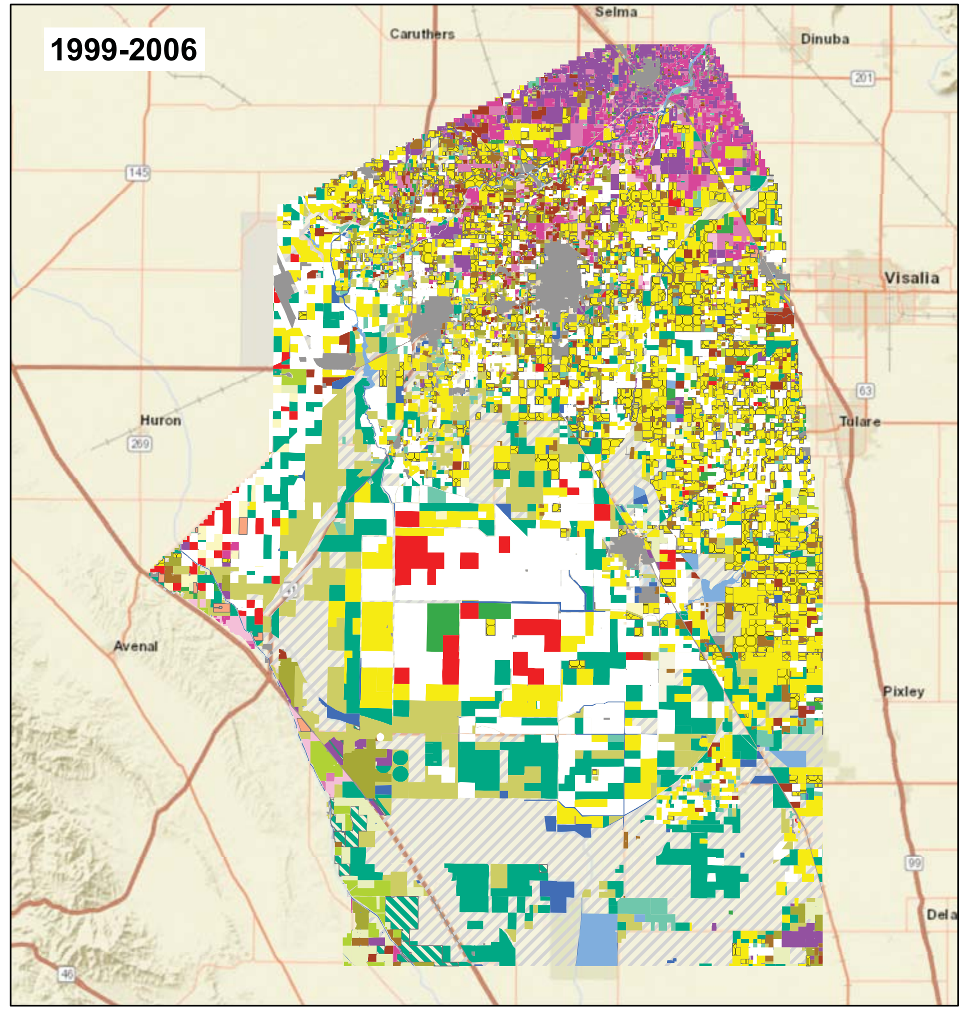
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSe ing\Figures\DAV S FOLD R\DRAFT_TLSB_SGMA_GWModel_Figures_v3Fig D2-10 an ord PPT 12 13 2019



Historical Annual Precipitation
Hanford, California
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure D





Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

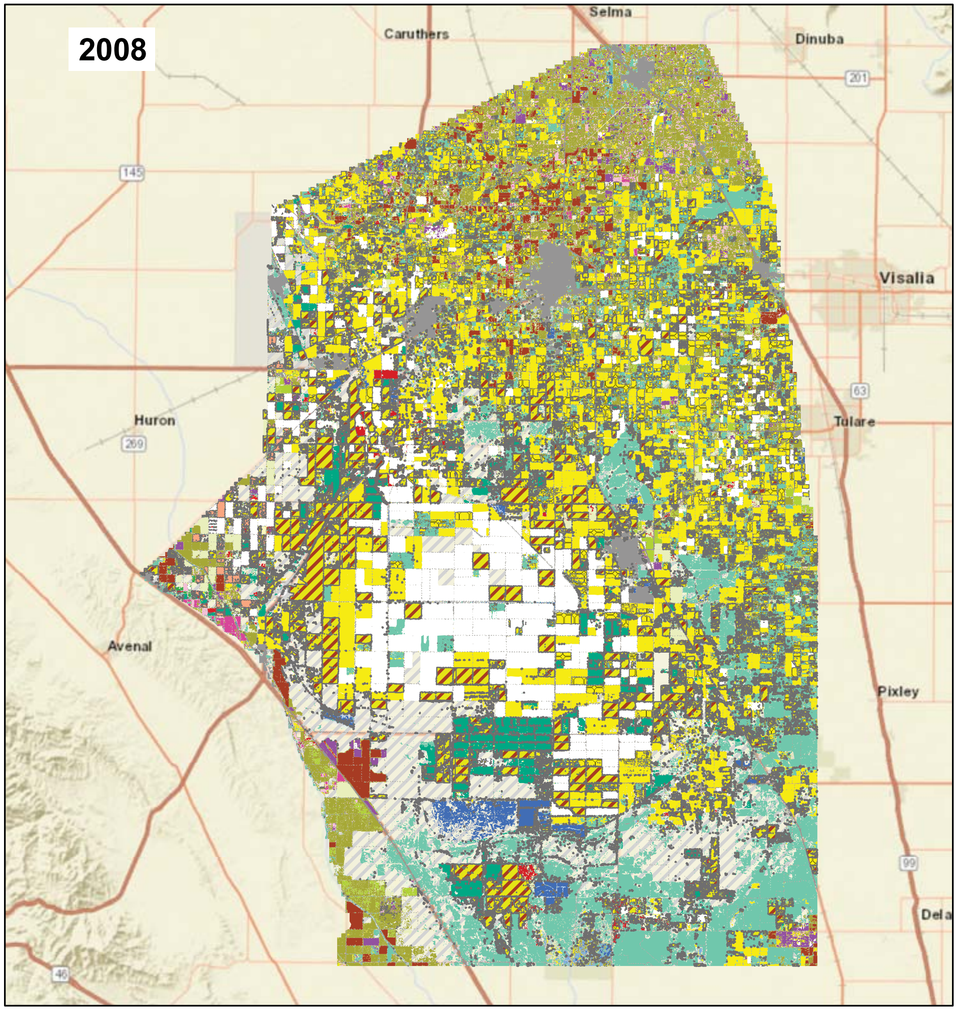
N

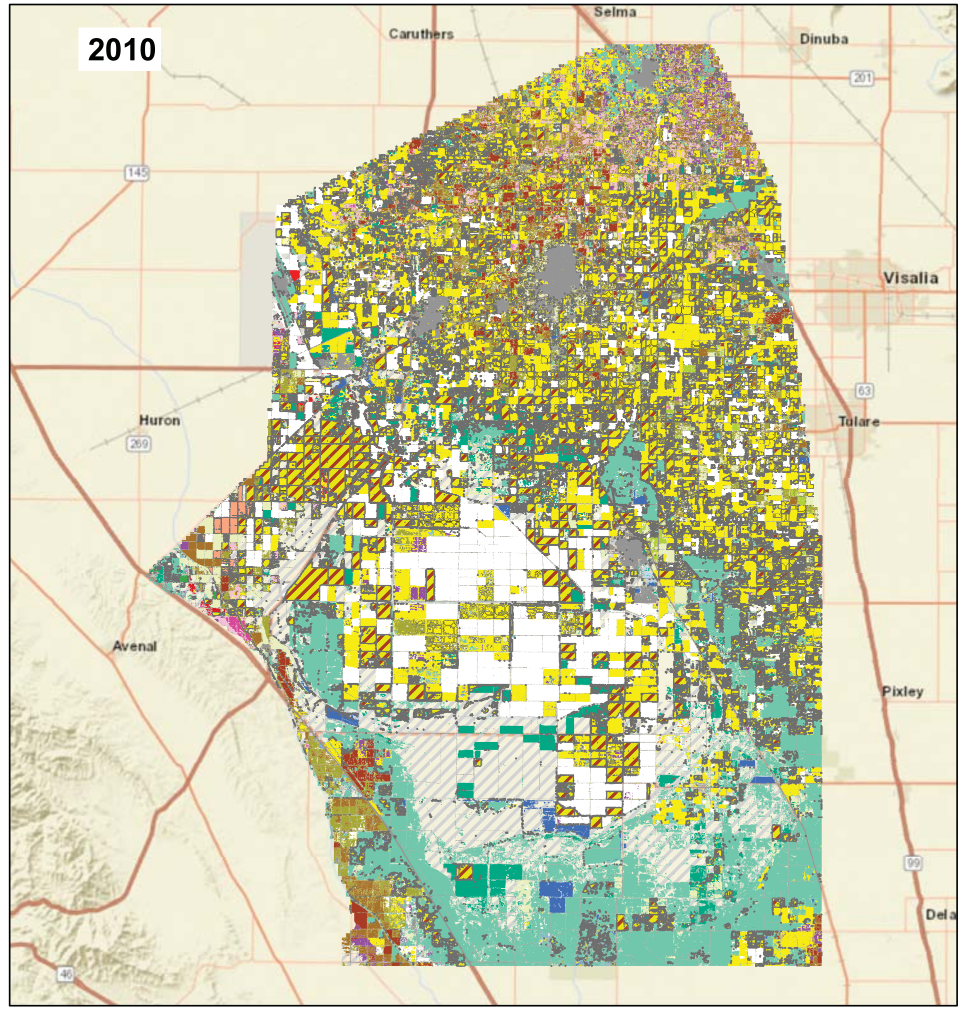
0 20,000 40,000
APPROXIMATE SCALE IN FEET

Crop Distributions
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp	Date: 3/26/2019	Project No.: FR18161220
		Figure **D2-11a**

\\fsn-fs1\Graphics\ FR projects\FR18s\FR18161220\gis\maps\2018\Hydrogeologic Conceptual Model\Arcmap 10.4\ fig3-8a CropDistributions rev.mxd





Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

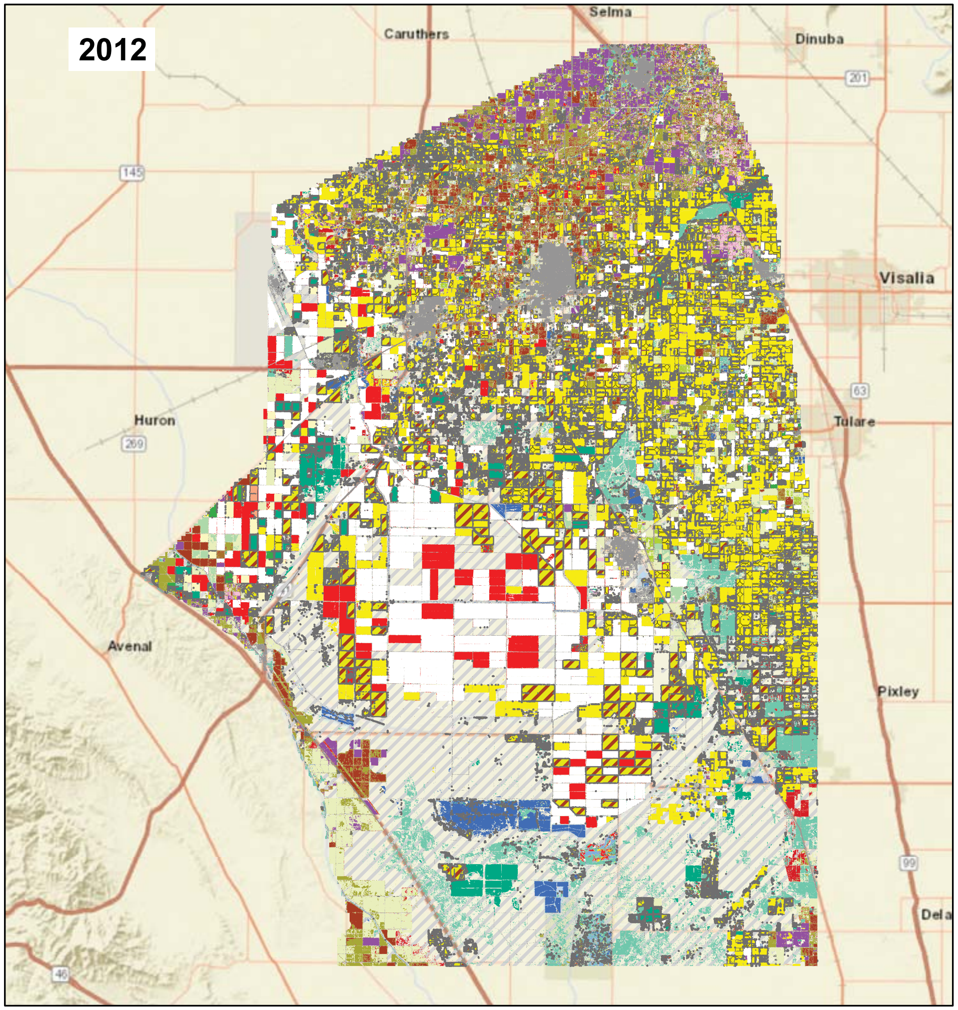
N

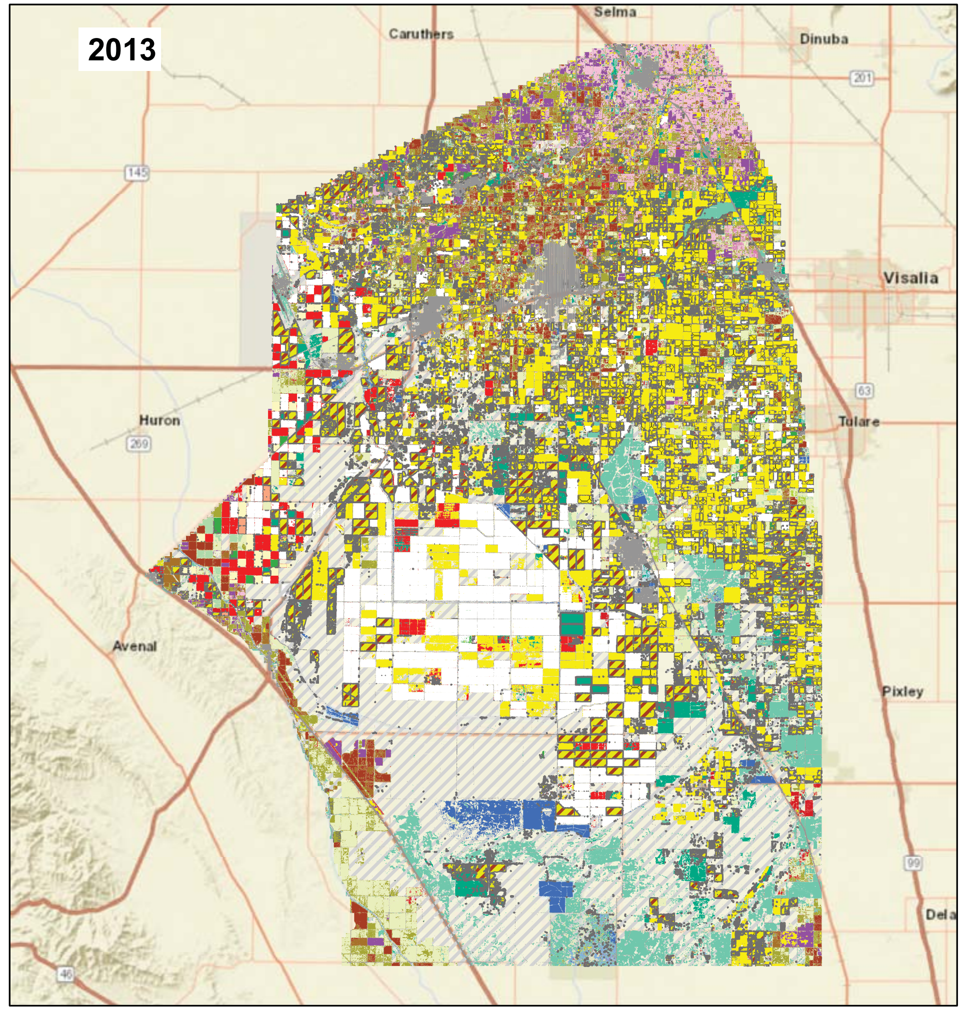
0 20,000 40,000
APPROXIMATE SCALE IN FEET

Crop Distributions
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp	Date: 3/26/2019	Project No.: FR18161220
		Figure **D2-11b**

\\fsn-fs1\Graphics\ FR projects\FR18s\FR18161220\gis\maps\2018\Hydrogeologic Conceptual Model\Arcmap 10.4\ fig3-8b CropDistributions rev.mxd





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Explanation

- Alfalfa Hay and Clover
- Almonds (Young)
- Almonds (Adolescent)
- Almonds (Mature)
- Berries
- Carrot Single Crop
- Citrus (no ground cover)
- Corn and Grain Sorghum
- Cotton
- Dairy Single Crop
- Fallow Land
- Forest
- Grain and Grain Hay
- Melons
- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
- Pistachio (Young)
- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

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0 20,000 40,000
APPROXIMATE SCALE IN FEET

Crop Distributions
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp	Date: 3/26/2019	Project No.: FR18161220
		Figure **D2-11c**

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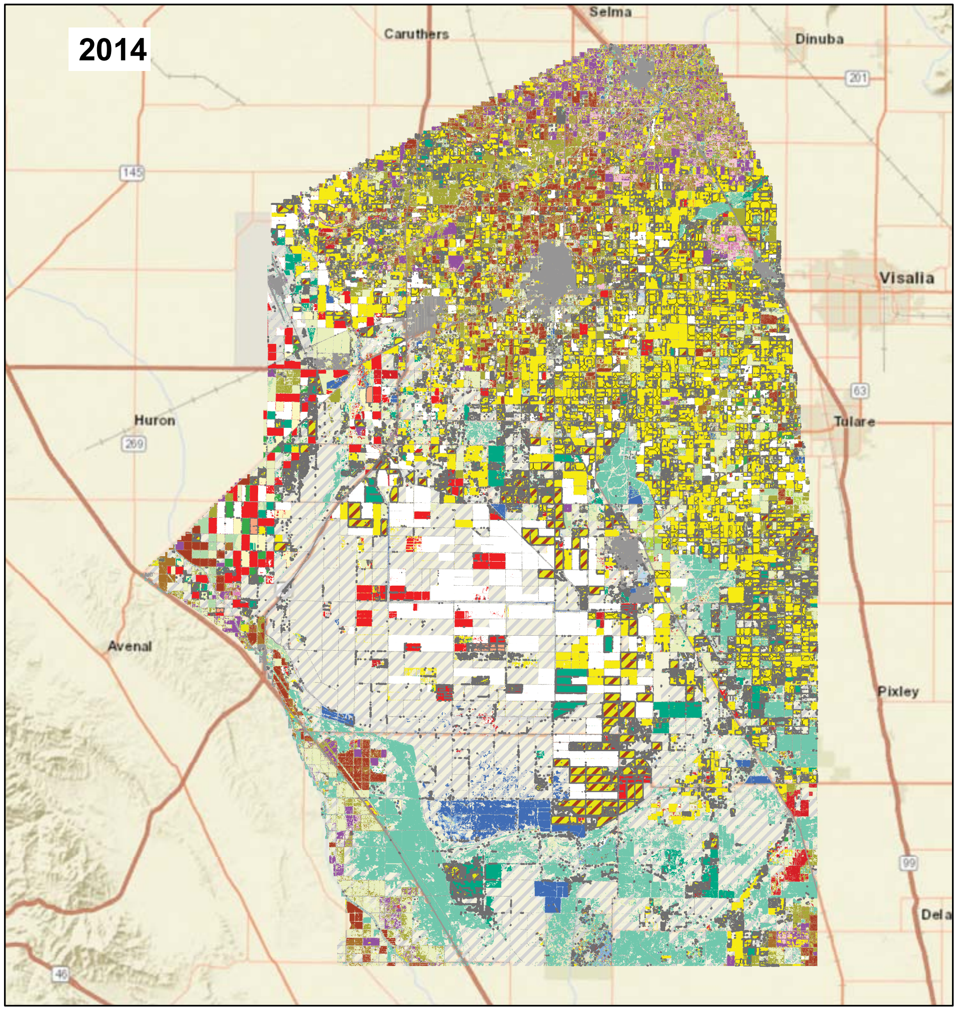

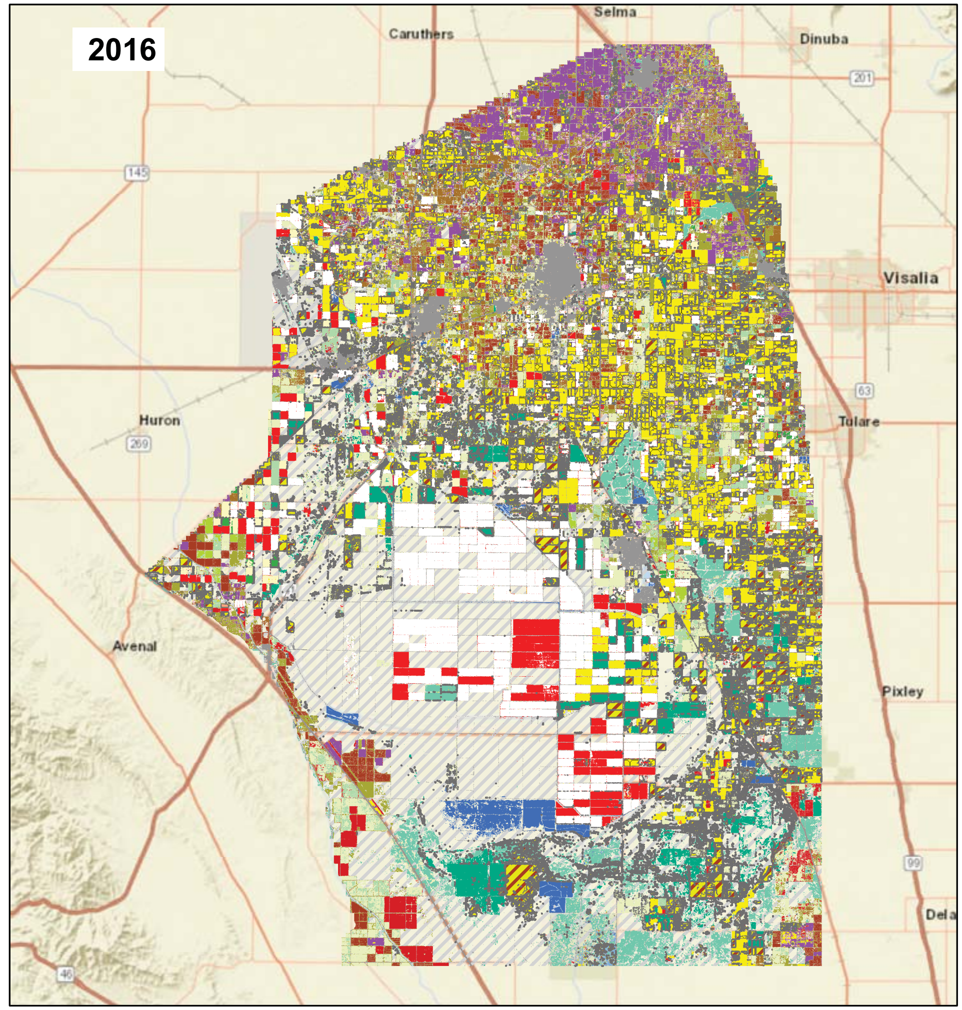

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Explanation

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- Grain and Grain Hay
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- Misc. field crops
- Onions and Garlic
- Open Water
- Pasture and Misc. Grasses
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- Pistachio (Adolescent)
- Pistachio (Mature)
- Pomegranates (Young)
- Pomegranates (Adolescent)
- Potatoes, Sugar beets, Turnip etc..
- Riparian
- Small Vegetables
- Stone Fruit (Young)
- Stone Fruit (Adolescent)
- Stone Fruit (Mature)
- Tomatoes and Peppers
- Urban, Commercial
- Urban, Industrial
- Wine Grapes with 80% canopy
- Winter Wheat

N

0 20,000 40,000
APPROXIMATE SCALE IN FEET

Crop Distributions
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: jmp | Date: 3/26/2019 | Project No.: FR18161220

Figure **D2-11d**

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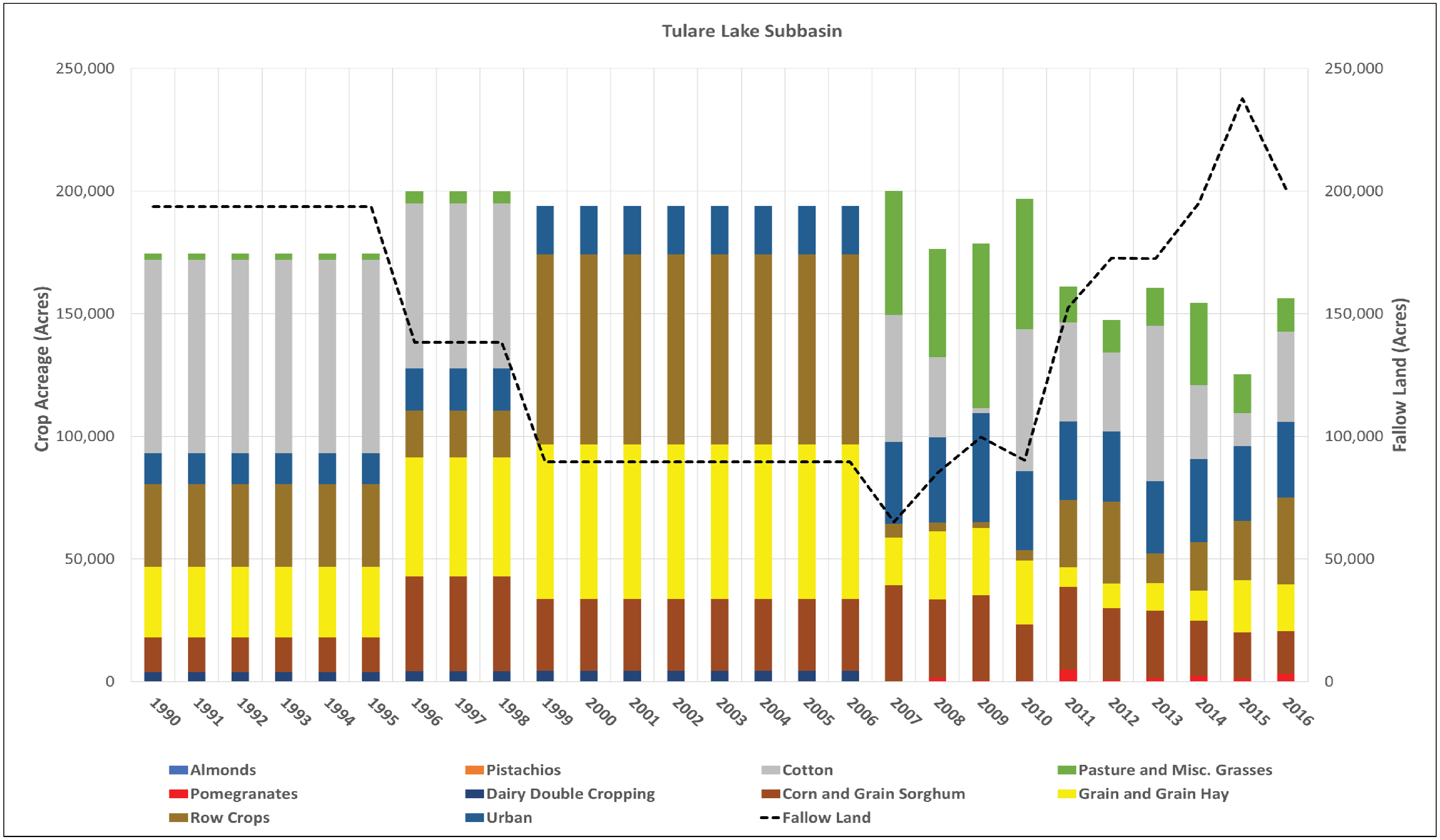
N:_FR_projects\FR18s\FR18161220\temp\DBean_Hydro_\Wood Figure TemplatesFig 2-12 HstoricalCrop Acreage 9/7/2019



Historical Crop Acreage in Model Domain

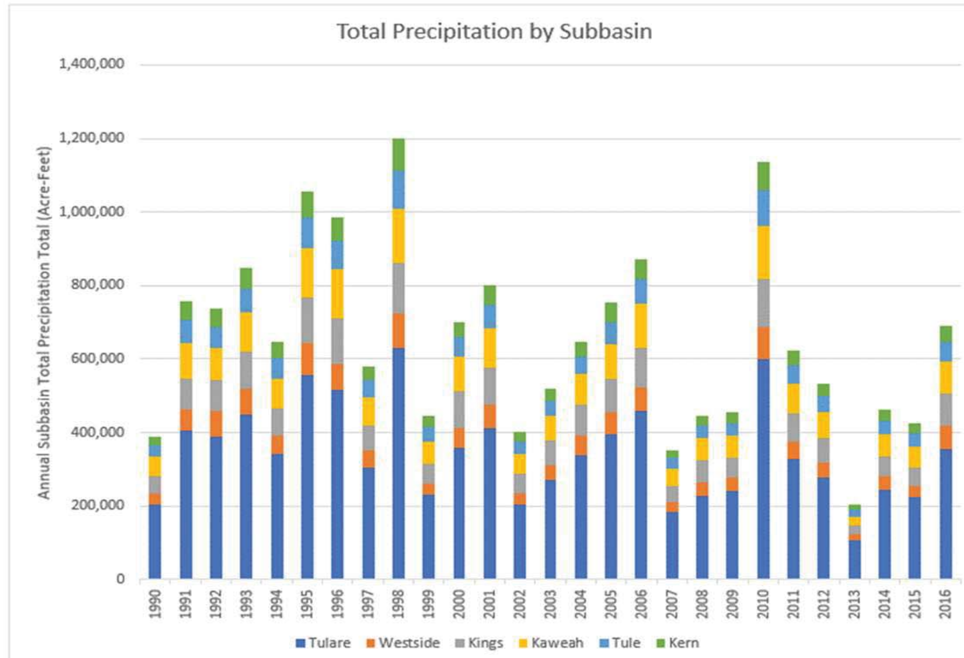
Tulare Lake Subbasin Groundwater Sustainabilty Plan

Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D2-12**

ANNUAL TOTAL PRECIPITATION (ACRE-FEET)

SP	Tulare	Westside	Kings	Kaweah	Tule	Kern	Total
1990	205,446	28,212	48,930	51,309	30,947	24,023	388,867
1991	405,080	57,267	83,913	96,137	63,627	50,916	756,939
1992	390,074	67,498	84,716	87,700	57,619	48,389	735,997
1993	447,720	71,443	101,727	105,426	65,907	54,792	847,015
1994	340,437	50,626	75,966	80,699	54,192	45,398	647,318
1995	556,440	85,801	126,208	134,572	83,809	68,943	1,055,774
1996	517,621	70,468	123,183	132,981	78,164	62,576	984,993
1997	304,204	46,045	70,190	75,198	46,704	38,101	580,442
1998	628,620	94,415	137,547	149,223	102,104	88,545	1,200,453
1999	231,988	30,280	53,202	60,123	39,033	32,569	447,196
2000	358,410	53,273	99,777	96,159	51,600	40,115	699,334
2001	411,922	63,322	101,366	106,449	63,662	52,859	799,578
2002	205,011	30,798	53,013	53,586	32,171	26,641	401,219
2003	270,548	40,570	66,233	68,593	40,425	33,269	519,638
2004	339,269	53,188	82,590	83,239	49,381	40,603	648,271
2005	394,033	61,121	90,935	93,355	60,700	53,816	753,960
2006	457,938	64,091	108,085	119,504	69,821	52,995	872,434
2007	184,578	26,460	44,432	46,579	29,322	21,777	353,148
2008	228,631	37,419	58,349	59,869	35,246	27,247	446,762
2009	240,260	36,916	55,236	59,739	34,814	29,497	456,461
2010	598,897	88,582	130,029	144,182	96,270	80,046	1,138,006
2011	328,748	46,550	76,276	80,288	51,437	40,143	623,442
2012	277,729	39,653	66,630	72,324	43,489	33,195	533,019
2013	108,142	15,048	22,376	25,747	19,794	14,606	205,713
2014	243,088	37,368	54,143	61,105	38,200	29,654	463,558
2015	223,458	29,592	51,681	58,217	35,773	25,262	423,982
2016	356,639	60,978	87,691	88,184	53,105	44,307	690,904
min	108,142	15,048	22,376	25,747	19,794	14,606	205,713
max	628,620	94,415	137,547	149,223	102,104	88,545	1,200,453
mean	342,775	51,370	79,793	84,833	52,864	42,973	654,608



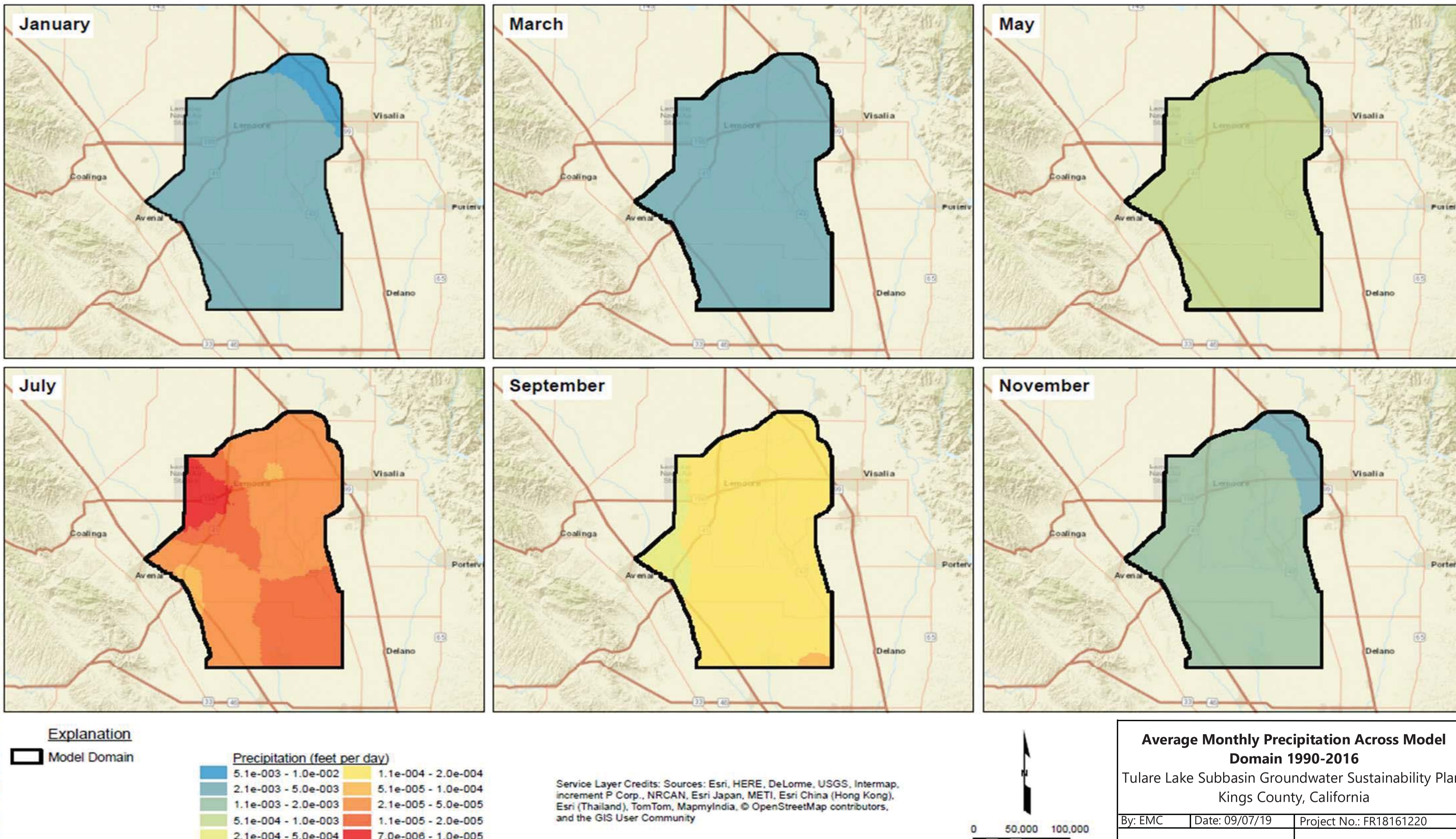
Note:
Annual precipitation totals are based on 4-kilometer grids of precipitation from the Oregon State University PRISM database. Monthly totals taken from January 1990 to December 2016

Estimated Annual Total Precipitation by Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure **D2-13a**

N:_FR_projects\FR18s\FR18161220\temp\DBean_Hydro_\Wood Figure TemplatesFig 2-13b Month Avg PPT 9/7/2019



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APPROXIMATE SCALE IN FEET

Average Monthly Precipitation Across Model Domain 1990-2016

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 09/07/19	Project No.: FR18161220
		Figure **D2-13b**

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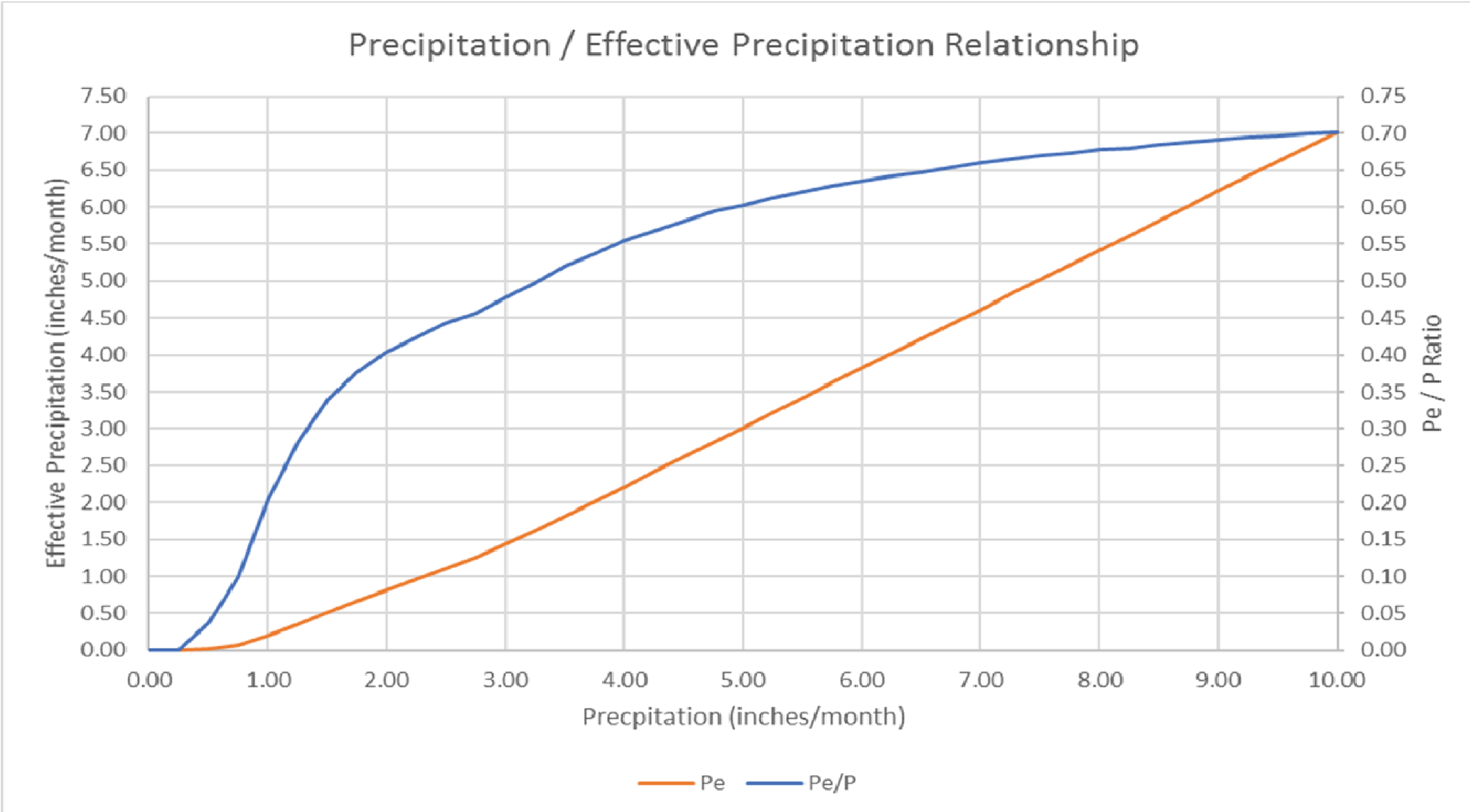


Modified from:
United Nations Food and Agricultre Organization (FAO)
FAO 56, Chapter 3 Table 6
Precipitation (P) and Effective Precipitation (Pe) in mm/month

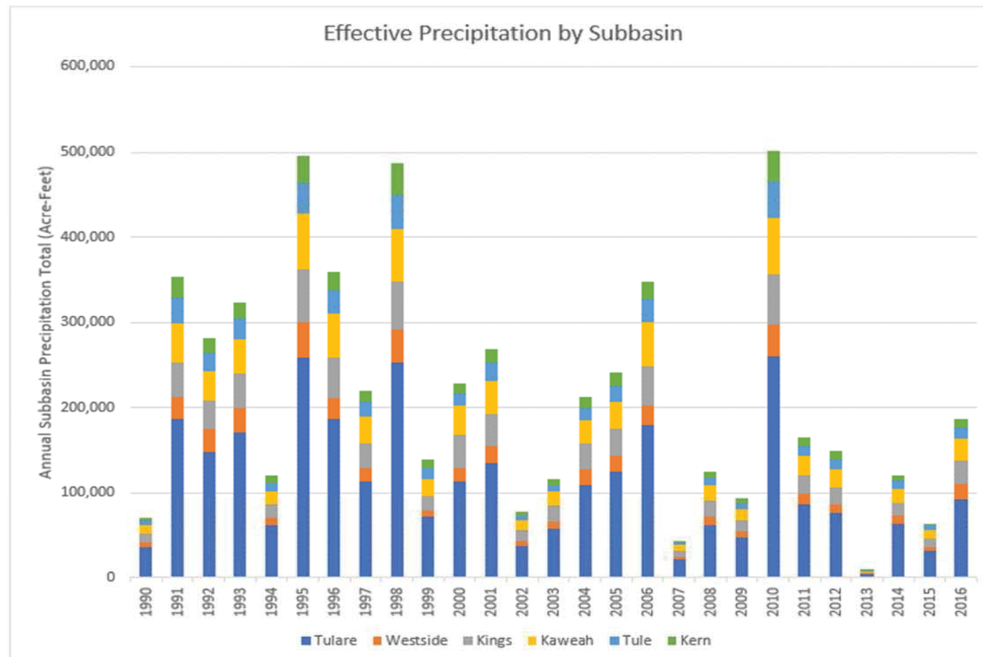
Precipitation Versus
Effective Precipitation
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D2-14**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D2-15 Annual SB Eff PPT 12/19/2019

ANNUAL EFFECTIVE PRECIPITATION (ACRE-FEET)

Date	Tulare	Westside	Kings	Kaweah	Tule	Kern	Total
1990	35,788	5,208	10,921	10,176	4,812	3,714	70,619
1991	187,134	25,313	40,273	46,723	29,809	23,715	352,967
1992	148,073	27,645	33,148	33,386	21,388	17,350	280,990
1993	170,267	29,369	40,873	40,049	23,350	19,250	323,158
1994	61,232	8,593	15,645	16,141	10,127	8,240	119,978
1995	259,175	41,208	62,347	64,874	37,212	30,391	495,207
1996	186,149	24,278	48,754	51,487	27,483	21,442	359,593
1997	113,642	15,748	28,680	30,918	17,369	13,352	219,710
1998	252,323	38,854	56,898	60,724	41,542	36,341	486,681
1999	71,917	7,632	16,648	20,114	13,016	10,619	139,945
2000	113,113	16,314	38,555	34,058	15,532	11,155	228,726
2001	134,333	20,616	37,779	38,654	20,766	17,000	269,148
2002	37,068	5,535	12,943	11,666	5,956	4,445	77,613
2003	57,809	8,545	17,995	17,097	8,207	6,806	116,460
2004	109,787	18,411	29,462	28,012	14,496	12,064	212,232
2005	124,268	19,089	31,607	31,363	18,469	16,100	240,896
2006	179,592	23,246	45,635	51,807	27,290	19,450	347,021
2007	20,953	2,745	7,604	7,072	3,259	1,764	43,397
2008	61,111	11,105	18,873	18,211	9,119	6,389	124,809
2009	47,768	7,417	12,492	13,028	6,456	5,711	92,872
2010	260,214	37,095	58,830	65,701	43,440	35,754	501,035
2011	86,495	12,603	22,107	21,802	12,693	9,244	164,943
2012	75,839	10,048	19,758	21,768	12,555	8,764	148,732
2013	4,721	561	939	1,214	1,153	735	9,322
2014	63,051	9,701	14,375	17,224	9,896	6,761	121,008
2015	30,969	4,190	10,169	11,275	5,114	1,900	63,617
2016	92,375	18,143	27,302	25,956	12,925	10,086	186,788
min	4,721	561	939	1,214	1,153	735	9,322
max	260,214	41,208	62,347	65,701	43,440	36,341	501,035
mean	110,562	16,638	28,171	29,278	16,794	13,279	214,721



Note:
Annual effective precipitation totals are based on 4-kilometer grids of precipitation from the Oregon State University PRISM database and Effective Precipitation Chart

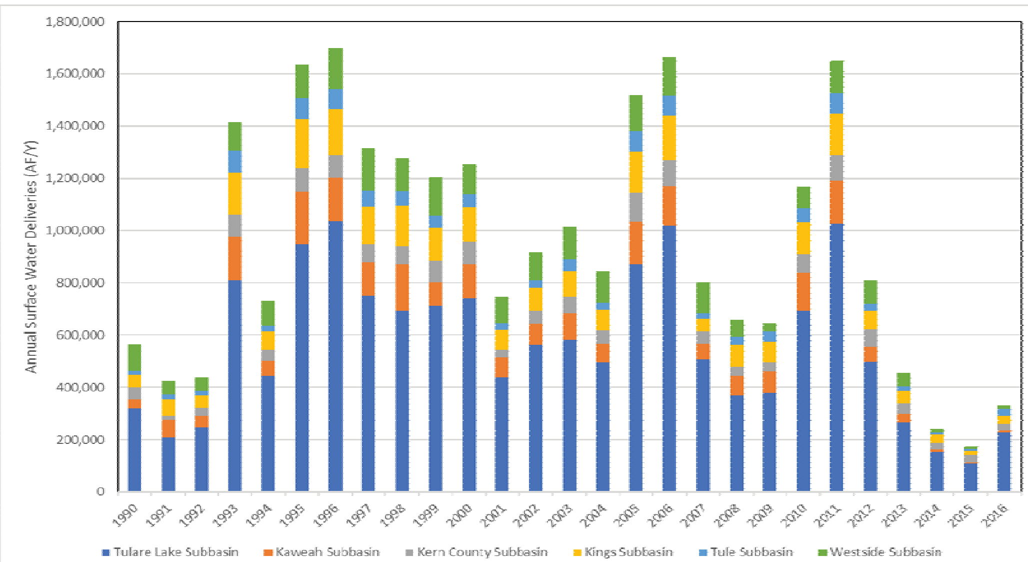
Estimated Annual Effective Precipitation by Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure **D2-15**

Annual Surface Water Deliveries (Acre-Feet / Year)

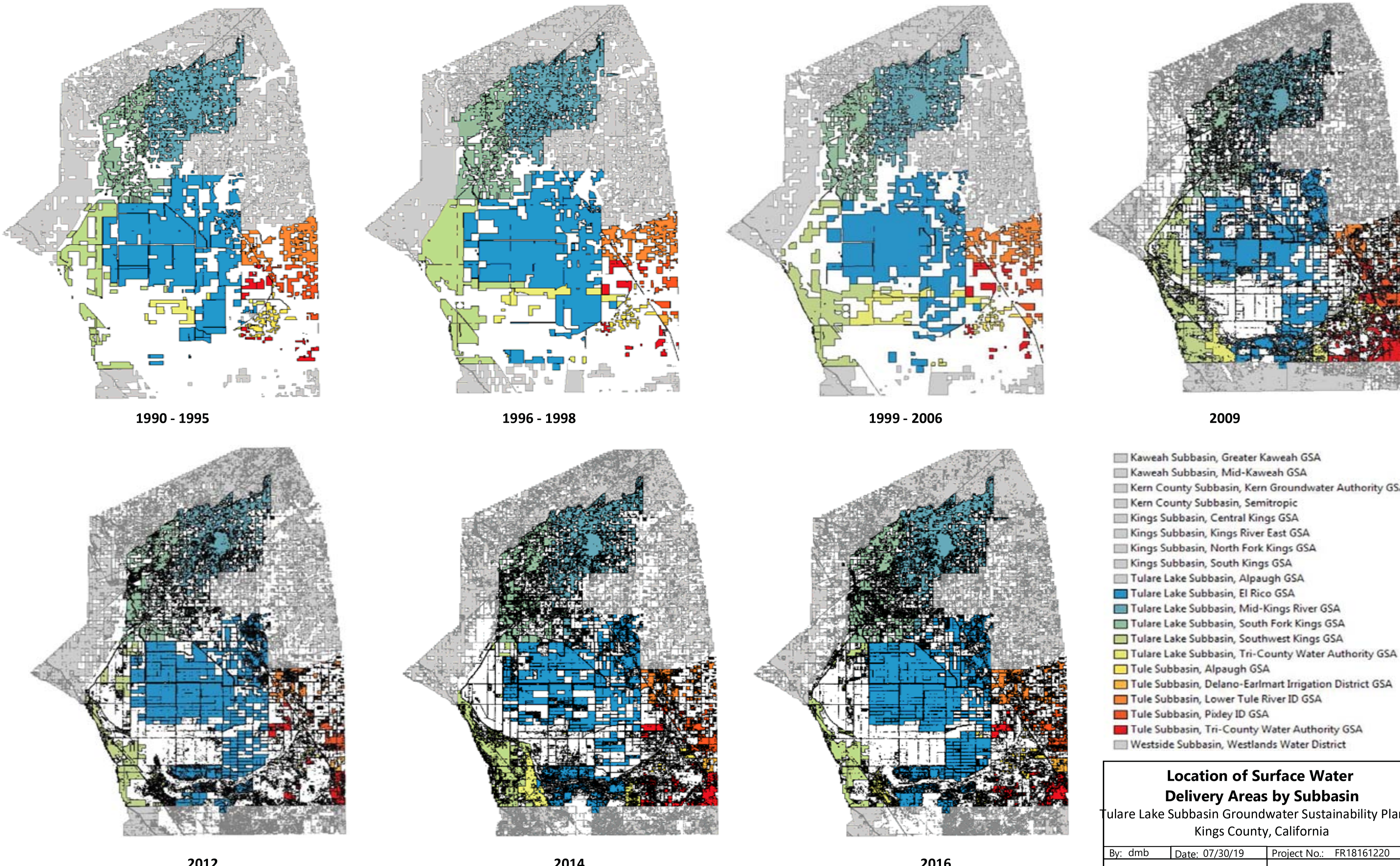
Date	Tulare Lake Subbasin	Kaweah Subbasin	Kern County Subbasin	Kings Subbasin	Tule Subbasin	Westside Subbasin	Total Model Domain
1990	319,638	34,691	46,977	47,706	14,494	101,753	565,259
1991	209,115	66,976	16,670	60,707	20,365	50,314	424,147
1992	244,988	48,175	29,248	47,266	18,257	51,537	439,472
1993	810,344	165,910	83,835	160,515	85,065	109,771	1,415,439
1994	443,205	56,606	44,535	69,284	22,852	94,931	731,414
1995	947,855	199,690	91,209	186,720	82,330	127,670	1,635,474
1996	1,036,790	163,574	87,848	177,280	75,768	155,283	1,696,544
1997	748,244	131,645	68,613	142,094	63,303	162,313	1,316,212
1998	693,058	179,630	69,486	153,596	54,029	127,191	1,276,990
1999	712,379	90,346	82,217	123,948	49,408	147,138	1,205,436
2000	740,630	131,085	85,279	129,655	53,811	114,126	1,254,586
2001	437,390	75,793	31,430	73,740	27,230	100,268	745,851
2002	563,492	79,353	51,035	87,765	28,672	107,362	917,680
2003	582,626	100,822	63,030	96,972	46,562	125,166	1,015,176
2004	495,419	71,381	49,475	80,158	28,180	120,407	845,020
2005	872,486	161,327	109,892	158,076	78,061	139,083	1,518,926
2006	1,019,418	150,216	100,573	170,799	74,941	147,368	1,663,316
2007	508,584	60,204	44,265	51,185	21,408	118,138	803,785
2008	370,440	74,103	34,343	83,836	29,913	64,483	657,118
2009	378,849	81,144	34,414	79,124	39,295	33,190	646,016
2010	693,453	145,197	71,837	120,646	54,005	81,772	1,166,909
2011	1,025,466	165,643	97,315	159,548	78,345	125,949	1,652,265
2012	498,360	56,953	65,646	72,022	26,220	90,518	809,719
2013	264,069	33,712	41,542	46,333	17,950	51,684	455,291
2014	154,035	8,482	24,232	31,689	7,799	15,092	241,330
2015	107,068	7,140	24,818	18,233	7,799	9,836	174,894
2016	227,433	8,482	24,232	31,689	24,908	15,092	331,837
1990-2016 Average	**559,438**	**94,381**	**58,296**	**98,540**	**41,888**	**95,831**	**948,374**
1998-2010 Average	**620,633**	**107,739**	**63,637**	**108,423**	**45,039**	**109,669**	**1,055,139**



Estimated Annual Surface Water Diversions by Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D2-16**

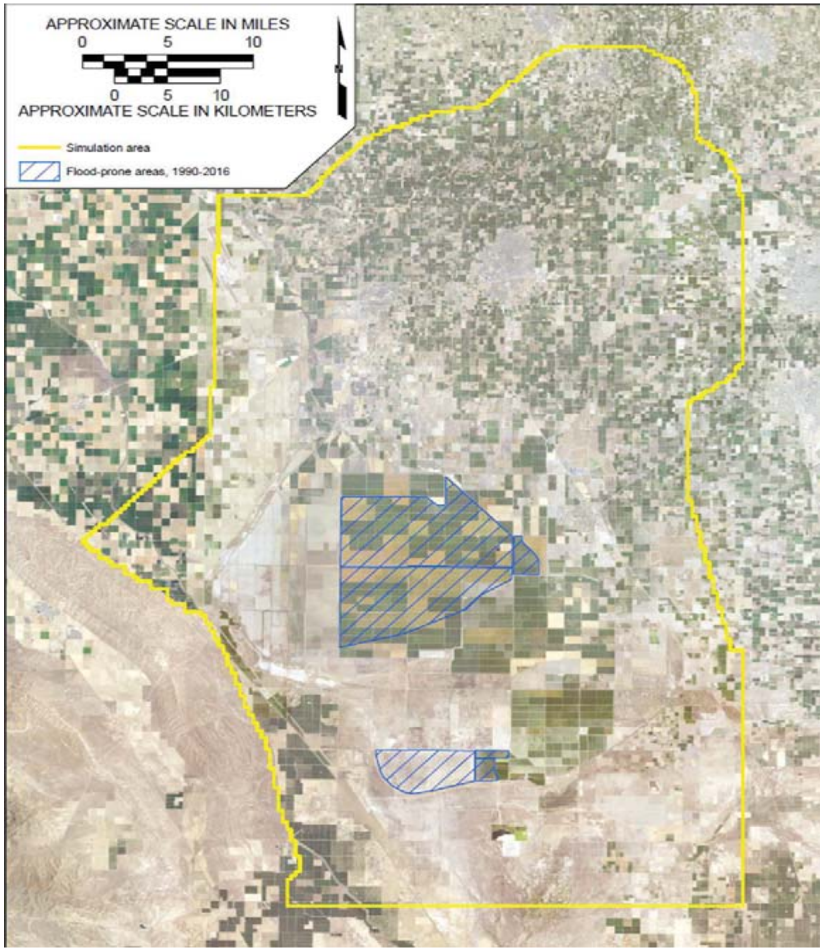


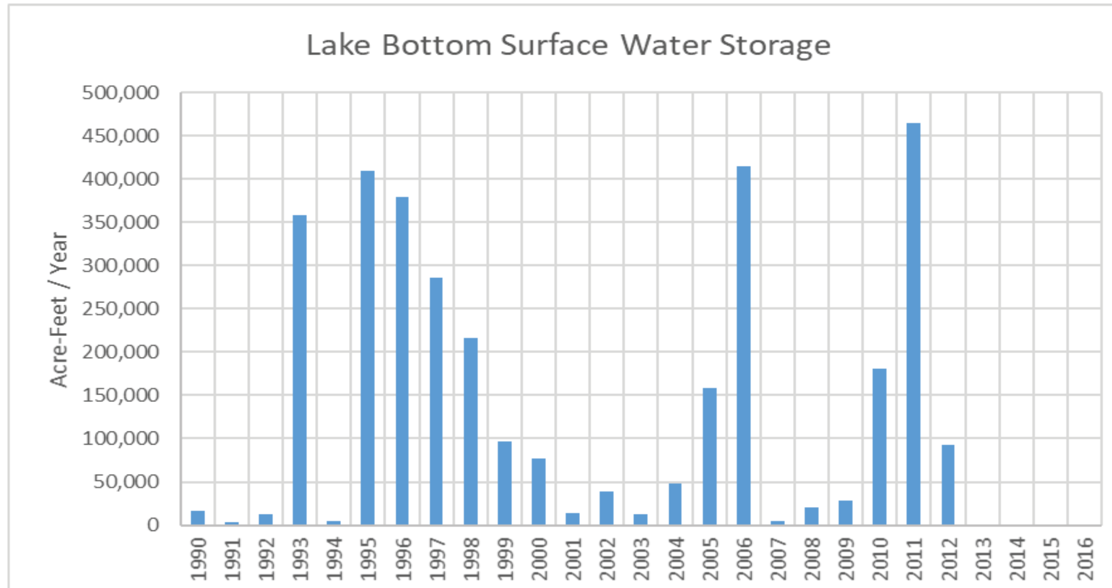
Location of Surface Water Delivery Areas by Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure **D2-17**





Explanation

Model Area

Surface Water Ponds

Location of Surface Water Storage Areas and Estimated Annual Lake Bottom Storage

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D2-18**

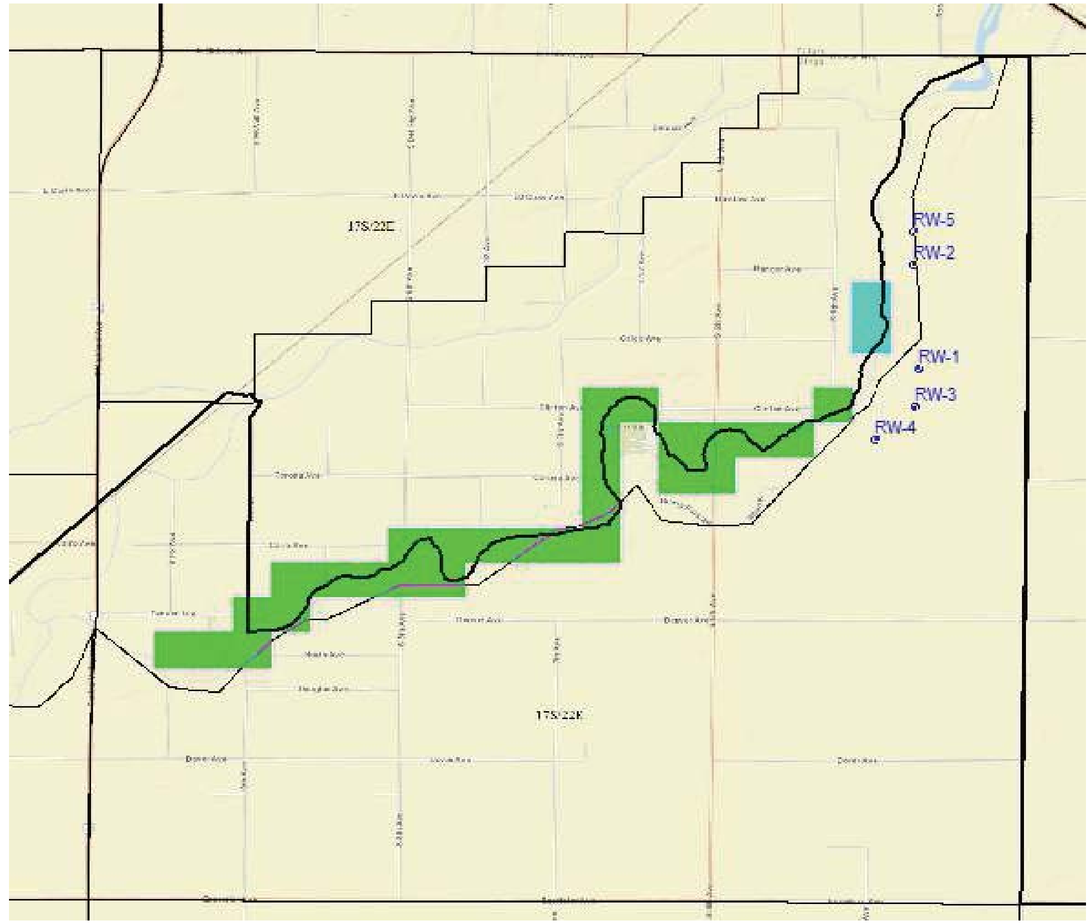
Date	Pond 1 (AF/Y)	Pond 2 (AF/Y)	Pond 3 (AF/Y)	Pond 4 (AF/Y)	Pond 5 (AF/Y)	Pond 6 (AF/Y)	Pond 7 (AF/Y)	Pond 8 (AF/Y)	Pond 9 (AF/Y)	Total (AF/Y)
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	10,700	12,840	0	0	0	0	0	0	0	23,540
1995	10,700	12,840	0	0	0	0	0	0	0	23,540
1996	10,700	12,840	0	0	0	0	0	0	0	23,540
1997	10,700	12,840	0	0	0	0	0	0	0	23,540
1998	10,700	12,840	0	0	0	0	0	0	0	23,540
1999	0	0	0	0	0	0	0	0	0	0
2000	10,700	12,840	0	0	0	0	0	0	0	23,540
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	10,700	12,840	0	0	0	0	0	0	0	23,540
2004	10,700	0	0	0	0	0	0	0	0	10,700
2005	10,700	12,840	14,980	14,980	0	0	0	0	0	53,500
2006	10,700	12,840	14,980	14,980	21,400	25,680	12,840	23,540	10,700	147,660
2007	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0
2009	10,700	0	0	0	0	0	0	0	0	10,700
2010	10,700	12,840	0	0	0	0	0	0	0	23,540
2011	10,700	12,840	14,980	14,980	21,400	25,680	12,840	23,540	10,700	147,660
2012	10,700	0	0	0	0	0	0	0	0	10,700
2013	0	0	0	0	0	0	0	0	0	0
2014	10,600	12,720	0	0	0	0	0	0	0	23,320
2015	10,700	12,840	0	0	0	0	0	0	0	23,540
2016	0	0	0	0	0	0	0	0	0	0
Total	171,100	166,800	44,940	44,940	42,800	51,360	25,680	47,080	21,400	616,100

Estimated Annual Intentional Recharge - Corcorian Irrigation District
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure **D2-19**

Date	Cond 8 Recharge (AF/Y)	APEX Recharge (AF/Y)	APEX Recovery (AF/Y)	APEX Storage (AF/Y)
1990	1,021	--	--	--
1991	0	--	--	--
1992	0	--	--	--
1993	61	--	--	--
1994	0	--	--	--
1995	36,806	--	--	--
1996	8,541	--	--	--
1997	19,259	--	--	--
1998	37,879	--	--	--
1999	0	--	--	--
2000	0	--	--	--
2001	0	--	--	--
2002	0	225	0	225
2003	0	3,742	526	3,216
2004	0	0	912	-912
2005	5,442	10,994	0	10,994
2006	22,611	12,152	6,939	5,213
2007	0	3,630	6,319	-2,689
2008	0	2,792	5,435	-2,643
2009	0	9,514	7,677	1,837
2010	0	9,154	6,345	2,809
2011	32,441	10,292	0	10,292
2012	0	3,692	9,044	-5,352
2013	0	6,962	4,970	1,992
2014	0	441	298	143
2015	0	0	0	0
2016	42,672	0	0	0
Total	206,732	73,590	48,465	25,125

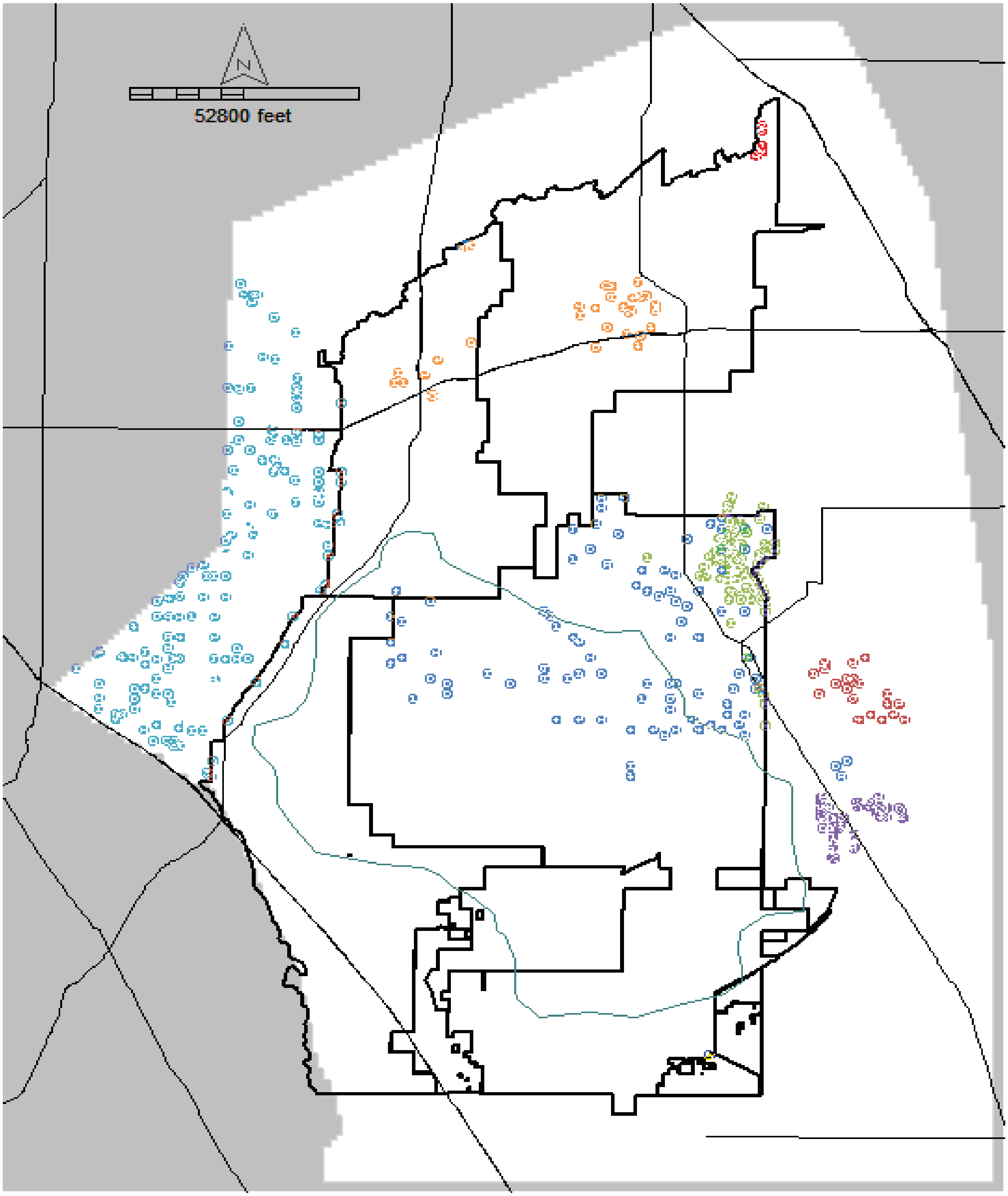


Condition 8 Recharge Area
APEX Ranch Water Bank Recharge Pond
APEX Ranch Recover Well

Estimated Annual Intentional Recharge - Condition 8 and APEX Ranch
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure D2-20



Municipal
Westlands Water District
Corcoran Irrigation District
El Rico GSA
Creighton Ranch
Angiola Well Field
Apex Ranch

Location of Wells with Specified Pumping and Known Construction

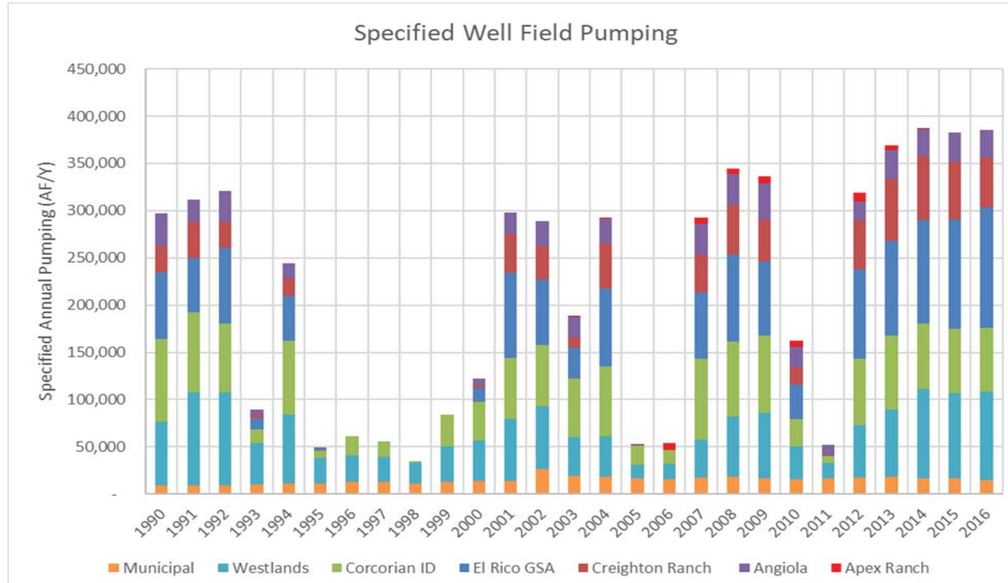
Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure D2-21

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D2-21 Specified Well Map 12/19/2019

Date	El Rico GSA Well Field (AF/Y)	Creighton Ranch Well Field (AF/Y)	Corcorian ID Well Field (AF/Y)	Angiola Well Field (AF/Y)	Westlands Well Field (AF/Y)	Municipal Well Fields (AF/Y)	Apex Ranch Well Field (AF/Y)
1990	70,716	27,222	87,977	34,500	67,131	9,370	--
1991	57,509	38,484	84,438	23,396	98,656	9,109	--
1992	80,012	27,255	72,348	33,494	98,344	9,666	--
1993	11,395	4,035	14,248	5,956	44,056	10,208	--
1994	48,043	17,986	78,297	16,389	72,674	10,928	--
1995	2,897	905	7,145	-	27,589	10,775	--
1996	-	-	20,261	-	28,516	12,719	--
1997	-	-	15,586	-	27,000	12,775	--
1998	-	-	2,484	-	20,988	11,555	--
1999	-	-	33,406	-	37,185	13,087	--
2000	14,910	2,849	40,672	6,784	43,392	13,421	--
2001	89,799	41,120	64,353	23,244	65,947	13,895	--
2002	68,933	35,843	64,736	26,537	66,530	26,701	-
2003	32,420	10,856	62,246	22,429	40,841	19,349	526
2004	82,875	47,511	74,007	26,805	42,115	18,777	912
2005	-	468	20,138	662	14,744	16,536	-
2006	-	72	14,034	141	16,526	15,822	6,939
2007	69,863	40,266	85,434	32,894	40,373	17,221	6,319
2008	92,269	52,980	79,362	32,502	63,519	18,432	5,435
2009	78,097	45,292	81,493	37,798	69,904	16,354	7,677
2010	36,129	17,740	29,669	22,568	34,895	15,271	6,345
2011	606	314	7,328	11,336	15,509	17,042	-
2012	95,154	52,325	70,008	19,388	55,298	17,467	9,044
2013	100,275	66,005	78,175	30,528	70,940	18,411	4,970
2014	108,976	68,726	69,880	27,695	94,077	16,930	298
2015	116,254	61,050	67,982	30,220	90,723	16,146	-
2016	126,886	53,113	67,982	29,047	93,853	14,555	-



Notes:

1. El Rico Groundwater Sustainability Agency (GSA), Corcoran Irrigation District, and Creighton Ranch pumping provided by the El Rico GSA
2. Angiola Well Field pumping data provided by Angiola Water District
3. Westlands pumping provided by Westlands Water District
4. Municipal pumping and Apex pumping provided by various municipalities and Kings River Water District

Annual Specified Pumping by Well Field
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure D2-22

Annual Crop Demand (AF/Y)

Date	TLSB	Westside	Kings	Kaweah	Tule	Kern	Total
1990	901,131	291,990	328,863	424,556	197,637	87,217	2,231,393
1991	901,119	288,262	328,849	424,556	197,637	87,217	2,227,639
1992	902,016	284,489	329,148	424,998	197,921	87,318	2,225,890
1993	901,095	283,147	328,833	424,556	197,637	87,217	2,222,484
1994	900,719	263,495	328,833	424,556	197,637	87,217	2,202,456
1995	900,633	243,070	328,775	424,556	197,637	87,217	2,181,887
1996	982,820	257,687	292,187	406,852	254,257	107,481	2,301,283
1997	985,893	268,823	300,664	408,439	253,933	108,406	2,326,158
1998	989,781	243,239	309,316	410,462	254,000	109,483	2,316,281
1999	1,062,749	263,950	316,538	415,430	253,992	63,054	2,375,713
2000	1,079,872	258,530	324,230	418,470	254,108	66,574	2,401,785
2001	1,089,515	283,910	325,407	419,045	253,769	69,132	2,440,778
2002	1,100,326	277,743	326,810	420,081	253,820	71,790	2,450,569
2003	1,111,248	299,919	328,199	421,117	253,870	74,447	2,488,801
2004	1,113,509	289,665	328,509	422,104	254,310	75,582	2,483,679
2005	1,113,269	268,262	328,310	422,163	253,971	76,507	2,462,481
2006	1,114,369	261,146	328,236	422,685	254,021	77,537	2,457,995
2007	1,074,260	280,336	257,665	387,633	290,933	205,928	2,496,756
2008	1,004,624	273,945	256,884	421,390	296,194	186,808	2,439,846
2009	1,012,322	305,821	256,214	336,797	250,674	237,356	2,399,183
2010	995,249	278,025	281,457	346,870	301,120	247,643	2,450,365
2011	764,558	257,795	219,117	346,680	152,303	67,393	1,807,847
2012	738,639	292,444	227,094	361,650	182,653	73,426	1,875,904
2013	743,729	318,593	202,452	346,907	166,566	96,210	1,874,457
2014	701,059	365,392	239,018	343,552	193,931	120,344	1,963,297
2015	566,898	370,658	223,336	318,118	170,463	83,566	1,733,039
2016	646,034	371,623	241,082	317,784	152,776	80,645	1,809,944
Min	566,898	243,070	202,452	317,784	152,303	63,054	1,733,039
Max	1,114,369	371,623	329,148	424,998	301,120	247,643	2,496,756
1990-2016 Average	940,646	286,739	292,075	394,889	227,325	104,545	2,246,219
1998-2010 Average	1,066,238	275,730	305,213	404,942	263,445	120,142	2,435,710

Annual Effective Precipitation Utilized by Crops (AF/Y)

Date	TLSB	Westside	Kings	Kaweah	Tule	Kern	Total
1990	19,958	4,318	9,898	10,134	4,021	1,244	49,574
1991	78,722	16,428	27,444	38,793	21,719	7,694	190,800
1992	64,818	24,269	24,144	28,899	15,747	5,740	163,617
1993	67,191	20,008	25,068	30,973	16,254	6,004	165,498
1994	34,514	6,123	14,367	15,929	7,877	2,828	81,637
1995	95,479	21,157	36,745	48,040	24,113	8,897	234,430
1996	100,745	20,047	33,683	44,875	24,361	9,632	233,344
1997	58,885	12,805	17,579	24,815	14,337	6,118	134,539
1998	116,167	25,963	38,123	50,183	32,155	14,137	276,727
1999	34,039	6,590	10,459	14,066	7,218	1,858	74,231
2000	70,413	13,814	26,881	29,672	15,472	3,995	160,246
2001	94,963	18,024	32,490	38,749	21,039	5,954	211,219
2002	26,034	4,299	12,099	11,948	5,990	1,685	62,054
2003	40,108	7,125	16,388	17,922	7,930	2,591	92,063
2004	74,858	15,360	24,636	28,506	14,362	4,272	161,995
2005	80,390	16,208	27,519	30,024	16,637	5,669	176,448
2006	104,703	19,345	34,578	43,910	25,059	7,201	234,795
2007	14,800	1,940	6,669	7,093	3,456	1,379	35,337
2008	35,836	9,454	12,655	18,355	10,733	4,599	91,630
2009	32,367	5,698	10,965	12,592	6,666	4,957	73,244
2010	88,203	22,750	27,939	32,256	23,244	16,507	210,899
2011	52,937	10,835	19,879	21,821	10,643	3,971	120,086
2012	45,317	8,817	17,930	23,369	12,074	5,282	112,788
2013	2,800	326	525	1,175	893	527	6,246
2014	30,586	10,563	12,275	15,813	7,632	3,413	80,282
2015	15,085	3,280	7,920	10,283	4,837	1,131	42,536
2016	41,890	13,881	19,341	21,746	9,312	4,102	110,272
Min	2,800	326	525	1,175	893	527	6,246
Max	116,167	25,963	38,123	50,183	32,155	16,507	276,727
1990-2016 Average	56,363	12,571	20,304	24,887	13,473	5,237	132,835
1998-2010 Average	62,529	12,813	21,646	25,790	14,612	5,754	143,145

Annual Farm Demand (AF/Y)

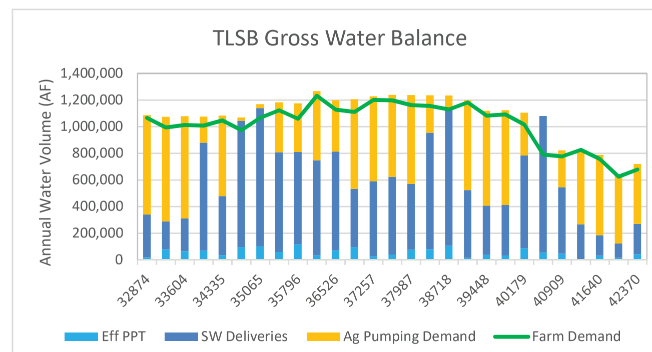
Date	TLSB	Westside	Kings	Kaweah	Tule	Kern	Total
1990	1,065,856	379,829	425,121	552,538	256,615	114,629	2,794,588
1991	994,832	358,828	401,725	514,334	233,176	106,035	2,608,931
1992	1,012,909	343,450	406,535	528,115	241,481	108,779	2,641,268
1993	1,008,709	347,335	404,875	524,762	240,425	108,288	2,634,395
1994	1,047,937	339,746	419,143	544,830	251,521	112,514	2,715,691
1995	973,503	292,869	389,226	502,007	229,979	104,424	2,492,007
1996	1,067,962	313,585	344,546	482,623	304,804	130,465	2,643,985
1997	1,123,726	337,872	377,306	511,503	317,630	136,383	2,804,420
1998	1,059,009	286,711	361,492	480,381	294,124	127,132	2,608,849
1999	1,232,448	339,665	407,814	535,160	327,150	81,596	2,923,833
2000	1,127,412	284,814	349,602	457,426	279,949	73,623	2,572,827
2001	1,111,506	309,426	344,390	447,420	273,032	74,325	2,560,098
2002	1,201,455	318,210	370,000	480,162	290,750	82,471	2,743,049
2003	1,198,411	341,139	366,586	474,349	288,517	84,529	2,753,532
2004	1,162,011	319,587	357,269	463,075	281,525	83,897	2,667,364
2005	1,155,548	293,659	353,639	461,355	278,436	83,344	2,625,980
2006	1,129,741	281,543	345,256	445,626	268,596	82,751	2,553,513
2007	1,183,096	324,200	294,958	447,694	338,016	240,627	2,828,591
2008	1,083,093	307,929	286,930	474,164	335,571	214,361	2,702,048
2009	1,091,697	349,701	288,327	381,416	286,941	273,394	2,671,475
2010	1,016,725	297,419	297,831	370,133	326,713	271,898	2,580,720
2011	791,090	287,744	234,224	382,183	166,368	74,617	1,936,226
2012	776,133	330,525	245,767	397,981	200,454	80,173	2,031,033
2013	826,405	371,025	237,221	406,748	194,551	112,569	2,148,518
2014	757,265	413,917	266,385	385,588	218,818	137,564	2,179,536
2015	624,647	428,797	253,146	362,160	194,523	96,982	1,960,255
2016	677,936	417,581	260,622	348,283	168,493	90,048	1,962,964
Min	624,647	281,543	234,224	348,283	166,368	73,623	1,936,226
Max	1,232,448	428,797	425,121	552,538	338,016	273,394	2,923,833
1990-2016 Average	1,018,558	333,967	336,664	457,853	262,524	121,756	2,531,322
1998-2010 Average	1,134,781	311,846	340,315	455,259	297,640	136,457	2,676,298

Annual SW Deliveries (AF/Y)

Date	TLSB	Westside	Kings	Kaweah	Tule	Kern	Total
1990	319,870	101,619	47,539	34,733	14,511	46,975	565,248
1991	209,568	50,258	60,256	67,030	20,368	16,662	424,142
1992	245,345	51,466	46,973	48,204	18,265	29,256	439,510
1993	811,312	109,501	159,335	166,035	85,071	83,829	1,415,083
1994	443,731	94,821	68,919	56,681	22,866	44,530	731,548
1995	948,773	127,445	185,554	199,827	82,318	91,195	1,635,112
1996	1,038,046	155,077	176,089	163,768	75,817	87,846	1,696,643
1997	749,117	162,214	141,157	131,813	63,410	68,603	1,316,314
1998	693,908	127,058	152,543	179,774	54,049	69,486	1,276,818
1999	713,206	147,012	123,314	90,454	49,410	82,217	1,205,613
2000	741,494	114,048	128,808	131,211	53,836	85,257	1,254,654
2001	437,871	100,121	73,383	75,856	27,236	31,432	745,899
2002	564,134	107,249	87,249	79,437	28,684	51,013	917,765
2003	583,124	124,958	96,413	100,930	46,590	63,012	1,015,028
2004	495,764	120,232	79,759	71,463	28,189	49,469	844,876
2005	873,425	138,809	157,030	161,487	78,104	109,872	1,518,728
2006	1,020,922	147,160	169,818	150,345	74,983	100,583	1,663,811
2007	508,886	117,825	51,225	60,221	21,430	44,262	803,848
2008	371,231	64,289	83,113	74,197	29,911	34,341	657,082
2009	379,590	33,075	78,392	81,233	39,292	34,417	645,999
2010	694,592	81,618	119,468	145,326	54,007	71,839	1,166,851
2011	1,026,568	125,783	158,177	165,812	78,345	97,317	1,652,002
2012	498,937	90,342	71,505	57,021	26,222	65,649	809,676
2013	264,515	51,613	45,947	33,756	17,953	41,540	455,323
2014	154,346	15,048	31,361	8,517	7,799	24,232	241,303
2015	107,212	9,806	18,103	7,154	7,800	24,819	174,894
2016	227,755	15,061	31,385	8,505	24,909	24,233	331,849
Min	107,212	9,806	18,103	7,154	7,799	16,662	174,894
Max	1,038,046	162,214	185,554	199,827	85,071	109,872	1,696,643
1990-2016 Average	560,120	95,685	97,882	94,474	41,903	58,292	948,356
1998-2010 Average	621,396	109,497	107,732	107,841	45,055	63,631	1,055,152

Annual Agricultural Pumping Demand (AF/Y)

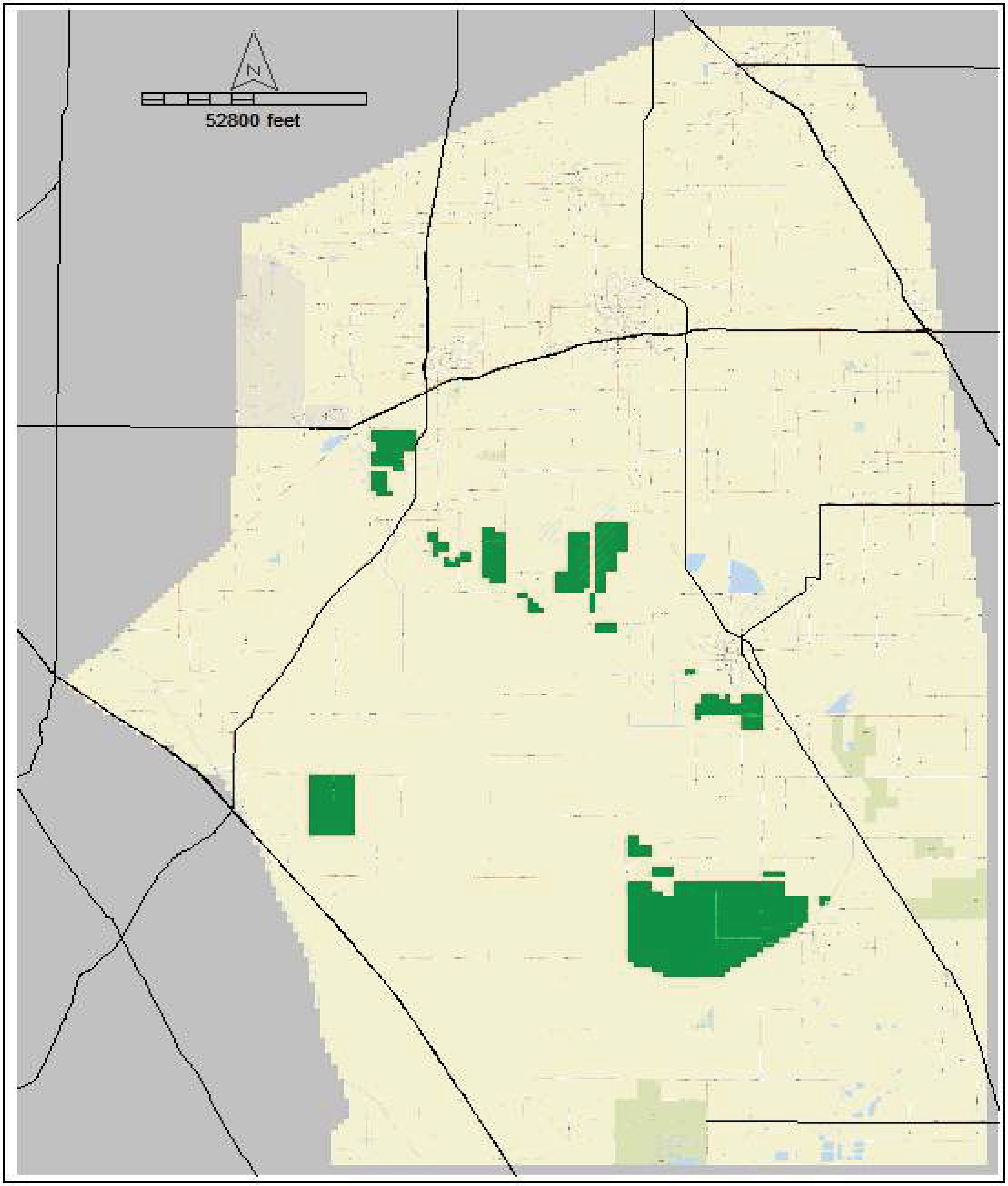
Date	TLSB	Westside	Kings	Kaweah	Tule	Kern	Total
1990	-745,986	-278,210	-377,582	-517,805	-242,104	-67,654	-2,229,341
1991	-785,264	-308,570	-341,469	-447,304	-212,809	-89,372	-2,184,789
1992	-767,564	-291,984	-359,561	-479,910	-223,216	-79,523	-2,201,759
1993	-197,397	-237,834	-245,540	-358,728	-155,354	-24,459	-1,219,312
1994	-604,206	-244,926	-350,224	-488,149	-228,655	-67,983	-1,984,143
1995	-24,730	-165,424	-203,672	-302,179	-147,661	-13,229	-856,896
1996	-29,915	-158,508	-168,457	-318,855	-228,987	-42,619	-947,342
1997	-374,608	-175,659	-236,149	-379,690	-254,220	-67,780	-1,488,105
1998	-365,102	-159,653	-208,949	-300,607	-240,074	-57,645	-1,332,031
1999	-519,242	-192,653	-284,500	-444,706	-277,739	621	-1,718,220
2000	-385,918	-170,767	-220,794	-326,215	-226,113	11,634	-1,318,173
2001	-673,635	-209,305	-271,007	-371,563	-245,796	-42,893	-1,814,199
2002	-637,322	-210,961	-282,751	-400,725	-262,067	-31,459	-1,825,285
2003	-615,287	-216,181	-270,173	-373,419	-241,927	-21,516	-1,738,504
2004	-666,247	-199,354	-277,510	-391,613	-253,336	-34,428	-1,822,488
2005	-282,123	-154,850	-196,609	-299,869	-200,331	26,529	-1,107,252
2006	-108,819	-134,383	-175,438	-295,282	-193,614	17,832	-889,703
2007	-674,210	-206,375	-243,733	-387,473	-316,586	-196,365	-2,024,743
2008	-711,862	-243,641	-203,818	-399,968	-305,659	-180,020	-2,044,967
2009	-712,107	-316,626	-209,935	-300,183	-247,649	-238,977	-2,025,477
2010	-322,133	-215,801	-178,363	-224,807	-272,706	-200,059	-1,413,869
2011	0	-161,961	-76,046	-216,371	-88,024	22,700	-519,702
2012	-277,196	-240,183	-174,262	-340,959	-174,232	-14,524	-1,221,356
2013	-561,890	-319,412	-191,274	-372,992	-176,598	-71,029	-1,693,195
2014	-602,919	-398,869	-235,024	-377,071	-211,018	-113,332	-1,938,233
2015	-517,434	-418,991	-235,043	-355,006	-186,723	-72,163	-1,785,361
2016	-450,181	-402,520	-229,237	-339,778	-143,584	-65,815	-1,631,116
Min	-785,264	-418,991	-377,582	-517,805	-316,586	-238,977	-2,229,341
Max	0	-134,383	-76,046	-216,371	-88,024	26,529	-519,702
1990-2016 Average	-467,159	-238,282	-238,782	-363,379	-220,622	-63,464	-1,591,687
1998-2010 Average	-513,385	-202,350	-232,583	-347,418	-252,584	-72,827	-1,621,147



Gross Annual Water Balance
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D2-23**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D2-24 Ag Drains



Legend

Model Area

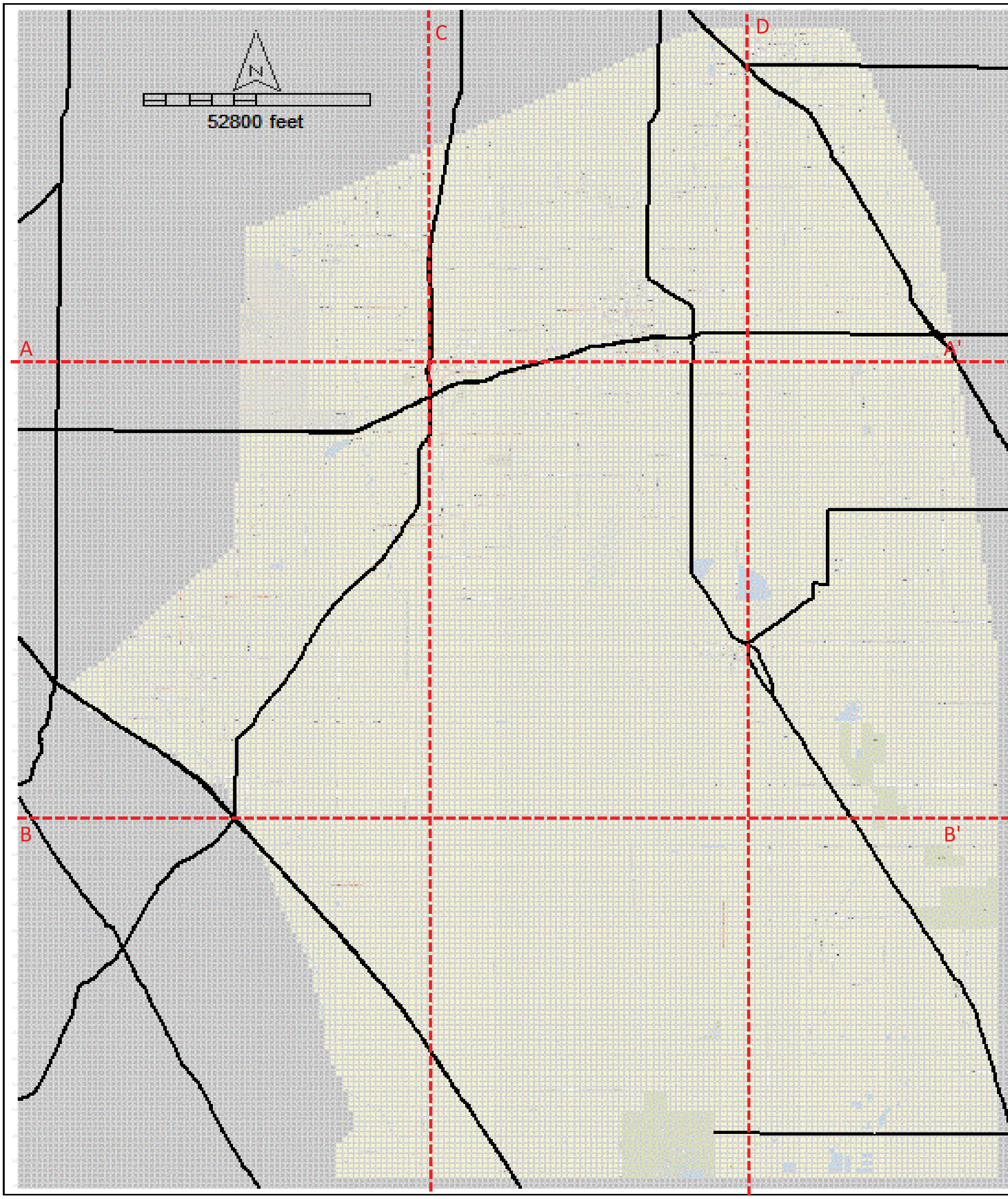
Sub-Surface Drains

Approximate Location of Sub-Surface Drainage Systems

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D2-24**



Explanation

Cross Section

Major Roads

No Flow

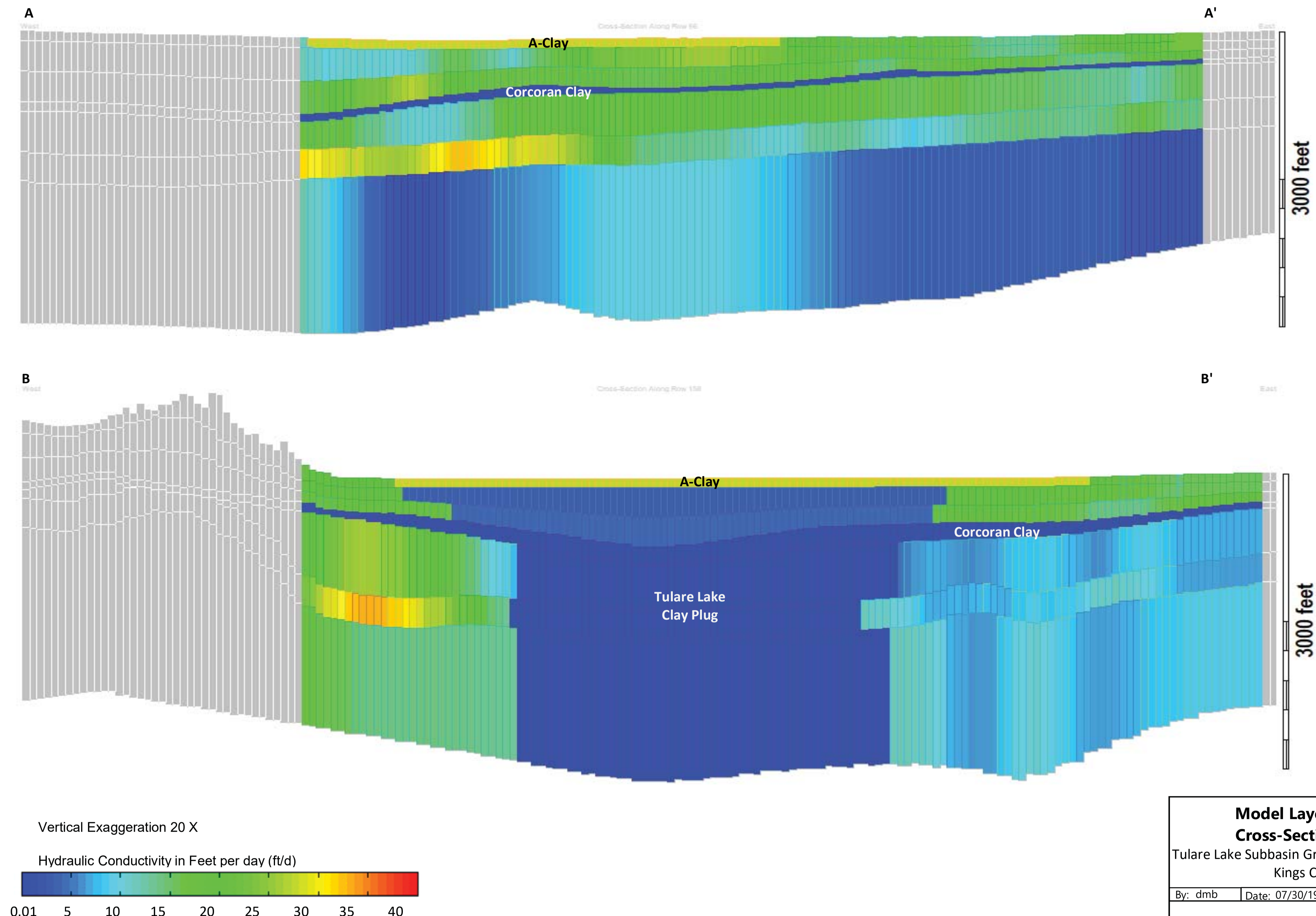
Tulare Lake Subbasin Hydrologic Model Domain and Grid

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-1**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D4-2 E-W X-Sections 12/19/2019

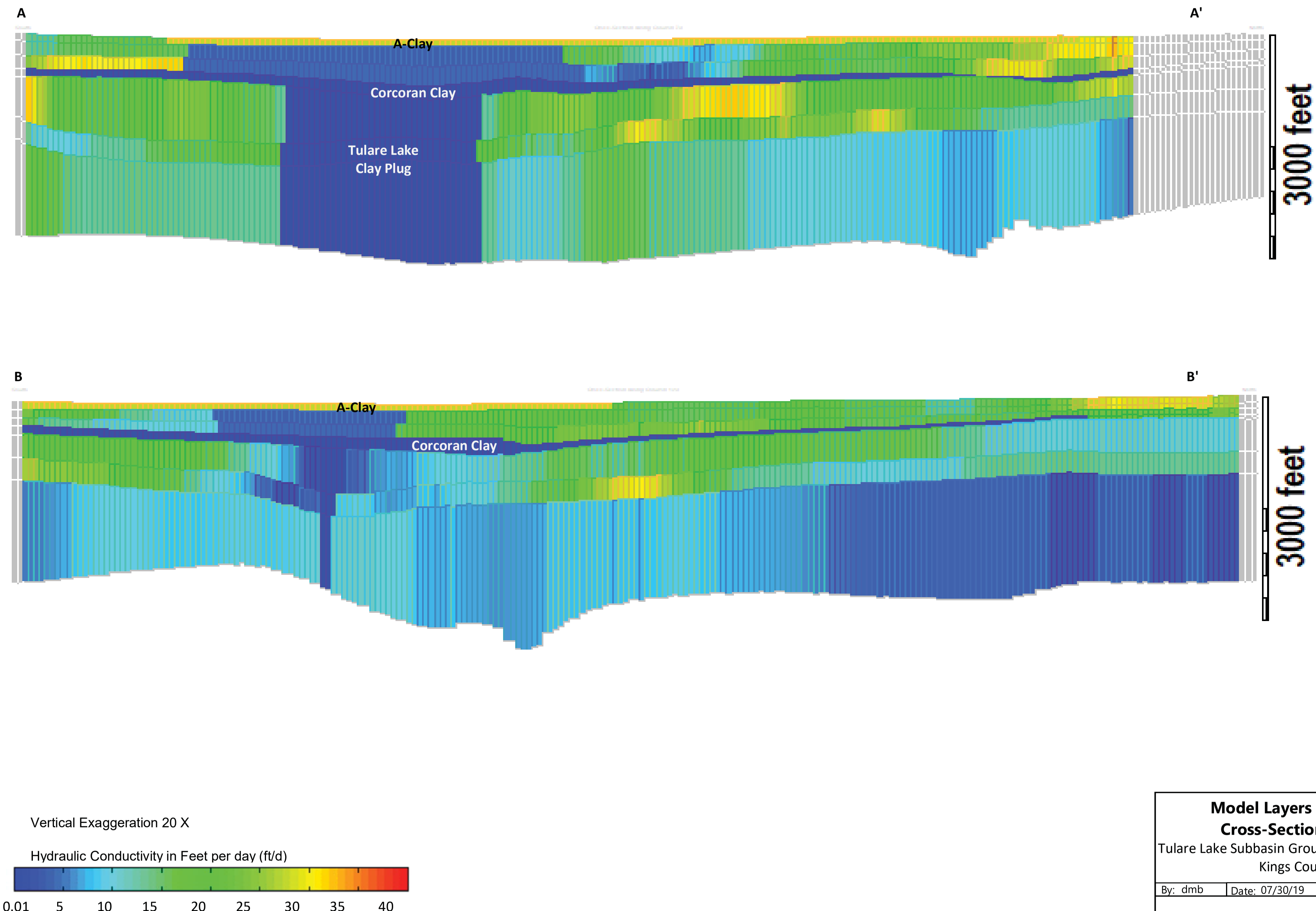


Model Layers and East-West Cross-Sections A-A' and B-B'

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-2**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D4-3 N-S X-Sections 12/19/2019



Model Layers and North-South Cross-Sections C-C' and D-D'

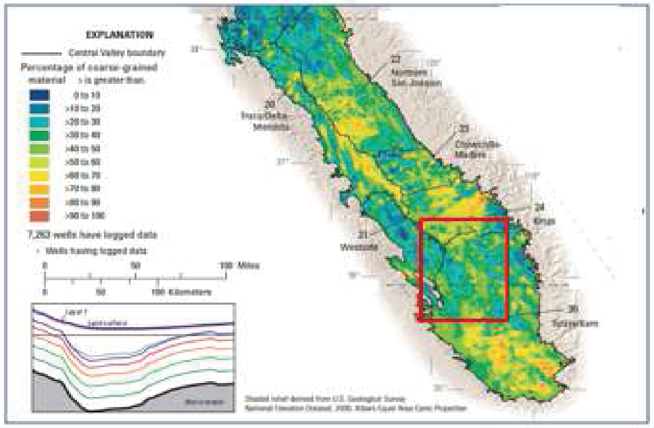
Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

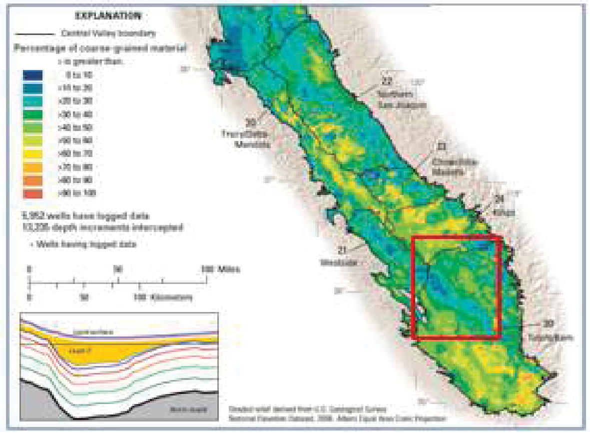
By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-3**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D4-4 Texture Model 12/19/2019

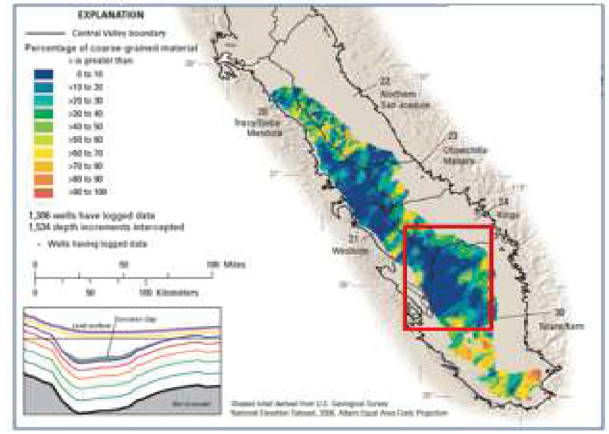
a. 0 - 50 foot depth interval



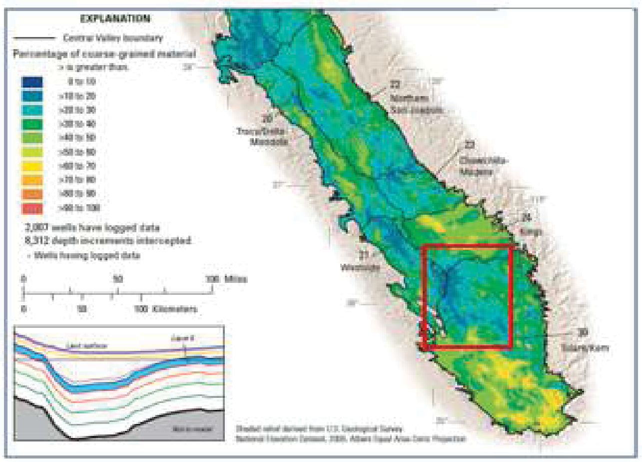
b. 50 - 200 foot depth interval



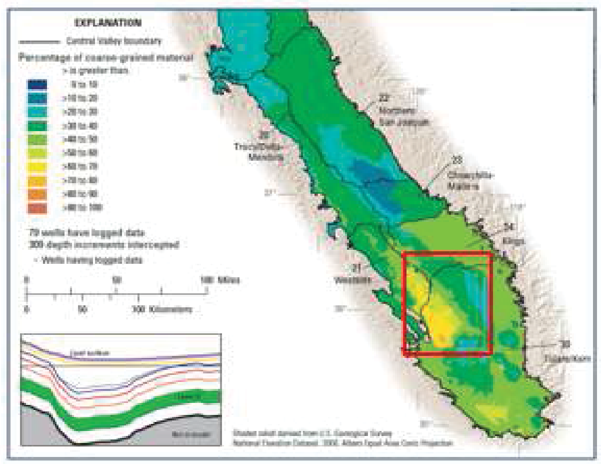
c. Corcoran Clay Depth interval



d. 100 foot depth interval immediately below Corcoran Clay



e. 200 foot depth interval from 400 to 700 feet bgs



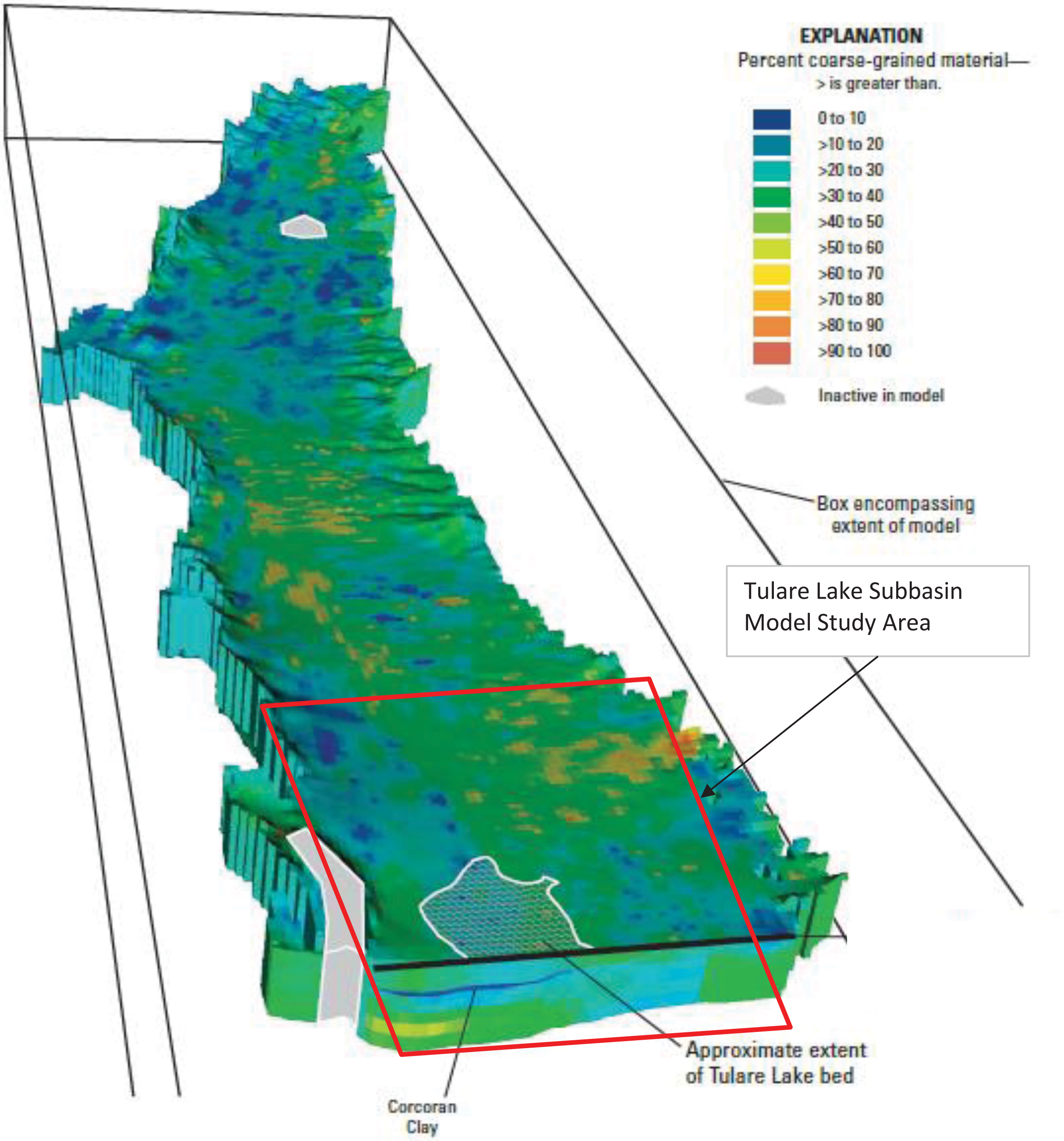
Tulare Lake Subbasin Hydrologic Model study area

*adapted from Fig. A12, USGS Prof. Paper 1766

Kriged Distribution of Coarse Fraction For San Joaquin Valley Basin-Fill Sediments at Five Depth Intervals

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-4**



Modified from USGS Prof. Paper 1766

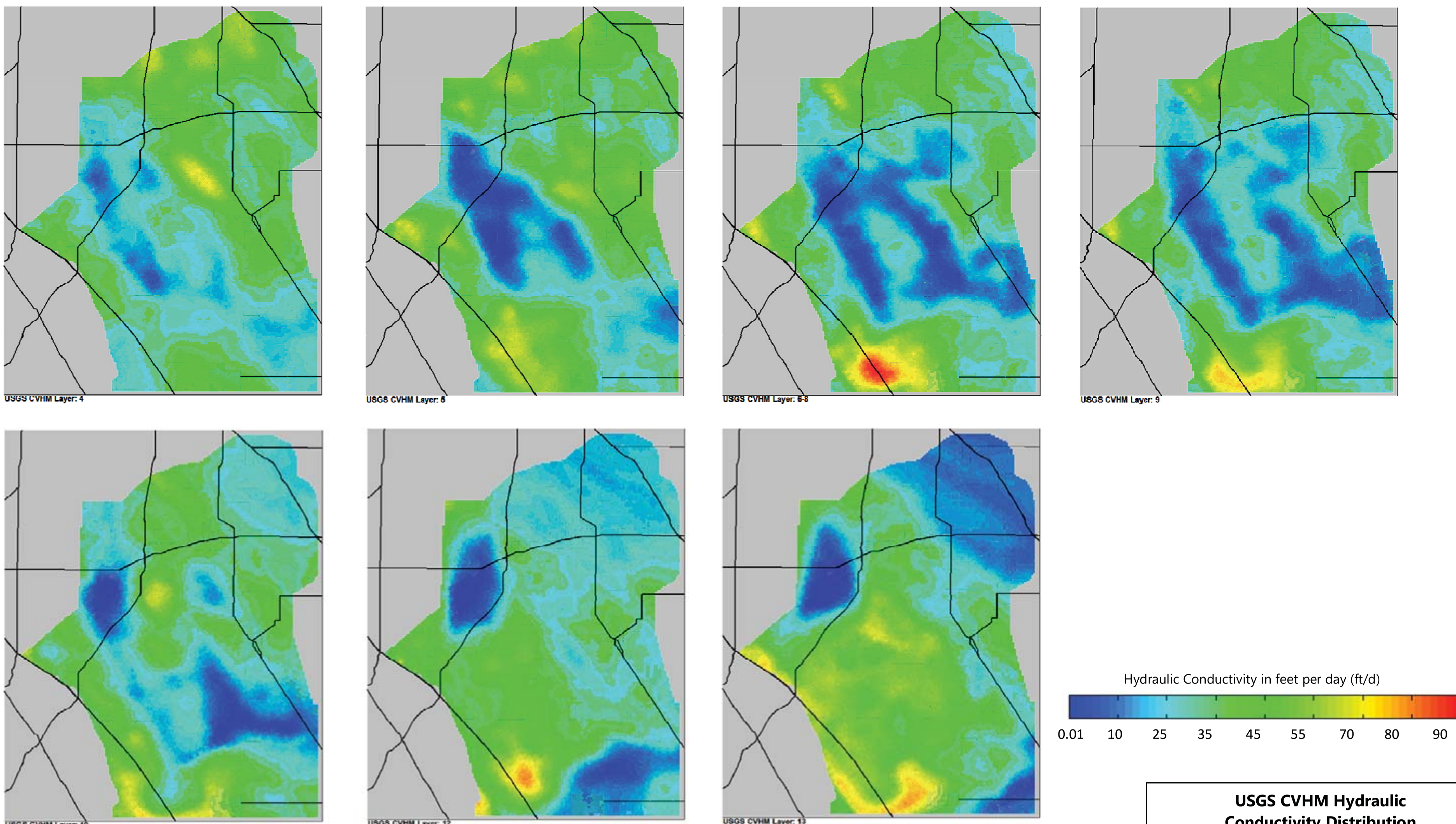
3D Oblique Image of San Joaquin Valley Coarse Fraction Percentage Estimated by USGS Sediment Texture Study

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-□**

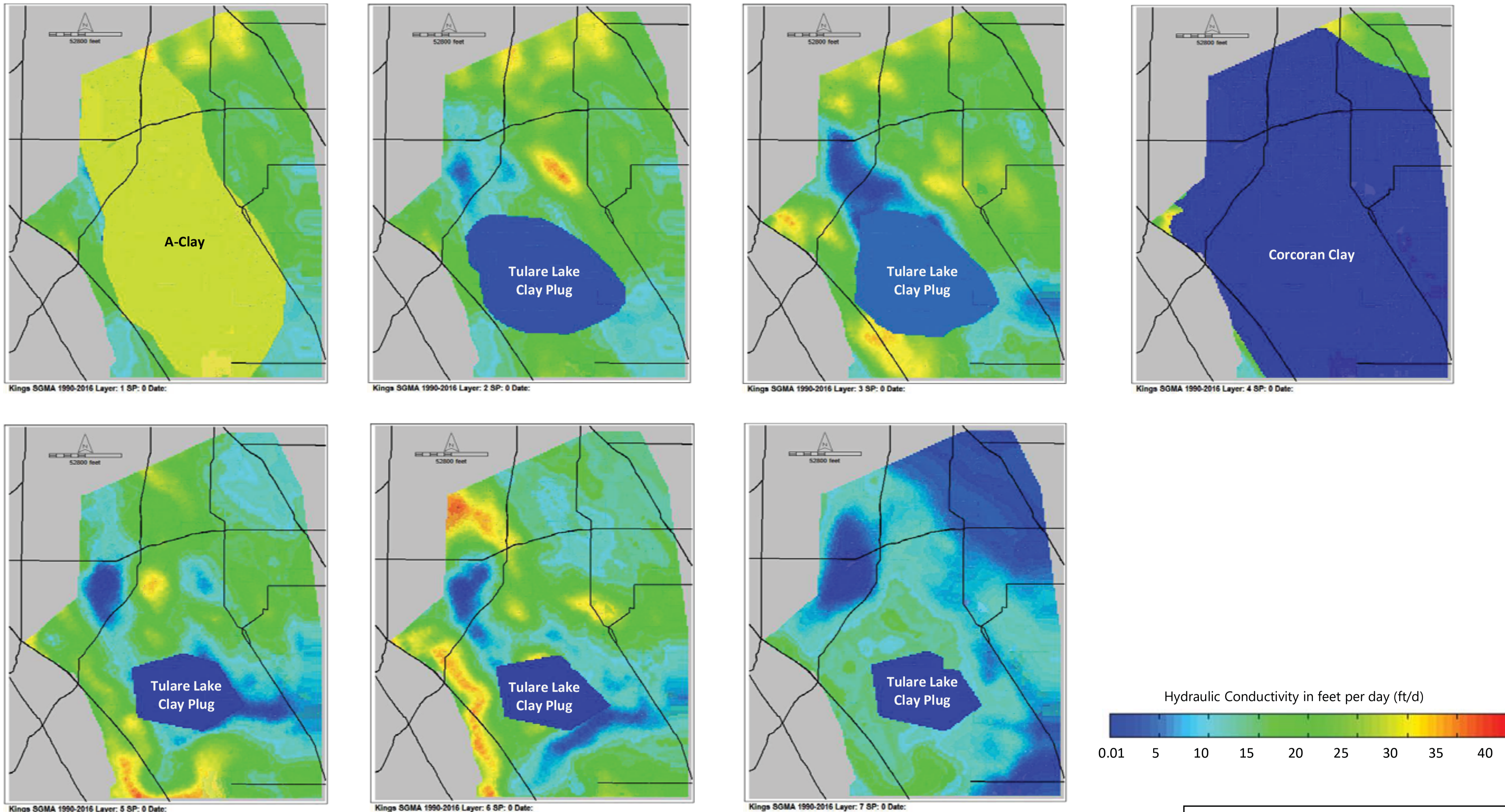
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\3-BasinSetting\Figures\DAVES FOLDER\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig 4-6 USCS CVHM Kh 1/6/2020



USGS CVHM Hydraulic Conductivity Distribution

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-6**

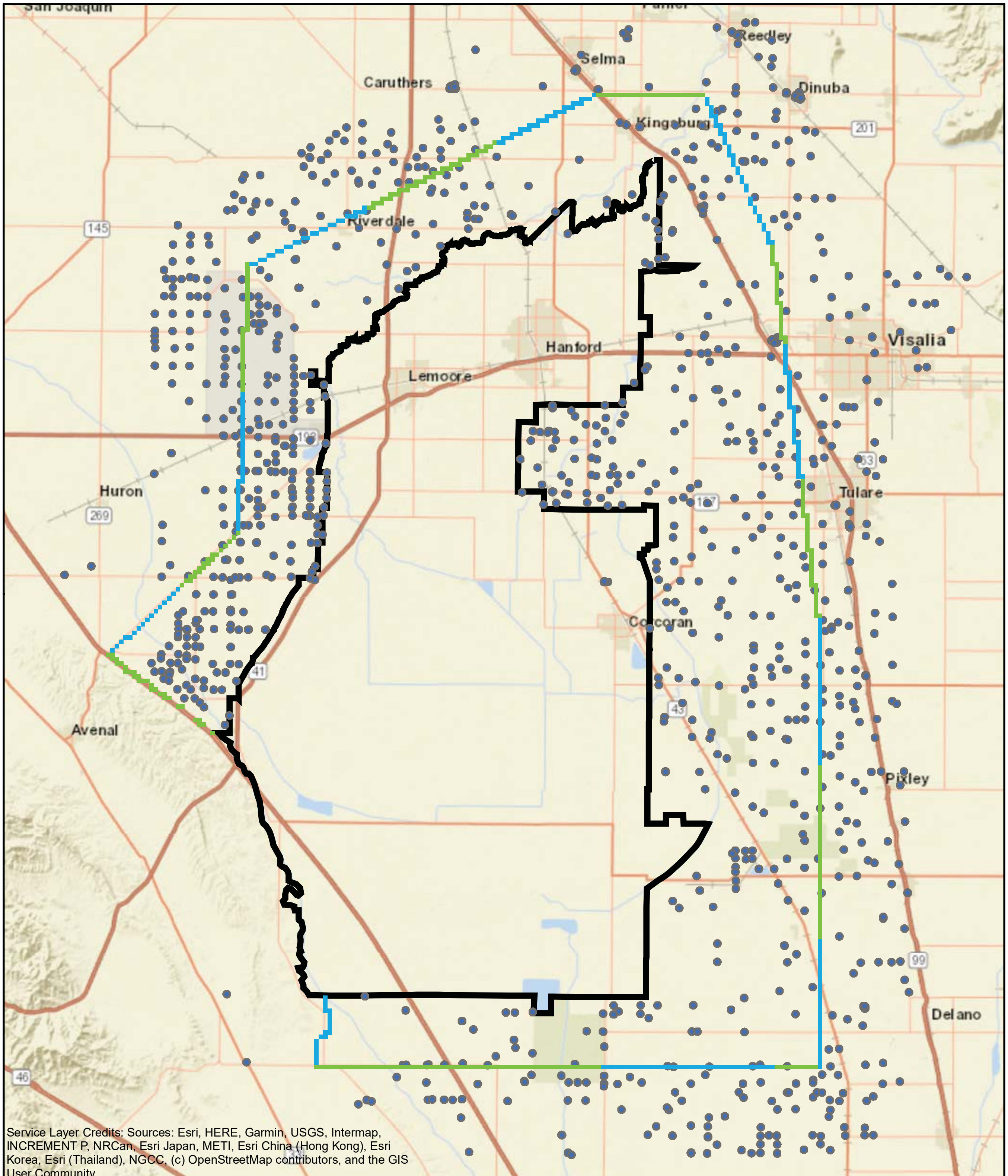


Calibrated Model Layer Hydraulic Conductivity Distribution

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure **D4-7**



Explanation

Evaluated wells

General head boundaries

Miles 0 2 4 8

0 2.5 5 10 Kilometers

N

Location of Wells Evaluated for General Head Boundaries

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: EMC	Date: 1/7/2020	Project No.: FR18161220
		Figure **D4-8**

Date: 1/7/2020 Printed by: elizabeth.chapman

Path: N:_FR_projects\FR18s\FR18161220\gis\maps\2019\AppendixD_figD4-8_wellsandGHBs.mxd

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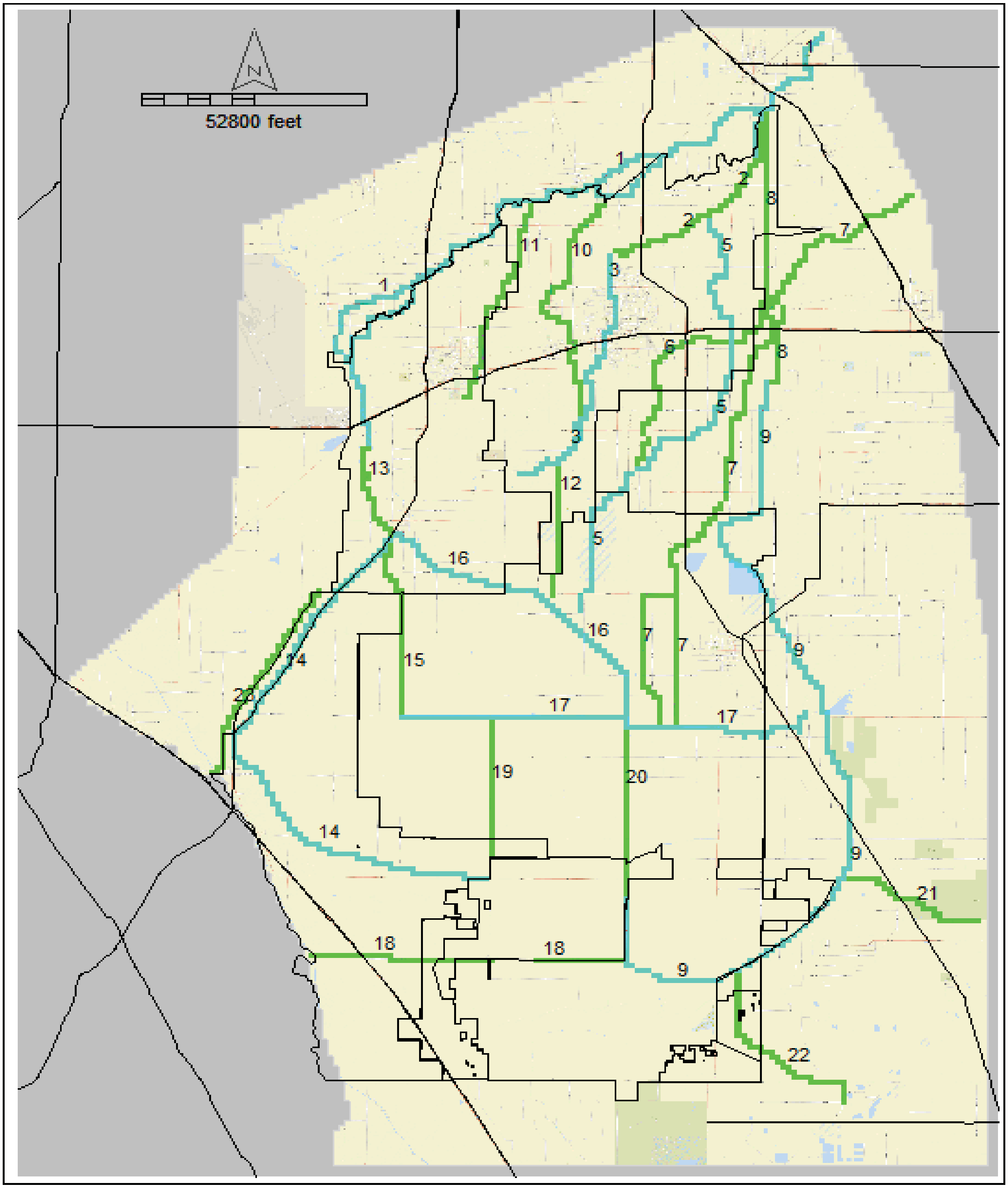


Notes:

1) Numbers shown are River Reaches

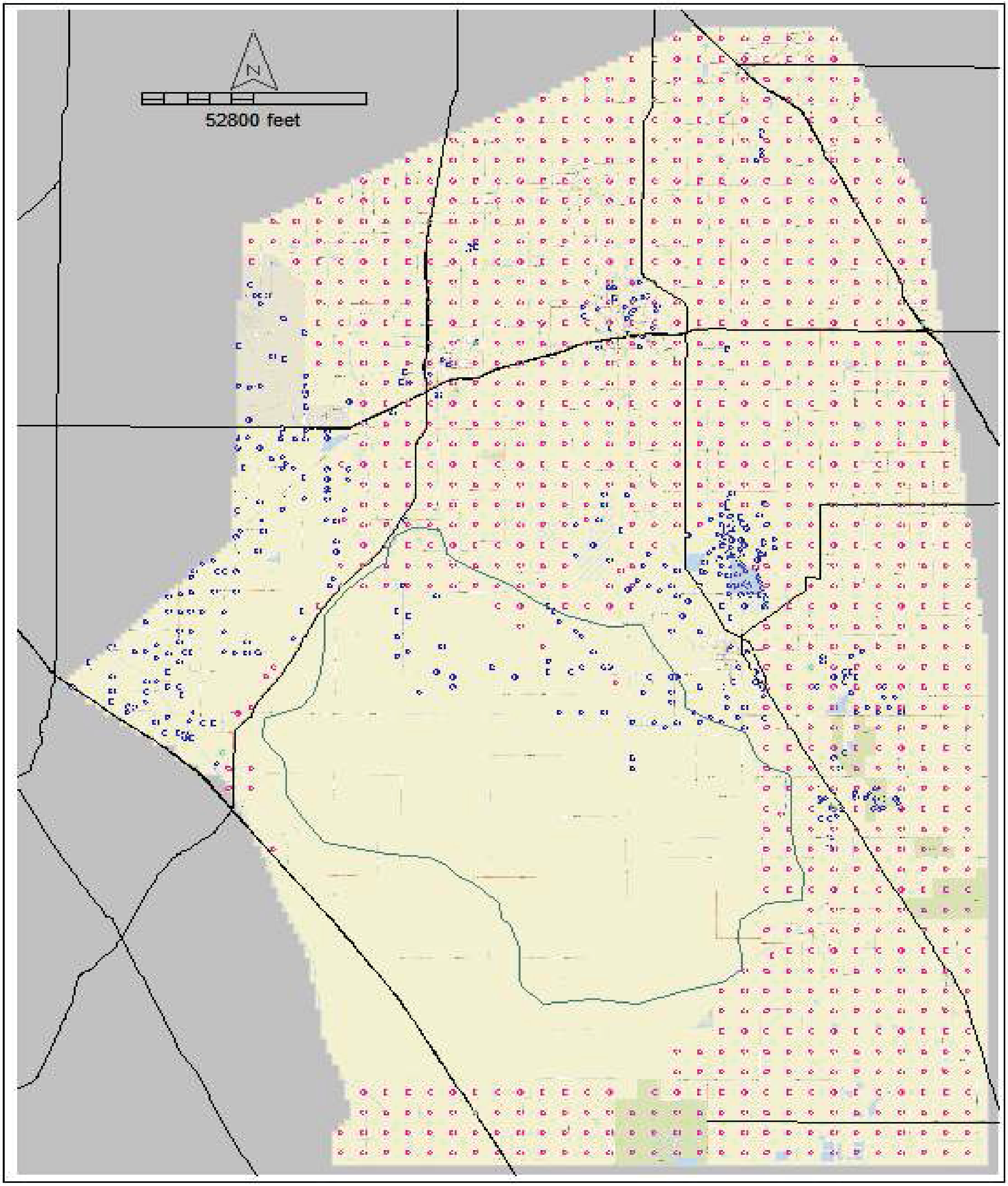
2) Colors delinate different reaches

Location of Rivers, Streams, and Canals for River Boundaries

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

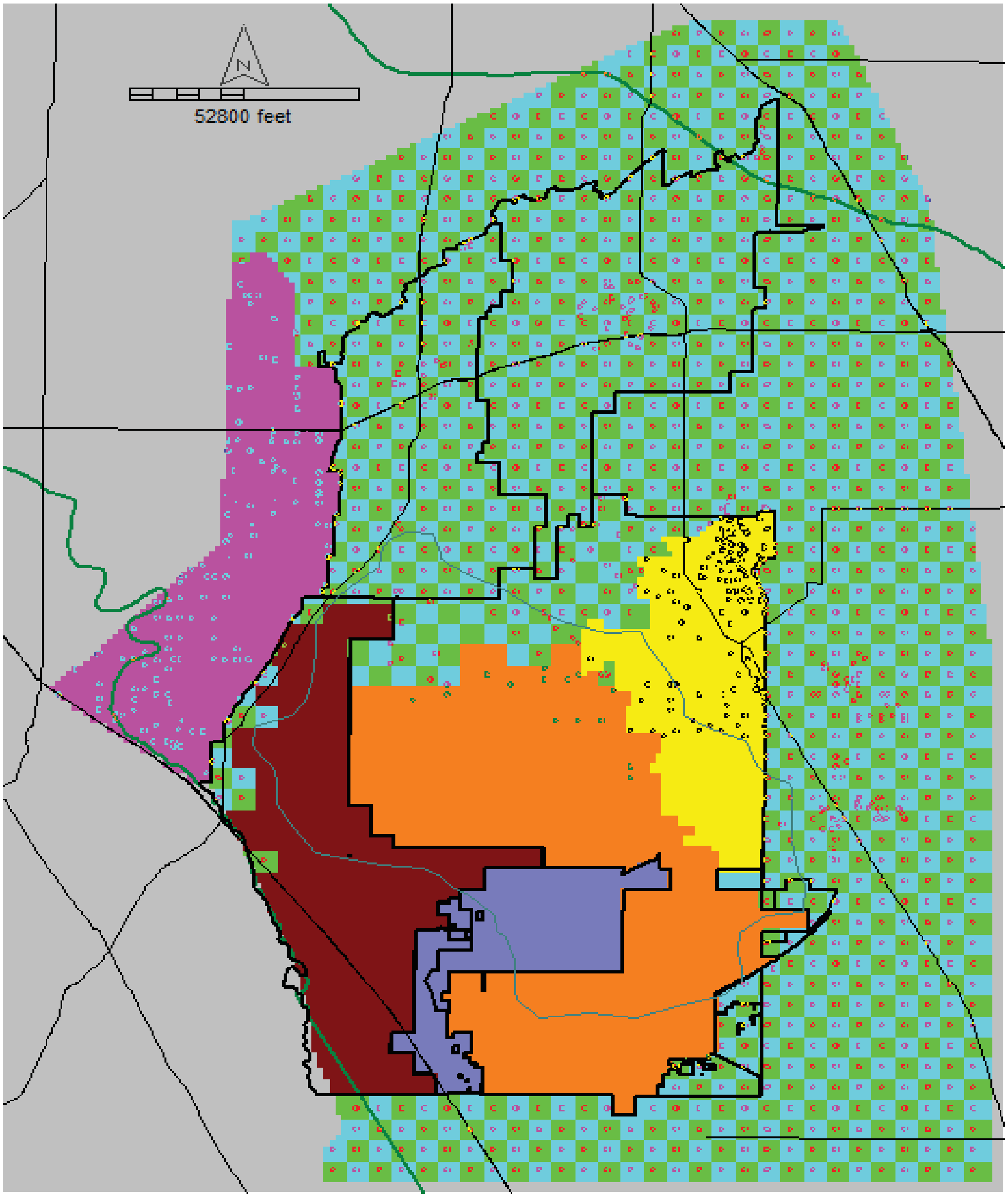
By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-9**



Location of Existing and Hypothetical Pumping Well within Model Domain

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-10**

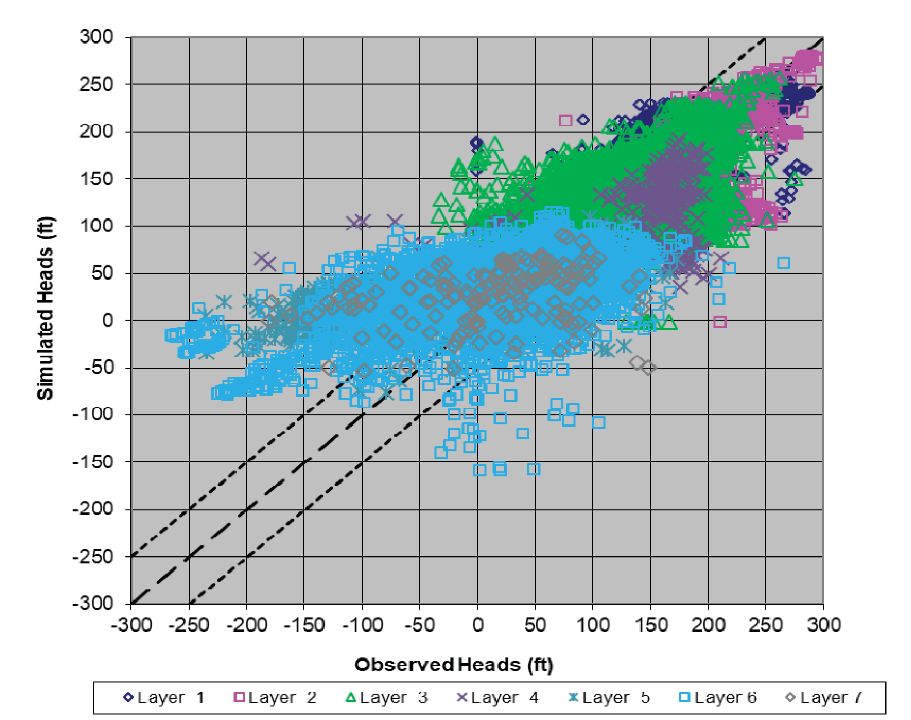


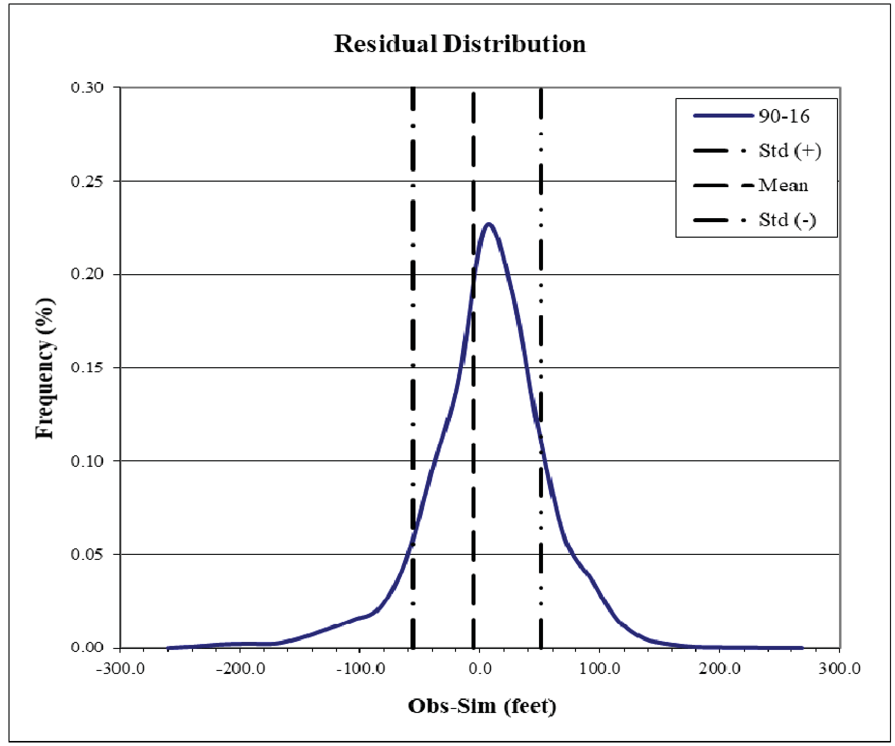
Hypothetical Agricultural Well Service Area
Hypothetical Agricultural Well Service Area
Corcorain ID Service Area
El Rico GSA Service Area
Westlands Water District Service Area
SouthWest Kings GSA Service Area
Tri County Water Authority Service Area

Location of Hypothetical Irrigation Well Service Areas within Model Domain

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D4-11**



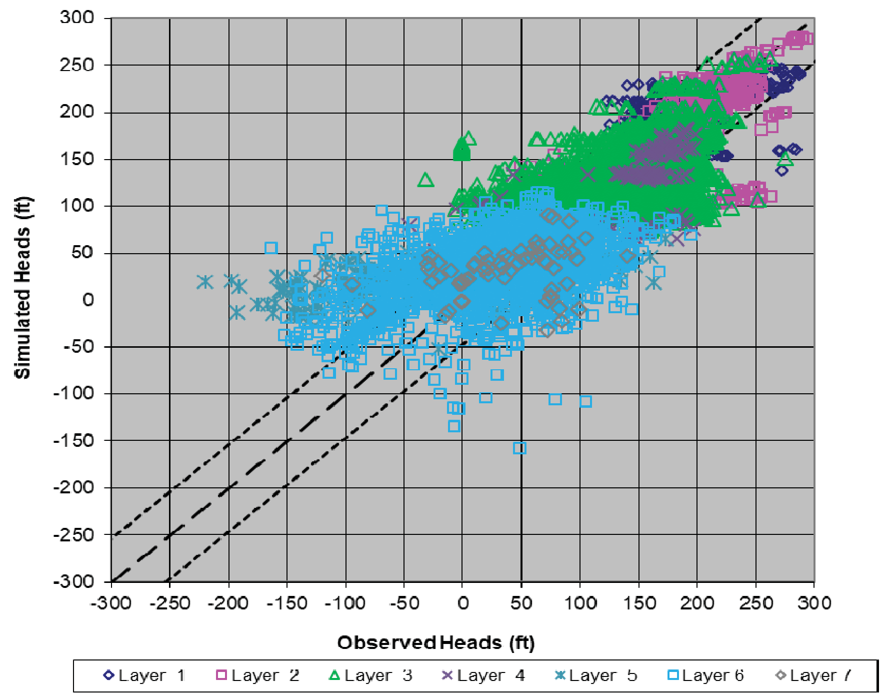


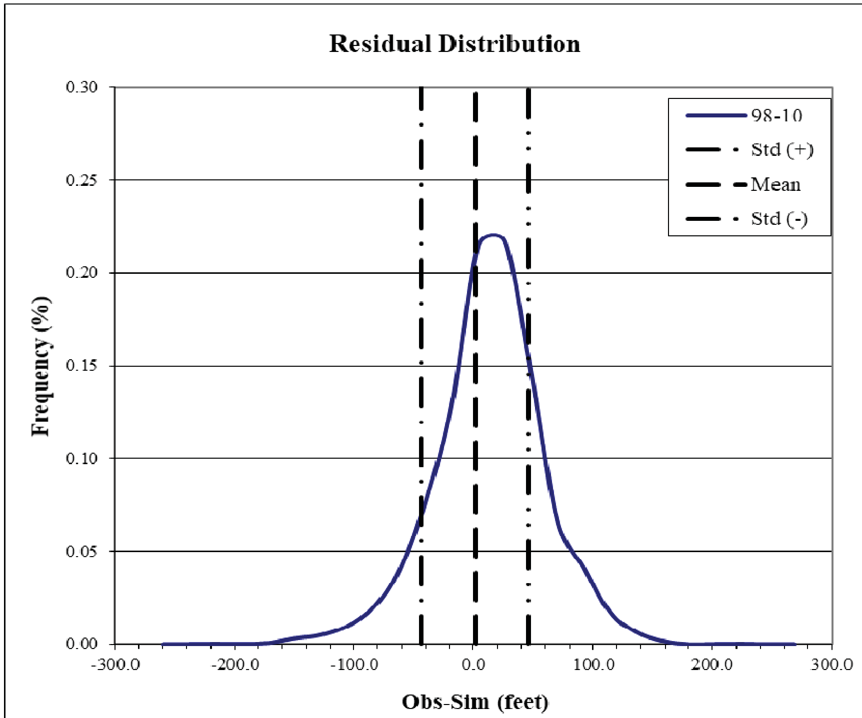
Statistics	Layer 1 - 7		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7
Residual Mean	-4.98	ft	-9.30	185.26	-1.18	25.67	-35.43	-11.66	-11.45
Absolute Residual Mean	37.03	ft	26.33	38.80	30.55	36.38	64.09	49.81	45.61
Residual Std. Deviation	50.61	ft	34.84	44.84	39.78	53.49	75.82	63.58	63.42
Sum of Squares	42586112	ft^2	1733398	45812399	12887543	1291708	5743049	18228849	780823
RMS Error	50.85	ft	34.84	44.84	39.78	53.49	75.82	63.58	63.42
Min. Residual	-255.01	ft	-179.50	-1.00	-180.93	-252.97	-240.51	-255.01	-197.45
Max. Residual	213.28	ft	152.58	280.01	143.90	151.42	154.06	213.28	197.53
Number of Observations	16468		1333	1261	8136	367	820	4363	188
Range in Observations	575.33	ft	332.09	281.01	324.83	404.39	394.58	468.29	394.98
Scaled Residual Std. Deviation	8.80%		10.49%	15.96%	12.25%	13.23%	19.22%	13.58%	16.06%
Scaled Absolute Residual Mean	6.44%		7.93%	13.81%	9.40%	9.00%	16.24%	10.64%	11.55%
Scaled RMS Error	8.84%		10.49%	15.96%	12.25%	13.23%	19.22%	13.58%	16.06%
Scaled Residual Mean	-0.87%		-2.80%	65.92%	-0.36%	6.35%	-8.98%	-2.49%	-2.90%
Correlation Coefficient	82%		66%	64%	74%	76%	92%	82%	82%

1990 - 2016 Calibration Statistics and Scattergram
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 11/20/19 | Project No.: FR18161220

Figure **D5-1a**



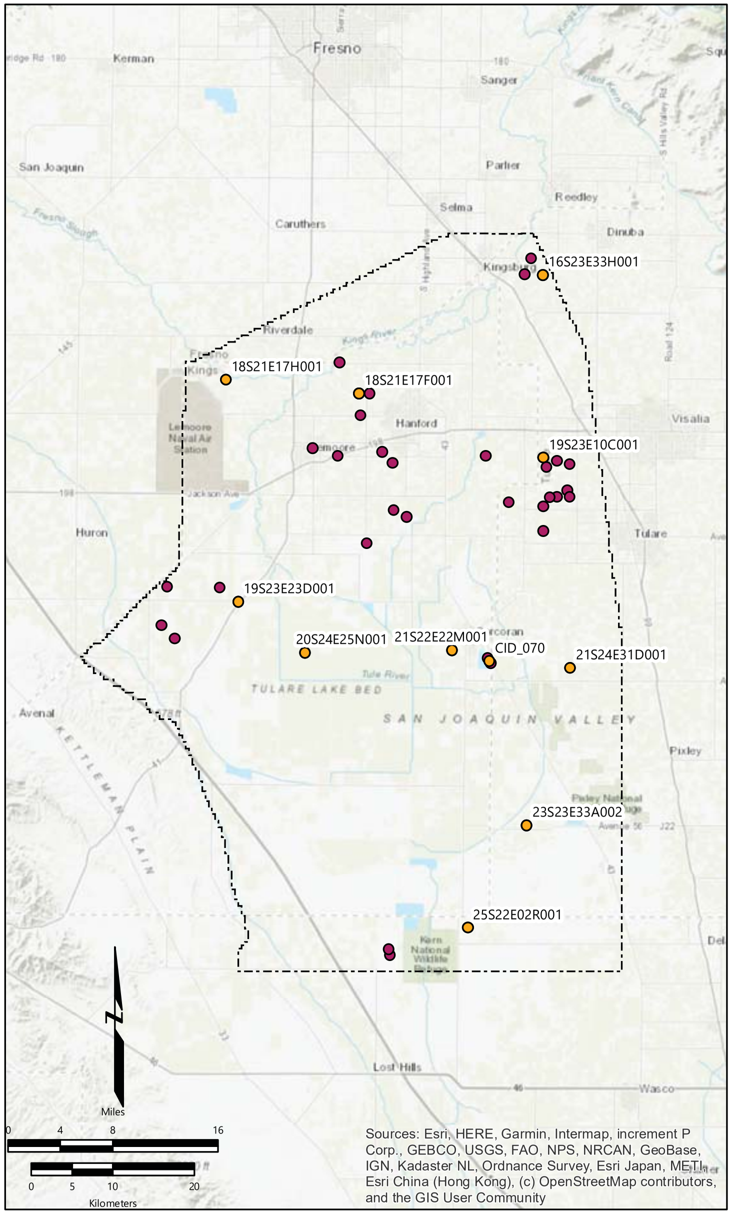


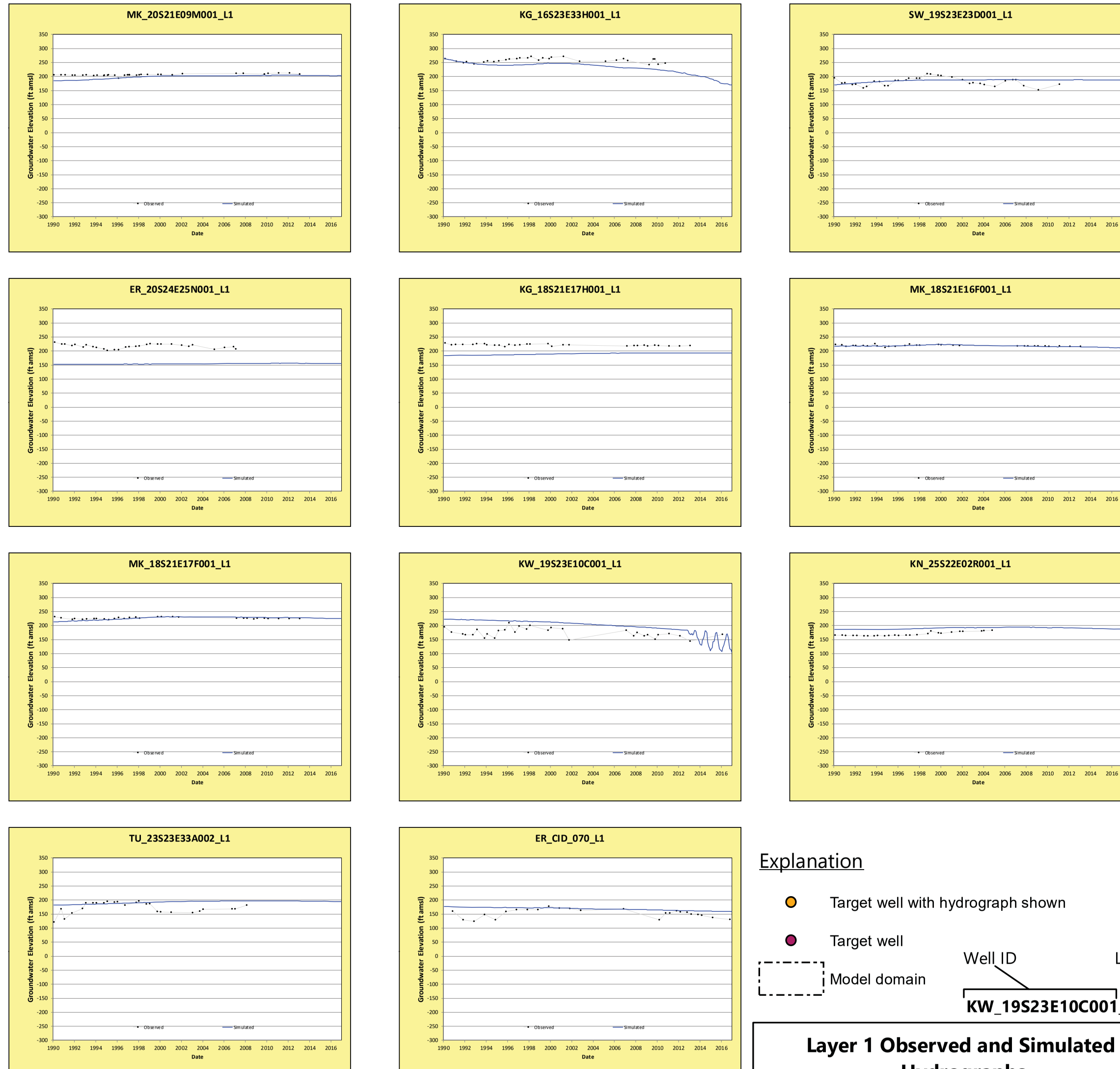
Statistics	Layer 1 - 7		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7
Residual Mean	2.26	ft	-3.24	185.61	5.32	20.05	-26.55	-1.71	4.83
Absolute Residual Mean	34.78	ft	23.78	40.69	29.78	28.23	61.79	44.63	35.33
Residual Std. Deviation	46.26	ft	32.01	47.25	38.69	40.99	73.64	55.32	48.41
Sum of Squares	15075869	ft^2	561933	19148686	5416707	316496	2009708	5707709	160941
RMS Error	46.32	ft	32.01	47.25	38.69	40.99	73.64	55.32	48.41
Min. Residual	-240.16	ft	-89.83	-1.00	-167.94	-125.53	-240.16	-219.41	-145.72
Max. Residual	213.28	ft	133.86	280.01	143.40	121.24	144.32	213.28	108.57
Number of Observations	7028		543.00	522.00	3552.00	152.00	328.00	1863.00	68.00
Range in Observations	545.16	ft	223.69	281.01	311.34	246.77	384.47	432.70	254.29
Scaled Residual Std. Deviation	8.49%		14.31%	16.81%	12.43%	16.61%	19.15%	12.79%	19.04%
Scaled Absolute Residual Mean	6.38%		10.63%	14.48%	9.57%	11.44%	16.07%	10.31%	13.89%
Scaled RMS Error	8.50%		14.31%	16.81%	12.43%	16.61%	19.15%	12.79%	19.04%
Scaled Residual Mean	0.41%		-1.45%	66.05%	1.71%	8.12%	-6.91%	-0.39%	1.90%
Correlation Coefficient	82%		58%	62%	77%	66%	91%	79%	78%

1998 - 2010 Calibration Statistics and Scattergram
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb | Date: 07/30/19 | Project No.: FR18161220

Figure **D5-1b**





Explanation

- Target well with hydrograph shown
- Target well
- Model domain

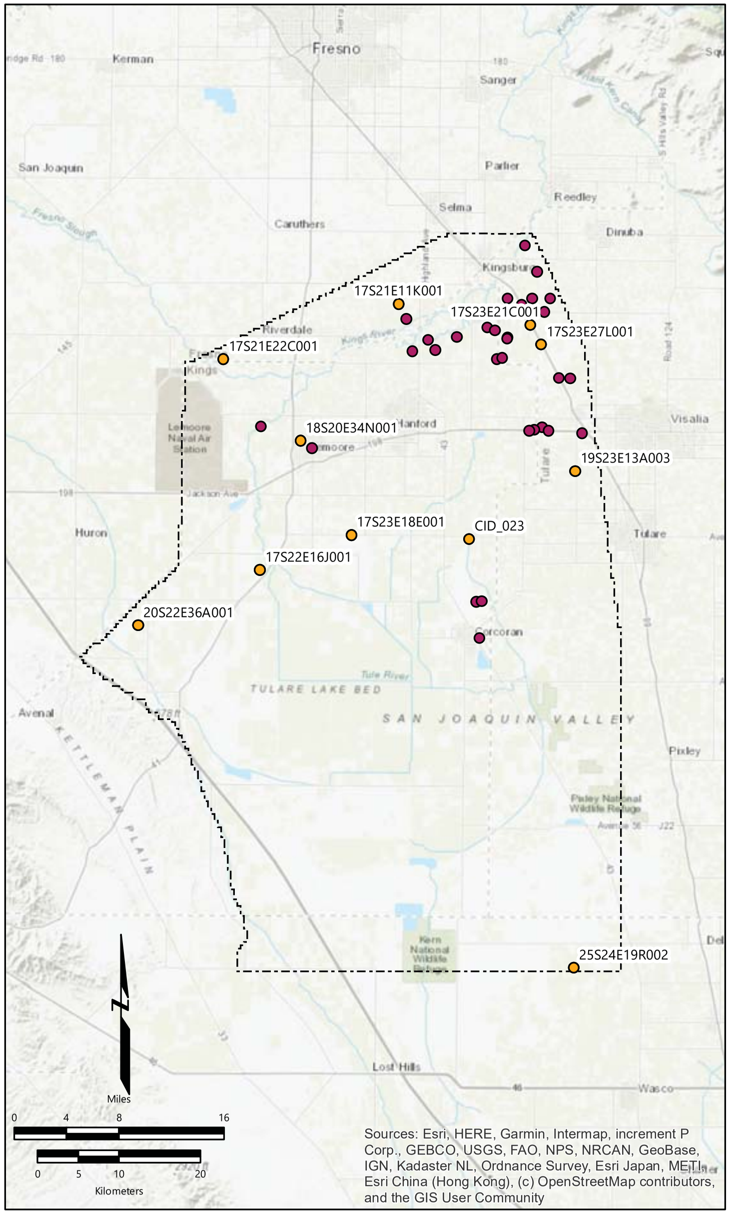
Well ID — Layer
KW_19S23E10C001_L1

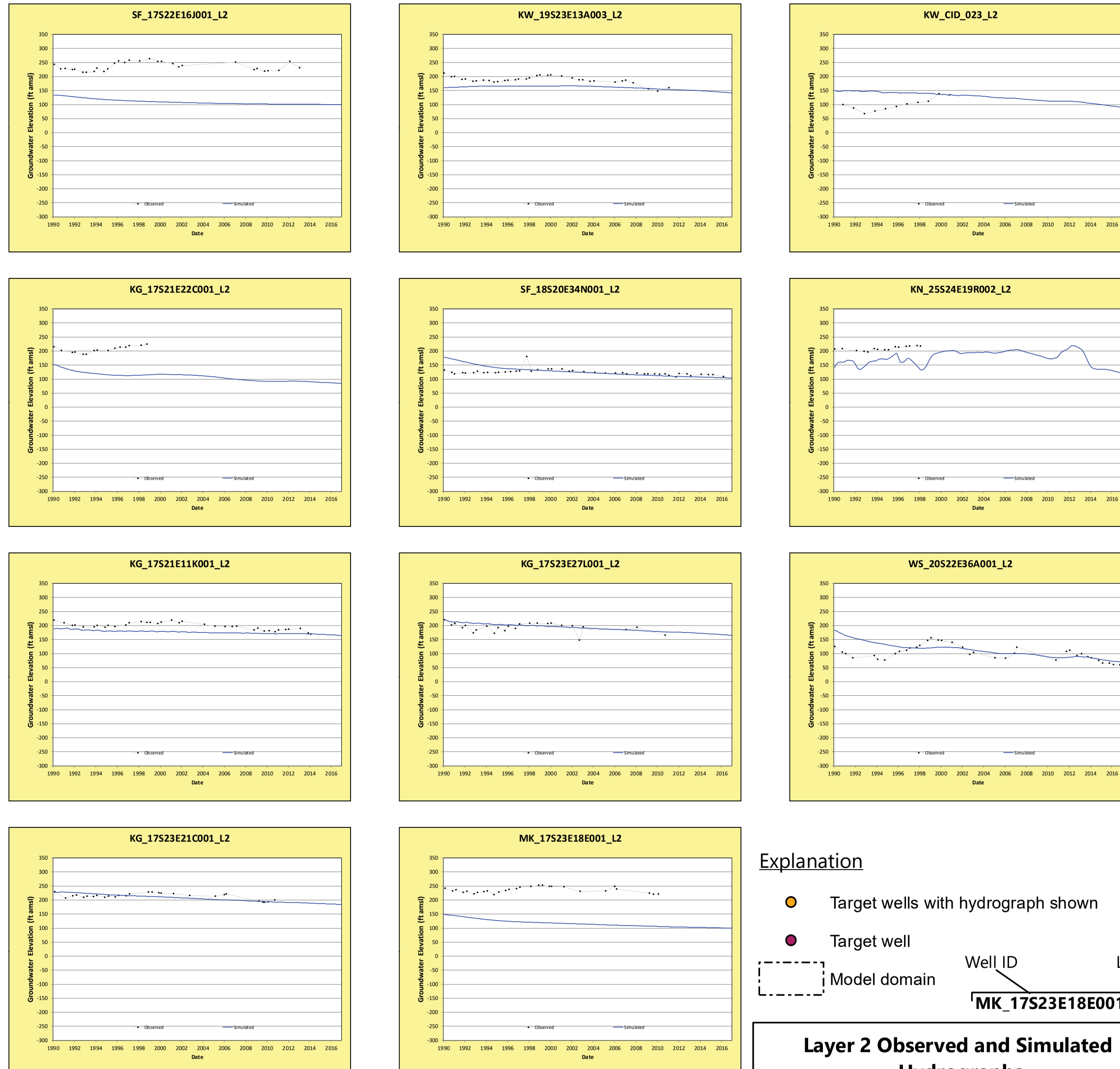
Layer 1 Observed and Simulated Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2a**

Date: 1/8/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\temp\DBean_Hydro__fig01_layeredHydrographs_20191218.mxd





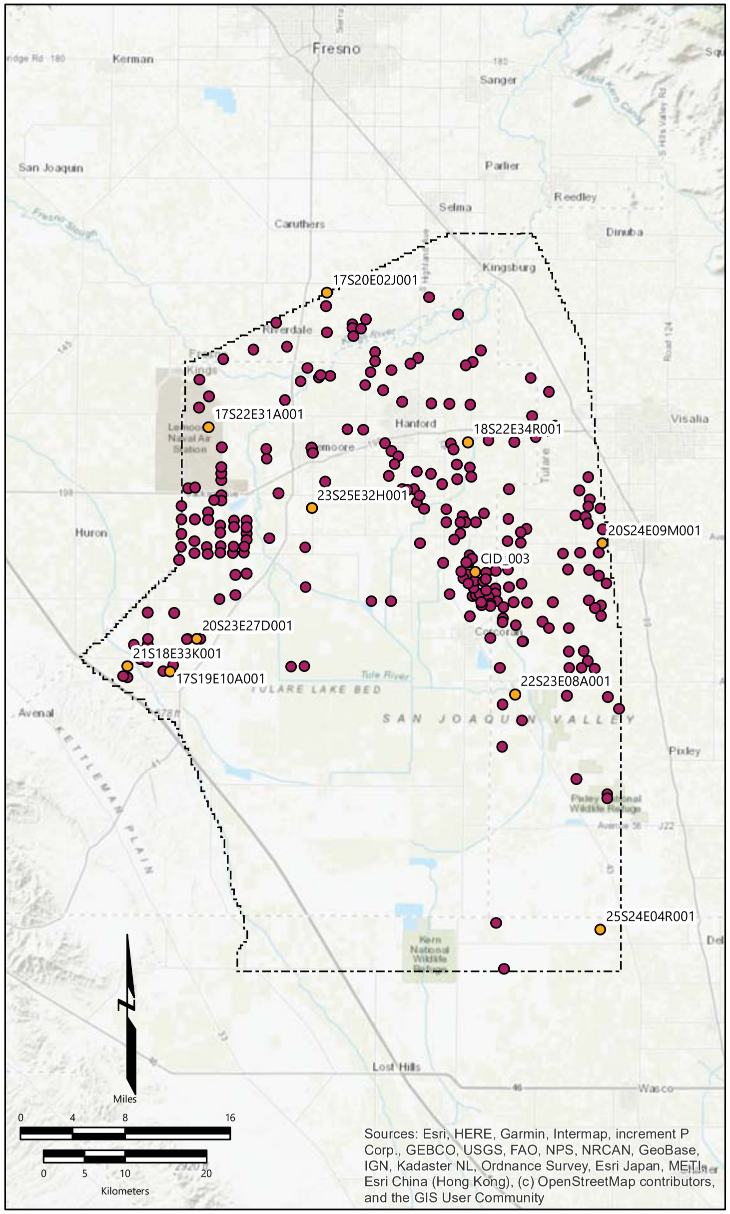
Explanation

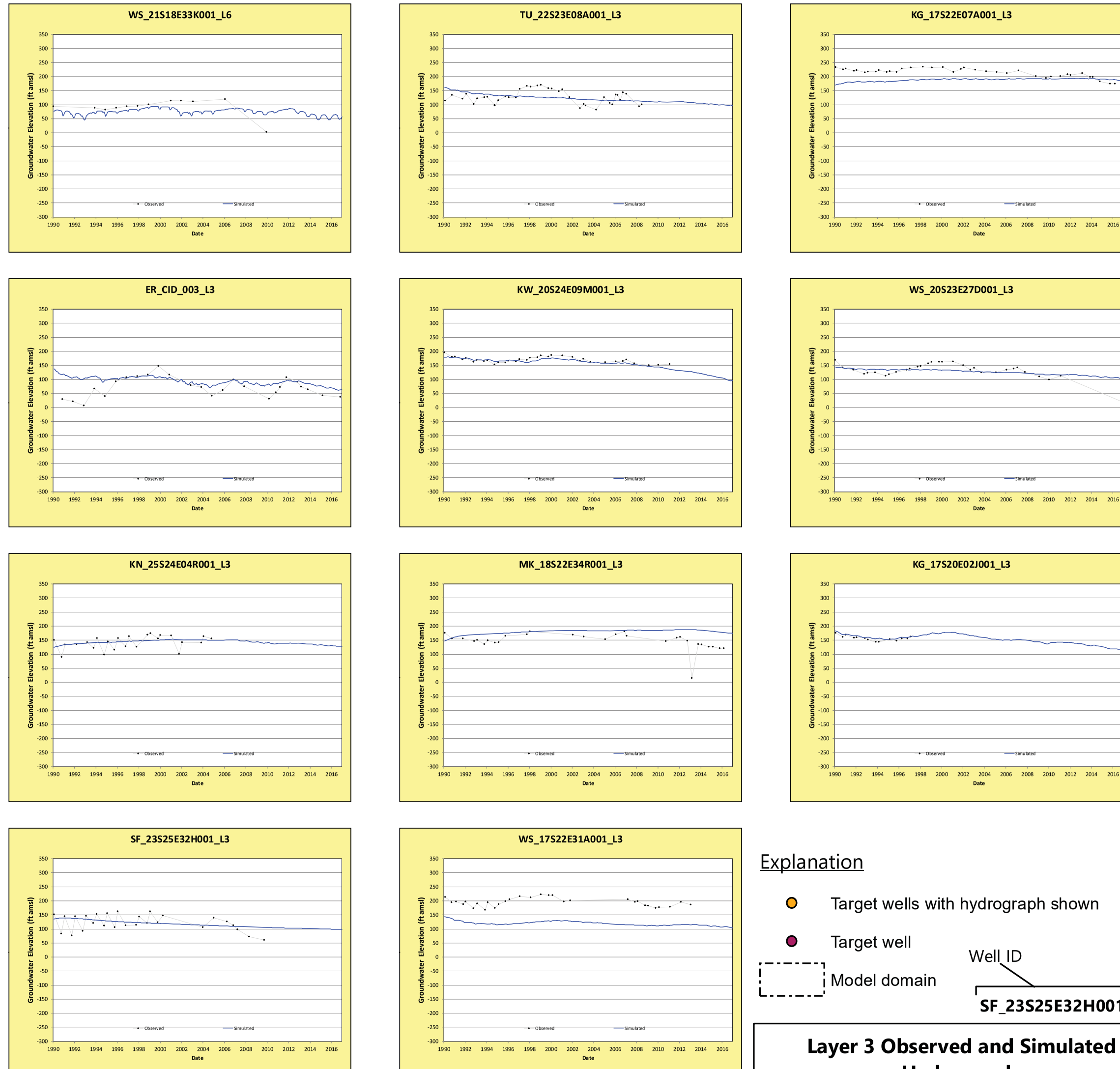
- Target wells with hydrograph shown
- Target well
- Model domain

Well ID — Layer
MK_17S23E18E001_L2

Layer 2 Observed and Simulated Hydrographs
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2b**





Explanation

- Target wells with hydrograph shown
- Target well
- Model domain

Well_ID Layer
SF_23S25E32H001_L3

Layer 3 Observed and Simulated Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2c**

Date: 1/8/2020 Printed by: elizabeth.chapman
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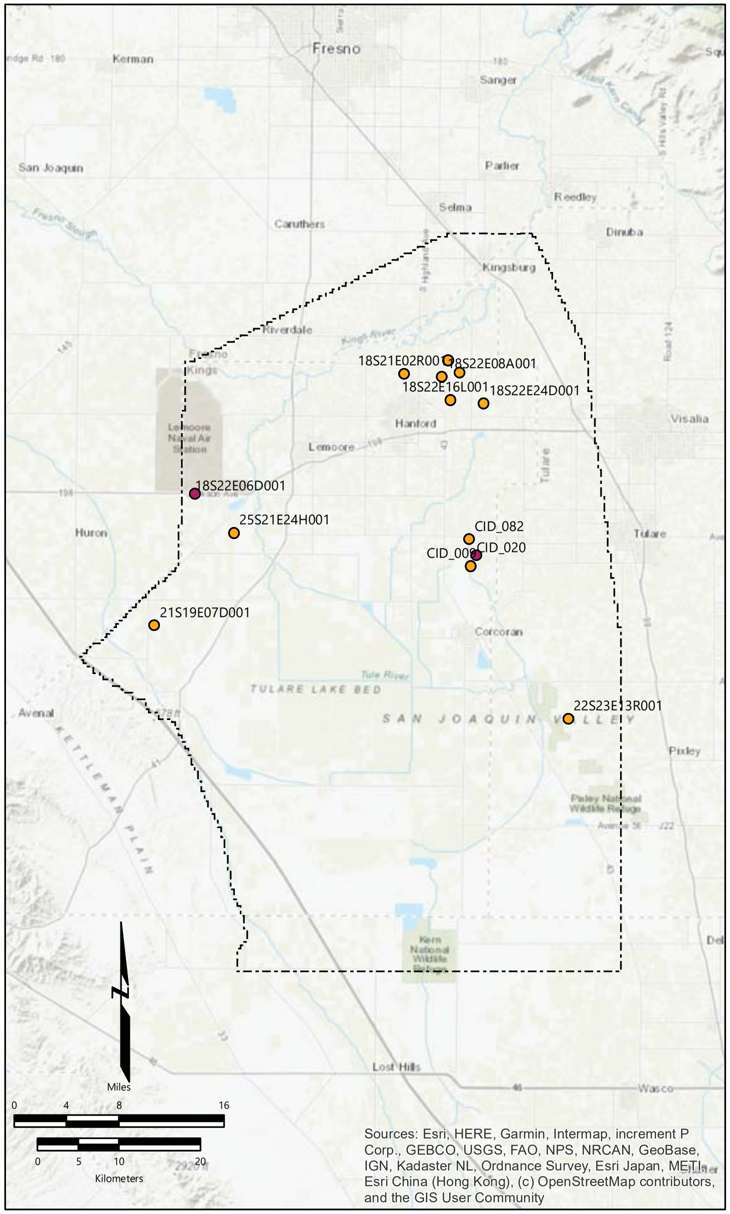

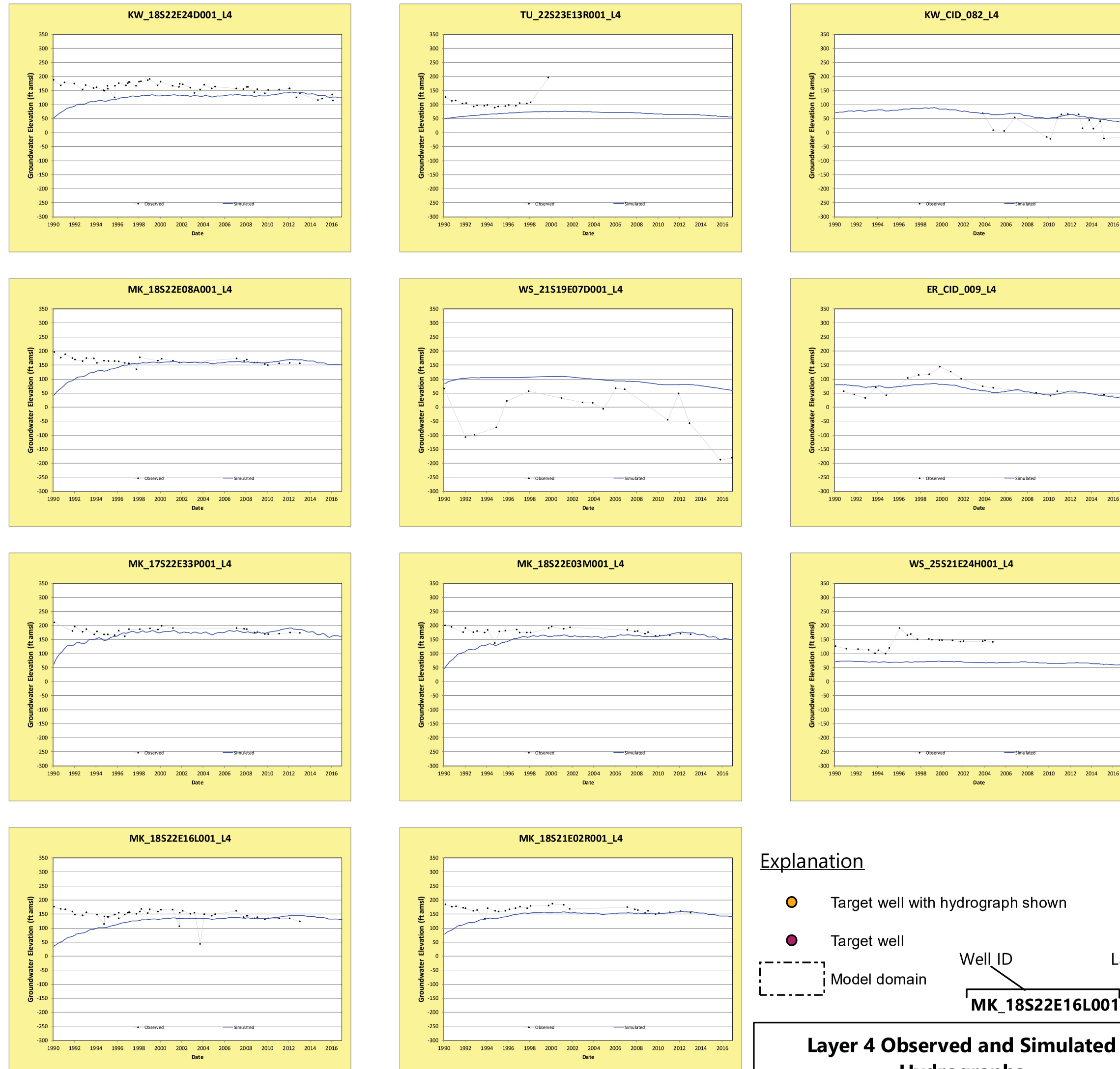

Explanation

- Target well with hydrograph shown
- Target well
- Model domain

Well ID — Layer
MK_18S22E16L001_L4

Layer 4 Observed and Simulated Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2d**

Date: 1/8/2020 Printed by: elizabeth.chapman
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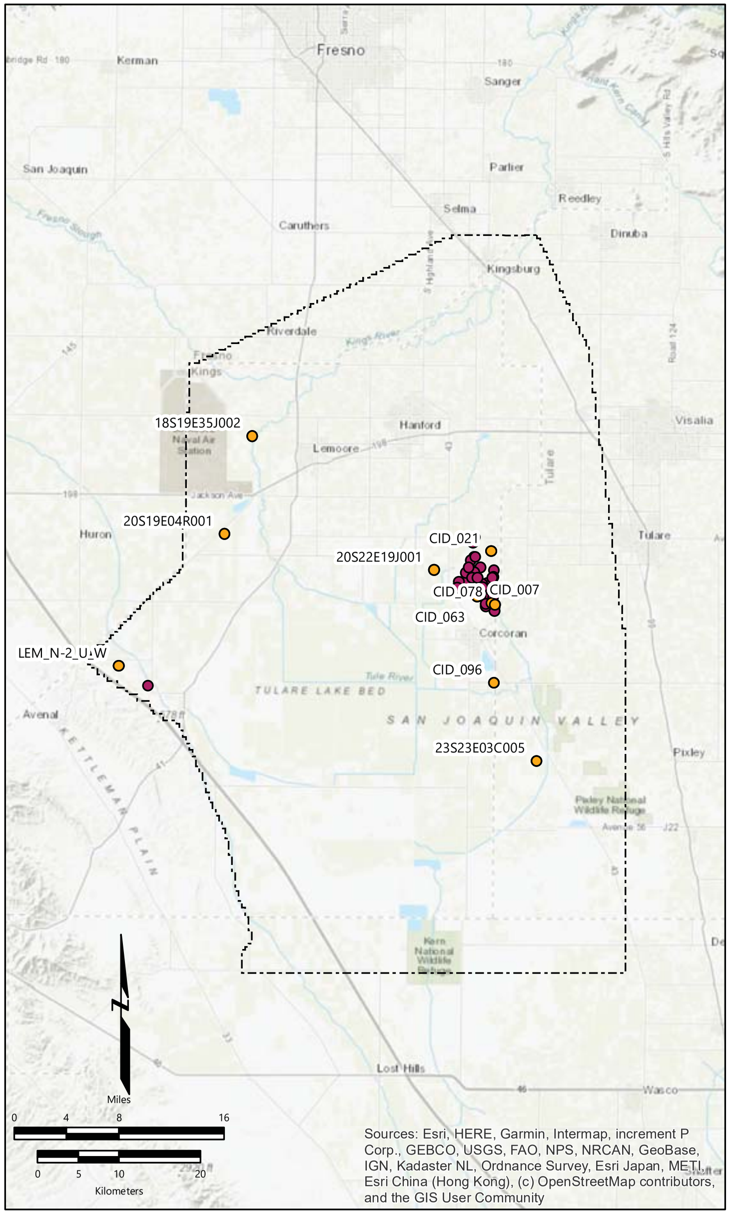

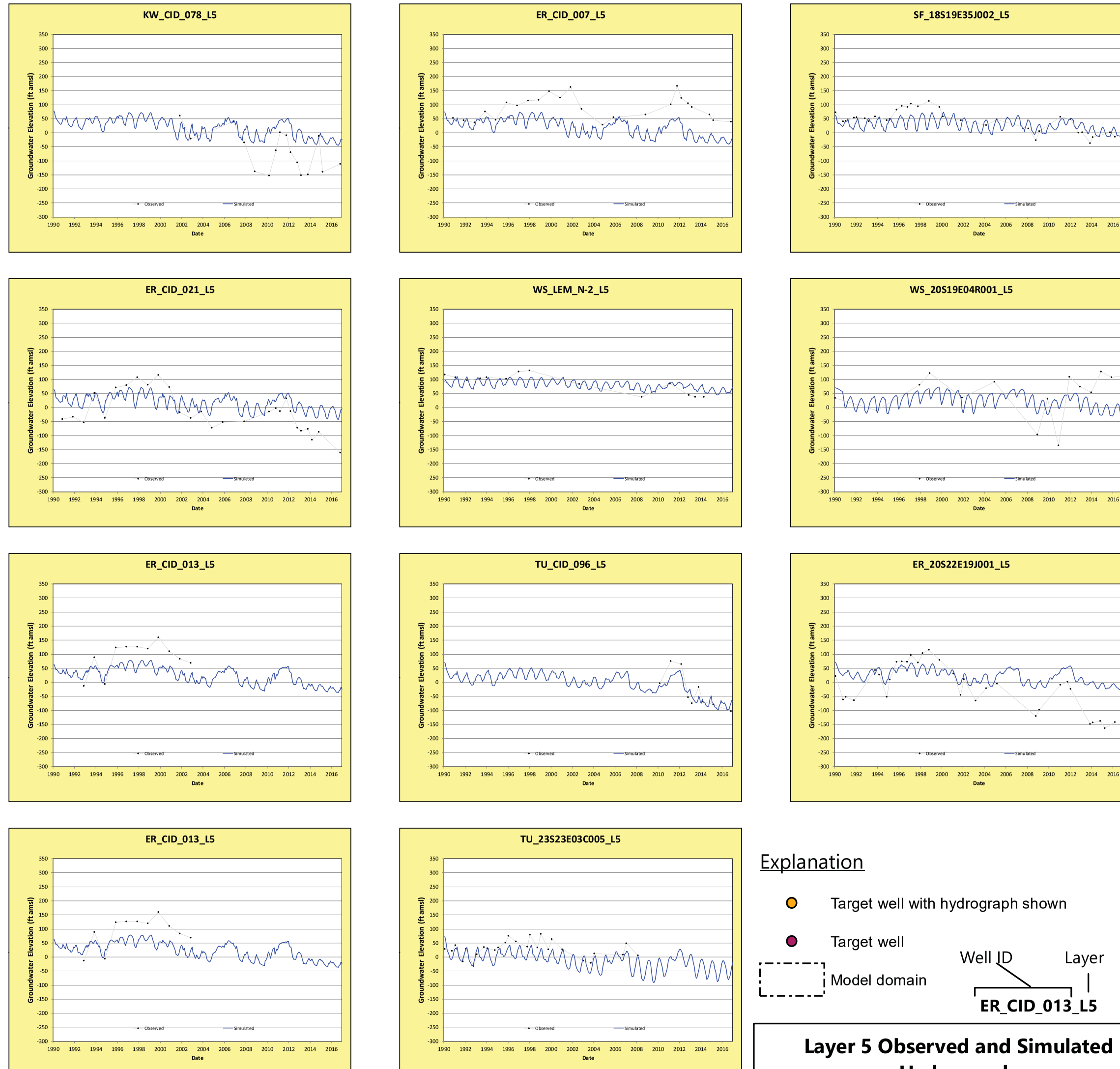

Explanation

- Target well with hydrograph shown
- Target well
- Model domain

Well ID Layer
ER_CID_013_L5

Layer 5 Observed and Simulated Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2e**

Date: 1/8/2020 Printed by: elizabeth.chapman
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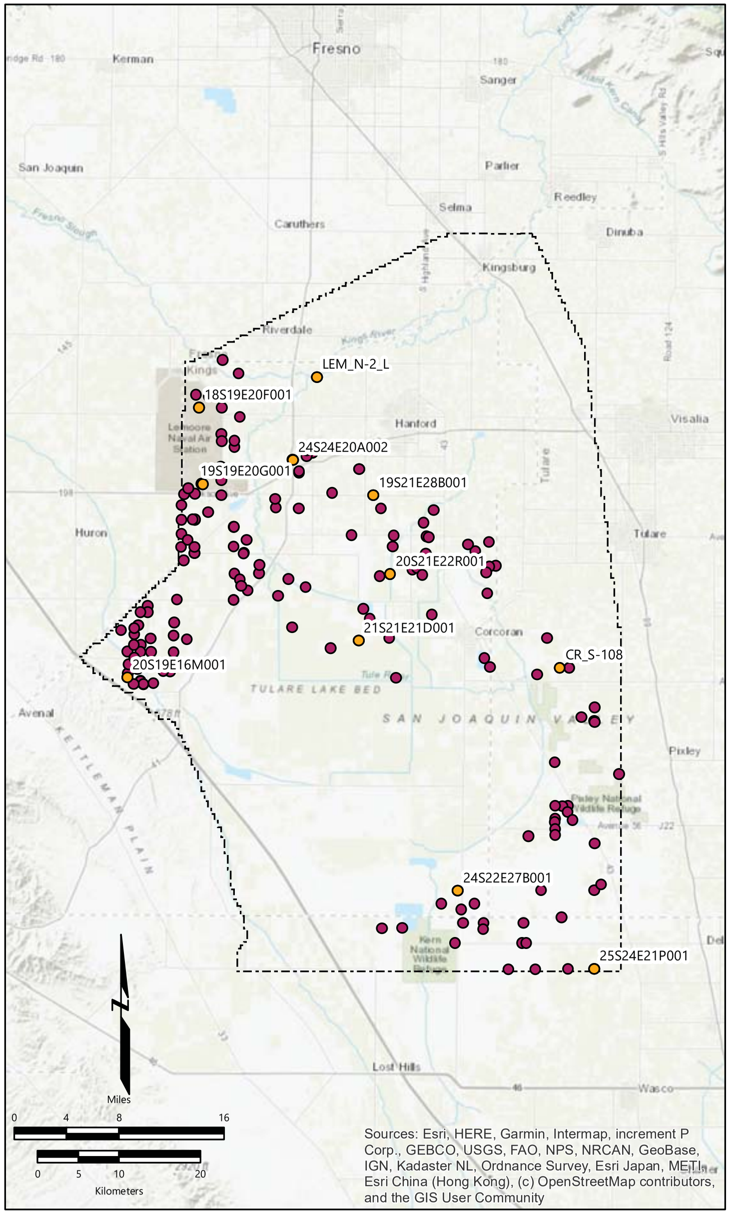
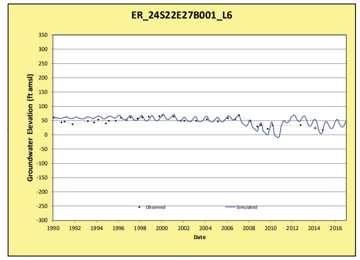
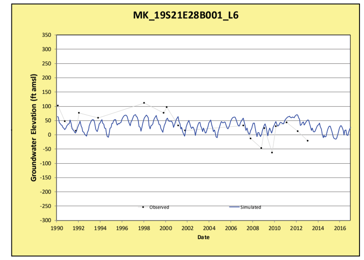
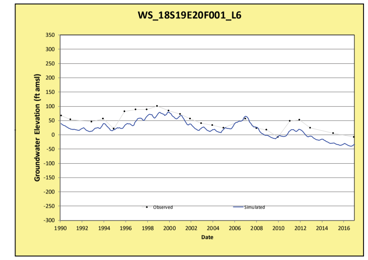
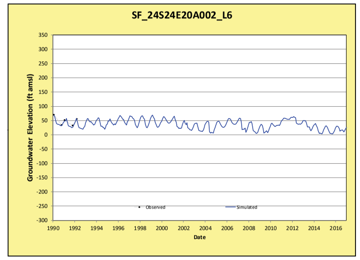
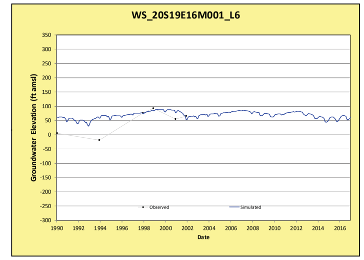


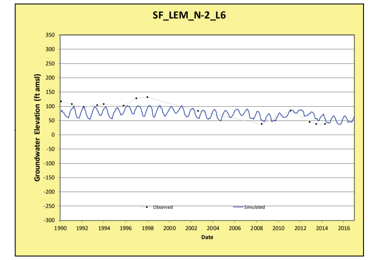


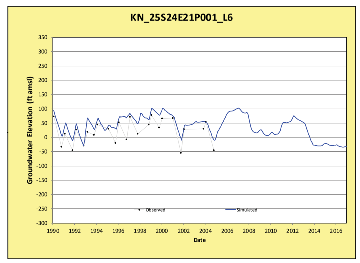


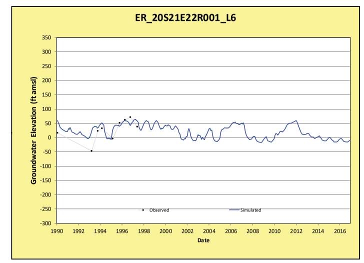


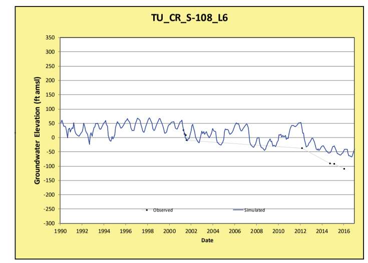


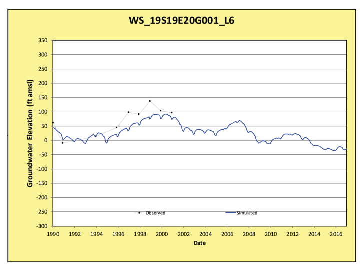


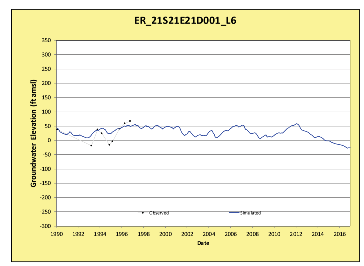












Explanation

- Target wells with hydrograph shown
- Target well
- Model domain

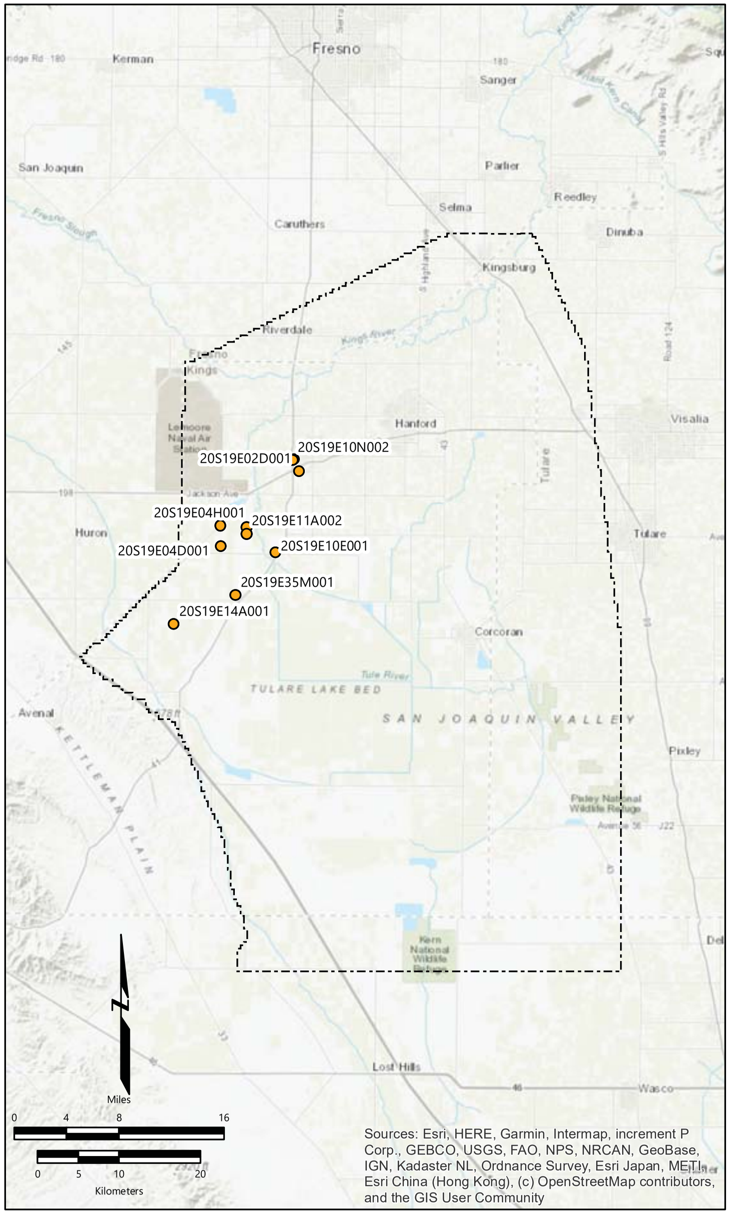
Well ID — Layer
ER_21S21ED001_L6

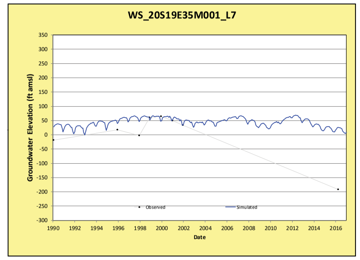
Layer 6 Observed and Simulated Hydrographs

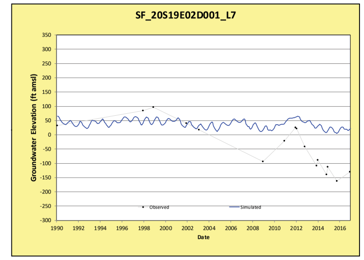
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

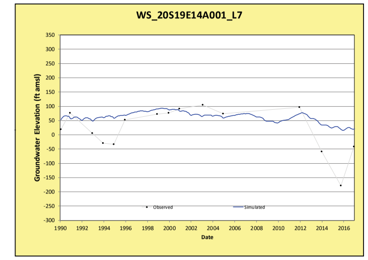
By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2f**

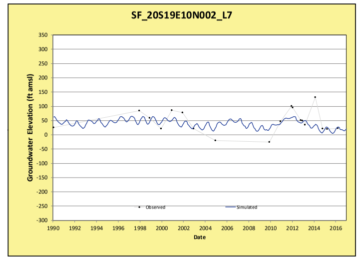
Date: 1/8/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\temp\DBean_Hydro__fig06_layeredHydrographs_20191218.mxd

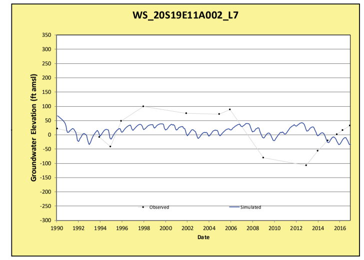


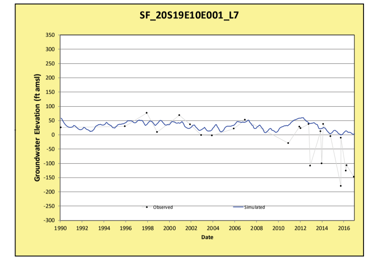


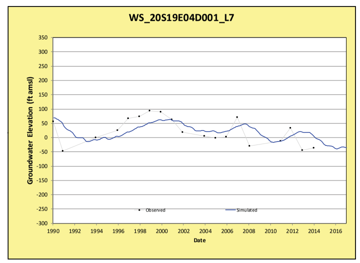


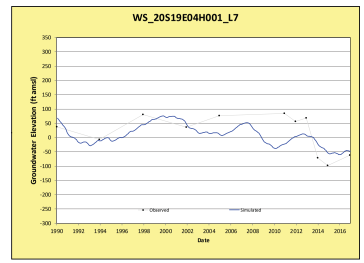


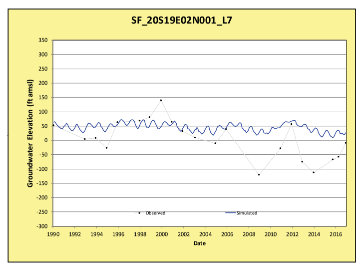


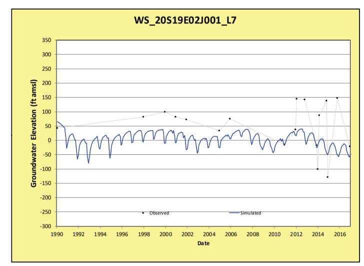












Explanation

Target well with hydrograph shown

Target well

Model domain

Well ID — Layer

WS_20S19E02J001_L7

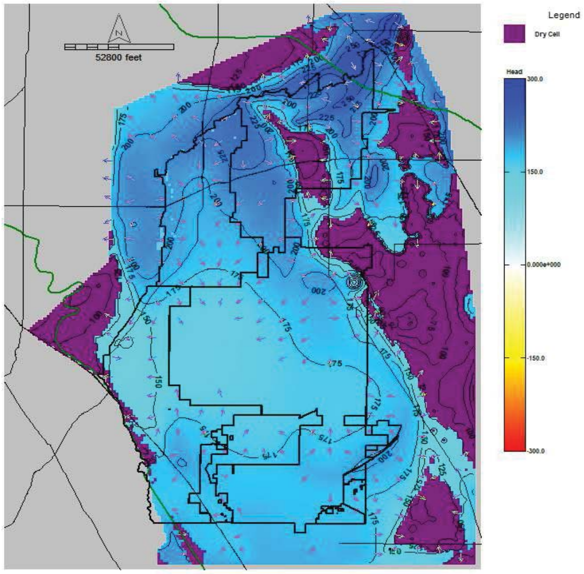
Layer 7 Observed and Simulated Hydrographs

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

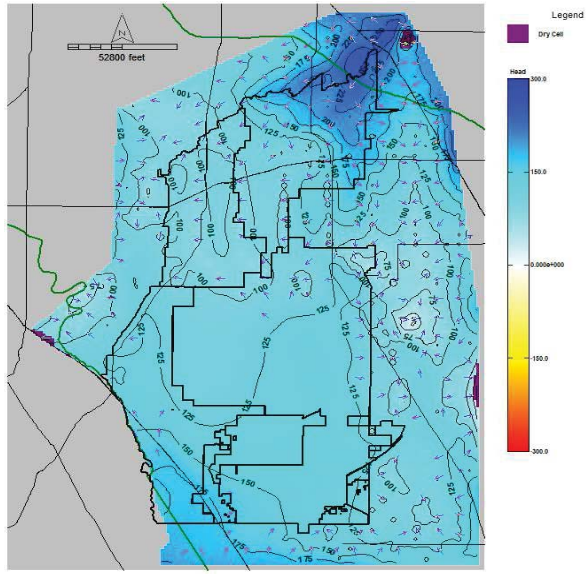
By: EMC	Date: 1/8/2020	Project No.: FR18161220
		Figure **D5-2g**

Date: 1/8/2020 Printed by: elizabeth.chapman
Path: N:_FR_projects\FR18s\FR18161220\temp\DBean_Hydro__fig07_layeredHydrographs_20191218.mxd

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D5-3 Calib Potentiometrics 12/19/2019



Kings SGMA 1990-2016 Layer: 1 SP: 312 Date: 2016.0



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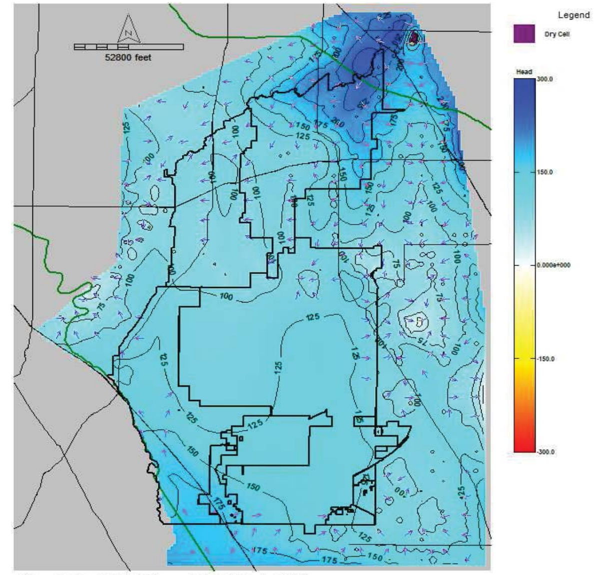

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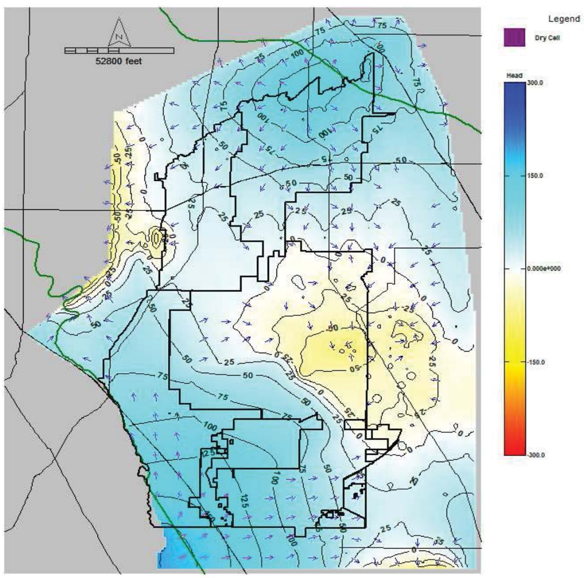

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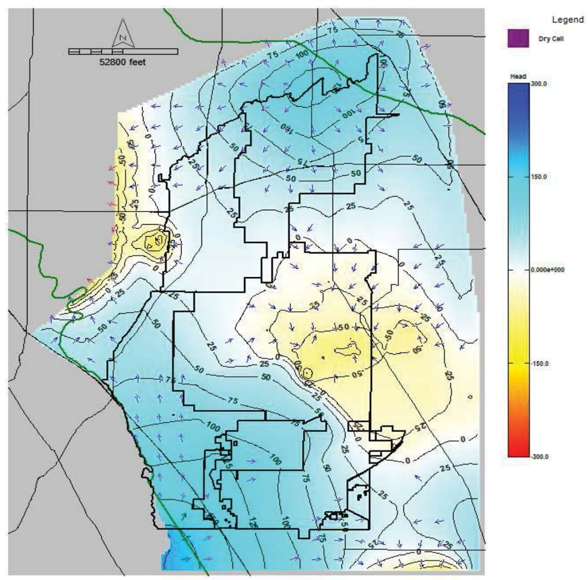


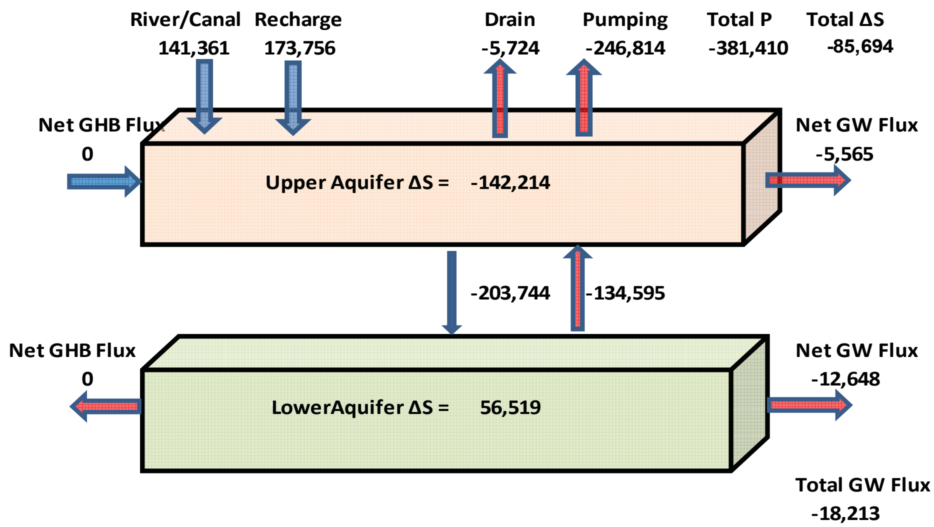
Kings SGMA 1990-2016 Layer: 6 SP: 312 Date: 2016.0

Simulated December 2015 Groundwater Elevations and Groundwater Flow Vectors

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

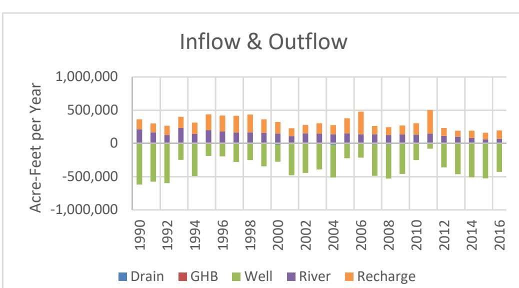
By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D5-3**

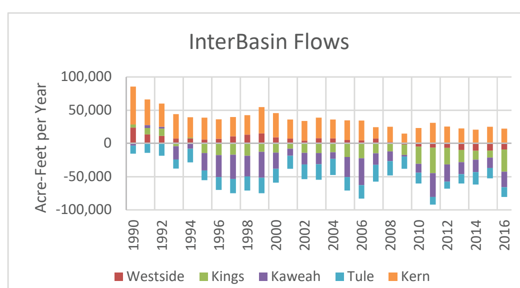
1990-2016
Average Groundwater Balance
Tulare Lake SB

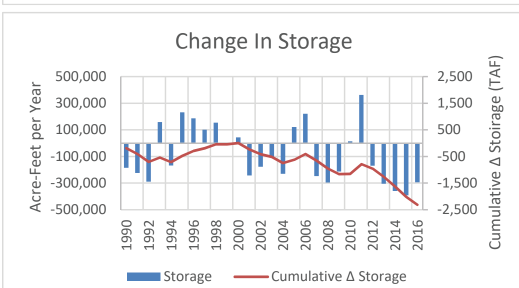


1990 - 2016
Tulare Lake Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	TulareLake Interbasin	Westside Interbasin	Kings Interbasin	Kaweah Interbasin	Tule Interbasin	Kern Interbasin
1990	0	0	-618,843	212,023	150,920	-185,926	69,929	23,632	4,815	-3,467	-12,024	56,971
1991	0	0	-577,240	164,892	135,941	-224,464	51,899	13,271	9,747	4,376	-14,187	38,693
1992	0	0	-596,994	125,681	139,491	-290,389	41,344	11,225	10,812	2,987	-18,583	34,904
1993	0	0	-248,824	231,839	167,981	157,279	6,232	7,344	-4,219	-20,133	-13,496	36,736
1994	-26	0	-491,956	139,080	173,457	-168,707	10,497	7,647	1,210	-8,114	-20,670	30,426
1995	-82	0	-188,622	200,925	235,917	231,421	-16,719	5,564	-14,724	-26,071	-14,705	33,217
1996	-251	0	-195,586	177,508	238,753	186,481	-33,990	6,788	-17,826	-32,867	-19,334	29,250
1997	-1,392	0	-278,726	162,833	252,651	100,786	-35,395	10,524	-17,146	-36,466	-21,396	29,090
1998	-1,870	0	-249,086	165,955	266,380	153,536	-28,386	13,146	-18,649	-31,067	-21,177	29,362
1999	-7,376	0	-338,241	159,660	201,878	522	-20,428	15,099	-12,823	-38,853	-23,234	39,384
2000	-17,343	0	-260,727	147,624	172,534	43,638	-13,661	9,202	-14,008	-24,256	-20,878	36,279
2001	-13,351	0	-467,326	108,934	119,202	-243,059	-2,375	7,046	-8,208	-10,602	-19,402	28,791
2002	-10,253	0	-435,270	150,502	128,082	-178,393	-20,389	4,116	-14,310	-17,484	-22,160	29,448
2003	-8,170	0	-385,602	145,737	157,010	-101,083	-16,217	7,968	-14,505	-16,849	-23,580	30,749
2004	-20,849	0	-494,263	137,236	138,732	-231,122	-11,678	7,475	-13,320	-9,952	-24,296	28,416
2005	-5,413	0	-217,488	150,074	227,638	121,017	-36,335	4,993	-20,418	-30,344	-20,294	29,728
2006	-9,651	0	-205,429	138,230	339,860	220,649	-48,705	4,446	-22,451	-40,403	-20,192	29,895
2007	-14,999	0	-474,153	137,542	123,827	-248,490	-33,353	7,330	-14,948	-17,451	-25,274	16,990
2008	-13,795	0	-515,546	126,421	117,419	-296,277	-23,147	1,856	-12,181	-14,428	-21,584	23,191
2009	-4,295	0	-456,641	133,032	135,636	-213,010	-23,837	-1,793	-15,575	-2,407	-18,590	14,527
2010	-2,440	0	-249,776	129,805	171,969	13,129	-37,307	-5,091	-25,818	-13,379	-16,097	23,078
2011	-4,486	0	-77,680	147,432	355,590	361,228	-61,401	-6,641	-38,331	-35,573	-11,696	30,840
2012	-3,226	0	-357,301	111,314	120,601	-169,947	-42,994	-6,733	-25,065	-25,720	-10,775	25,299
2013	-8,381	0	-455,726	99,564	90,038	-305,607	-38,136	-9,909	-18,283	-18,315	-13,933	22,304
2014	-3,579	0	-508,253	82,742	107,427	-360,352	-41,461	-11,151	-13,313	-18,684	-18,842	20,529
2015	-829	0	-524,338	60,439	99,444	-392,279	-27,490	-10,951	-10,641	-15,502	-15,383	24,986
2016	-2,497	0	-428,423	69,718	123,037	-294,325	-58,248	-9,455	-33,115	-23,497	-14,438	22,257
1990-2016 Average	**-5,724**	**0**	**-381,410**	**141,361**	**173,756**	**-85,694**	**-18,213**	**3,961**	**-13,826**	**-19,427**	**-18,379**	**29,457**
1998-2010 Average	**-9,985**	**0**	**-365,350**	**140,827**	**176,936**	**-73,765**	**-24,294**	**5,830**	**-15,939**	**-20,575**	**-21,289**	**27,680**



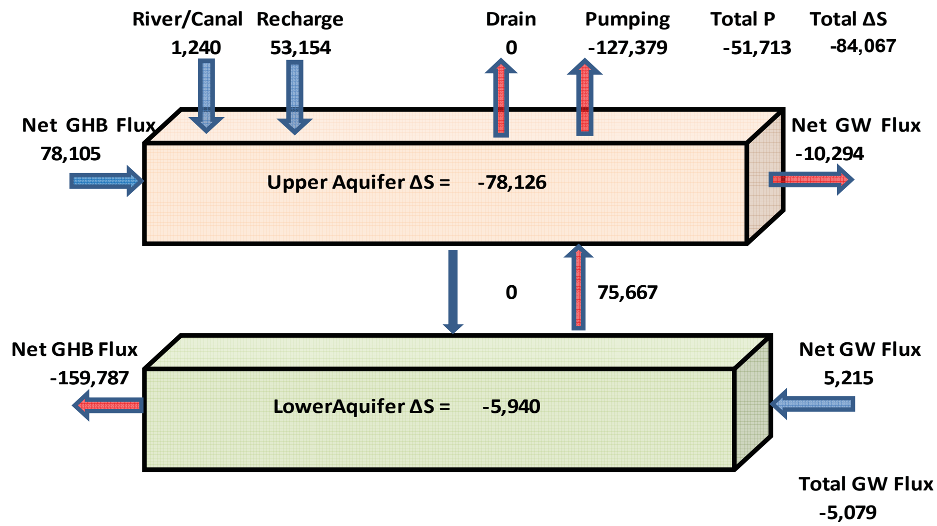




Groundwater Mass Balance
Tulare Lake Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

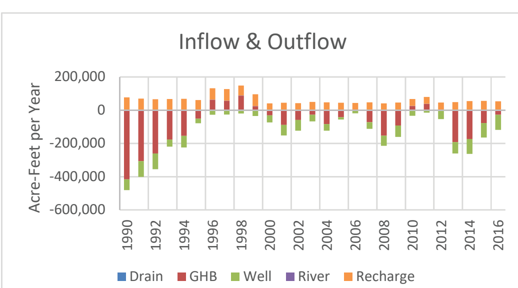
By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D5-4**

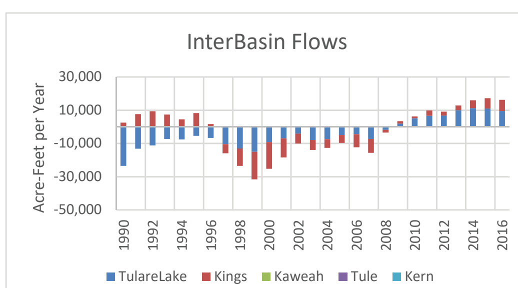
1990-2016
Average Groundwater Balance
Westside SB

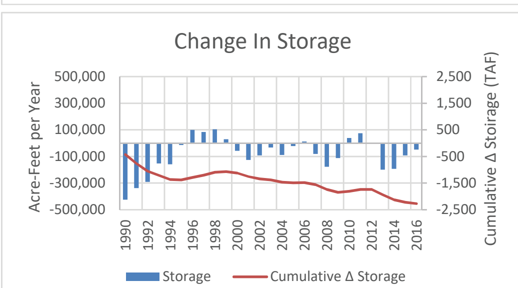


1990 - 2016
Westside Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
1990	0	-416,613	-64,299	1,305	75,411	-425,294	-23,632	0	2,518	0	0	0
1991	0	-306,833	-94,899	1,315	67,929	-338,123	-13,271	0	7,580	0	0	0
1992	0	-260,820	-94,233	1,297	64,558	-291,005	-11,225	0	9,334	0	0	0
1993	0	-177,022	-42,742	1,275	65,909	-152,615	-7,344	0	7,293	0	0	0
1994	0	-154,444	-69,800	1,262	67,284	-158,845	-7,647	0	4,416	0	0	0
1995	0	-51,451	-26,944	1,258	59,364	-15,122	-5,564	0	8,215	0	0	0
1996	0	61,385	-27,841	1,253	69,011	98,671	-6,788	0	1,651	0	0	0
1997	0	55,068	-26,074	1,249	69,862	84,080	-10,524	0	-5,501	0	0	0
1998	0	86,377	-20,708	1,252	60,275	103,573	-13,146	0	-10,476	0	0	0
1999	0	22,760	-35,621	1,250	71,595	28,355	-15,099	0	-16,531	0	0	0
2000	0	-31,098	-42,612	1,262	38,891	-58,827	-9,202	0	-16,069	0	0	0
2001	0	-88,368	-64,117	1,269	42,859	-126,795	-7,046	0	-11,392	0	0	0
2002	0	-59,530	-64,657	1,278	40,823	-92,170	-4,116	0	-5,977	0	0	0
2003	0	-28,132	-39,554	1,283	47,458	-32,937	-7,968	0	-6,025	0	0	0
2004	0	-83,841	-40,547	1,290	46,023	-89,837	-7,475	0	-5,288	0	0	0
2005	0	-42,330	-14,695	1,291	43,362	-22,114	-4,993	0	-4,750	0	0	0
2006	0	-2,135	-16,480	1,294	41,476	11,768	-4,446	0	-7,942	0	0	0
2007	0	-73,077	-39,686	1,296	45,543	-81,676	-7,330	0	-8,423	0	0	0
2008	0	-153,303	-61,382	1,307	39,326	-177,598	-1,856	0	-1,697	0	0	0
2009	0	-92,631	-68,431	1,308	44,595	-111,863	1,793	0	1,497	0	0	0
2010	0	24,802	-34,671	1,310	40,459	38,085	5,091	0	1,094	0	0	0
2011	0	37,267	-15,329	1,312	40,675	73,785	6,641	0	3,219	0	0	0
2012	0	-449	-54,215	1,318	44,354	99	6,733	0	2,358	0	0	0
2013	0	-191,800	-68,720	1,316	47,308	-199,093	9,909	0	2,894	0	0	0
2014	0	-173,365	-90,404	1,313	52,774	-193,733	11,151	0	4,762	0	0	0
2015	0	-77,549	-87,385	1,313	54,676	-91,693	10,951	0	6,279	0	0	0
2016	0	-28,273	-90,193	0	53,365	-48,877	9,455	0	6,768	0	0	0
1990-2016 Average	**0**	**-81,682**	**-51,713**	**1,240**	**53,154**	**-84,067**	**-3,961**	**0**	**-1,118**	**0**	**0**	**0**
1998-2010 Average	**0**	**-40,039**	**-41,782**	**1,284**	**46,360**	**-47,080**	**-5,830**	**0**	**-7,075**	**0**	**0**	**0**

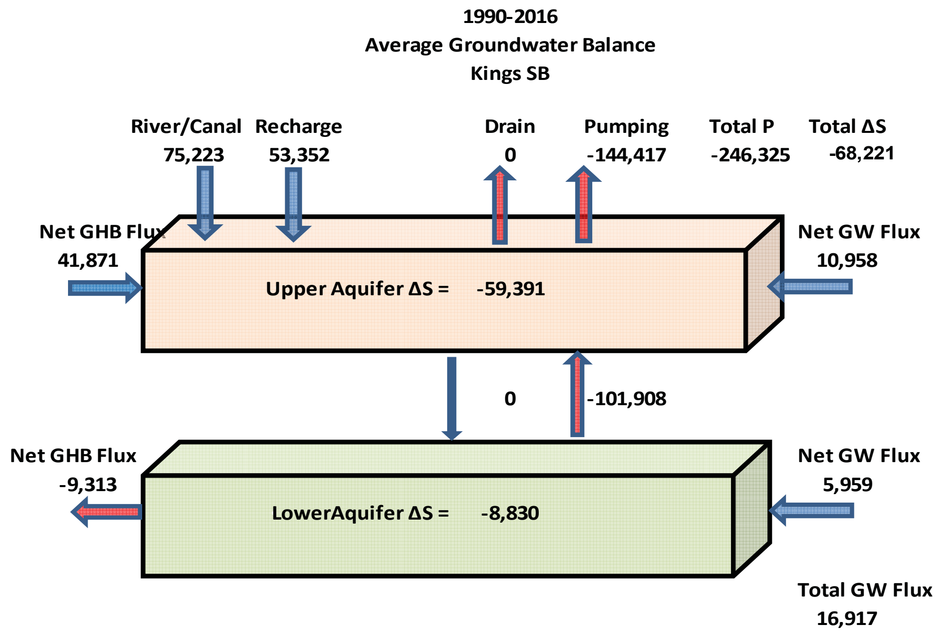






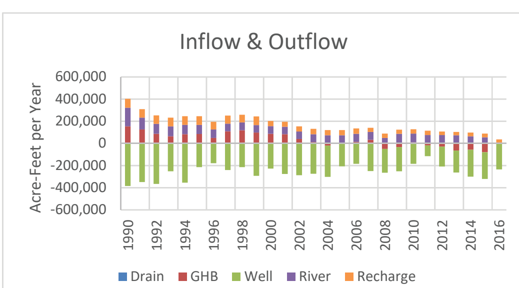
Groundwater Mass Balance
Westside Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

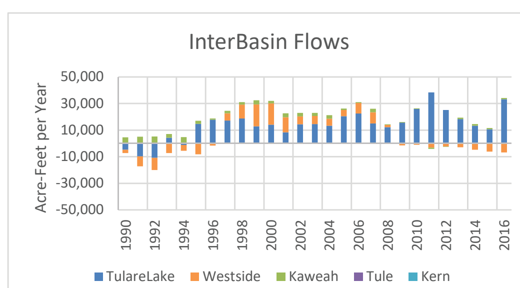
By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D5-5**

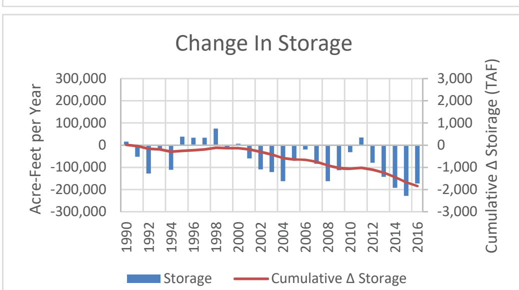


1990 - 2016
Kings Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
1990	0	153,507	-384,337	169,046	79,741	15,208	-4,815	-2,518	0	4,504	0	0
1991	0	124,539	-348,796	107,577	75,776	-53,100	-9,747	-7,580	0	5,048	0	0
1992	0	85,636	-366,658	91,057	76,643	-128,172	-10,812	-9,334	0	5,220	0	0
1993	0	63,444	-251,847	90,672	77,740	-20,149	4,219	-7,293	0	2,874	0	0
1994	0	82,944	-355,512	83,133	78,922	-111,410	-1,210	-4,416	0	4,642	0	0
1995	0	84,637	-215,315	82,151	77,734	38,072	14,724	-8,215	0	2,339	0	0
1996	0	48,223	-178,362	77,072	68,853	32,844	17,826	-1,651	0	873	0	0
1997	0	107,723	-241,638	70,229	72,279	33,073	17,146	5,501	0	1,803	0	0
1998	0	118,175	-214,567	69,924	69,494	74,029	18,649	10,476	0	1,860	0	0
1999	0	96,736	-292,444	67,565	78,859	-16,762	12,823	16,531	0	3,100	0	0
2000	0	85,919	-227,760	68,455	47,204	5,842	14,008	16,069	0	1,936	0	0
2001	0	82,301	-277,276	67,448	45,197	-59,687	8,208	11,392	0	2,987	0	0
2002	0	38,507	-286,933	68,043	47,651	-109,739	14,310	5,977	0	2,634	0	0
2003	0	10,551	-275,240	72,558	47,606	-121,577	14,505	6,025	0	2,345	0	0
2004	0	-19,464	-283,587	72,500	46,386	-162,951	13,320	5,288	0	2,545	0	0
2005	0	-4,898	-203,108	72,979	47,504	-61,361	20,418	4,750	0	976	0	0
2006	0	13,674	-184,500	72,546	47,592	-19,644	22,451	7,942	0	614	0	0
2007	0	32,310	-250,493	70,241	37,723	-84,139	14,948	8,423	0	2,632	0	0
2008	0	-50,566	-214,765	49,586	38,416	-162,941	12,181	1,697	0	463	0	0
2009	0	-33,972	-217,422	85,755	37,471	-113,549	15,575	-1,497	0	479	0	0
2010	0	9,787	-185,133	78,260	39,636	-32,243	25,818	-1,094	0	459	0	0
2011	0	-17,920	-97,073	75,380	39,597	34,158	38,331	-3,219	0	-966	0	0
2012	0	-29,573	-179,351	74,885	31,796	-79,785	25,065	-2,358	0	-281	0	0
2013	0	-64,621	-198,165	72,788	30,437	-143,078	18,283	-2,894	0	1,051	0	0
2014	0	-57,537	-243,399	63,777	34,247	-193,050	13,313	-4,762	0	1,243	0	0
2015	0	-79,762	-242,398	55,138	32,307	-229,309	10,641	-6,279	0	958	0	0
2016	0	-1,216	-234,685	2,254	33,689	-172,561	33,115	-6,768	0	944	0	0
1990-2016 Average	**0**	**32,559**	**-246,325**	**75,223**	**53,352**	**-68,221**	**13,826**	**1,118**	**0**	**1,973**	**0**	**0**
1998-2010 Average	**0**	**29,159**	**-239,479**	**70,451**	**48,518**	**-66,517**	**15,939**	**7,075**	**0**	**1,771**	**0**	**0**







Groundwater Mass Balance
Kings Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D5-6**

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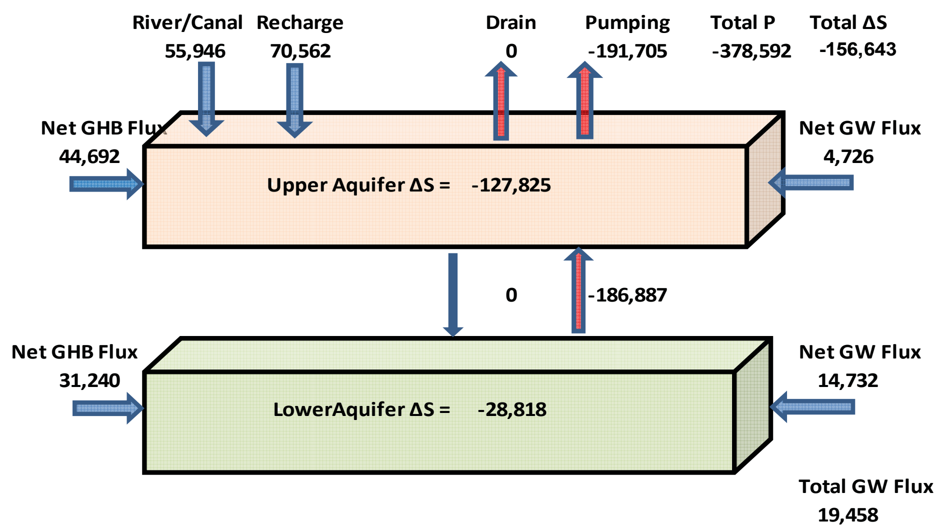
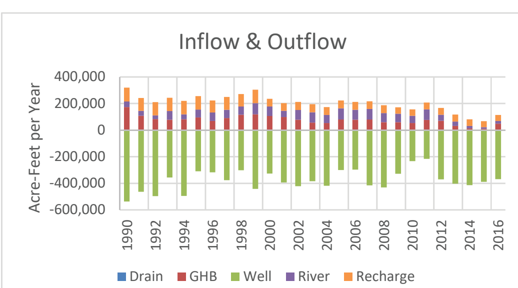
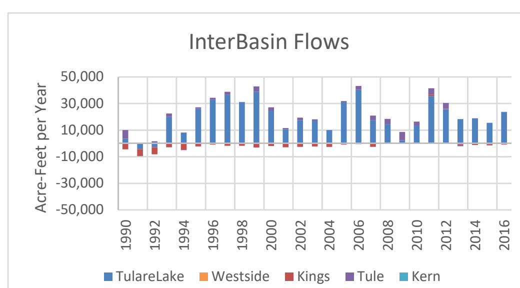
1990-2016
Average Groundwater Balance
Kaweah SB

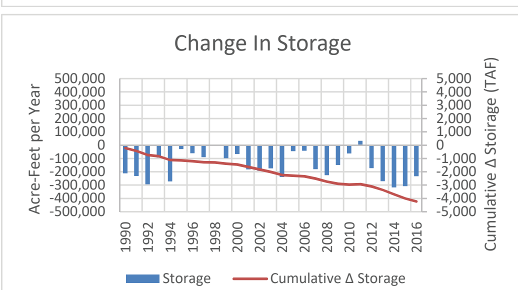


1990 - 2016
Kaweah Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
1990	0	172,831	-537,159	42,496	103,609	-212,649	3,467	0	-4,504	0	6,568	0
1991	0	107,583	-463,728	36,764	96,709	-232,084	-4,376	0	-5,048	0	-11	0
1992	0	81,651	-497,528	29,290	99,060	-294,105	-2,987	0	-5,220	0	1,542	0
1993	0	77,286	-356,606	66,092	99,049	-94,514	20,133	0	-2,874	0	2,383	0
1994	0	80,902	-495,185	37,053	102,172	-272,016	8,114	0	-4,642	0	-549	0
1995	0	94,932	-309,662	59,838	100,083	-30,023	26,071	0	-2,339	0	1,054	0
1996	0	68,503	-317,375	63,686	91,031	-60,703	32,867	0	-873	0	1,443	0
1997	0	89,438	-377,453	63,327	96,295	-91,317	36,466	0	-1,803	0	2,354	0
1998	0	114,652	-301,969	63,291	92,691	-2,106	31,067	0	-1,860	0	22	0
1999	0	118,216	-442,308	84,491	100,527	-99,162	38,853	0	-3,100	0	4,070	0
2000	0	106,502	-327,865	70,296	58,536	-67,290	24,256	0	-1,936	0	2,897	0
2001	0	97,263	-394,189	48,197	57,101	-182,971	10,602	0	-2,987	0	972	0
2002	0	78,197	-422,360	72,804	61,265	-193,353	17,484	0	-2,634	0	1,815	0
2003	0	56,243	-384,827	77,120	60,606	-175,029	16,849	0	-2,345	0	1,236	0
2004	0	53,353	-419,713	60,149	59,185	-239,862	9,952	0	-2,545	0	-308	0
2005	0	78,649	-300,204	85,039	59,441	-46,176	30,344	0	-976	0	1,502	0
2006	0	77,866	-298,321	74,806	59,613	-43,395	40,403	0	-614	0	2,795	0
2007	0	79,789	-415,842	79,484	57,284	-180,937	17,451	0	-2,632	0	3,492	0
2008	0	58,458	-431,763	68,344	60,460	-226,521	14,428	0	-463	0	4,003	0
2009	0	58,932	-329,201	63,510	48,642	-150,022	2,407	0	-479	0	6,147	0
2010	0	52,112	-234,294	55,673	48,421	-62,200	13,379	0	-459	0	2,962	0
2011	0	76,346	-216,915	79,408	50,989	31,298	35,573	0	966	0	4,929	0
2012	0	70,075	-370,148	45,029	50,752	-173,616	25,720	0	281	0	4,380	0
2013	0	31,050	-403,265	33,241	51,860	-270,970	18,315	0	-1,051	0	-1,157	0
2014	0	12,193	-415,074	18,863	49,171	-317,311	18,684	0	-1,243	0	26	0
2015	0	9,525	-390,330	11,544	46,175	-309,136	15,502	0	-958	0	-619	0
2016	0	47,596	-368,704	20,716	44,451	-233,187	23,497	0	-944	0	174	0
1990-2016 Average	**0**	**75,931**	**-378,592**	**55,946**	**70,562**	**-156,643**	**19,427**	**0**	**-1,973**	**0**	**2,005**	**0**
1998-2010 Average	**0**	**79,249**	**-361,758**	**69,477**	**63,367**	**-128,386**	**20,575**	**0**	**-1,771**	**0**	**2,431**	**0**



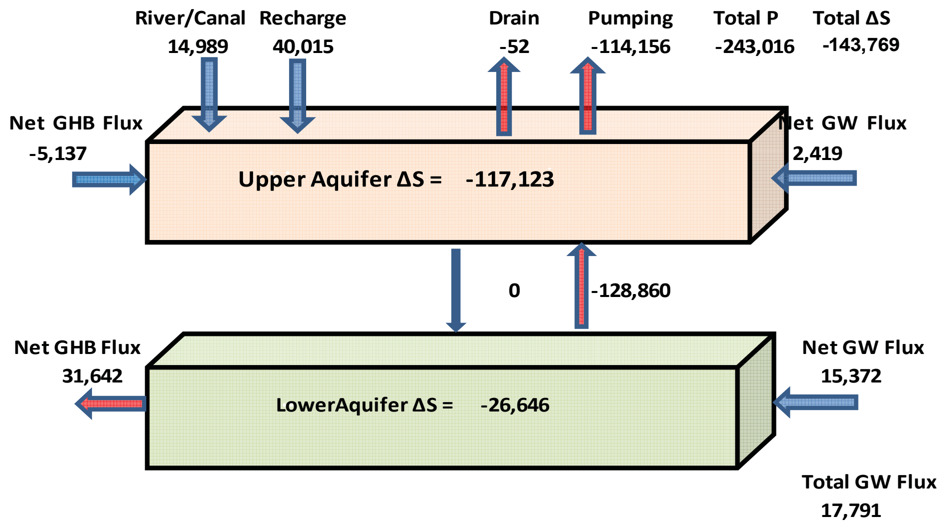




Groundwater Mass Balance
Kaweah Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

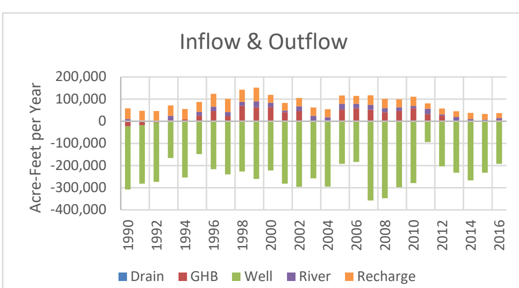
By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D5-7**

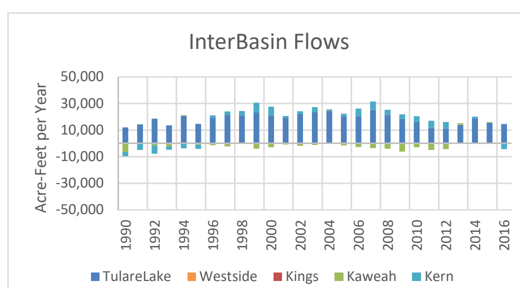
1990-2016
Average Groundwater Balance
Tule SB

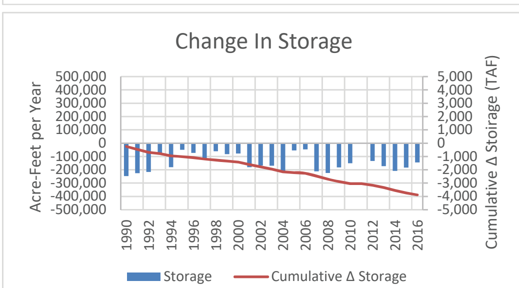


1990 - 2016
Tule Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
1990	0	-23,566	-284,555	9,618	48,228	-247,845	12,024	0	0	-6,568	0	-3,025
1991	0	-18,667	-263,398	3,449	43,409	-225,953	14,187	0	0	11	0	-4,946
1992	0	-5,300	-268,690	684	45,275	-217,174	18,583	0	0	-1,542	0	-6,183
1993	0	4,326	-165,862	20,019	46,394	-86,494	13,496	0	0	-2,383	0	-2,484
1994	0	7,958	-253,837	0	46,982	-181,434	20,670	0	0	549	0	-3,757
1995	0	25,307	-148,402	16,882	44,943	-50,717	14,705	0	0	-1,054	0	-3,098
1996	0	45,820	-216,603	19,552	57,888	-73,711	19,334	0	0	-1,443	0	1,739
1997	0	23,106	-239,747	18,382	59,597	-116,961	21,396	0	0	-2,354	0	2,659
1998	0	68,956	-227,472	17,741	54,979	-61,553	21,177	0	0	-22	0	3,087
1999	-94	62,510	-260,854	27,404	61,127	-83,406	23,234	0	0	-4,070	0	7,338
2000	-82	63,667	-221,821	19,580	35,921	-78,068	20,878	0	0	-2,897	0	6,685
2001	-43	40,136	-282,286	7,462	34,734	-180,420	19,402	0	0	-972	0	1,148
2002	-77	45,471	-295,718	21,943	36,975	-169,024	22,160	0	0	-1,815	0	2,037
2003	-143	785	-257,704	23,994	36,852	-170,227	23,580	0	0	-1,236	0	3,644
2004	-88	3,599	-294,831	14,519	35,955	-215,230	24,296	0	0	308	0	1,012
2005	-174	52,654	-191,897	26,378	36,973	-55,320	20,294	0	0	-1,502	0	1,954
2006	-151	57,771	-184,092	20,669	35,792	-46,574	20,192	0	0	-2,795	0	6,040
2007	-209	51,182	-357,542	22,998	43,001	-212,594	25,274	0	0	-3,492	0	6,196
2008	-143	40,599	-347,405	18,133	42,686	-224,920	21,584	0	0	-4,003	0	3,628
2009	-103	46,193	-297,514	16,553	36,625	-182,508	18,590	0	0	-6,147	0	3,296
2010	-36	58,280	-279,500	10,122	41,904	-151,840	16,097	0	0	-2,962	0	4,255
2011	-58	32,131	-94,078	23,936	24,249	-1,823	11,696	0	0	-4,929	0	5,231
2012	-13	25,701	-203,630	4,825	26,348	-135,064	10,775	0	0	-4,380	0	5,310
2013	0	3,110	-232,680	16,090	25,641	-173,089	13,933	0	0	1,157	0	-340
2014	0	505	-266,921	8,515	28,447	-209,336	18,842	0	0	-26	0	1,301
2015	0	-1,136	-231,535	6,160	26,210	-184,562	15,383	0	0	619	0	-262
2016	0	4,541	-192,869	9,100	23,267	-145,904	14,438	0	0	-174	0	-4,209
1990-2016 Average	**-52**	**26,505**	**-243,016**	**14,989**	**40,015**	**-143,769**	**18,379**	**0**	**0**	**-2,005**	**0**	**1,417**
1998-2010 Average	**-103**	**45,523**	**-269,126**	**19,038**	**41,040**	**-140,899**	**21,289**	**0**	**0**	**-2,431**	**0**	**3,871**

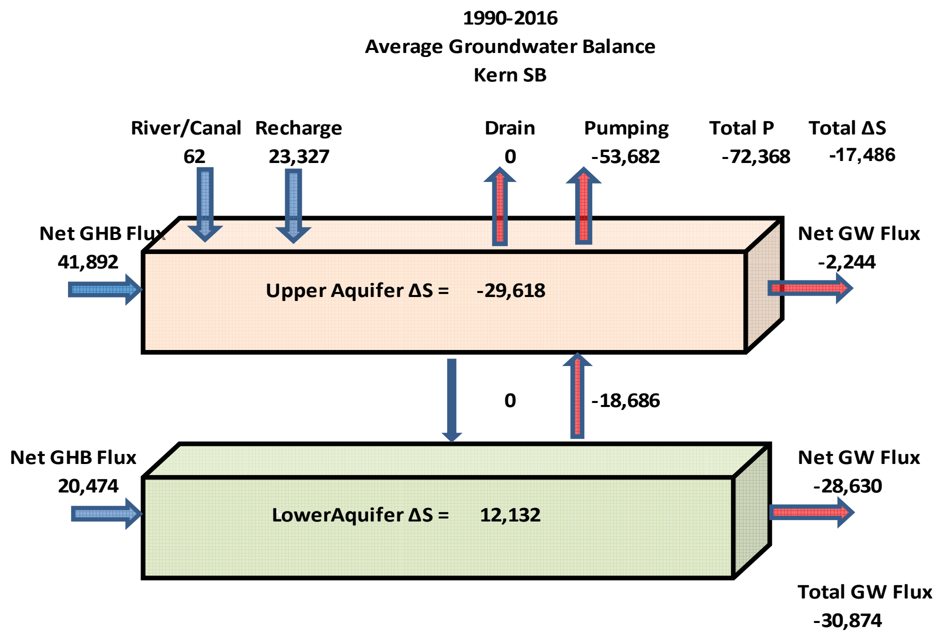






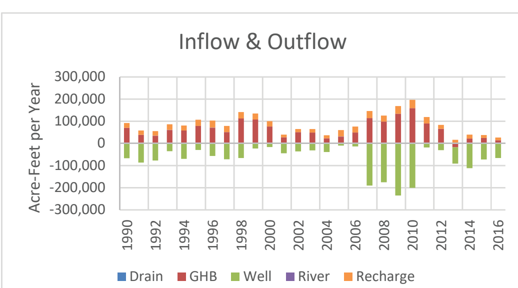
Groundwater Mass Balance
Tule Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

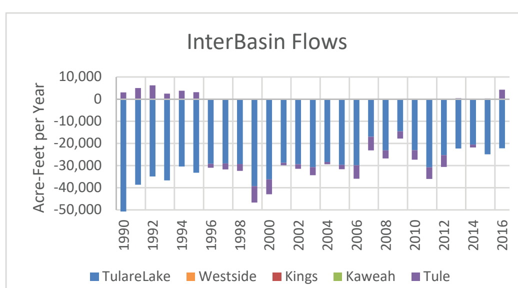
By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D5-8**

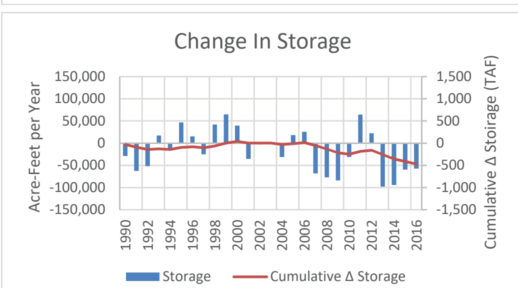


1990 - 2016
Kern Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
1990	0	69,796	-67,231	0	22,116	-29,265	-56,971	0	0	0	3,025	0
1991	0	38,262	-87,211	0	20,006	-62,690	-38,693	0	0	0	4,946	0
1992	0	34,064	-77,917	187	20,626	-51,761	-34,904	0	0	0	6,183	0
1993	0	60,245	-35,270	185	26,026	16,935	-36,736	0	0	0	2,484	0
1994	0	57,842	-69,714	0	22,828	-15,712	-30,426	0	0	0	3,757	0
1995	0	78,149	-30,062	185	28,292	46,446	-33,217	0	0	0	3,098	0
1996	0	70,592	-56,706	187	31,895	14,979	-29,250	0	0	0	-1,739	0
1997	0	50,141	-72,084	185	28,287	-25,219	-29,090	0	0	0	-2,659	0
1998	0	111,858	-66,609	185	28,908	41,894	-29,362	0	0	0	-3,087	0
1999	0	107,107	-23,290	0	27,767	64,863	-39,384	0	0	0	-7,338	0
2000	0	75,337	-17,088	187	24,123	39,596	-36,279	0	0	0	-6,685	0
2001	0	27,538	-44,901	0	11,757	-35,545	-28,791	0	0	0	-1,148	0
2002	0	50,642	-36,158	0	13,888	-3,114	-29,448	0	0	0	-2,037	0
2003	0	48,468	-31,250	0	16,522	-652	-30,749	0	0	0	-3,644	0
2004	0	22,793	-39,107	0	14,192	-31,550	-28,416	0	0	0	-1,012	0
2005	0	30,314	-10,054	185	29,176	17,940	-29,728	0	0	0	-1,954	0
2006	0	48,548	-13,906	185	26,744	25,637	-29,895	0	0	0	-6,040	0
2007	0	114,520	-190,698	0	31,175	-68,188	-16,990	0	0	0	-6,196	0
2008	0	97,862	-175,605	0	27,362	-77,200	-23,191	0	0	0	-3,628	0
2009	0	133,803	-235,193	0	34,866	-84,347	-14,527	0	0	0	-3,296	0
2010	0	159,358	-200,492	0	36,801	-31,667	-23,078	0	0	0	-4,255	0
2011	0	89,684	-18,947	0	29,513	64,180	-30,840	0	0	0	-5,231	0
2012	0	65,311	-30,394	0	17,679	21,988	-25,299	0	0	0	-5,310	0
2013	0	-18,128	-73,820	0	15,969	-97,943	-22,304	0	0	0	340	0
2014	0	21,647	-111,701	0	17,652	-94,232	-20,529	0	0	0	-1,301	0
2015	0	24,001	-72,531	0	13,114	-60,141	-24,986	0	0	0	262	0
2016	0	14,125	-65,994	0	12,550	-57,368	-22,257	0	0	0	4,209	0
1990-2016 Average	**0**	**62,366**	**-72,368**	**62**	**23,327**	**-17,486**	**-29,457**	**0**	**0**	**0**	**-1,417**	**0**
1998-2010 Average	**0**	**79,088**	**-83,412**	**57**	**24,868**	**-10,949**	**-27,680**	**0**	**0**	**0**	**-3,871**	**0**

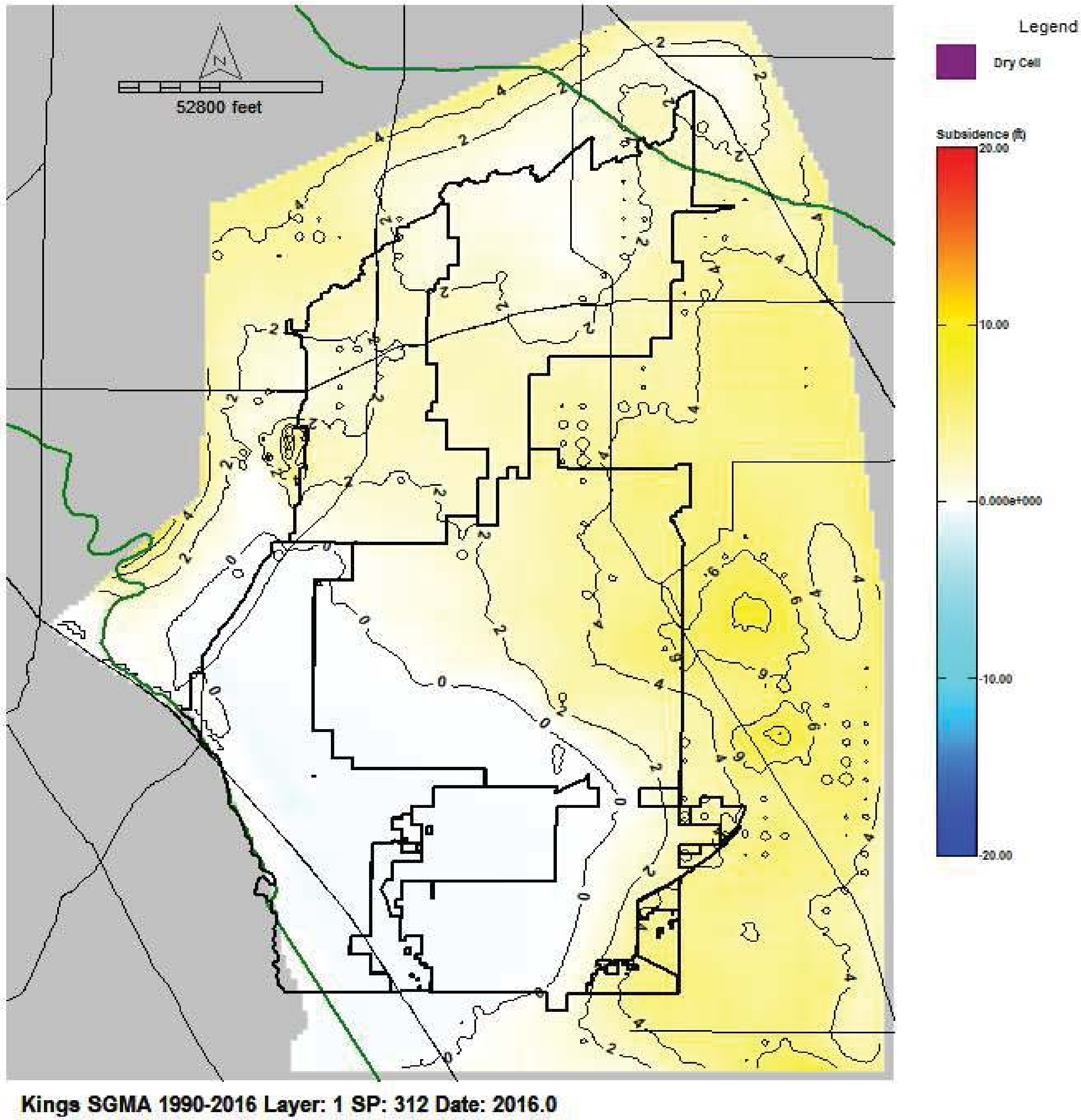






Groundwater Mass Balance
Kern Subbasin
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

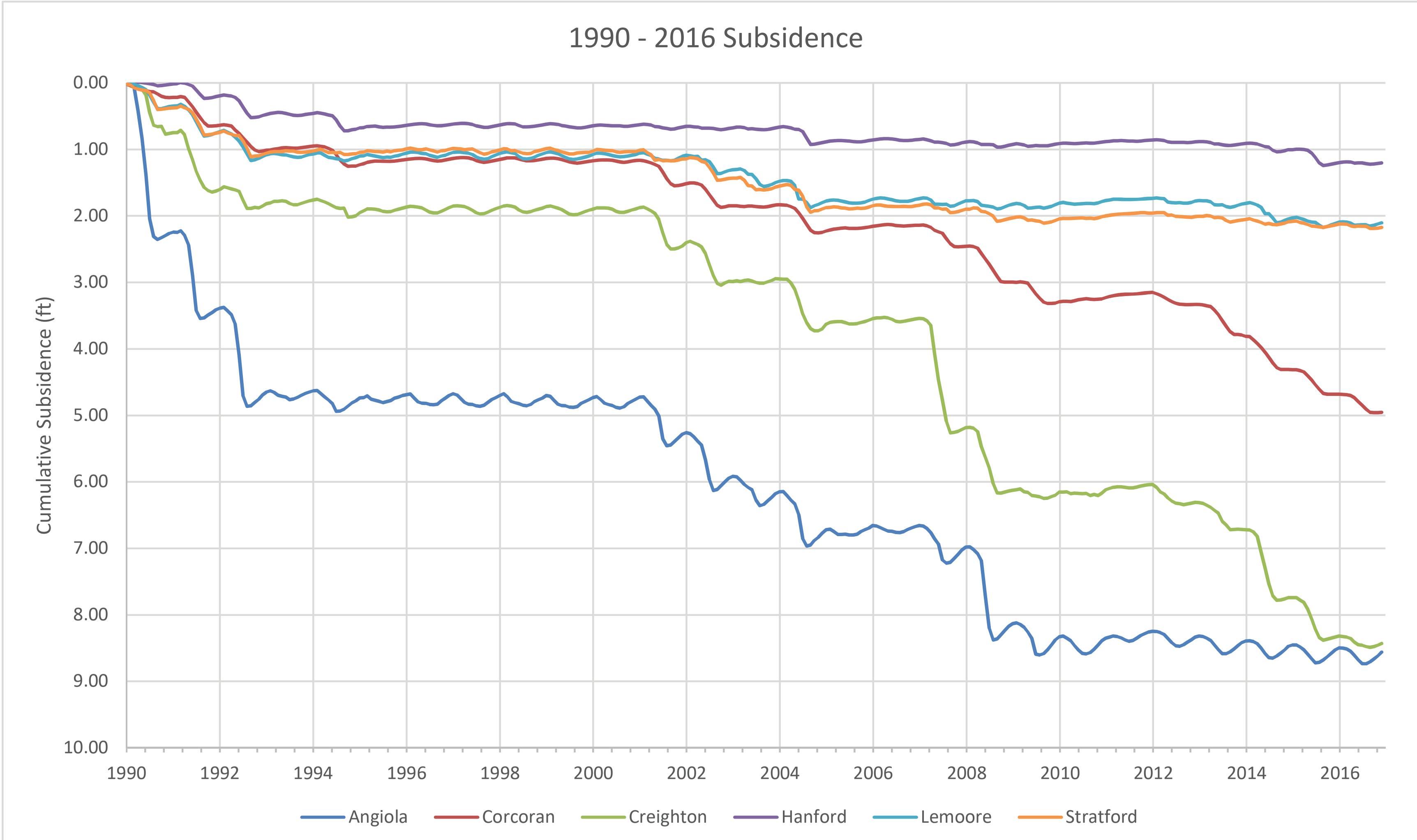
By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D5-9**



Simulated Subsidence 1990-2015
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/19	Project No.: FR18161220
		Figure **D5-10**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D5-11 Sub Hydrographs



Simulated Cumulative Subsidence
Municipal and Agricultural Well Field
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/19	Project No.: FR18161220
		Figure **D5-11**

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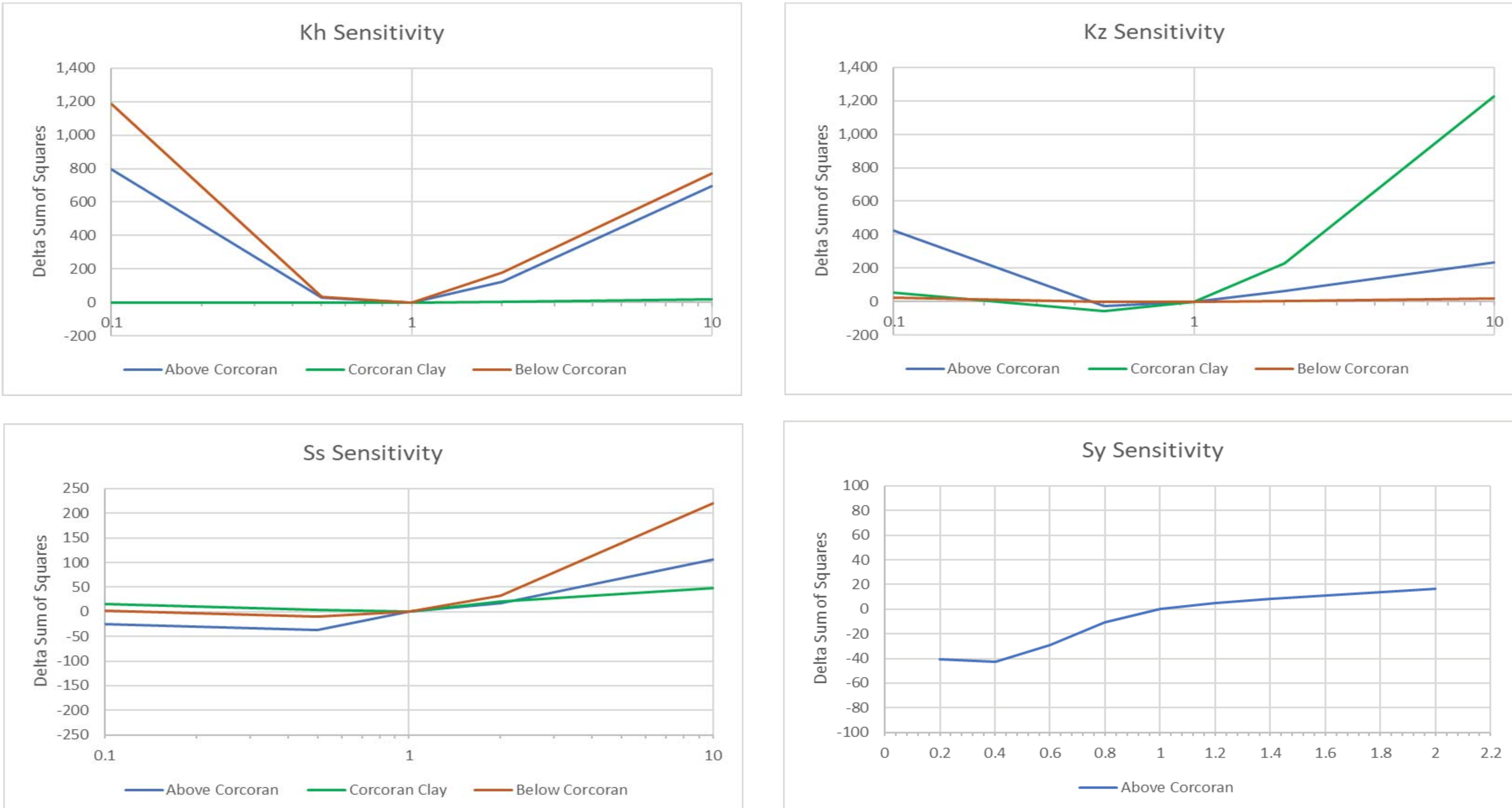
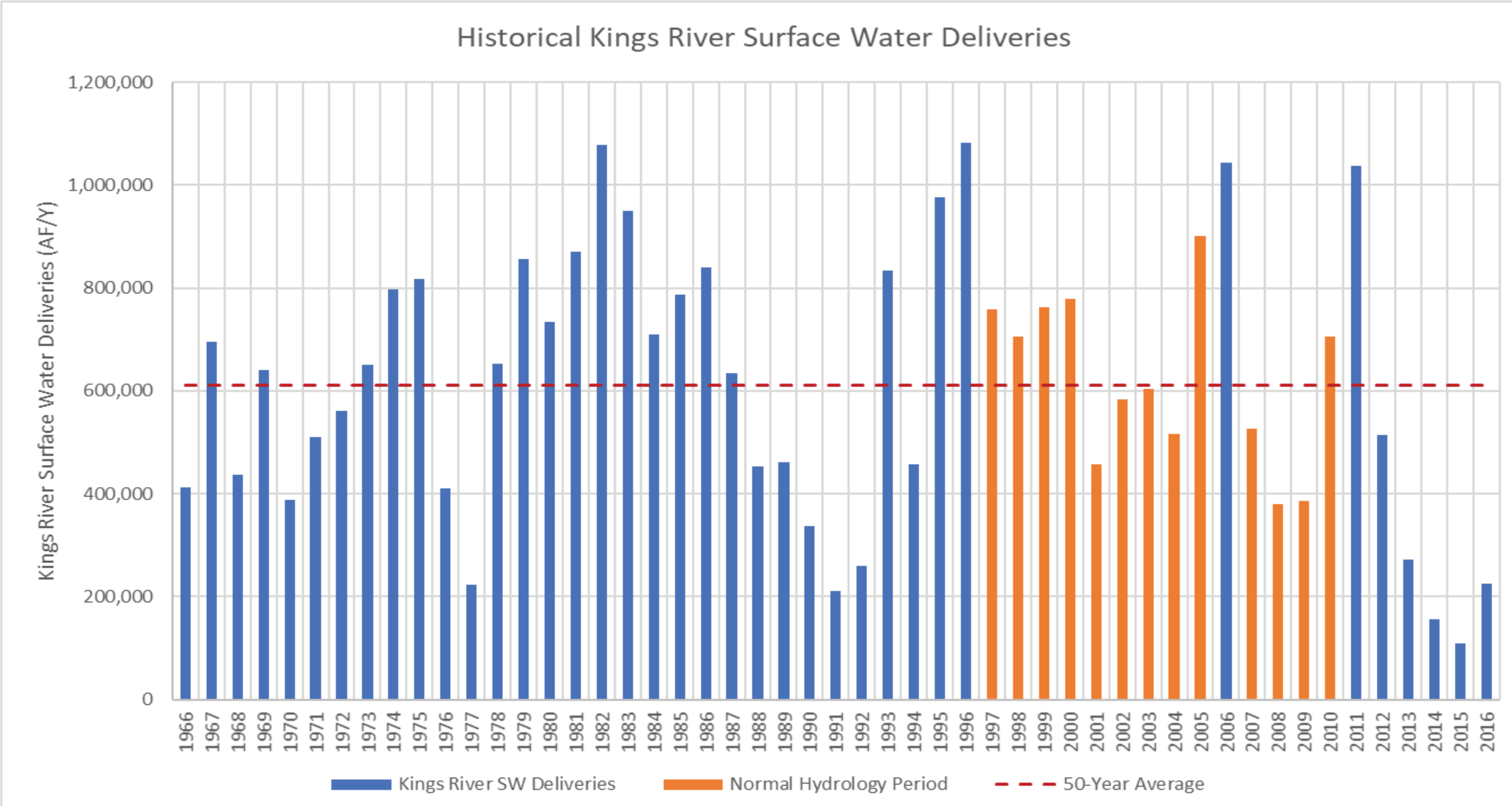


Model Hydraulic Parameter Sensitivity Anlysis
Tulare Lake Subbasin SGMA Model
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D6-1**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D7-1 Normal Kings Hydrology



Note: Normal Hydrology cycle included 199[illegible] instead of 2006 to match the [illegible]0-Year average

Historical Kings River Surface Water Deliveries with Normal Hydrology

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure D[illegible]

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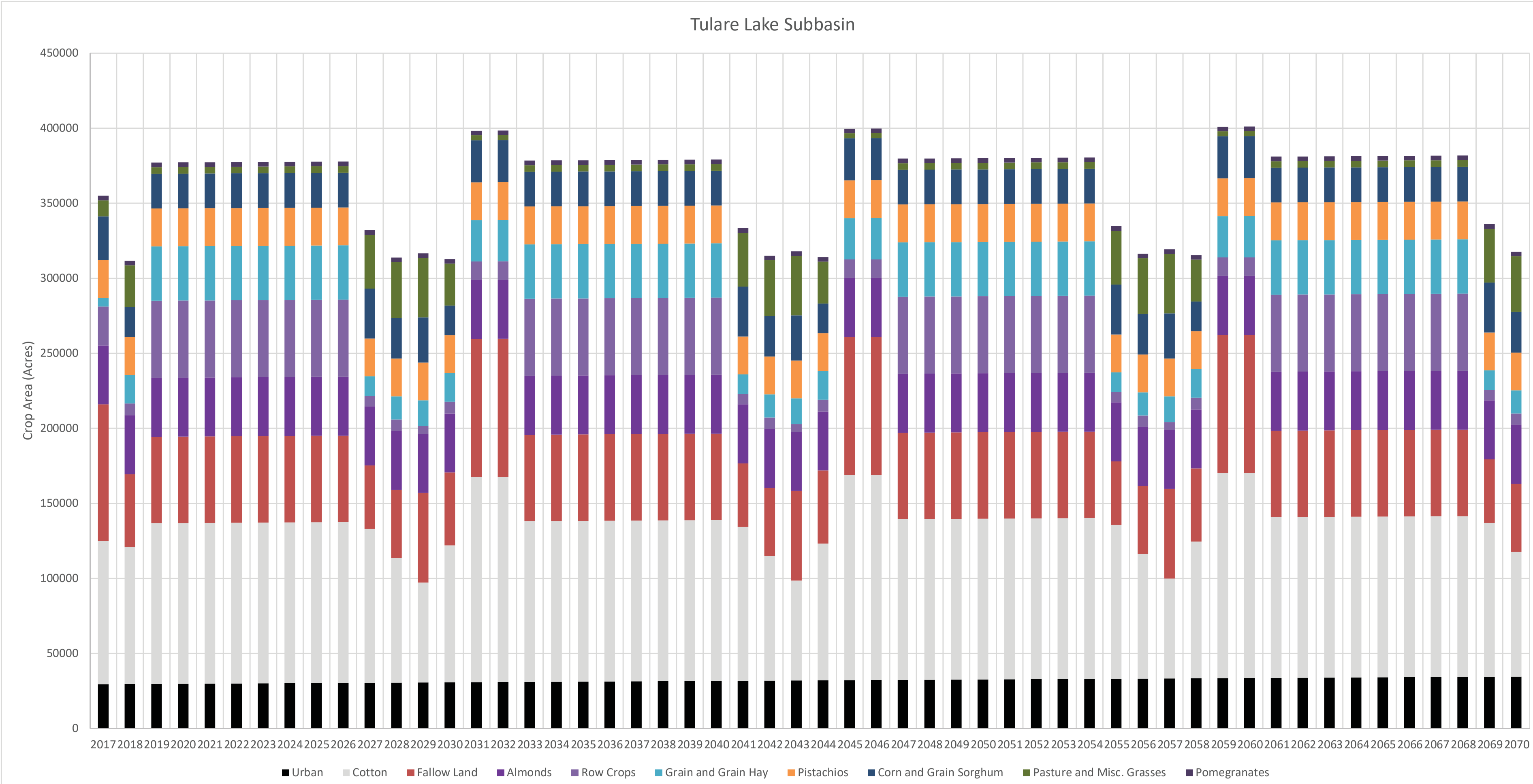
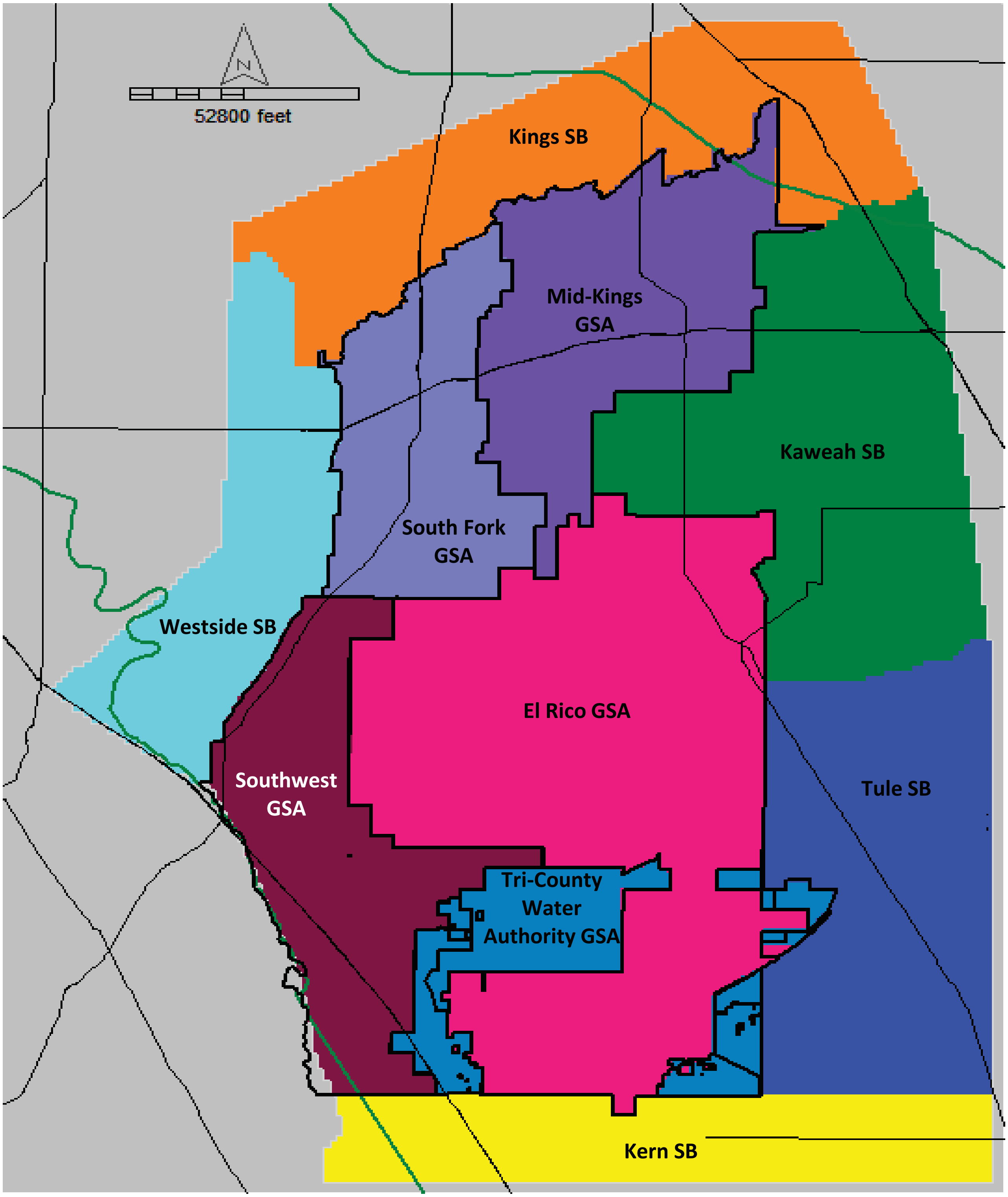


2017-2070 Baseline Forecast
Crop Acerage
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-2**

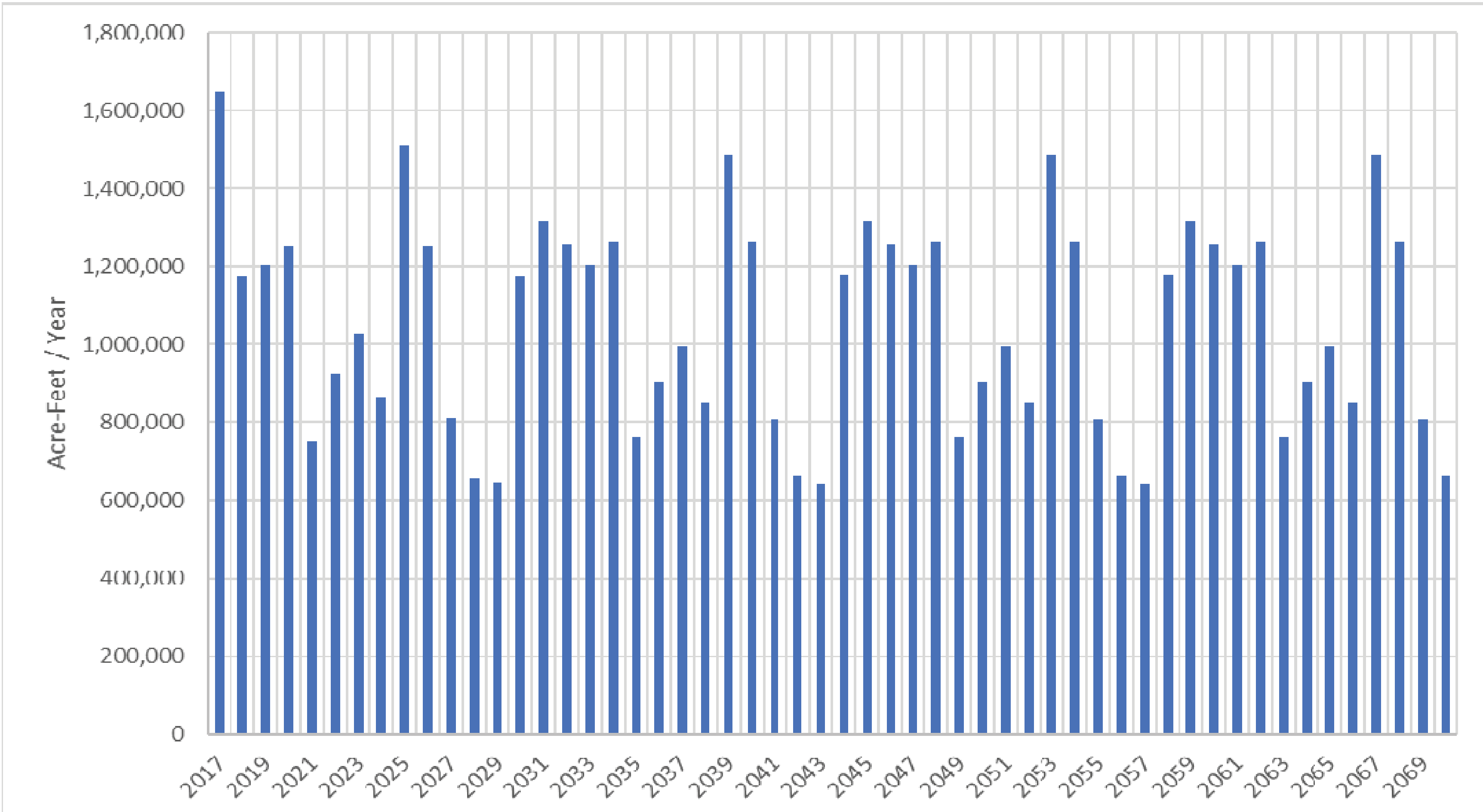


Forecast Model Service Areas

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 12/12/19	Project No.: FR18161220
		Figure **D7-3**

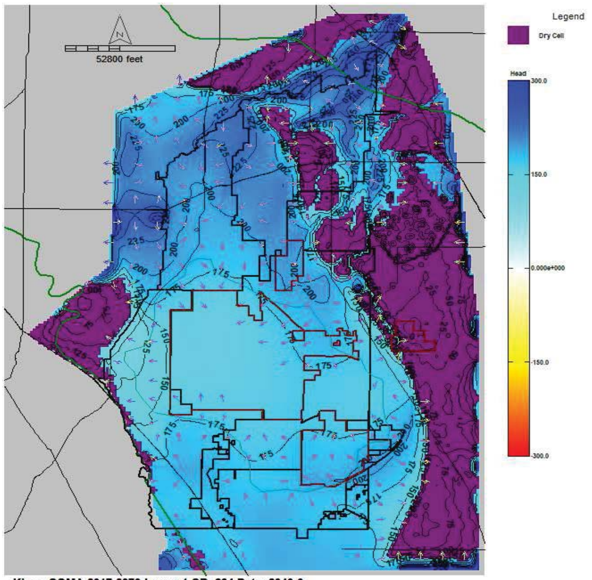


2017-2070 Baseline Forecast of Surface Water Deliveries with CNRA

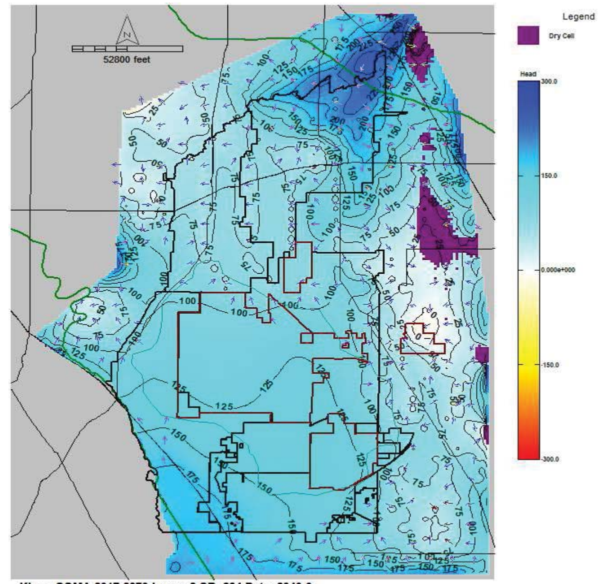
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-4**

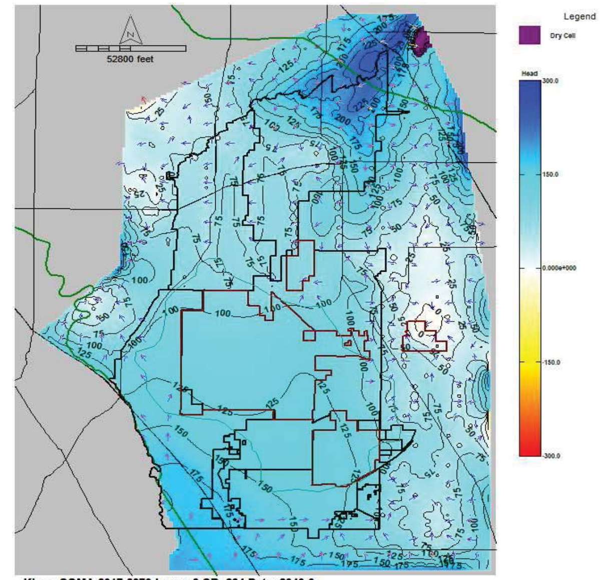
I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D7-5 2040 Baseline Potentio 12/19/2019



Kings SGMA 2017-2070 Layer: 1 SP: 284 Date: 2040.6



Kings SGMA 2017-2070 Layer: 2 SP: 284 Date: 2040.6



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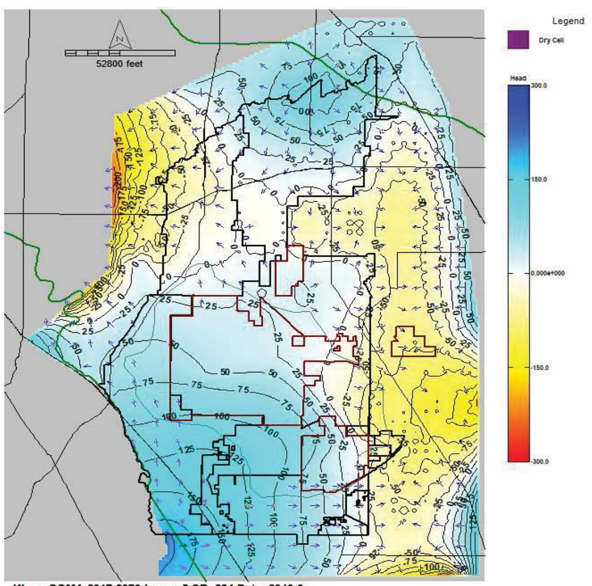
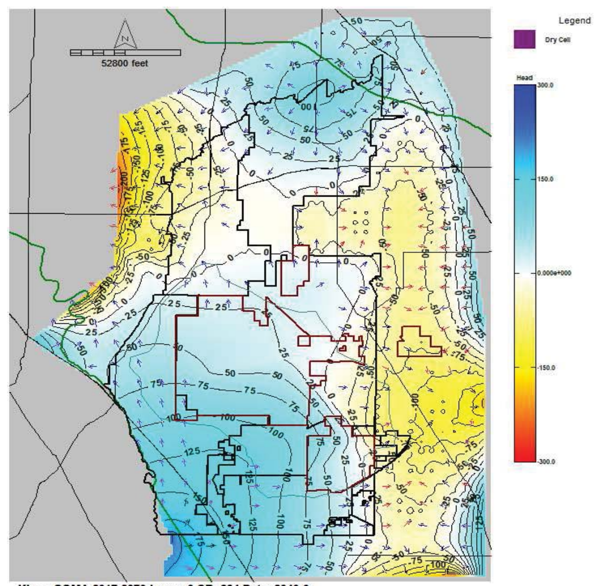


Kings SGMA 2017-2070 Layer: 5 SP: 284 Date: 2040.6



Kings SGMA 2017-2070 Layer: 6 SP: 284 Date: 2040.6

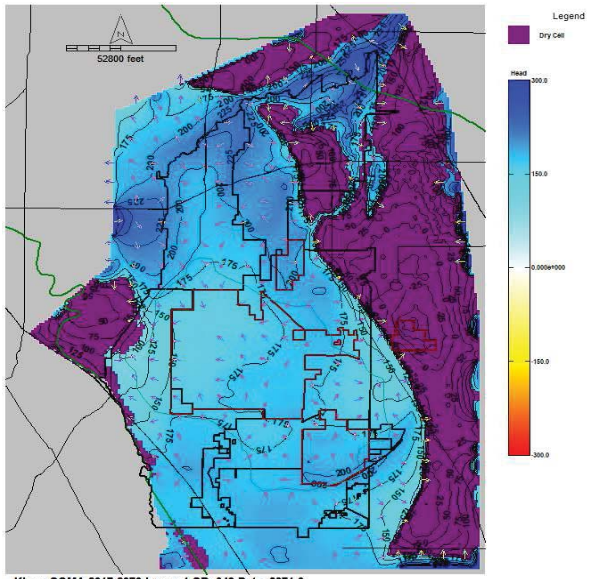
2040 Baseline Forecast Groundwater Elevations and Groundwater Flow Vectors

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-5a**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFigD7-5b 2070 Baseline Potentio 12/19/2019



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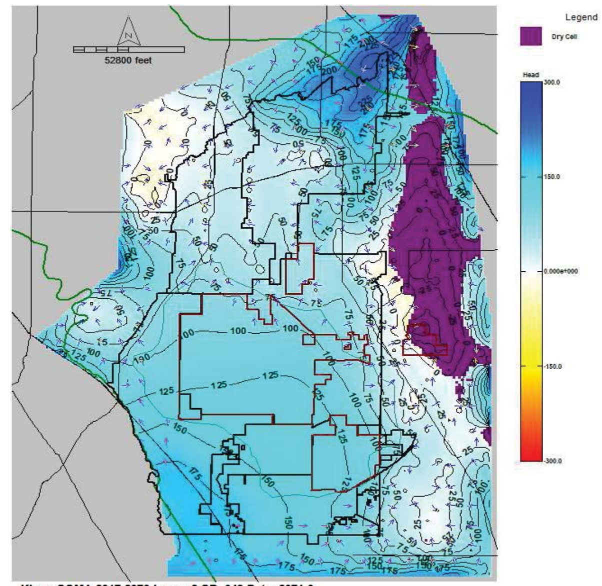

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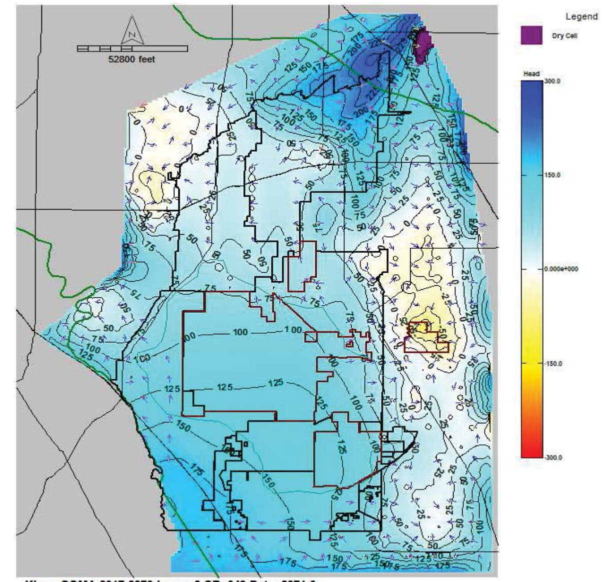
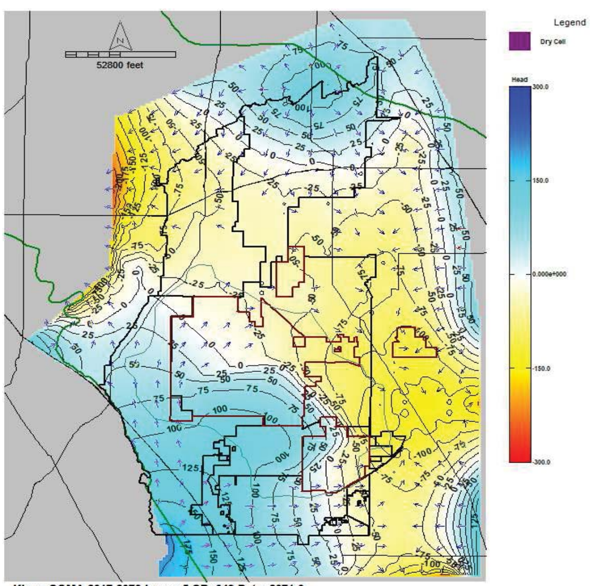


Kings SGMA 2017-2070 Layer: 3 SP: 649 Date: 2071.0



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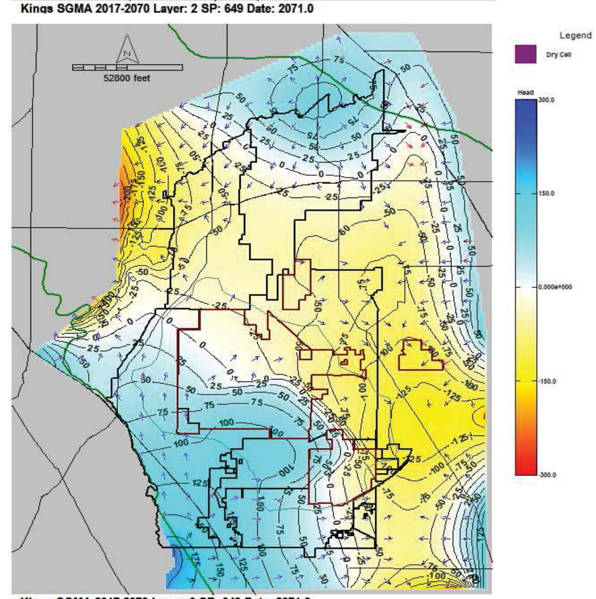


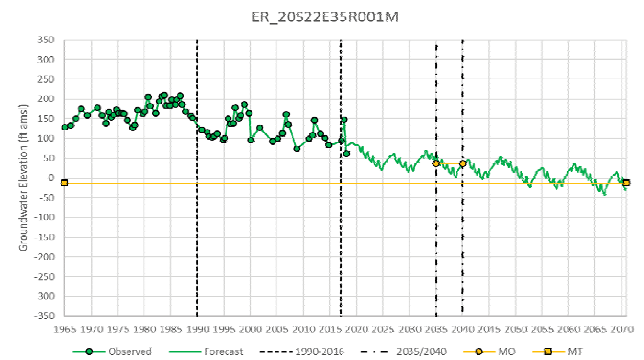
Kings SGMA 2017-2070 Layer: 6 SP: 649 Date: 2071.0

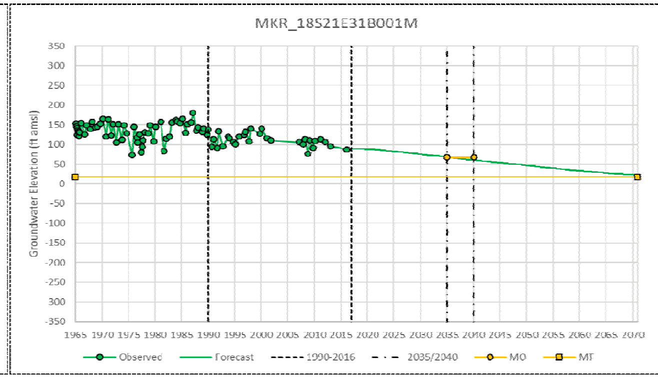
2070 Baseline Forecast Groundwater Elevations and Groundwater Flow Vectors

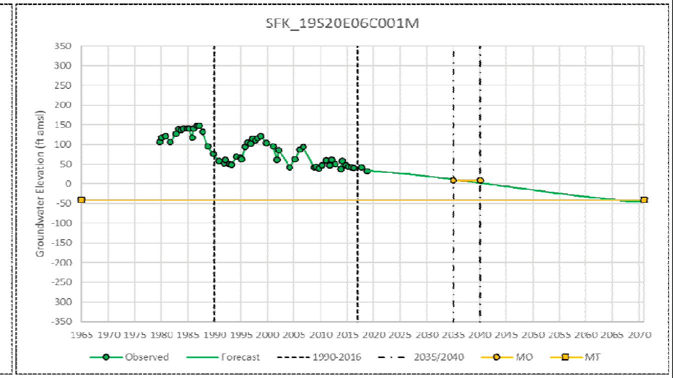
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-5b**

Above the Corcoran Clay



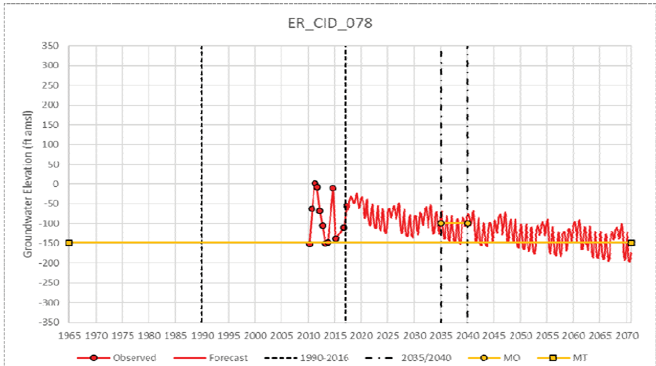


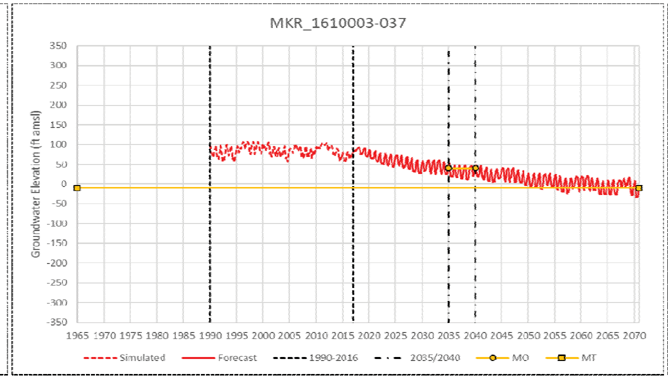


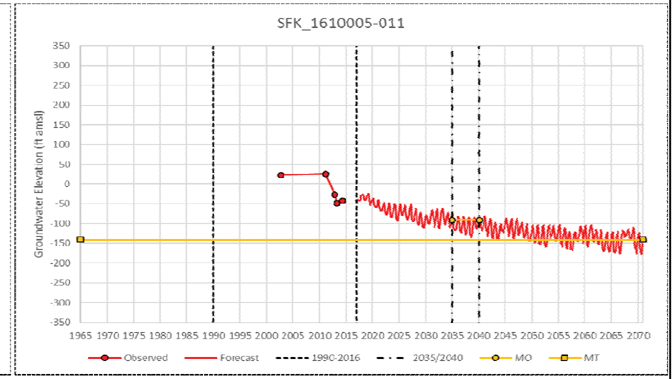
Corcoran

Hanford

Lemoore



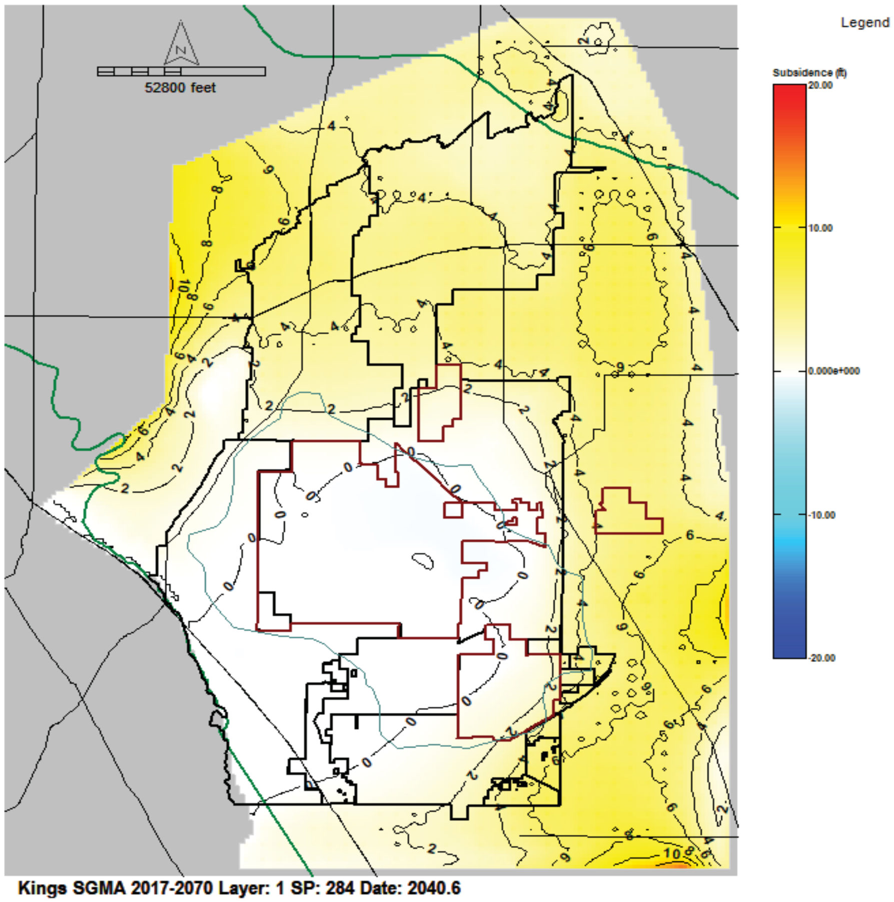


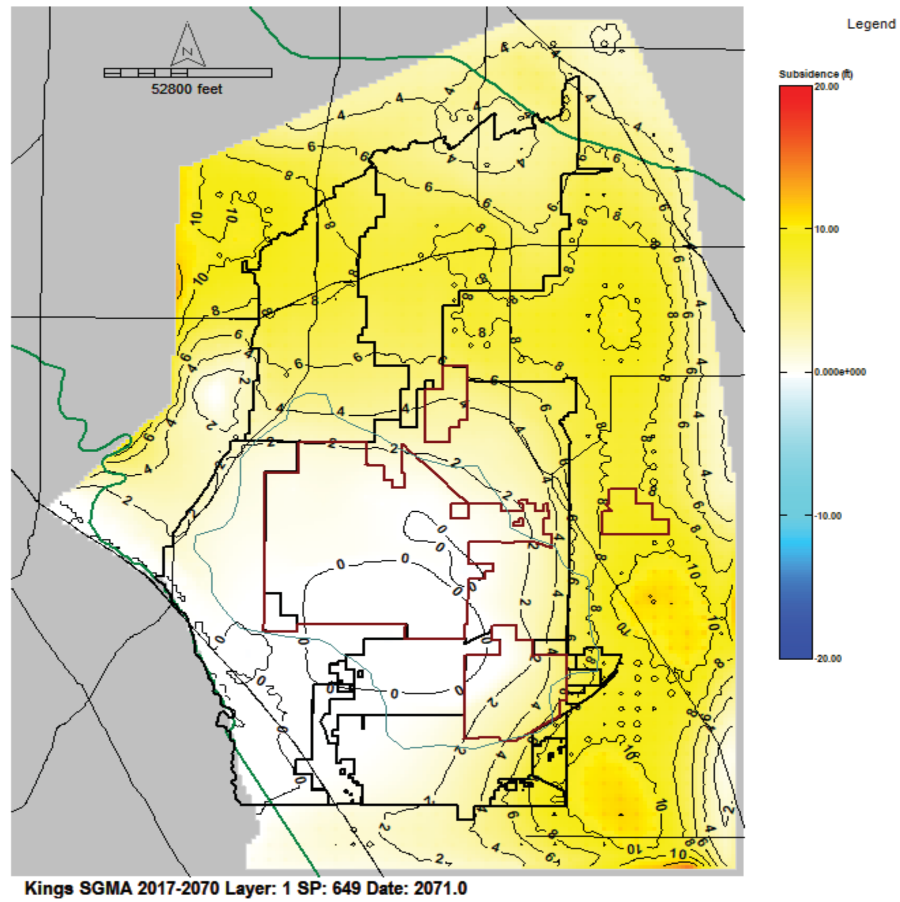


Below the Corcoran Clay

Baseline Forecast Hydrographs for Selected Compliance Wells
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-6**

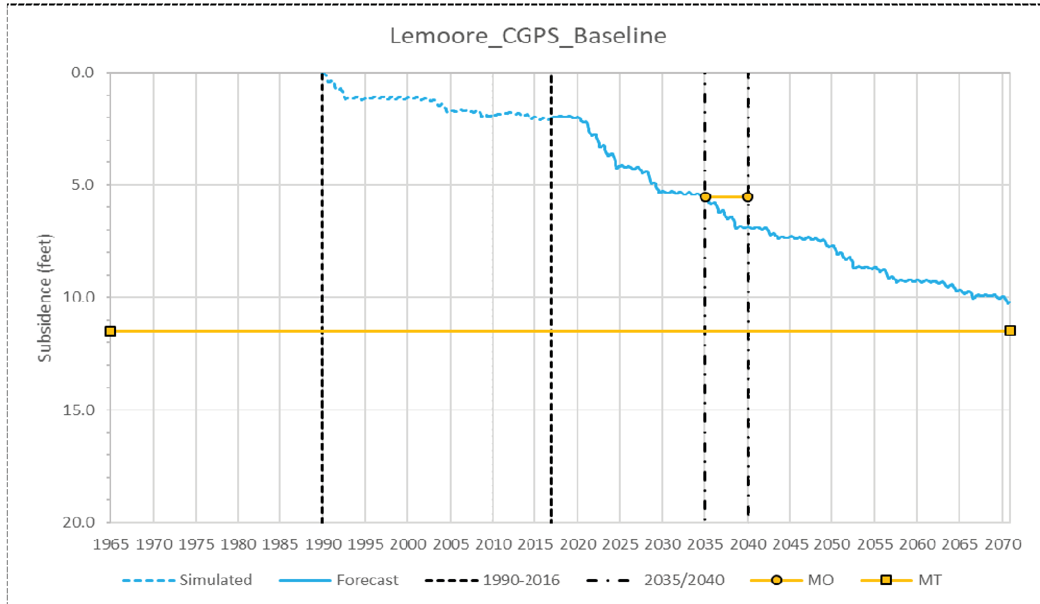


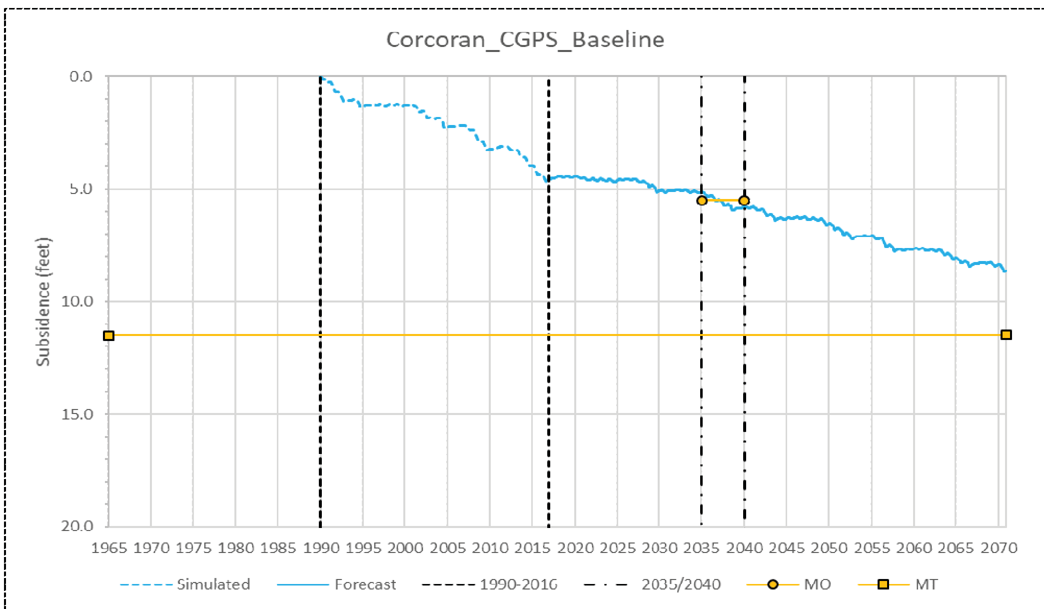


Cumulative Subsidence Since 2017
Baseline Forecast 2040 and 2070
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-7**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D7-8 BaselineSub Hydrograph

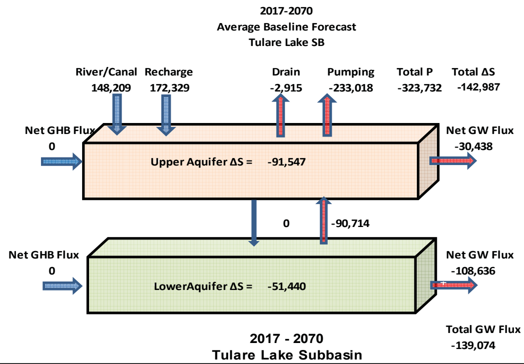




Baseline Forecast Cumulative Subsidence Compliance Monitoring Points

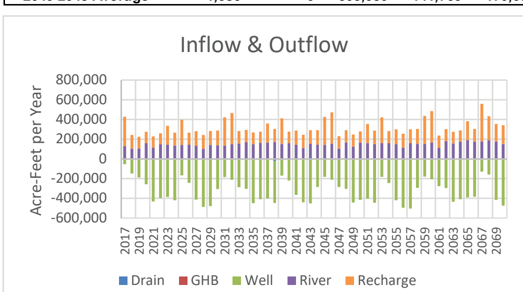
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

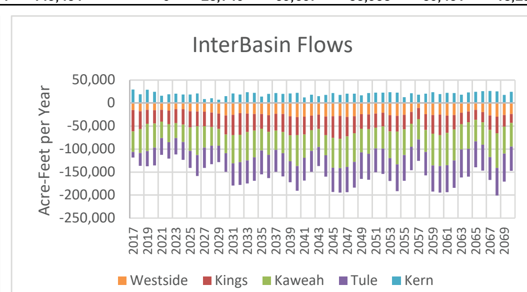
By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-8**

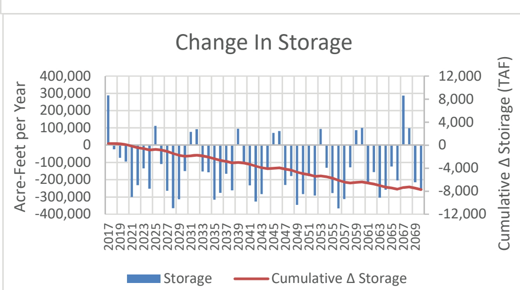


2017 - 2070
Tulare Lake Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
2017	-3,292	0	-50,431	129,387	298,093	287,496	0	-15,464	-46,141	-45,027	-11,808	29,206
2018	-750	0	-148,570	103,459	138,862	-24,232	0	-17,988	-38,795	-51,760	-28,153	18,718
2019	-396	0	-188,615	104,781	118,404	-74,022	0	-15,131	-29,903	-59,520	-32,928	28,989
2020	-1,210	0	-257,766	157,370	117,021	-95,284	0	-15,775	-29,008	-52,335	-38,614	24,297
2021	-2,134	0	-431,121	113,552	113,998	-301,058	0	-14,764	-25,890	-35,441	-36,496	15,557
2022	-9,578	0	-389,656	148,571	110,833	-232,720	0	-16,726	-29,434	-38,896	-35,732	18,943
2023	-9,797	0	-377,216	144,092	191,118	-135,035	0	-13,681	-29,968	-32,679	-35,692	20,379
2024	-9,276	0	-411,385	134,798	130,845	-252,348	0	-13,684	-33,320	-37,721	-38,735	18,554
2025	-9,008	0	-159,588	141,173	253,920	111,310	0	-17,983	-35,252	-50,832	-36,944	18,440
2026	-9,295	0	-234,658	143,339	121,516	-109,828	0	-18,531	-31,998	-62,773	-45,480	20,936
2027	-3,084	0	-411,439	132,425	148,658	-264,518	0	-18,810	-31,605	-46,647	-44,056	8,731
2028	-4,347	0	-482,752	101,674	139,826	-365,116	0	-20,740	-31,663	-40,554	-40,011	10,437
2029	-6,207	0	-473,450	141,914	140,738	-313,258	0	-22,944	-33,514	-36,563	-35,540	7,245
2030	-5,243	0	-300,946	136,633	150,653	-150,025	0	-27,132	-41,551	-40,361	-40,522	14,791
2031	-1,757	0	-183,915	134,735	285,585	76,477	0	-25,861	-44,113	-61,335	-48,021	20,901
2032	-2,659	0	-210,461	147,907	316,900	92,627	0	-22,307	-46,545	-59,821	-49,298	18,382
2033	-6,860	0	-282,130	156,810	126,029	-152,839	0	-23,116	-40,010	-61,887	-49,937	23,404
2034	-3,818	0	-300,116	169,446	122,795	-157,549	0	-23,758	-36,466	-58,144	-50,904	22,083
2035	-8,633	0	-441,194	147,758	120,698	-315,937	0	-23,778	-32,290	-47,258	-51,696	13,843
2036	-2,844	0	-407,576	162,808	113,725	-277,090	0	-26,818	-35,974	-49,950	-50,780	19,653
2037	-6,973	0	-393,826	164,766	193,473	-165,962	0	-23,577	-36,481	-41,818	-47,739	21,758
2038	-23,724	0	-423,714	170,466	133,975	-261,844	0	-23,777	-39,306	-46,292	-50,188	20,025
2039	-8,671	0	-162,253	150,468	261,073	94,885	0	-28,683	-41,620	-56,396	-45,765	20,788
2040	-8,057	0	-212,170	157,556	119,233	-106,996	0	-30,546	-39,238	-67,365	-53,540	21,850
2041	-5,104	0	-361,502	144,072	142,798	-233,348	0	-29,977	-38,432	-50,504	-49,720	12,021
2042	-2,748	0	-438,341	110,385	133,689	-327,522	0	-27,427	-31,574	-45,003	-45,971	18,233
2043	-1,965	0	-450,808	154,853	135,856	-283,322	0	-25,454	-30,918	-39,388	-41,293	15,057
2044	0	0	-285,516	142,901	148,782	-136,357	0	-29,141	-40,661	-43,988	-46,473	17,555
2045	0	0	-183,727	141,152	284,955	70,430	0	-29,079	-46,558	-65,167	-52,607	21,462
2046	0	0	-211,949	154,734	316,279	81,644	0	-27,918	-50,088	-63,422	-53,666	17,673
2047	0	0	-285,777	102,969	125,867	-230,338	0	-30,204	-42,632	-66,180	-54,785	20,405
2048	0	0	-305,758	167,267	123,023	-179,098	0	-28,919	-36,899	-62,428	-55,825	20,440
2049	0	0	-444,243	125,538	120,150	-346,793	0	-24,332	-31,416	-51,824	-57,332	16,661
2050	0	0	-415,786	163,797	114,030	-283,289	0	-25,029	-31,754	-53,927	-56,321	21,685
2051	0	0	-404,556	159,642	194,042	-178,887	0	-23,093	-30,523	-44,967	-51,903	22,394
2052	0	0	-446,277	150,374	135,694	-291,833	0	-21,035	-29,966	-48,316	-54,946	22,494
2053	0	0	-183,305	159,180	263,059	93,063	0	-26,612	-35,116	-58,392	-49,382	23,630
2054	0	0	-244,986	159,110	123,386	-131,840	0	-28,062	-34,361	-71,317	-58,079	22,469
2055	0	0	-420,853	148,192	151,360	-277,705	0	-25,895	-31,453	-55,998	-55,894	12,657
2056	0	0	-496,998	114,335	140,360	-366,983	0	-19,449	-25,676	-50,048	-50,927	21,022
2057	0	0	-504,789	159,039	140,232	-312,851	0	-10,938	-24,080	-44,316	-46,355	17,853
2058	0	0	-294,759	152,165	150,384	-129,034	0	-24,334	-34,112	-48,062	-51,043	20,463
2059	0	0	-180,750	151,281	284,994	86,505	0	-26,011	-40,937	-68,809	-56,756	23,490
2060	0	0	-208,497	167,175	316,329	99,201	0	-25,369	-44,674	-67,186	-57,771	19,186
2061	0	0	-278,224	111,075	125,072	-214,084	0	-27,627	-37,207	-70,470	-58,722	21,985
2062	0	0	-295,518	179,447	121,650	-156,830	0	-26,398	-31,219	-67,227	-59,432	21,834
2063	0	0	-435,625	155,188	119,632	-304,744	0	-21,333	-24,539	-55,367	-60,737	17,855
2064	0	0	-410,660	176,101	112,798	-258,488	0	-18,537	-23,571	-57,476	-60,516	23,108
2065	0	0	-390,901	190,501	191,607	-124,017	0	-14,810	-21,614	-47,222	-56,154	24,170
2066	0	0	-385,749	175,809	126,968	-204,212	0	-19,675	-22,308	-48,698	-56,466	25,517
2067	0	0	-130,038	177,997	380,464	286,962	0	-27,089	-31,484	-59,206	-49,777	26,094
2068	0	0	-159,015	188,104	244,419	97,660	0	-29,769	-36,271	-75,275	-59,838	25,307
2069	0	0	-416,014	176,019	178,001	-215,012	0	-26,190	-25,091	-58,935	-60,557	17,413
2070	0	0	-475,674	149,023	191,903	-257,301	0	-24,047	-19,259	-51,309	-53,012	24,403
2017-2070 Average	**-2,915**	**0**	**-323,732**	**148,209**	**172,329**	**-142,987**	**0**	**-23,062**	**-34,157**	**-53,181**	**-48,534**	**19,860**
2040-2048 Average	**-1,986**	**0**	**-303,950**	**141,765**	**170,054**	**-149,434**	**0**	**-28,740**	**-39,667**	**-55,938**	**-50,431**	**18,299**



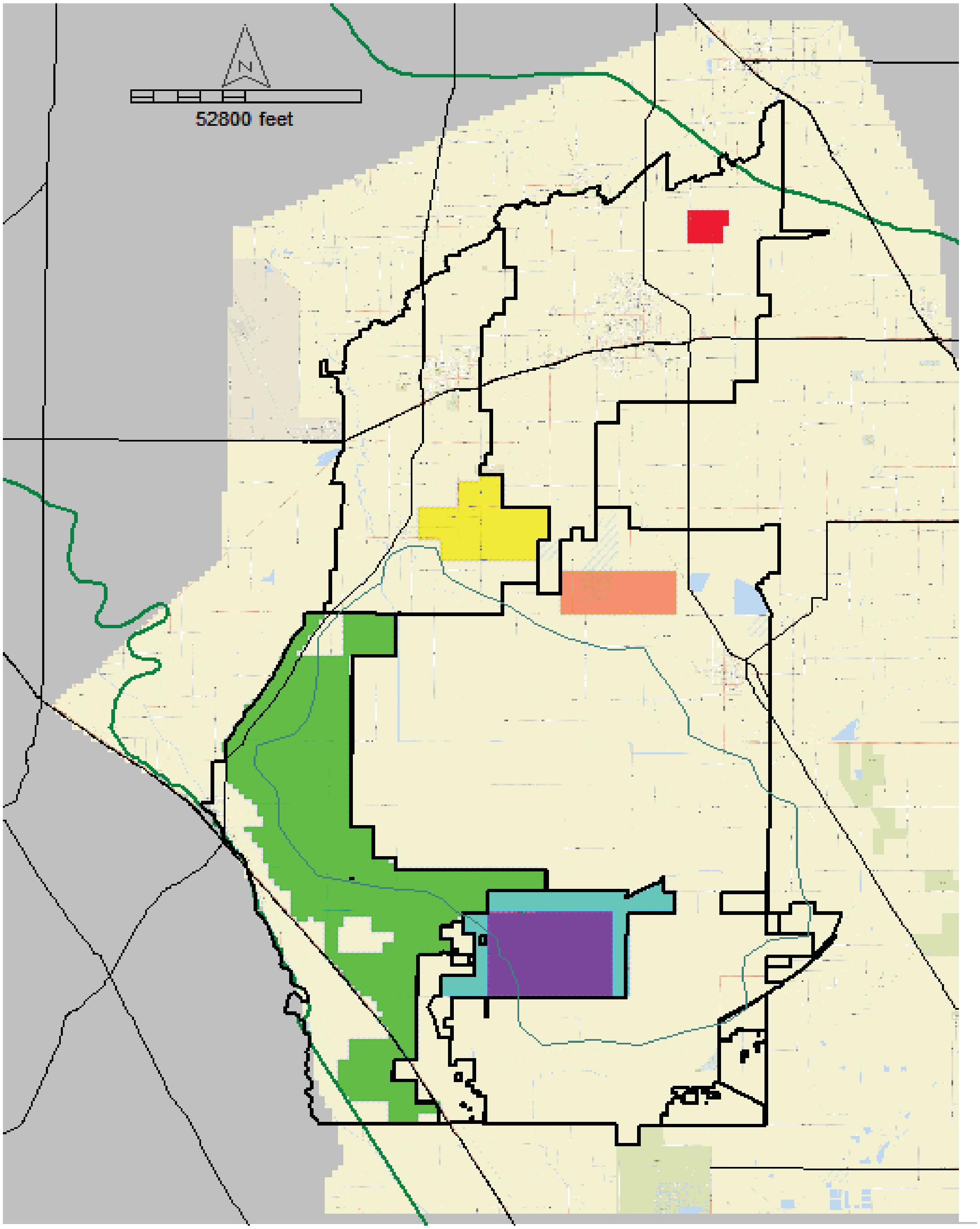




Baseline Forecast Groundwater Mass Balance Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/15/19	Project No.: FR18161220
		Figure **D7-9**



Explanation

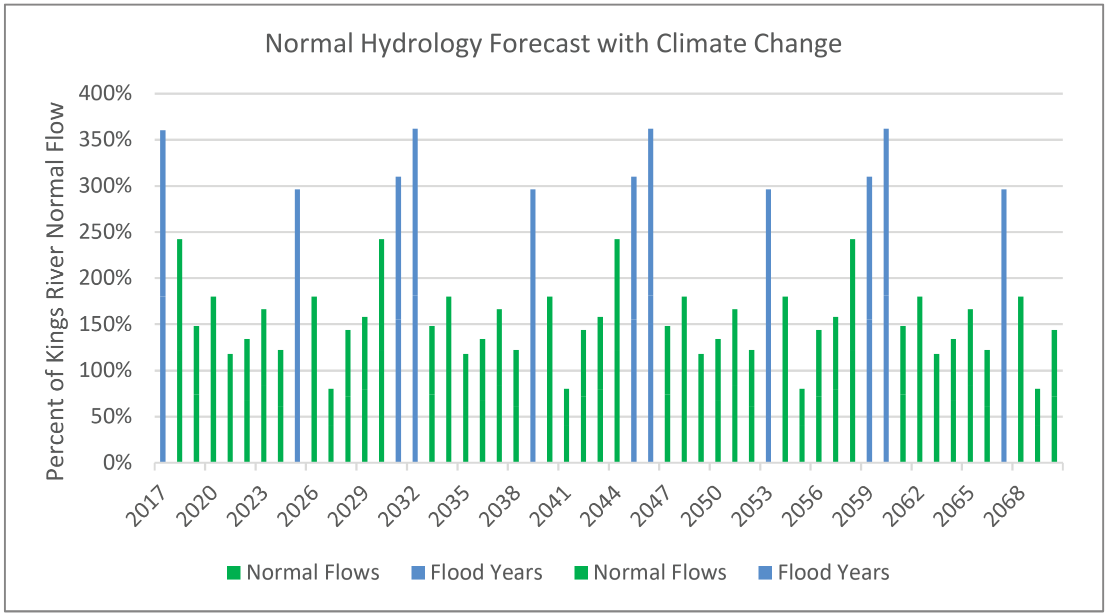
- Mid-Kings River GSA Intentional Recharge Basins
- El Rico GSA Intermittal Surface Water Storage Ponds
- South Fork Kings GSA Surface Water Storage Ponds
- TCWA GSA Surface Water Storage Ponds
- Southwest Kings GSA Land Fallowing
- TCWA GSA Land Fallowing

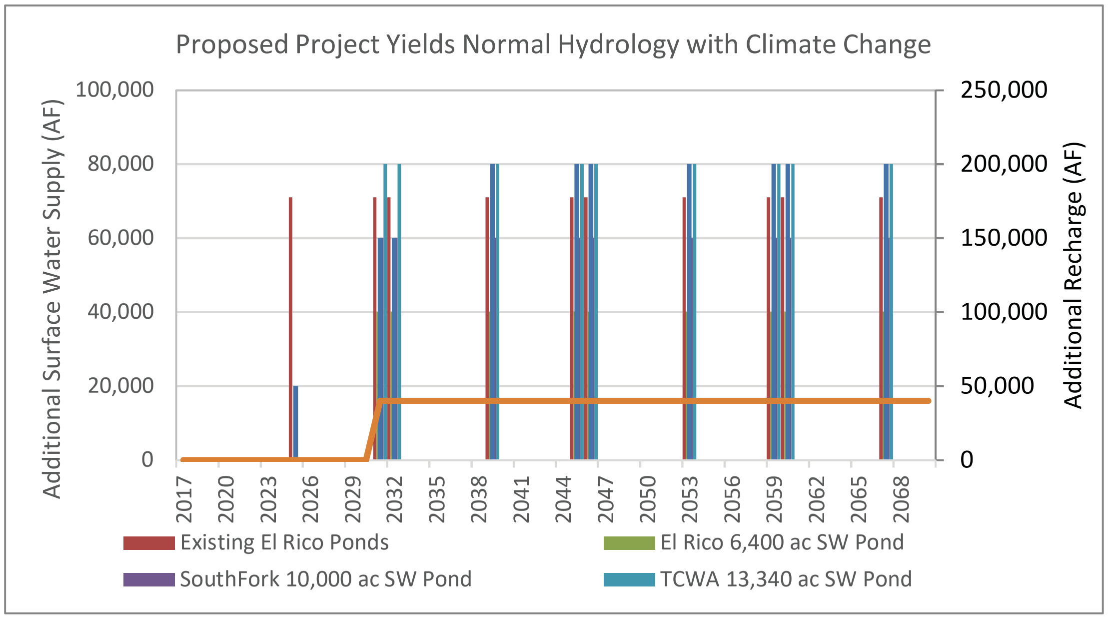
Forecast Project Areas

Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D7-10**

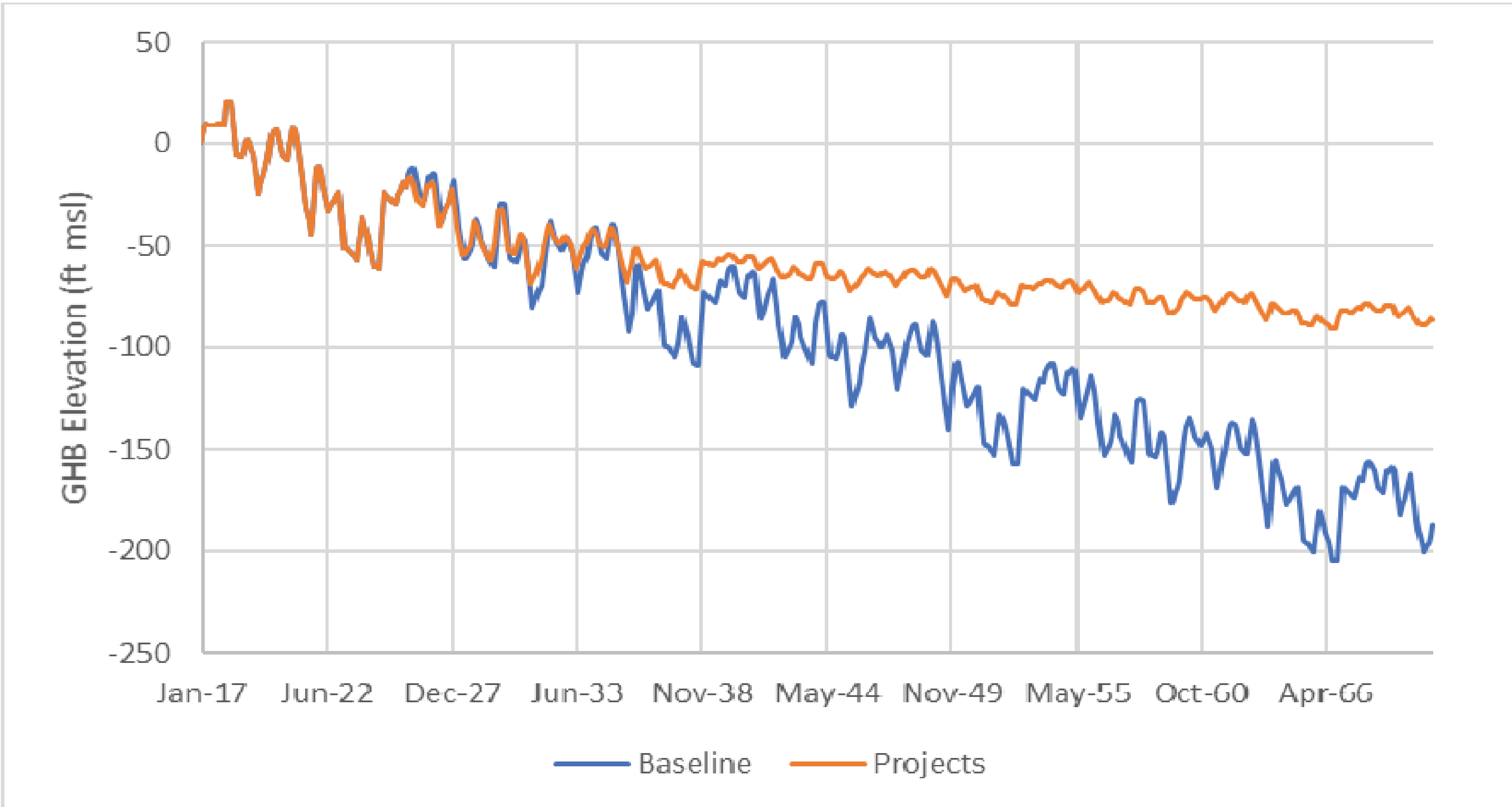




Project Forecast Flood Years and Project Performance

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D7-11**



Project vs Baseline GHB Example
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 07/30/19	Project No.: FR18161220
		Figure **D7-12**

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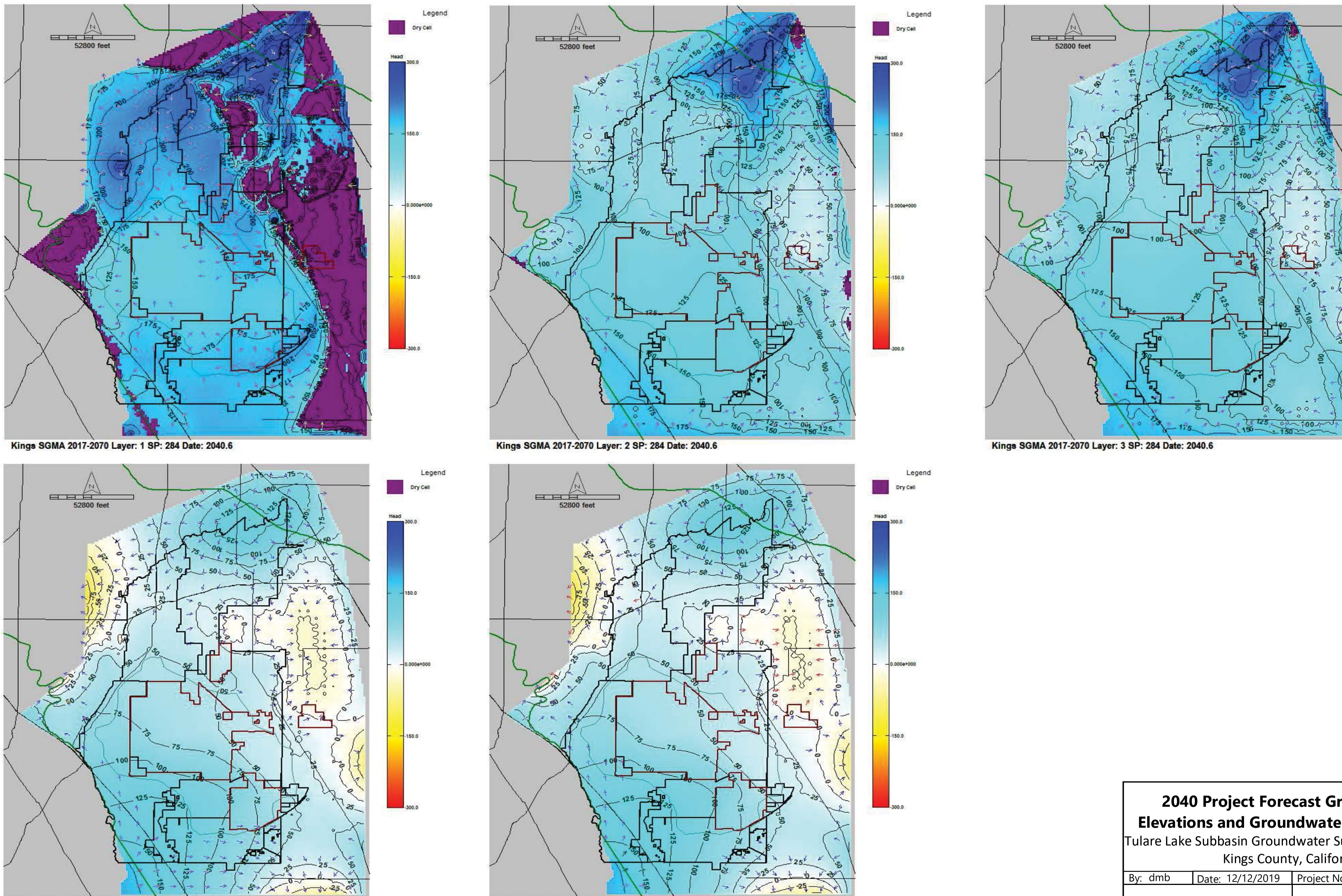
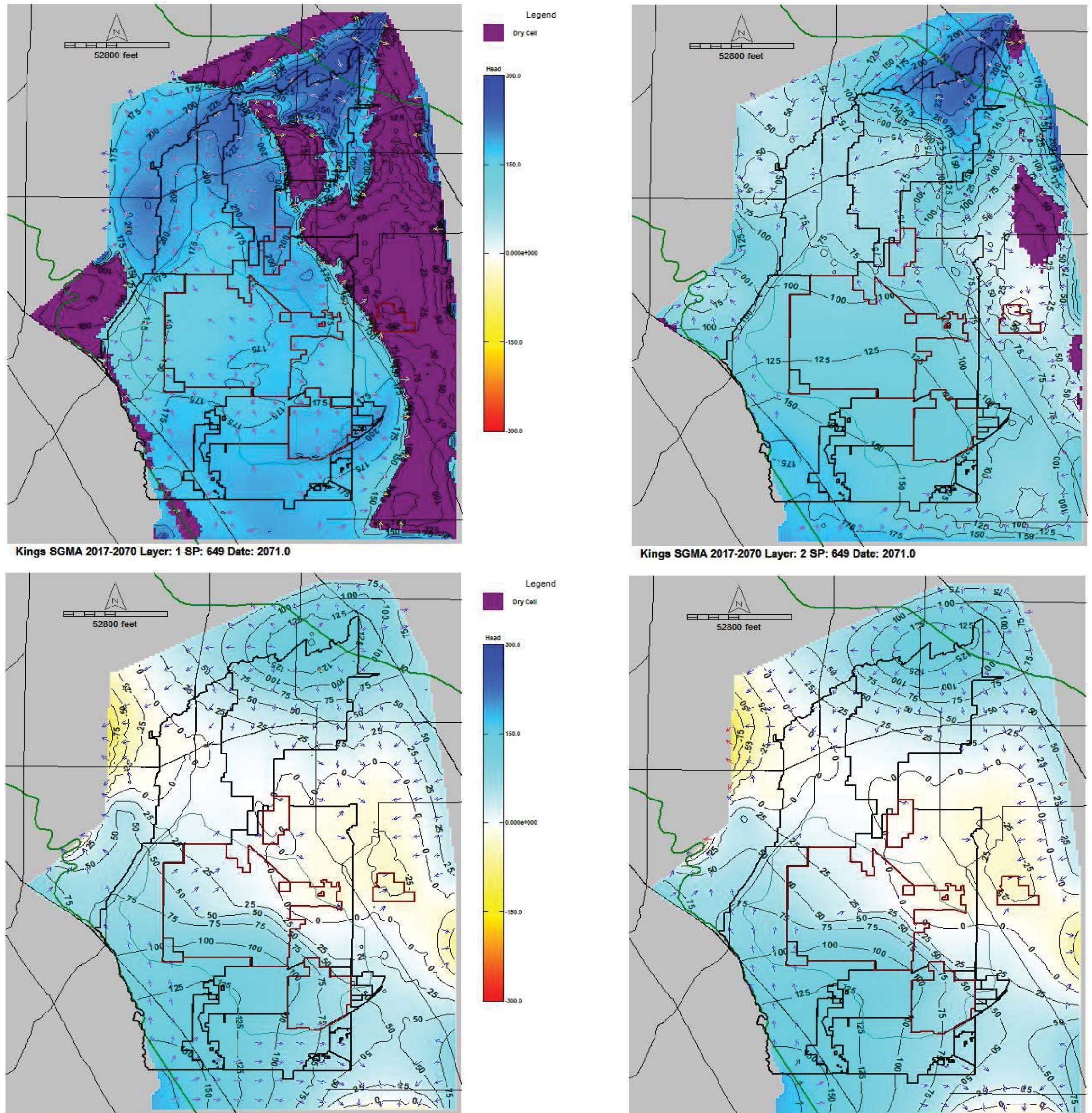


2040 Project Forecast Groundwater Elevations and Groundwater Flow Vectors

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-13**



Kings SGMA 2017-2070 Layer: 1 SP: 649 Date: 2071.0

Kings SGMA 2017-2070 Layer: 2 SP: 649 Date: 2071.0

Kings SGMA 2017-2070 Layer: 3 SP: 649 Date: 2071.0

Kings SGMA 2017-2070 Layer: 5 SP: 649 Date: 2071.0

Kings SGMA 2017-2070 Layer: 6 SP: 649 Date: 2071.0

2070 Project Forecast Groundwater Elevations and Groundwater Flow Vectors

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-14**

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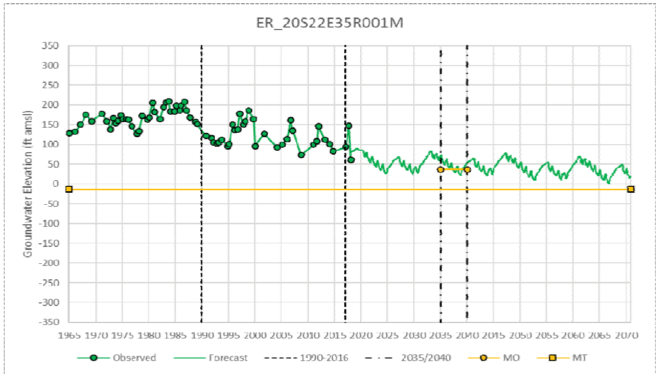
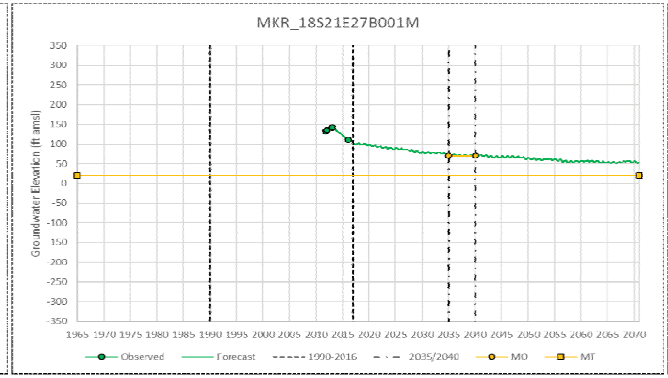
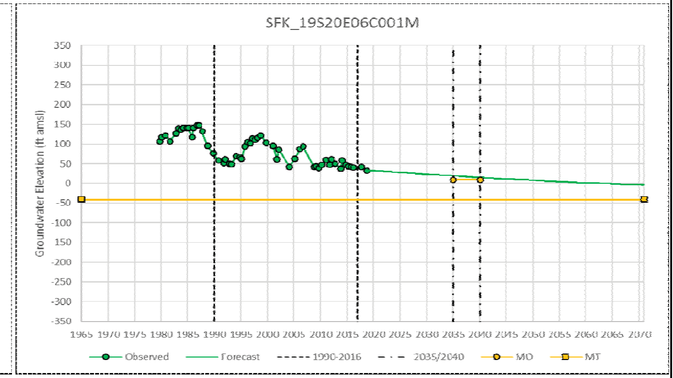
Above the Corcoran Clay



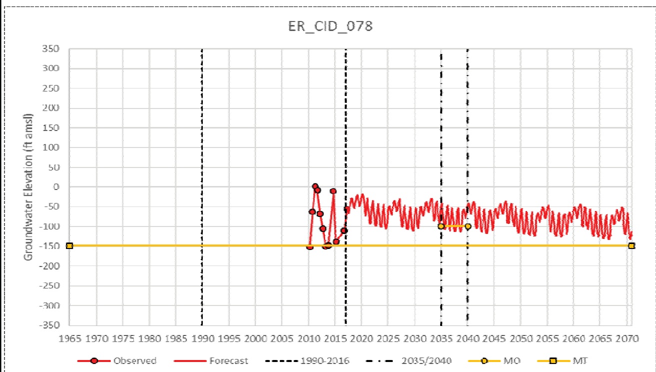


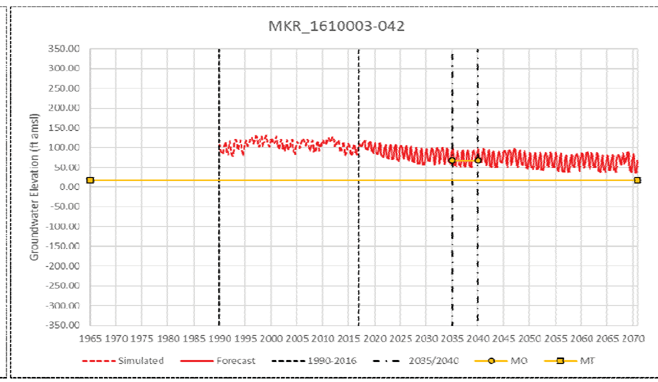


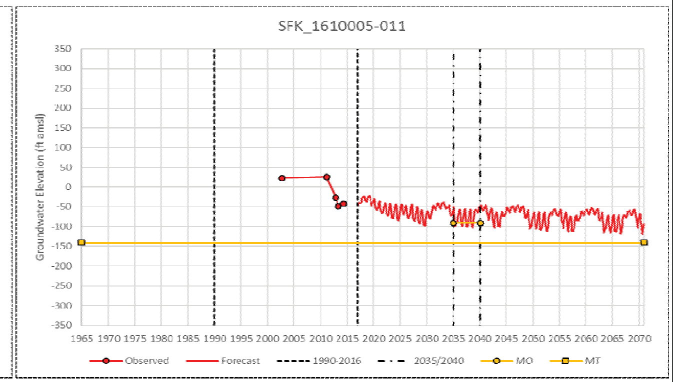
Corcoran

Hanford

Lemoore







Below the Corcoran Clay

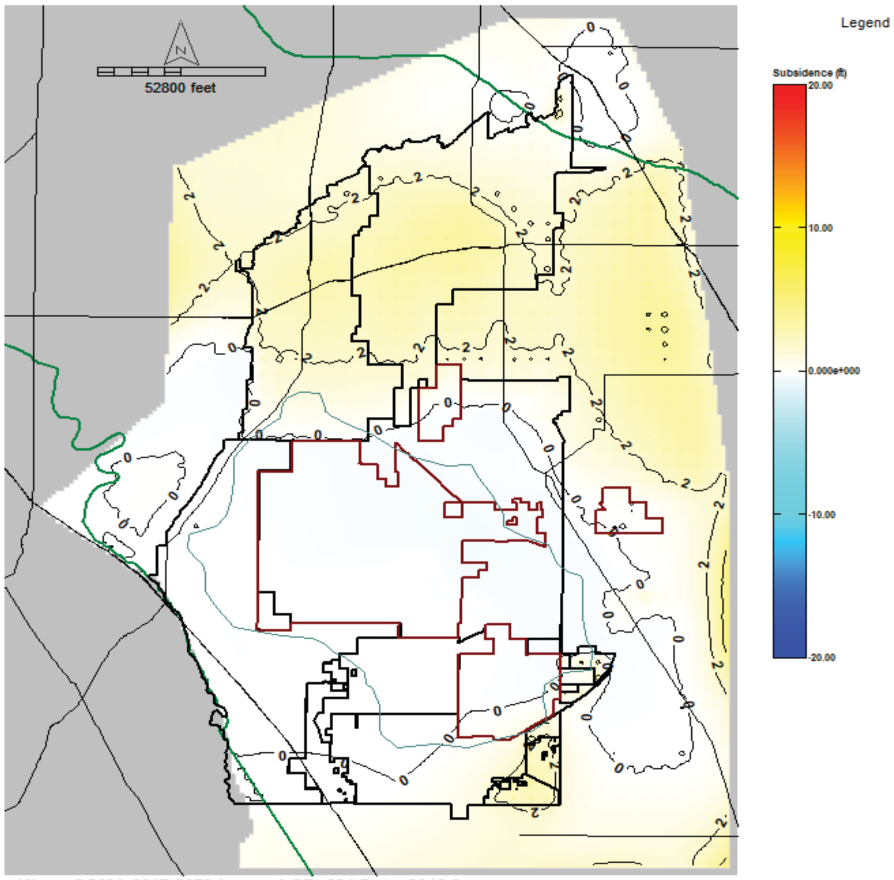
Project Forecast Hydrographs for Selected Compliance Wells

Tulare Lake Subbasin Groundwater Sustainability Plan

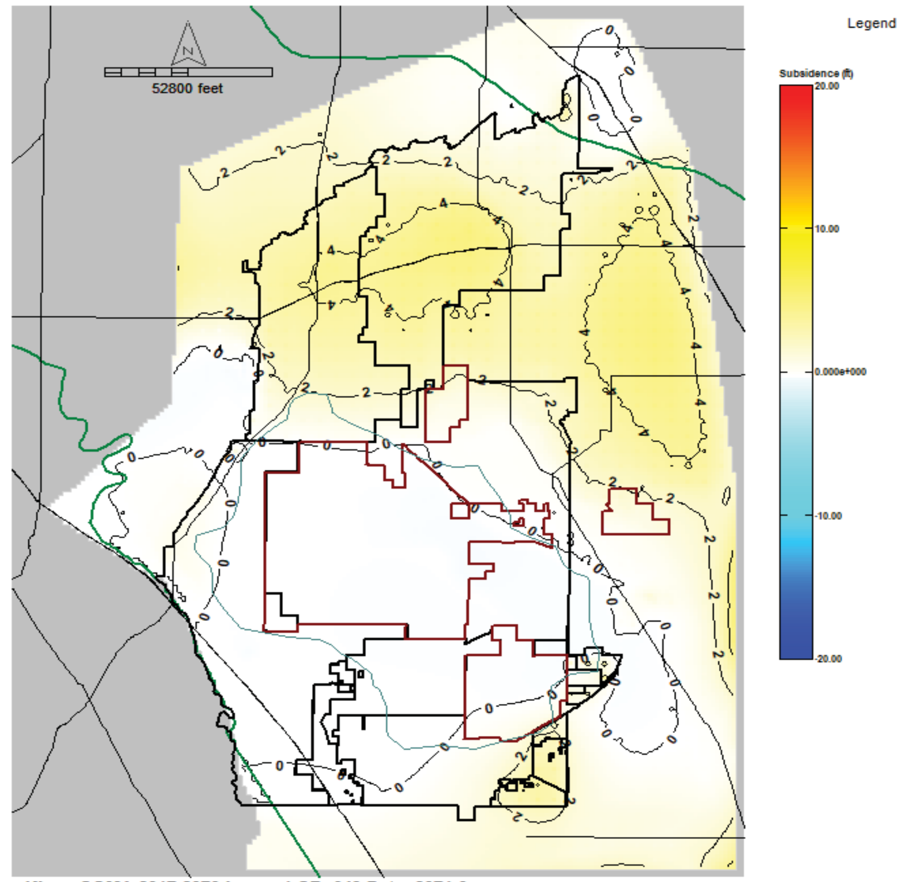
Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure D7-15

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D7-16 Project Subsidence



Kings SGMA 2017-2070 Layer: 1 SP: 284 Date: 2040.6



Kings SGMA 2017-2070 Layer: 1 SP: 649 Date: 2071.0

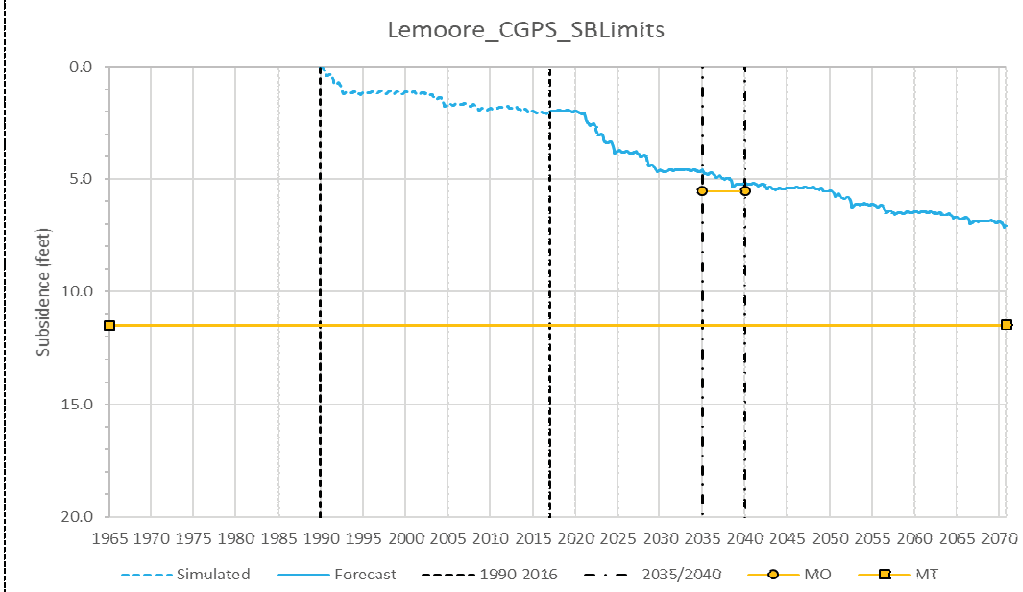
Cumulative Subsidence Since 2017
Project Forecast 2040 and 2070

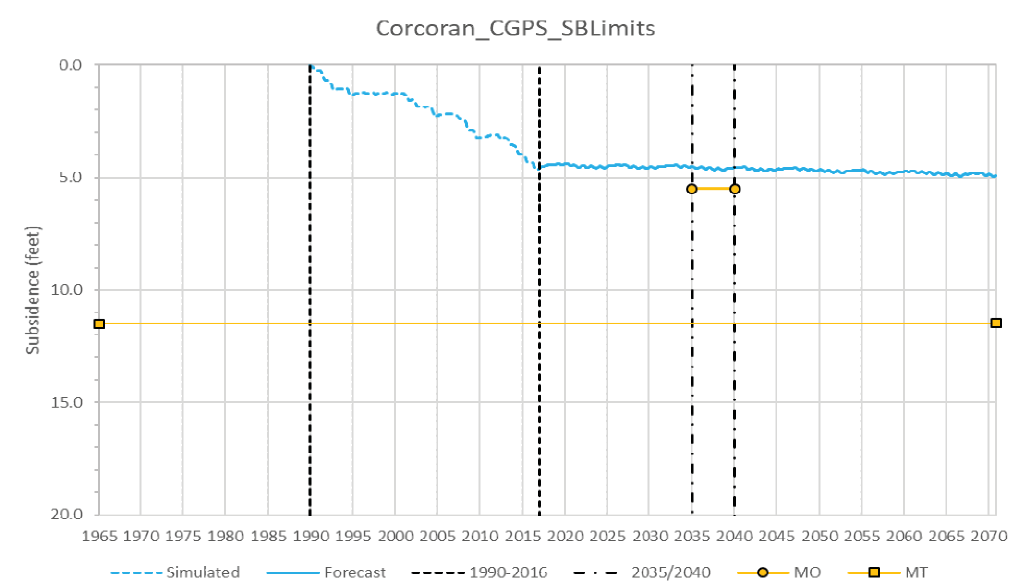
Tulare Lake Subbasin Groundwater Sustainability Plan

Kings County, California

By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-16**

I:\FR18s\FR18161220 Tulare Lake GSP\Figures\8-Appendices\Figures\PendingReview\AppendixD\December2019\DRAFT_TLSB_SGMA_GWModel_Figures_v3.xlsxFig D7-17 Project Sub Hydros

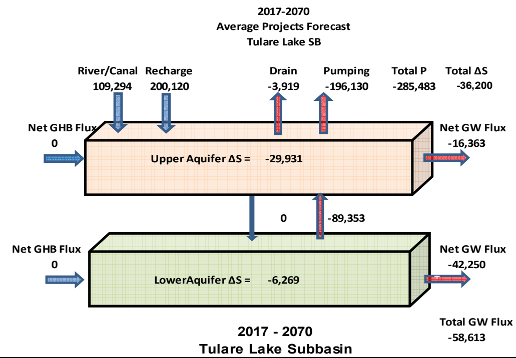




Project Forecast with Subbasin Pumping Limits Cumulative Subsidence Compliance Monitoring Points

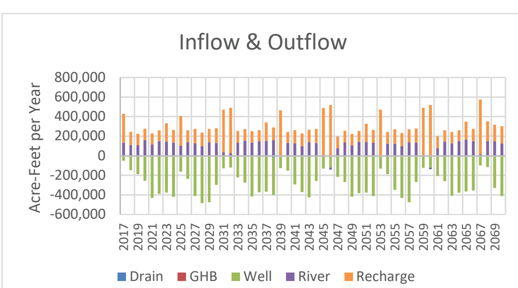
Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

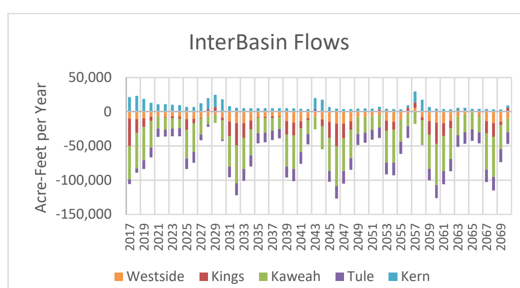
By: dmb	Date: 12/12/2019	Project No.: FR18161220
		Figure **D7-17**

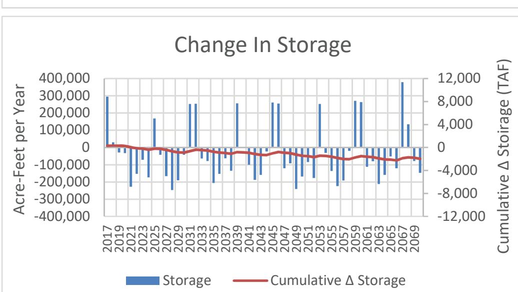


2017 - 2070
Tulare Lake Subbasin

TulareLake Date	Net Drain	Net GHB	Net Well	Net River	Net Recharge	Net Storage	Interbasin TulareLake	Interbasin Westside	Interbasin Kings	Interbasin Kaweah	Interbasin Tule	Interbasin Kern
2017	-768	0	-49,996	134,061	294,631	293,851	0	-9,992	-40,297	-48,598	-6,953	21,200
2018	-51	0	-147,931	106,461	137,333	29,785	0	-10,916	-20,328	-51,541	-6,322	23,003
2019	-69	0	-188,204	107,068	117,120	-29,333	0	-9,689	-12,439	-49,028	-12,606	18,498
2020	-751	0	-255,895	160,022	116,429	-33,567	0	-7,499	-6,200	-38,702	-14,321	12,890
2021	-2,567	0	-429,344	114,591	113,000	-228,163	0	-6,324	1,150	-18,147	-12,345	9,568
2022	-742	0	-387,832	149,597	110,391	-153,344	0	-8,036	-1,192	-16,819	-10,142	11,115
2023	-2,081	0	-375,607	144,279	186,092	-72,254	0	-6,559	-3,333	-14,772	-11,461	10,147
2024	-12,152	0	-409,790	134,618	129,097	-173,684	0	-6,923	-3,333	-14,122	-11,585	9,682
2025	-5,901	0	-158,066	103,591	300,300	167,712	0	-11,065	-15,504	-41,827	-15,388	6,934
2026	-6,425	0	-231,683	138,003	120,755	-42,544	0	-10,328	-7,050	-41,311	-15,866	6,838
2027	-4,097	0	-408,650	128,404	144,489	-166,792	0	-9,442	-924	-23,018	-8,481	12,393
2028	-3,806	0	-479,787	98,269	137,572	-247,432	0	-6,650	4,048	-12,008	-3,496	15,713
2029	-4,776	0	-470,493	136,664	136,267	-190,413	0	-4,525	6,786	-11,984	87	17,840
2030	-2,184	0	-296,843	131,230	148,799	-43,406	0	-8,521	-4,397	-27,797	-2,292	17,851
2031	-1,342	0	-128,244	34,194	435,214	252,338	0	-14,173	-21,527	-44,586	-15,432	8,110
2032	-2,135	0	-118,244	25,043	464,633	253,462	0	-16,860	-32,389	-55,308	-17,407	5,767
2033	-2,751	0	-219,926	132,336	120,754	-64,405	0	-16,851	-21,233	-45,466	-17,455	5,077
2034	-2,351	0	-273,863	153,223	119,220	-78,745	0	-12,647	-13,009	-38,118	-16,298	4,879
2035	-1,785	0	-414,804	134,016	116,897	-206,981	0	-7,842	-1,636	-21,888	-14,849	4,870
2036	-1,969	0	-372,544	149,859	110,501	-153,893	0	-7,391	-2,192	-21,086	-14,068	4,967
2037	-4,264	0	-363,305	152,162	186,307	-63,641	0	-6,467	-2,997	-18,447	-13,642	4,983
2038	-15,878	0	-386,782	158,310	129,519	-135,618	0	-6,736	-1,043	-17,305	-13,856	4,989
2039	-12,937	0	-112,427	-1,549	463,139	255,562	0	-13,698	-19,924	-46,314	-16,200	4,904
2040	-4,822	0	-147,191	129,532	113,179	-3,861	0	-15,971	-18,585	-49,122	-17,955	4,620
2041	-6,403	0	-288,654	125,667	136,255	-100,523	0	-13,749	-10,872	-34,353	-17,111	4,246
2042	-2,511	0	-369,213	97,116	129,325	-188,355	0	-9,518	-2,914	-20,346	-15,076	3,738
2043	-5,152	0	-419,146	138,244	128,118	-160,121	0	-7,192	1,016	-18,647	3,140	15,790
2044	-1,928	0	-256,990	128,874	144,339	-23,229	0	-11,233	-9,893	-34,027	233	17,141
2045	-1,615	0	-127,421	-2,607	487,733	260,886	0	-14,968	-23,284	-48,182	-15,906	6,928
2046	-2,192	0	-118,440	-22,036	518,991	254,254	0	-17,181	-33,280	-58,225	-18,145	4,513
2047	-1,846	0	-213,881	74,677	120,491	-120,887	0	-17,529	-21,199	-48,012	-18,486	3,949
2048	-3,121	0	-266,286	136,608	119,296	-92,692	0	-14,027	-12,735	-41,083	-17,137	3,833
2049	-955	0	-417,584	104,902	116,316	-241,563	0	-8,059	420	-24,754	-15,986	3,853
2050	-2,104	0	-380,556	141,874	110,770	-169,379	0	-7,332	852	-23,106	-14,955	3,988
2051	-2,151	0	-373,868	139,939	186,903	-85,094	0	-6,328	191	-20,161	-14,365	4,080
2052	-2,945	0	-409,066	132,768	131,240	-178,002	0	-4,743	2,951	-18,330	-15,302	4,171
2053	-1,757	0	-130,174	5,547	465,172	251,586	0	-13,057	-14,939	-46,488	-17,189	4,219
2054	-5,694	0	-182,931	124,170	117,298	-32,521	0	-14,787	-11,432	-48,072	-18,716	3,894
2055	-2,953	0	-346,167	123,932	144,789	-137,299	0	-11,714	-597	-31,503	-17,950	3,589
2056	-5,089	0	-426,442	96,606	136,007	-224,340	0	-3,053	5,860	-18,230	-17,157	3,278
2057	-2,832	0	-472,419	136,967	132,395	-192,493	0	5,515	7,767	-17,808	129	16,150
2058	-1,986	0	-265,982	132,665	145,904	-19,975	0	-8,004	-4,928	-34,531	-1,020	17,529
2059	-1,441	0	-124,741	1,848	487,775	270,056	0	-13,579	-19,998	-49,951	-16,865	6,926
2060	-5,248	0	-115,440	-16,351	519,068	263,398	0	-16,253	-30,525	-60,325	-19,196	4,327
2061	-878	0	-207,328	77,986	119,694	-112,695	0	-16,694	-19,066	-50,528	-19,593	3,699
2062	-6,177	0	-255,034	141,942	117,940	-79,683	0	-13,385	-11,283	-44,118	-18,210	3,559
2063	-2,104	0	-409,125	127,082	115,805	-213,067	0	-7,479	2,086	-27,132	-16,779	3,593
2064	-2,912	0	-375,558	149,053	109,563	-159,420	0	-3,670	1,802	-26,339	-16,899	3,789
2065	-4,655	0	-360,424	163,296	184,366	-52,779	0	-1,038	-312	-24,380	-16,820	4,124
2066	-4,273	0	-350,525	150,290	122,618	-121,655	0	-5,683	-471	-24,161	-15,961	4,244
2067	-5,939	0	-94,695	15,041	558,534	377,959	0	-13,561	-18,174	-52,954	-18,116	3,915
2068	-13,107	0	-102,855	148,782	203,000	133,847	0	-16,690	-20,384	-58,120	-19,784	3,545
2069	-7,533	0	-321,613	147,416	168,607	-78,689	0	-14,878	-4,800	-35,079	-19,070	3,256
2070	-7,539	0	-406,054	125,600	176,541	-146,985	0	-9,685	5,622	-20,423	-17,074	3,291
2017-2070 Average	**-3,919**	**0**	**-285,483**	**109,294**	**200,120**	**-36,200**	**0**	**-10,086**	**-8,890**	**-33,827**	**-13,587**	**7,778**
2040-2048 Average	**-3,288**	**0**	**-245,247**	**89,564**	**210,859**	**-19,392**	**0**	**-13,485**	**-14,638**	**-39,111**	**-12,938**	**7,195**







Projects Forecast Groundwater Mass Balance Tulare Lake Subbasin

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

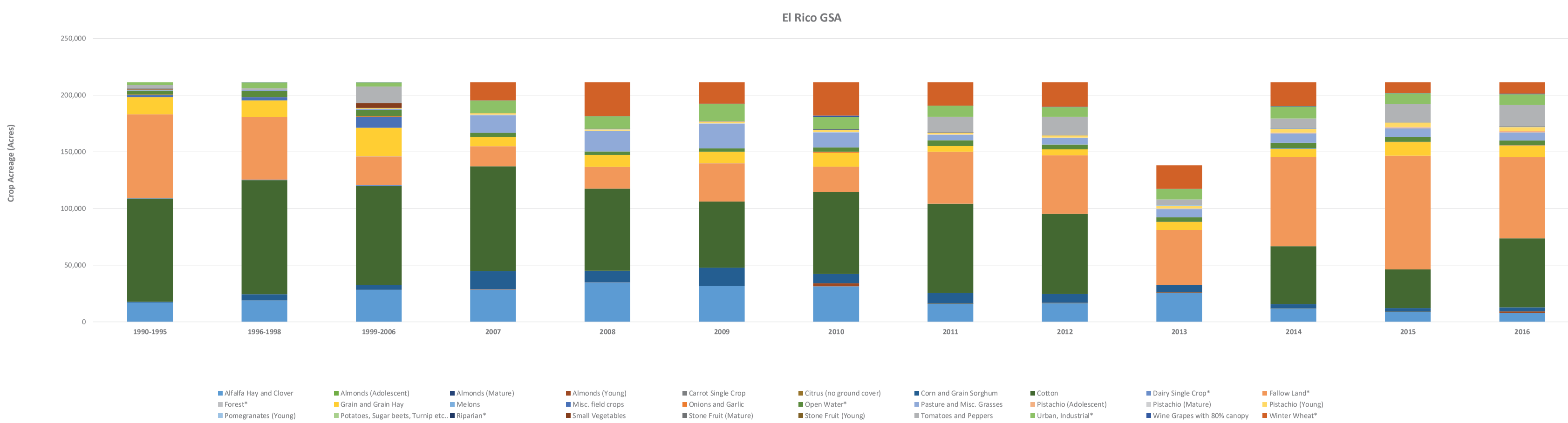
By: dmb	Date: 12/16/19	Project No.: FR18161220
		Figure **D7-18**

Appendix D1
Land Use and Crop Acreage

APPENDIX D1-1

Sum of Crop Acreage (Acres) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
El Rico GSA													
Alfalfa Hay and Clover	17062	18882	28224	28550	34759	31625	31388	16035	16646	25428	11801	8919	7682
Almonds (Adolescent)	0	0	0	0	0	0	0	2	1	1	8	2	4
Almonds (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Almonds (Young)	0	0	0	258	180	197	2669	238	259	636	208	246	1546
Carrot Single Crop	0	0	0	0	0	0	0	6	2	0	0	0	4
Citrus (no ground cover)	0	0	0	0	0	0	0	5	0	2	0	1	1
Corn and Grain Sorghum	782	5521	4532	16009	10213	16088	8204	9059	7686	6589	3771	2958	3518
Cotton	91026	100576	87075	92487	72329	58241	72345	78989	70591	0	50987	34147	60879
Dairy Single Crop*	386	493	718	0	0	0	0	0	0	0	0	0	0
Fallow Land*	73850	55208	25343	17545	19197	33697	22362	45881	51731	48511	78767	100327	71667
Forest*	0	12	156	0	3	36	1	0	0	0	0	0	0
Grain and Grain Hay	15048	14737	25257	8152	10582	10260	12219	4876	5254	7028	7005	12142	10308
Melons	0	0	0	0	0	0	0	1	6	1	491	3	63
Misc. field crops	2012	2737	9414	0	2	0	0	0	0	0	0	0	0
Onions and Garlic	253	165	606	0	0	0	1031	26	59	28	43	82	62
Open Water*	3550	5363	5676	3742	3038	2939	3748	5020	4152	4064	4826	4456	4232
Pasture and Misc. Grasses	444	682	902	15534	17925	21653	13233	4887	5745	7242	8473	7506	7212
Pistachio (Adolescent)	0	0	0	0	0	0	0	168	188	225	433	732	931
Pistachio (Mature)	0	0	0	519	494	348	294	286	281	260	259	414	386
Pistachio (Young)	0	92	612	1286	1030	1613	2066	1148	1837	2468	3146	3862	3324
Pomegranates (Young)	0	0	0	3	518	237	24	460	92	425	541	324	292
Potatoes, Sugar beets, Turnip etc..	465	0	0	5	0	0	0	1	0	1	0	1	1
Riparian*	0	0	260	11	59	93	386	20	14	54	83	92	101
Small Vegetables	807	298	4282	0	0	2	58	14	18	67	64	5	73
Stone Fruit (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	0	0	2	13	64	3	4	123	1	2	57	60
Tomatoes and Peppers	3069	1361	14625	5	1	67	0	13774	16185	4920	8549	16040	18943
Urban, Industrial*	2645	5070	3531	11025	10872	15246	10536	9841	8535	9304	10539	9274	9570
Wine Grapes with 80% canopy	0	196	130	160	142	18	1400	89	407	36	215	186	377
Winter Wheat*	0	0	0	16033	29951	18879	29323	20451	21465	20757	21059	9497	10032
El Rico GSA Irrigated Crop Acreage	**130966**	**145246**	**175658**	**162969**	**148189**	**140412**	**144935**	**130069**	**125380**	**128584**	**95998**	**87624**	**115666**
El Rico GSA Total Crop Acreage	**211398**	**211393**	**211342**	**211325**	**211311**	**211301**	**211291**	**211282**	**211278**	**211273**	**211272**	**211270**	**211268**

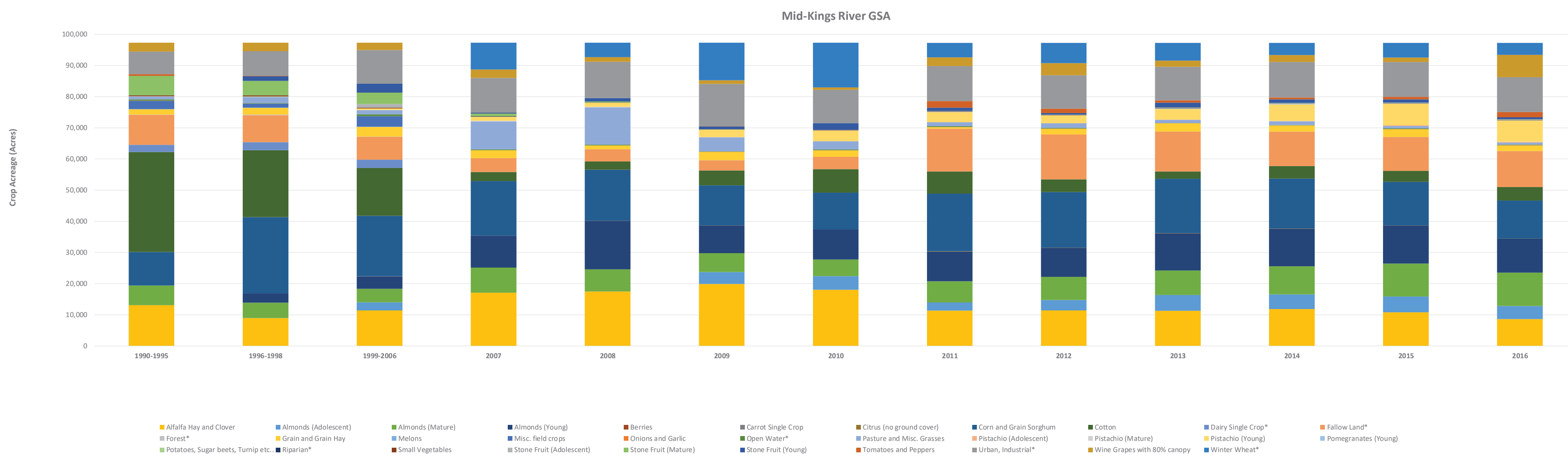
Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D1-2

Sum of Crop Acreage (Acres) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mid-Kings River GSA													
Alfalfa Hay and Clover	13077	8955	11390	17127	17455	19907	17997	11349	11422	11310	11841	10814	8641
Almonds (Adolescent)	0	0	2646	0	0	3787	4400	2615	3312	5048	4677	5026	4221
Almonds (Mature)	6279	4955	4272	8040	7115	6086	5356	6765	7410	7851	9051	10582	10643
Almonds (Young)	0	3000	4011	10240	15571	8903	9640	9566	9308	11916	12070	12231	10961
Berries	0	0	0	0	0	0	0	0	1	2	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	1	2	0	2	0	4
Citrus (no ground cover)	0	0	21	0	10	9	4	110	27	89	30	17	4
Corn and Grain Sorghum	10777	24410	19454	17506	16434	12857	11789	18456	17872	17415	16054	13966	12211
Cotton	32138	21479	15330	2895	2617	4746	7523	7128	4136	2391	4027	3536	4295
Dairy Single Crop*	2278	2624	2666	0	0	0	0	0	0	0	0	0	0
Fallow Land*	9607	8651	7329	4456	3877	3288	3992	13754	14408	12757	11022	10897	11563
Forest*	93	163	71	2	0	7	1	0	0	1	0	0	0
Grain and Grain Hay	1658	2181	3123	2539	1275	2690	2058	498	1815	2657	1915	2558	1776
Melons	151	56	27	0	0	0	0	1	3	4	0	0	13
Misc. field crops	2574	1297	3410	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	58	0	0	0	0	1	20	36	71	4	61	7	118
Open Water*	457	209	560	246	228	121	274	280	177	103	122	203	212
Pasture and Misc. Grasses	860	1881	1360	8942	12009	4550	2646	1272	1468	1001	1177	750	595
Pistachio (Adolescent)	0	0	0	0	0	0	0	2	14	41	112	244	227
Pistachio (Mature)	99	78	74	244	95	46	27	25	17	16	14	14	19
Pistachio (Young)	0	137	452	1302	1386	2477	3444	3198	2521	3410	5367	6919	6844
Pomegranates (Young)	0	0	0	1	21	5	5	114	50	254	220	26	74
Potatoes, Sugar beets, Turnip etc..	0	1	0	2	0	2	0	0	0	0	0	0	1
Riparian*	0	20	20	178	18	20	4	66	9	29	69	10	38
Small Vegetables	336	348	236	15	1	2	98	99	64	102	87	29	92
Stone Fruit (Adolescent)	0	0	1183	0	0	3	60	100	124	69	46	191	166
Stone Fruit (Mature)	6217	4597	3662	793	345	29	7	3	23	41	23	27	39
Stone Fruit (Young)	0	1504	2816	342	1126	953	2187	1008	485	1549	1150	1093	612
Tomatoes and Peppers	589	132	48	1	0	35	0	2108	1412	788	603	763	1651
Urban, Industrial*	7209	7934	10796	11097	11599	13542	10655	11296	10679	10709	11395	11219	11192
Wine Grapes with 80% canopy	2868	2713	2368	2768	1506	1180	778	2768	3935	2023	2241	1448	7218
Winter Wheat*	0	0	0	8574	4606	12043	14313	4658	6509	5691	3894	4696	3835
Mid-Kings River GSA Irrigated Crop A	**77681**	**77725**	**75883**	**72754**	**76968**	**68269**	**68042**	**67222**	**65492**	**67981**	**70768**	**70242**	**70424**
Mid-Kings River GSA Total Crop Acre	**97326**	**97326**	**97325**	**97307**	**97296**	**97289**	**97282**	**97276**	**97273**	**97272**	**97269**	**97267**	**97265**

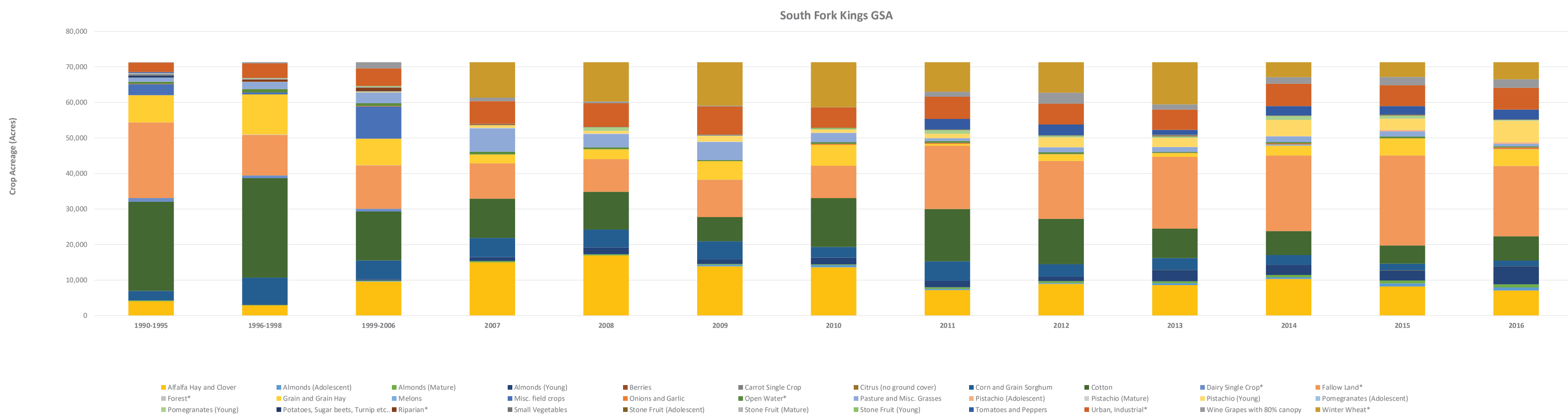
Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D1-3

Sum of Crop Acreage (Acres) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
South Fork Kings GSA													
Alfalfa Hay and Clover	4030	2892	9546	14989	16927	13848	13603	7183	8911	8561	10328	8208	7048
Almonds (Adolescent)	0	0	172	0	0	431	605	301	272	538	469	857	905
Almonds (Mature)	213	143	135	383	332	259	221	507	522	584	651	818	829
Almonds (Young)	0	188	322	1113	1972	1328	1916	1794	1231	3147	2833	2825	5066
Berries	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	1	0	2	0	2	7
Citrus (no ground cover)	0	0	5	0	0	0	0	4	1	5	0	1	1
Corn and Grain Sorghum	2721	7461	5363	5344	4974	5058	2951	5499	3523	3375	2758	1893	1639
Cotton	25101	27984	13748	11091	10661	6816	13753	14685	12783	8294	6759	5136	6829
Dairy Single Crop*	998	761	781	0	0	0	0	0	0	0	0	0	0
Fallow Land*	21306	11422	12200	9929	9182	10491	9125	17821	16304	20156	21235	25318	19818
Forest*	6	106	97	4	1	4	3	0	0	0	0	1	0
Grain and Grain Hay	7688	11325	7401	2545	2791	5254	5903	570	1868	1073	2824	4829	4710
Melons	0	0	0	0	0	0	5	0	2	1	302	0	10
Misc. field crops	3029	537	9083	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	146	0	164	0	0	4	278	262	63	61	316	40	446
Open Water*	568	944	770	707	508	239	479	505	493	289	363	435	314
Pasture and Misc. Grasses	1196	1992	3076	6612	3776	5167	2585	764	1385	1335	1598	1466	736
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	15	20	45	388	391
Pistachio (Mature)	0	0	0	138	122	64	61	61	61	56	51	50	58
Pistachio (Young)	0	34	231	784	778	1662	903	1265	2756	2520	4547	3177	6029
Pomegranates (Adolescent)	0	0	0	0	0	0	0	0	0	0	3	16	27
Pomegranates (Young)	0	0	0	10	1005	102	188	996	411	467	1142	933	292
Potatoes, Sugar beets, Turnip etc..	468	0	209	0	0	2	0	0	0	38	0	1	0
Riparian*	0	648	841	190	14	66	27	101	22	212	32	124	43
Small Vegetables	430	2	0	5	0	8	11	14	30	43	4	38	28
Stone Fruit (Adolescent)	0	0	65	0	0	0	0	1	0	0	1	0	4
Stone Fruit (Mature)	408	316	192	3	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	94	245	38	53	95	229	61	94	86	85	32	40
Tomatoes and Peppers	287	51	0	93	2	8	12	2982	3060	1400	2605	2355	2749
Urban, Industrial*	2631	4086	4952	6415	6654	7933	5793	6213	5863	5729	6304	5928	6151
Wine Grapes with 80% canopy	80	317	1706	974	503	254	60	1408	3084	1481	1877	2279	2329
Winter Wheat*	0	0	0	9941	11051	12214	12590	8305	8551	11832	4173	4154	4807
South Fork Kings GSA Irrigated Crop	**45796**	**53338**	**51663**	**44120**	**43896**	**40359**	**43287**	**38359**	**40073**	**33087**	**39198**	**35344**	**40172**
South Fork Kings GSA Total Crop Ac	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**	**71305**

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D1-4

Sum of Crop Acreage (Acres) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Southwest Kings GSA													
Alfalfa Hay and Clover	4524	1347	4850	10391	9787	5943	6228	3472	4626	3475	1381	960	715
Almonds (Adolescent)	0	0	90	0	0	908	2921	304	879	1889	1372	337	235
Almonds (Mature)	1190	143	143	4474	4377	3481	2797	2867	2887	3005	3175	3646	3633
Almonds (Young)	0	90	4957	4922	8214	4248	6657	2329	3744	4631	2555	1577	3997
Berries	20	0	0	0	0	0	0	0	0	0	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	0	0	0	0	0	0
Citrus (no ground cover)	0	0	0	0	3	4	0	0	2	3	59	4	4
Corn and Grain Sorghum	0	17	0	66	18	640	85	492	32	73	34	4	31
Cotton	10438	26255	2279	2960	1746	2428	3832	4690	1444	5300	1466	1388	1671
Dairy Single Crop*	39	0	15	0	0	0	0	0	0	0	0	0	0
Fallow Land*	53229	41443	25225	17464	35584	26521	24733	48292	49251	49716	51859	61821	58286
Forest*	321	527	2617	0	0	0	0	0	0	0	0	3	0
Grain and Grain Hay	1595	4379	14293	1981	1010	2189	1583	188	597	306	132	796	1251
Melons	100	0	257	0	0	0	9	0	0	0	4	0	1
Misc. field crops	8580	5377	20902	0	0	0	0	0	0	0	2	0	0
Onions and Garlic	0	314	0	0	0	2	25	64	104	2	80	20	15
Open Water*	902	1805	1657	606	473	737	891	1233	536	543	749	774	619
Pasture and Misc. Grasses	0	472	276	9716	1984	24511	23979	1343	898	1176	10802	1403	998
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	1	84	293	2212	2288
Pistachio (Mature)	4595	3730	3730	5195	1195	476	21	21	20	17	6	6	6
Pistachio (Young)	0	1316	3094	829	1002	2610	1360	7358	7551	7459	5794	8509	5688
Pomegranates (Young)	0	0	0	49	147	166	16	3397	249	241	161	23	2448
Potatoes, Sugar beets, Turnip etc..	0	0	0	0	0	0	0	2	0	0	0	0	0
Riparian*	0	0	0	76	1	219	186	35	27	13	25	13	12
Small Vegetables	27	0	0	1	1	0	38	14	19	2	9	5	5
Stone Fruit (Adolescent)	0	0	229	0	0	11	6	0	0	0	0	0	0
Stone Fruit (Mature)	445	72	0	518	198	139	11	0	0	0	0	0	0
Stone Fruit (Young)	0	229	1124	289	416	462	83	4	10	4	102	0	2
Tomatoes and Peppers	1689	83	3	19	0	1	0	2601	3012	3	144	7	54
Urban, Industrial*	169	262	546	3643	4212	6157	4050	3619	2776	2885	4250	3199	3148
Wine Grapes with 80% canopy	0	0	1576	1684	1312	788	505	1093	1796	1113	2137	757	1060
Winter Wheat*	0	0	0	22975	16175	5212	7839	4436	7394	5913	1262	388	1688
Southwest Kings GSA Irrigated Crop	**33202**	**43824**	**57801**	**43094**	**31411**	**49008**	**50156**	**30239**	**27869**	**28783**	**29707**	**21654**	**24100**
Southwest Kings GSA Total Crop Acr	**87862**	**87862**	**87860**	**87858**	**87856**	**87855**	**87854**	**87854**	**87853**	**87853**	**87852**	**87852**	**87852**

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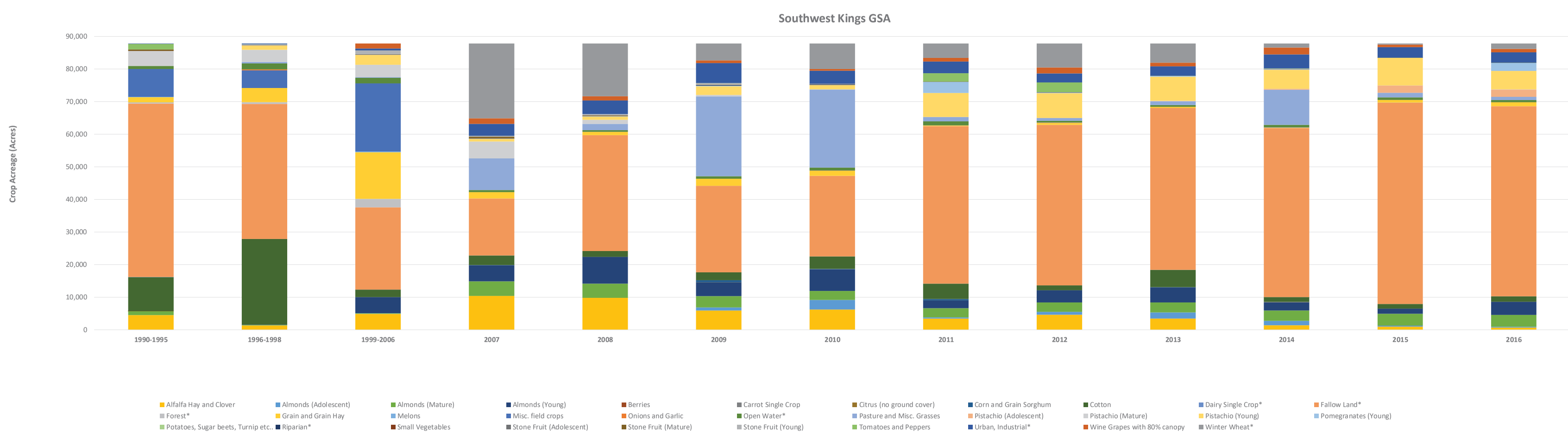

Sum of Crop Acreage (Acres) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tri-County Water Authority GSA													
Alfalfa Hay and Clover	2917	488	290	1402	1672	181	469	750	526	544	469	765	159
Almonds (Adolescent)	0	0	0	0	0	0	0	0	0	0	0	0	0
Almonds (Young)	0	0	0	5	28	2	6	42	21	11	12	104	7
Carrot Single Crop	0	0	0	0	0	0	0	2	0	9	0	0	0
Citrus (no ground cover)	0	0	0	0	0	0	0	1	0	0	0	0	0
Corn and Grain Sorghum	0	1486	0	347	123	0	2	274	62	114	20	5	1
Cotton	830	4665	6333	172	952	210	714	49	39	104	147	325	47
Dairy Single Crop*	116	199	205	0	0	0	0	0	0	0	0	0	0
Fallow Land*	35703	21667	19509	15775	17303	25691	29979	26643	41003	41346	32290	39427	39639
Forest*	0	0	14	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	2719	15911	12888	4050	12212	7013	4217	1625	433	130	336	872	1024
Melons	0	0	0	0	0	0	0	0	0	0	0	15	0
Misc. field crops	921	2871	8503	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	0	0	0	0	0	0	3	22	5	0	1	0	2
Open Water*	90	771	305	274	49	13	42	665	86	45	764	51	58
Pasture and Misc. Grasses	0	1	1	9885	8538	11063	10637	6414	3873	4601	11501	4618	4202
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pistachio (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pistachio (Young)	0	1	1	151	63	164	309	16	11	22	342	212	685
Pomegranates (Young)	0	0	0	0	14	35	22	46	2	8	143	7	5
Potatoes, Sugar beets, Turnip etc..	4803	0	0	0	0	0	0	6	0	1	0	0	0
Riparian*	0	0	0	63	42	0	11	3	67	5	30	9	1
Small Vegetables	0	0	0	0	0	0	6	0	1	30	0	1	1
Stone Fruit (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	0	0	1	0	0	0	0	0	0	1	0	0
Tomatoes and Peppers	0	0	0	0	0	0	0	17	1	4	20	46	24
Urban, Industrial*	0	39	50	1247	1374	1594	1184	1122	722	740	1413	910	868
Wine Grapes with 80% canopy	0	0	0	2	36	0	3	2	6	2	3	2	0
Winter Wheat*	0	0	0	14715	5675	2104	462	10361	1199	337	563	685	1327
Irrigated Crop Acreage	**12191**	**25423**	**28017**	**16014**	**23638**	**18668**	**16387**	**9267**	**4981**	**5582**	**12994**	**6971**	**6157**
Total Crop Acreage	**48099**	**48099**	**48099**	**48088**	**48081**	**48070**	**48064**	**48061**	**48059**	**48056**	**48053**	**48053**	**48051**

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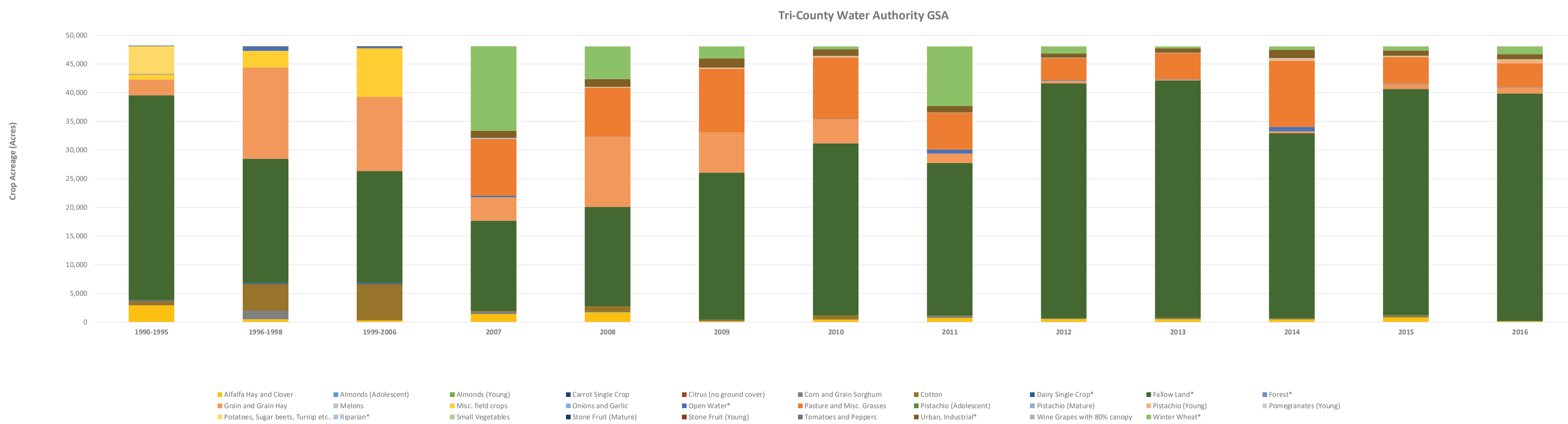

Sum of Crop Acreage (Acres) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tulare Lake Subbasin													
Alfalfa Hay and Clover	41604	32564	54301	72459	80600	71504	69685	38789	42131	49318	35820	29665	24245
Almonds (Adolescent)	0	0	2908	0	0	5127	7927	3222	4464	7476	6526	6222	5365
Almonds (Mature)	7682	5241	4550	12897	11825	9826	8374	10140	10818	11441	12876	15046	15105
Almonds (Young)	0	3278	9290	16538	25966	14678	20887	13968	14564	20341	17678	16983	21576
Berries	20	0	0	0	0	0	0	0	1	2	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	11	5	12	2	2	16
Citrus (no ground cover)	0	0	25	0	13	14	4	120	29	100	89	22	9
Corn and Grain Sorghum	14280	38896	29349	39271	31762	34643	23031	33780	29175	27566	22638	18826	17400
Cotton	159534	180960	124764	109605	88304	72441	98167	105541	88993	89317	63385	44532	73720
Dairy Single Crop*	3816	4077	4385	0	0	0	0	0	0	0	0	0	0
Fallow Land*	193695	138392	89606	65169	85144	99688	90192	152391	172697	172486	195172	237790	200972
Forest*	420	809	2955	6	5	46	5	0	0	1	0	4	0
Grain and Grain Hay	28708	48533	62962	19266	27870	27406	25980	7758	9968	11194	12213	21196	19069
Melons	250	56	284	0	0	0	14	2	11	7	797	18	86
Misc. field crops	17116	12819	51311	0	2	0	0	0	0	0	2	0	0
Onions and Garlic	457	479	770	0	0	7	1358	411	302	94	502	149	644
Open Water*	5568	9092	8968	5576	4296	4049	5434	7703	5443	5045	6824	5919	5435
Pasture and Misc. Grasses	2500	5029	5615	50688	44232	66944	53080	14680	13368	15355	33551	15744	13743
Pistachio (Adolescent)	0	0	0	0	0	0	0	170	218	370	882	3575	3836
Pistachio (Mature)	4694	3808	3804	6096	1907	934	404	394	380	348	330	485	469
Pistachio (Young)	0	1580	4390	4351	4259	8527	8083	12985	14676	15878	19195	22678	22570
Pomegranates (Adolescent)	0	0	0	0	0	0	0	0	0	0	3	16	27
Pomegranates (Young)	0	0	0	61	1705	545	256	5012	804	1395	2207	1312	3111
Potatoes, Sugar beets, Turnip etc..	5736	1	209	6	0	3	0	9	0	41	0	2	2
Riparian*	0	668	1120	517	134	398	615	226	138	313	239	248	194
Small Vegetables	1599	647	4518	20	2	13	212	142	133	244	165	78	198
Stone Fruit (Adolescent)	0	0	1478	0	0	14	66	100	125	69	47	191	170
Stone Fruit (Mature)	7070	4985	3854	1314	544	168	18	3	23	41	23	27	39
Stone Fruit (Young)	0	1827	4185	672	1609	1573	2502	1077	712	1641	1340	1183	713
Tomatoes and Peppers	5634	1627	14676	117	2	110	12	21482	23670	7114	11922	19211	23420
Urban, Industrial*	12654	17391	19875	33427	34711	44471	32218	32091	28576	29366	33901	30530	30930
Wine Grapes with 80% canopy	2948	3226	5779	5588	3499	2240	2746	5361	9228	4655	6472	4672	10985
Winter Wheat*	0	0	0	72238	67458	50451	64526	48212	45118	44530	30950	19420	21690
Tulare Lake Subbasin Irrigated Crop	**299832**	**345557**	**389021**	**338951**	**324102**	**316717**	**322806**	**275156**	**263796**	**264018**	**248665**	**221837**	**256519**
Tulare Lake Subbasin Total Crop Acr	**515986**	**515986**	**515931**	**515883**	**515849**	**515821**	**515796**	**515779**	**515768**	**515759**	**515751**	**515747**	**515741**

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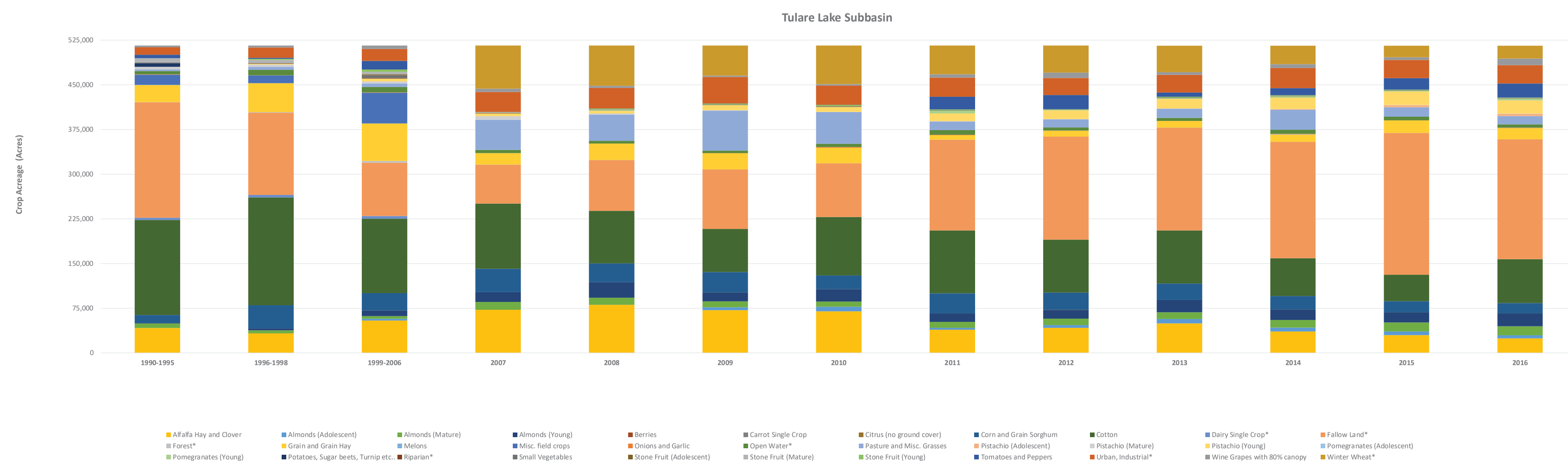

APPENDIX D1-7

Sum of Crop Acreage (Acres) Kaweah Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kaweah Subbasin													
Alfalfa Hay and Clover	27850	25488	29418	43095	41094	43668	40716	32231	33810	31880	30293	28662	26949
Almonds (Adolescent)	0	0	771	0	0	1532	2066	872	1229	1617	1456	1803	3445
Almonds (Mature)	3153	2535	2191	1736	1410	1077	921	1634	1819	1926	2456	2749	2995
Almonds (Young)	0	790	398	6870	11485	6194	8294	5130	4634	6064	9091	13550	14488
Berries	0	9	9	0	0	0	0	0	0	0	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	26	2	0	3	0	4
Citrus (no ground cover)	0	0	0	4	10	15	4	12	10	53	73	5	8
Corn and Grain Sorghum	26638	43219	43776	27456	32303	22468	21812	45387	47930	48395	48640	42286	34456
Cotton	59129	39071	33139	13910	9429	11494	18937	17481	13112	10144	9699	6535	10619
Dairy Single Crop*	4739	5962	6386	0	0	0	0	0	0	0	0	0	0
Fallow Land*	9002	7460	7147	2975	2992	3242	3633	15205	9874	13007	11274	12526	11575
Forest*	176	46	35	0	1	20	0	0	0	1	3	0	0
Grain and Grain Hay	7117	7703	8178	6799	501	2199	1849	745	1957	2730	1408	2541	1462
Melons	153	101	101	0	0	1	0	3	1	14	0	2	102
Misc. field crops	1745	1167	1439	0	1	1	0	0	0	0	0	0	0
Onions and Garlic	429	229	229	0	0	0	33	167	24	1	9	4	277
Open Water*	1210	726	866	246	233	247	516	579	378	199	277	492	424
Pasture and Misc. Grasses	1206	1112	1494	14364	26396	9090	9378	3711	6078	5345	5242	4515	4501
Pistachio (Adolescent)	0	0	0	0	0	0	0	336	493	880	1833	4513	4211
Pistachio (Mature)	1020	955	955	2307	1657	1343	1083	1034	886	794	771	1046	900
Pistachio (Young)	0	1985	2037	2026	2702	4762	4110	8081	9263	8907	9834	8573	8411
Pomegranates (Young)	0	0	0	4	155	10	3	89	52	430	128	102	395
Potatoes, Sugar beets, Turnip etc..	419	684	611	6	0	1	0	107	58	3	205	155	188
Riparian*	0	934	934	16	14	32	3	13	15	59	34	9	58
Small Vegetables	1749	3208	3163	89	1	5	2	175	490	782	766	780	725
Stone Fruit (Adolescent)	0	0	1320	0	0	22	26	20	128	382	403	82	30
Stone Fruit (Mature)	1645	883	762	125	24	5	0	19	3	7	70	94	17
Stone Fruit (Young)	0	1360	310	120	828	489	824	923	1191	818	1005	558	258
Tomatoes and Peppers	752	2013	1691	14	1	16	0	1188	384	697	546	1415	1750
Urban, Industrial*	3123	3412	3648	7583	7565	10932	7414	7056	6340	6453	6684	6941	6921
Wine Grapes with 80% canopy	801	1007	1036	1909	1183	630	547	1589	1944	1146	1170	862	4520
Winter Wheat*	0	0	0	20373	12023	32495	29802	8152	9855	9222	8580	11152	12262
Kaweah Subbasin Irrigated Crop Acr	**133807**	**133516**	**133027**	**120832**	**129180**	**105020**	**110604**	**120961**	**125498**	**123017**	**125103**	**120831**	**120710**
Kaweah Subbasin Total Crop Acreag	**152057**	**152057**	**152044**	**152025**	**152007**	**151987**	**151972**	**151966**	**151959**	**151957**	**151955**	**151951**	**151949**

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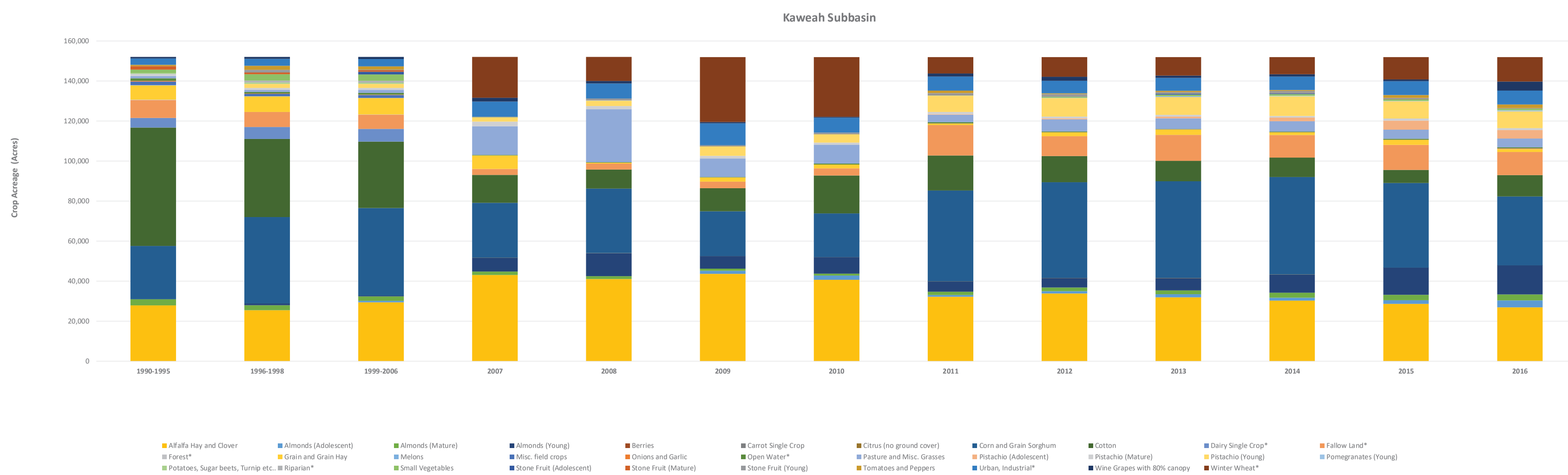

APPENDIX D1-8

Sum of Crop Acreage (Acres) Kern County Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kern County Subbasin													
Alfalfa Hay and Clover	4901	4407	1624	4680	3816	4559	6610	2076	2224	3033	3011	2533	2915
Almonds (Adolescent)	0	0	812	0	0	1015	2696	295	249	1001	1166	529	567
Almonds (Mature)	1966	1035	402	2459	2384	2079	1689	1674	1889	1875	1878	2559	2635
Almonds (Young)	0	835	2229	5818	7283	2776	1820	1994	3570	4715	3756	3421	2367
Berries	0	0	0	0	0	0	0	0	0	8	0	0	0
Carrot Single Crop	53	0	0	0	0	0	0	0	0	3	1	1	2
Citrus (no ground cover)	0	0	0	0	131	278	0	2	19	2	152	1	1
Corn and Grain Sorghum	234	184	439	635	878	504	218	964	1186	852	491	614	144
Cotton	7102	10686	800	474	798	283	1970	614	385	66	120	30	62
Dairy Single Crop*	1	0	331	0	0	0	0	0	0	0	0	0	0
Fallow Land*	48223	31069	38616	13275	16082	6615	6146	40232	43273	36573	35547	40594	38237
Forest*	168	3	4832	0	1	1	0	0	2	0	0	0	0
Grain and Grain Hay	4362	11541	8261	506	1043	838	1682	1944	1374	1267	1078	1121	2860
Melons	0	0	0	0	0	1	0	0	21	8	1	0	4
Misc. field crops	2316	1463	1842	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	130	56	0	0	0	0	9	52	71	10	16	34	102
Open Water*	2	308	376	513	376	796	241	553	408	202	331	137	126
Pasture and Misc. Grasses	1641	3129	2856	35869	32488	45504	44155	8180	8962	13185	18668	10827	9311
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	0	2	61	758	807
Pistachio (Mature)	1847	1786	1775	2033	207	1	0	0	0	0	0	0	0
Pistachio (Young)	0	1906	4110	1063	631	663	1182	5304	7047	7601	4011	8202	6088
Pomegranates (Young)	0	0	0	0	361	0	0	5246	486	199	188	59	3850
Potatoes, Sugar beets, Turnip etc..	84	0	0	0	0	1	0	0	1	0	2	5	1
Riparian*	0	4723	4997	1015	956	1662	470	406	748	1307	571	1029	788
Small Vegetables	22	0	50	0	2	0	12	4	12	9	6	11	12
Stone Fruit (Adolescent)	0	0	20	0	0	0	0	0	0	0	0	0	3
Stone Fruit (Mature)	1600	245	202	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	27	3	5	124	60	14	42	14	25	246	24	119
Tomatoes and Peppers	724	766	0	0	0	1	0	83	80	17	24	28	127
Urban, Industrial*	16	237	266	2445	2462	4764	3065	2002	1443	1807	2236	1848	1751
Wine Grapes with 80% canopy	1779	2764	2324	2284	1647	852	1439	1520	1657	1530	2223	1418	1343
Winter Wheat*	0	0	0	4077	5456	3860	3684	3907	1963	1781	1292	1290	2849
Kern County Subbasin Irrigated Crop	**28760**	**40830**	**27749**	**55826**	**51792**	**59414**	**63495**	**29994**	**29247**	**35407**	**37098**	**32174**	**33318**
Kern County Subbasin Total Crop Ac	**77170**	**77170**	**77168**	**77150**	**77125**	**77111**	**77102**	**77094**	**77084**	**77078**	**77074**	**77073**	**77070**

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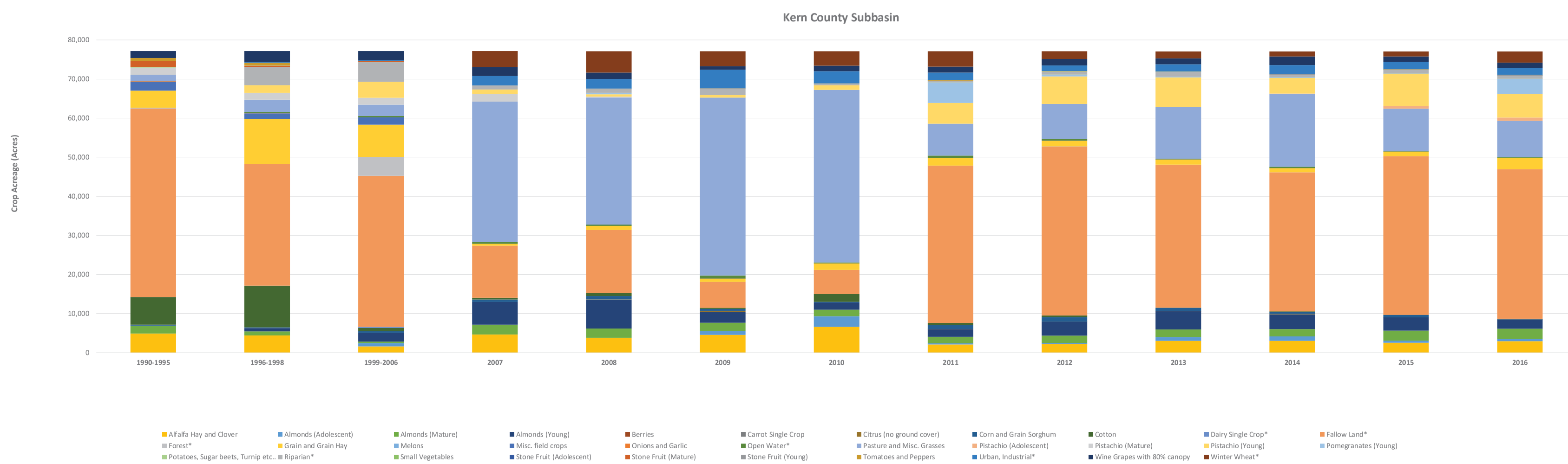

Sum of Crop Acreage (Acres) Kings Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kings Subbasin													
Alfalfa Hay and Clover	16306	11835	14019	24478	21394	30890	33571	14356	14247	13523	17393	14242	12182
Almonds (Adolescent)	0	0	3414	0	0	10231	8066	3031	3819	5446	5193	4806	8502
Almonds (Mature)	4542	3495	3350	5386	4752	3247	2623	5737	5882	3838	4426	6262	5965
Almonds (Young)	0	3529	1164	26493	40739	14505	10844	19230	18486	16474	23168	29556	14910
Berries	0	3	3	0	0	0	0	0	2	16	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	14	1	2	36	0	8
Citrus (no ground cover)	532	557	557	74	93	851	57	206	148	1165	2395	975	570
Corn and Grain Sorghum	9363	14915	13000	5986	10644	6420	7212	13547	12495	9374	12586	9486	8811
Cotton	17806	11022	8861	3151	3700	3875	7667	6017	4335	2911	4225	2613	3156
Dairy Single Crop*	2549	2553	2615	0	0	0	0	0	0	0	0	0	0
Fallow Land*	9327	7519	6268	4149	1922	4614	3512	10692	11063	6697	5755	7343	8050
Forest*	413	229	266	17	9	22	9	2	11	2	2	4	16
Grain and Grain Hay	3299	2801	3445	1384	1109	2770	3757	987	1365	3407	1774	2054	677
Melons	407	180	130	0	3	18	4	1	10	33	7	9	29
Misc. field crops	3315	3204	3954	0	0	1	0	0	0	0	0	0	0
Onions and Garlic	0	0	106	27	58	91	38	175	73	65	389	107	236
Open Water*	671	893	1398	536	483	241	350	473	459	471	418	539	374
Pasture and Misc. Grasses	3833	2326	1914	9370	10809	5861	6552	1431	2665	2291	1789	1361	1172
Pistachio (Adolescent)	0	0	0	0	0	0	0	3	10	3	21	38	34
Pistachio (Mature)	172	109	109	96	73	66	59	59	58	58	56	56	34
Pistachio (Young)	0	9	121	1806	1466	3603	1931	5141	3223	3251	4585	2899	4214
Pomegranates (Young)	0	0	0	142	194	337	312	966	661	581	601	414	315
Potatoes, Sugar beets, Turnip etc..	0	31	233	1	0	2	0	9	0	0	0	2	0
Riparian*	0	584	821	417	54	454	44	280	110	147	219	75	67
Small Vegetables	1465	961	728	9	38	3	15	80	133	591	63	20	52
Stone Fruit (Adolescent)	0	0	8693	0	0	9	87	120	241	326	234	311	141
Stone Fruit (Mature)	20143	16740	16500	1663	324	64	42	12	15	12	32	24	14
Stone Fruit (Young)	0	8804	865	632	3153	3757	6595	4583	2872	14281	4299	3588	1501
Tomatoes and Peppers	51	450	309	15	4	147	23	632	484	1101	554	489	1483
Urban, Commercial*	234	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Industrial*	4096	4846	4942	9013	8793	12129	8555	8395	7942	10273	7943	8218	8190
Wine Grapes with 80% canopy	20602	21532	21331	16829	6248	5113	8126	17826	21517	14294	17966	19448	34154
Winter Wheat*	0	0	0	7416	3009	9737	8988	5024	6696	8390	2883	4070	4153
Kings Subbasin Irrigated Crop Acrea	**101836**	**102501**	**102807**	**97542**	**104801**	**91860**	**97580**	**94163**	**92742**	**93040**	**101794**	**98762**	**98160**
Kings Subbasin Total Crop Acreage	**119125**	**119125**	**119116**	**119090**	**119071**	**119056**	**119038**	**119030**	**119023**	**119019**	**119014**	**119012**	**119009**

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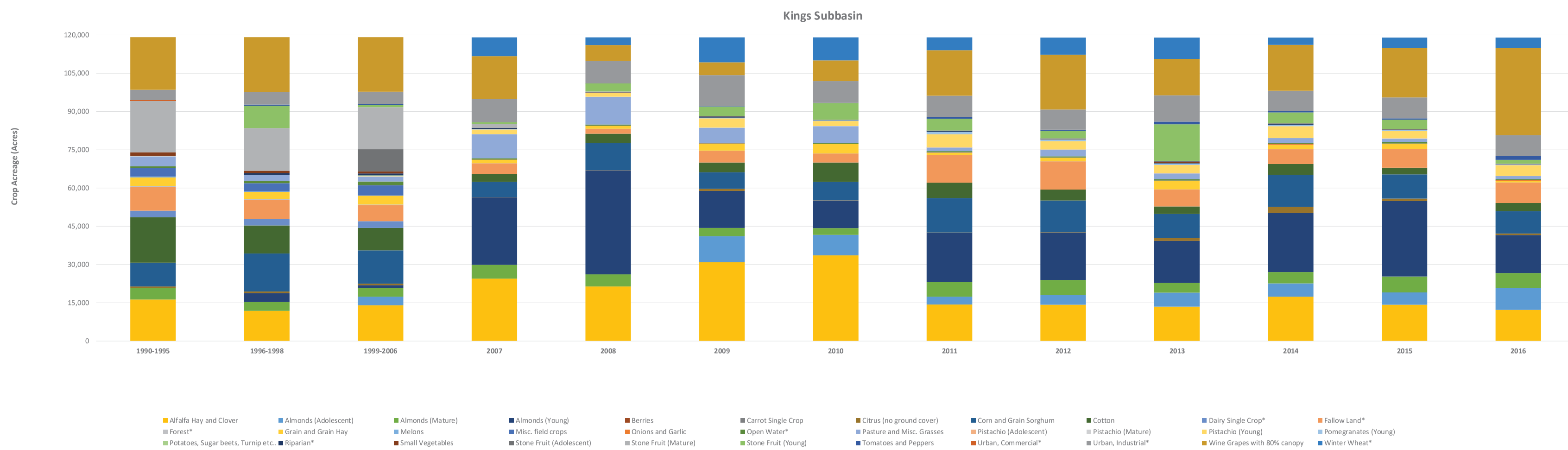

Sum of Crop Acreage (Acres) Tule Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tule Subbasin													
Alfalfa Hay and Clover	11815	24766	24766	24935	23335	18778	21039	12659	13696	12191	12634	10375	10831
Almonds (Adolescent)	0	0	2	0	0	48	32	5	3	20	48	98	413
Almonds (Mature)	43	13	13	0	0	0	0	3	0	0	0	6	6
Almonds (Young)	0	2	0	656	1520	1020	306	1111	740	1320	2101	2193	1892
Berries	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	1	0	0	0	1	17
Citrus (no ground cover)	0	0	0	0	0	0	0	5	0	3	4	2	1
Corn and Grain Sorghum	7656	13330	13330	8428	8660	5049	3069	18412	17304	11863	13687	10594	6087
Cotton	26378	13577	13577	1320	1507	2684	5541	2100	1527	1080	1498	1346	1809
Dairy Single Crop*	1668	3213	3213	0	0	0	0	0	0	0	0	0	0
Fallow Land*	50291	34370	34370	19350	25634	23018	24491	57622	52185	58262	47946	49332	40907
Forest*	59	9	9	0	0	13	0	0	0	0	0	0	0
Grain and Grain Hay	20747	22935	22934	3486	3875	4813	8244	6775	6675	7204	8679	11225	13366
Melons	12	0	0	0	0	5	0	1	2	1	65	4	27
Misc. field crops	1909	2492	2494	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	2	0	0	1	0	0	83	41	103	1	5	20	59
Open Water*	2437	1373	1373	686	547	653	788	935	437	716	654	700	650
Pasture and Misc. Grasses	238	2419	2419	36249	38175	33240	40465	7292	14196	15170	18730	15904	11931
Pistachio (Adolescent)	0	0	0	0	0	0	0	459	371	429	624	995	1192
Pistachio (Mature)	0	0	0	100	67	41	33	33	33	32	32	398	398
Pistachio (Young)	0	201	201	1954	1313	3170	3336	2747	3086	4184	4677	4328	6906
Pomegranates (Young)	0	0	0	2	98	67	17	1076	2311	1363	2648	2709	2393
Potatoes, Sugar beets, Turnip etc..	929	2278	2278	0	0	1	0	1	1	1	4	7	1
Riparian*	0	2509	2509	199	121	57	183	186	58	158	68	63	47
Small Vegetables	0	517	517	1	1	5	204	10	33	31	55	43	236
Stone Fruit (Adolescent)	0	0	20	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Mature)	9	0	0	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	20	0	7	72	9	2	35	31	1	43	41	6
Tomatoes and Peppers	2	18	18	1	0	2	0	105	108	72	268	233	658
Urban, Industrial*	950	1116	1116	4262	4258	6251	4117	3636	3116	3057	3771	3517	3402
Wine Grapes with 80% canopy	71	61	61	35	93	33	99	124	187	32	106	119	136
Winter Wheat*	0	0	0	23544	15937	26255	13161	9833	9005	8017	6859	10955	21832
Tule Subbasin Irrigated Crop Acreag	**69813**	**82629**	**82629**	**77175**	**78716**	**68963**	**82470**	**52997**	**60406**	**54997**	**65908**	**60640**	**58368**
Tule Subbasin Total Crop Acreage	**125218**	**125218**	**125218**	**125215**	**125214**	**125210**	**125209**	**125208**	**125207**	**125206**	**125206**	**125206**	**125205**

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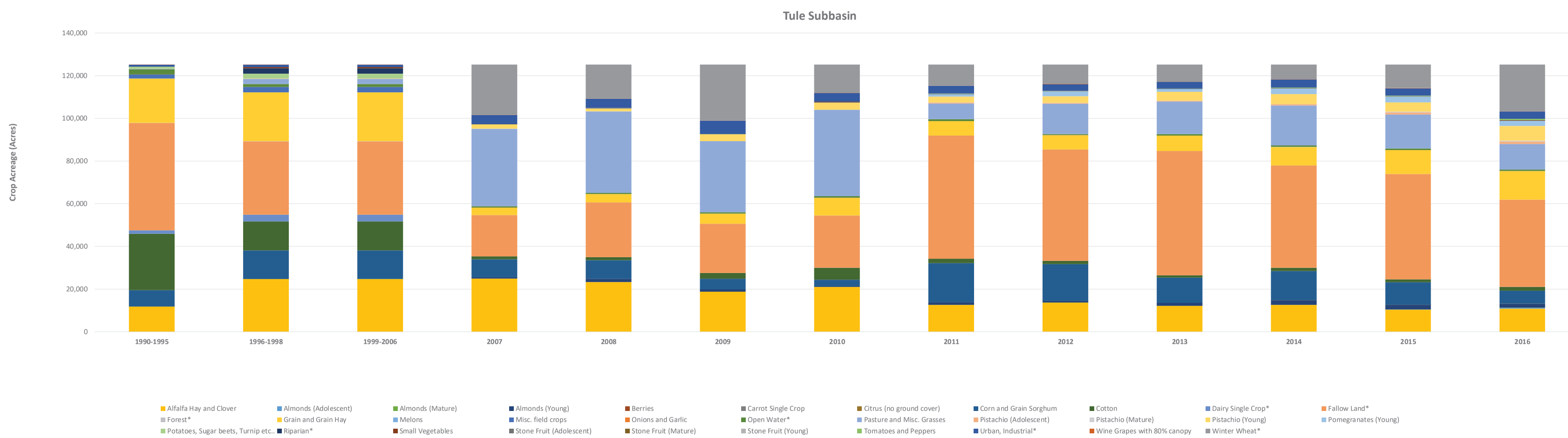

Sum of Crop Acreage (Acres) Westside Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Westside Subbasin													
Alfalfa Hay and Clover	3565	1318	4209	5516	7401	9897	6821	2099	2614	2755	1895	1262	1284
Almonds (Adolescent)	0	0	485	0	0	1873	2016	183	381	1622	1309	802	736
Almonds (Mature)	152	0	0	1044	968	729	240	1962	2029	2068	2348	3129	2866
Almonds (Young)	0	492	680	3525	4619	1617	3064	2645	2375	2820	2693	2702	3720
Berries	12	9	11	0	0	0	0	0	194	0	0	0	30
Carrot Single Crop	0	0	0	0	0	0	0	52	0	1	3	28	2
Citrus (no ground cover)	8	7	18	0	37	16	0	72	0	128	276	27	146
Corn and Grain Sorghum	484	805	423	3151	3625	4814	1747	312	302	9	29	8	45
Cotton	39262	43751	28342	19395	8364	4552	11801	22437	17678	8400	5293	4097	5286
Dairy Single Crop*	95	0	0	0	0	0	0	0	0	0	0	0	0
Fallow Land*	12574	9781	4611	12872	16866	19744	11787	11910	13995	19578	26359	36778	32844
Forest*	47	0	0	11	3	112	206	0	0	11	0	0	0
Grain and Grain Hay	5433	4637	8954	2865	5720	1326	3954	952	7891	2061	3743	1900	2345
Melons	777	2323	1020	3	3702	556	2743	368	414	741	394	158	85
Misc. field crops	5520	3801	14307	0	0	0	14	0	0	0	0	0	0
Onions and Garlic	1997	2306	3392	767	381	1373	385	3942	4252	4107	3712	3762	4236
Open Water*	517	986	678	490	351	385	275	348	379	233	369	479	364
Pasture and Misc. Grasses	0	2	74	2414	2521	2822	4201	429	894	988	881	254	280
Pistachio (Adolescent)	0	0	0	0	0	0	0	900	1016	1184	1676	1740	1956
Pistachio (Mature)	1089	1048	1046	748	387	3	2	2	2	1	0	874	876
Pistachio (Young)	0	382	481	3177	3380	2036	3957	4225	4973	5282	7563	3854	4571
Pomegranates (Adolescent)	0	0	0	0	0	0	0	0	0	24	0	0	0
Pomegranates (Young)	0	0	0	259	395	136	645	251	168	210	13	168	239
Potatoes, Sugar beets, Turnip etc..	0	0	1051	106	0	0	0	30	0	0	0	0	2
Riparian*	0	0	0	19	8	348	39	11	2	17	10	6	8
Small Vegetables	651	537	281	2210	421	286	305	834	878	1259	2529	385	814
Stone Fruit (Adolescent)	0	0	67	0	0	87	42	50	40	13	53	0	0
Stone Fruit (Mature)	865	712	508	1081	867	605	494	435	1	0	6	0	0
Stone Fruit (Young)	0	101	1173	250	485	452	1600	520	127	114	86	2	60
Tomatoes and Peppers	4765	4606	4502	2001	77	1284	497	7045	8011	10820	9286	6558	6171
Urban, Commercial*	21	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Industrial*	2219	2465	3683	6617	6463	8360	6217	5623	4131	4533	4628	4411	4697
Wine Grapes with 80% canopy	353	341	408	1780	1265	714	686	725	1333	1503	1881	1261	1756
Winter Wheat*	0	0	0	10100	12089	16257	16641	12017	6298	9893	3340	5724	4952
Westside Subbasin Irrigated Crop Ac	**64932**	**67173**	**71432**	**50291**	**44615**	**35179**	**45215**		**55572**	**46111**	**45668**	**32972**	**37506**
Westside Subbasin Total Crop Acrea	**80405**	**80405**	**80404**	**80400**	**80394**	**80386**	**80381**	**80378**	**80376**	**80375**	**80373**	**80371**	**80371**

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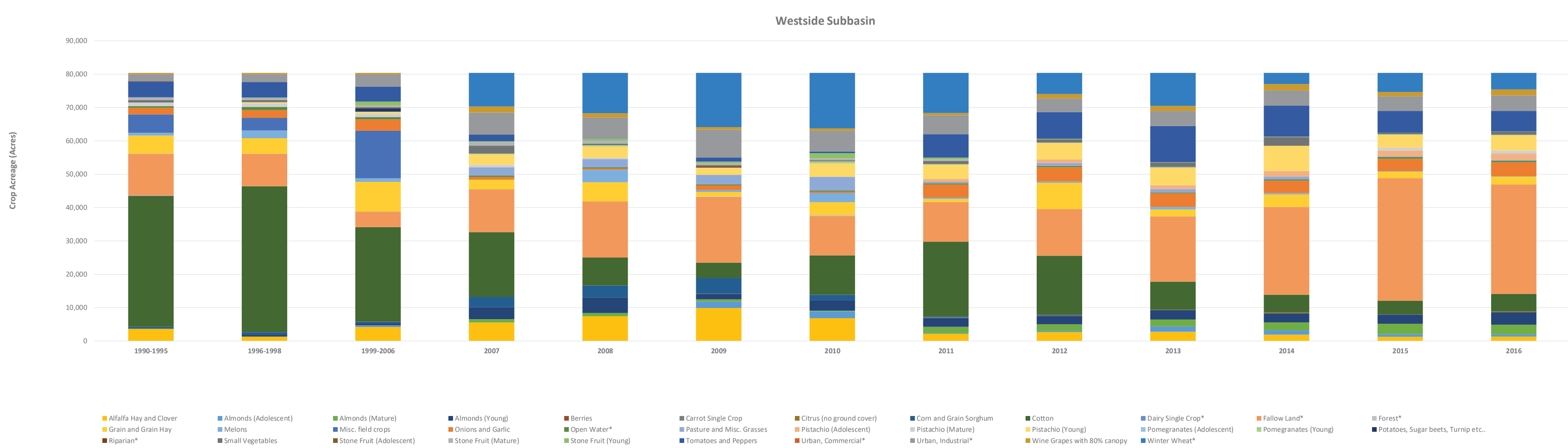


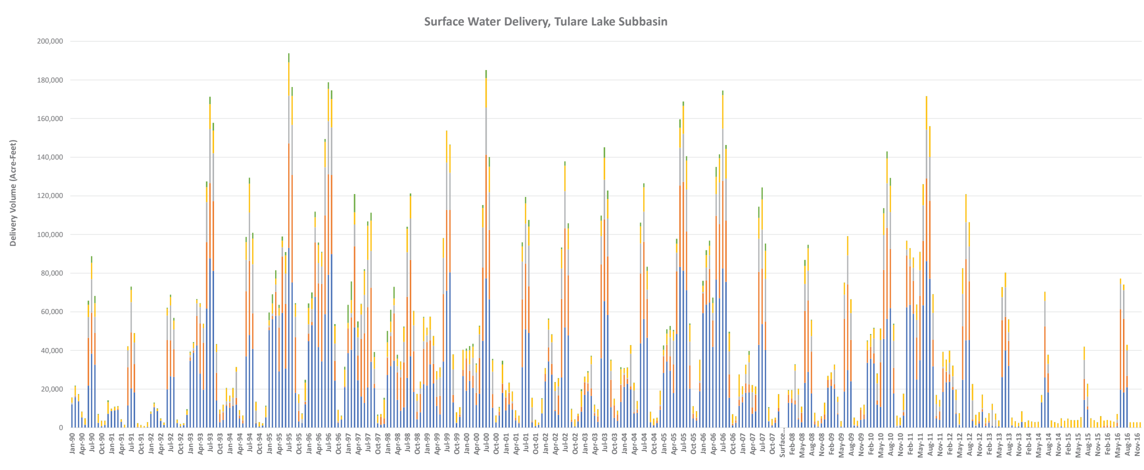
Appendix D2
Monthly Surface Water Deliveries by GSA and Subbasin

APPENDIX D2-1

Surface Water Delivery (Acre-Feet)	El Rico GSA	Mid-Kings River GSA	South Fork Kings GSA	Southwest Kings GSA	Tri-County Water Authority GSA	Tulare Lake Subbasin Total
Jan-90	12096	0	799	2753	12	15660
Feb-90	15780	532	389	4646	439	21787
Mar-90	13668	183	0	3383	136	17370
Apr-90	5311	0	0	3008	136	8454
May-90	1550	0	0	3191	159	4900
Jun-90	21777	24810	10647	6343	2198	65774
Jul-90	38337	21228	17294	8527	3431	88817
Aug-90	32604	16448	8315	7059	3826	68253
Sep-90	2580	0	0	4198	328	7106
Oct-90	788	0	0	2760	78	3626
Nov-90	1498	0	0	2048	164	3709
Dec-90	7192	0	0	6100	889	14181
Jan-91	8679	0	0	1104	181	9965
Feb-91	8930	0	0	1727	185	10843
Mar-91	9149	547	0	1291	182	11170
Apr-91	3017	45	0	1251	62	4375
May-91	114	0	0	1304	1	1420
Jun-91	11492	19825	8674	2059	6	42056
Jul-91	20315	29037	15627	6390	1621	72990
Aug-91	18326	14618	11119	4857	21	48941
Sep-91	329	202	0	1793	3	2328
Oct-91	58	0	0	1244	1	1303
Nov-91	111	0	0	725	1	837
Dec-91	540	0	0	2339	8	2888
Jan-92	7246	0	0	920	273	8440
Feb-92	10577	299	0	1569	546	12991
Mar-92	8589	0	0	1126	352	10067
Apr-92	3607	0	0	1104	175	4886
May-92	1444	0	0	1157	101	2702
Jun-92	19886	25477	12628	3649	434	62074
Jul-92	26610	18544	18112	4383	1222	68870
Aug-92	26266	14436	10146	4586	1475	56908
Sep-92	2425	0	17	1607	210	4260
Oct-92	733	0	0	1107	50	1890
Nov-92	1399	0	42	788	105	2334
Dec-92	6752	0	0	2247	568	9567
Jan-93	34635	1882	1061	1250	518	39346
Feb-93	38849	1049	1263	2577	606	44344
Mar-93	42588	15260	6536	1765	484	66632
Apr-93	27978	25934	8549	1783	190	64434
May-93	19683	24280	7672	2096	49	53781
Jun-93	61633	34418	20707	7760	2909	127427
Jul-93	87698	38923	27999	12806	3881	171307
Aug-93	81214	36099	24734	11805	3983	157835
Sep-93	14088	14353	10776	3878	252	43346
Oct-93	2877	4303	0	2120	24	9326
Nov-93	3993	3868	580	3408	51	11900
Dec-93	11465	490	1753	6678	277	20663
Jan-94	10334	2575	689	2961	7	16565
Feb-94	11346	324	3923	4813	240	20646
Mar-94	12003	3460	13518	2370	74	31425
Apr-94	4798	1453	468	2327	74	9121
May-94	2215	1617	63	2408	87	6390
Jun-94	36961	33759	16145	9249	2660	98774
Jul-94	48009	38368	25061	14823	3141	129403
Aug-94	40822	18407	25402	13274	2948	100854
Sep-94	2209	284	6397	4309	208	13407
Oct-94	589	0	0	2259	43	2891
Nov-94	1124	0	0	1123	90	2336
Dec-94	5419	0	0	5487	486	11392
Jan-95	50543	1489	872	2742	4002	59648
Feb-95	56193	1601	1274	5234	4718	69020
Mar-95	57904	12501	3713	3136	4209	81464
Apr-95	29106	22707	6177	3981	1644	63614
May-95	59386	29180	4786	3452	2211	99016
Jun-95	30642	33398	15773	9446	1637	90896
Jul-95	93097	54051	24738	17192	4769	193847
Aug-95	75149	55594	25997	14978	4617	176335
Sep-95	18055	28881	10439	6469	600	64444
Oct-95	3250	5460	4122	4404	130	17366
Nov-95	2410	0	1993	2751	275	7430
Dec-95	12155	1222	586	9321	1489	24773
Jan-96	44804	3917	4812	8505	2349	64387
Feb-96	53068	1691	6610	5587	3070	70027
Mar-96	67724	28082	7981	5191	2808	111787
Apr-96	41794	32997	10433	9367	1218	95808
May-96	34362	40058	8963	7192	410	90985
Jun-96	58752	51099	24996	13079	1533	149459
Jul-96	79092	52174	27425	16679	3469	178839
Aug-96	89843	40906	24649	14773	4495	174666
Sep-96	24394	10256	8963	9114	940	53668
Oct-96	2515	415	373	5858	131	9293
Nov-96	4276	0	0	1720	277	6274
Dec-96	21009	507	0	8581	1500	31597
Jan-97	38642	12784	0	2864	9282	63572
Feb-97	40362	16730	2192	6744	9729	75757
Mar-97	51972	41932	11303	6310	9411	120928
Apr-97	24596	12751	9437	5063	3232	55079
May-97	16136	29820	12593	5395	166	64110
Jun-97	12763	36157	19809	12465	842	82036
Jul-97	20865	41549	24488	17688	2223	106812
Aug-97	34090	38432	18975	15742	4045	111285
Sep-97	20520	2208	7805	6062	2594	39189
Oct-97	2187	0	294	3743	581	6804
Nov-97	1598	4010	0	1392	172	7173
Dec-97	1959	2947	0	9663	931	15499
Jan-98	27236	9019	488	7448	5942	50133
Feb-98	31844	15587	1993	5453	6191	61069
Mar-98	34696	24491	4235	3483	6014	72919
Apr-98	14460	14200	3219	3832	2058	37768
May-98	8776	17329	3981	4124	109	34318
Jun-98	10527	23256	10677	7449	401	52311
Jul-98	25767	42068	22992	12083	1124	104033
Aug-98	37026	49842	21467	11524	1358	121217
Sep-98	18449	21166	13410	7283	192	60500
Oct-98	4362	4005	5516	3488	45	17417
Nov-98	7941	9537	2820	3536	99	23932
Dec-98	22517	18341	3900	12154	528	57440
Jan-99	21858	22424	3602	3790	92	51766
Feb-99	32889	12418	5423	6632	105	57468
Mar-99	22875	10239	9343	4919	89	47466
Apr-99	11286	4682	8966	4310	35	29278
May-99	6892	9519	9693	5002	8	31114
Jun-99	34267	34956	18737	10197	60	98216
Jul-99	70847	41958	24375	16565	114	153859
Aug-99	80450	32271	19217	14414	173	146525
Sep-99	13128	3880	13204	7652	87	37951
Oct-99	2379	0	306	5179	4	7868
Nov-99	5597	1225	223	3566	9	10619
Dec-99	26748	3260	3	10193	47	40249
Jan-00	19168	16688	0	3981	1203	41040
Feb-00	24248	5154	3492	7221	2132	42247
Mar-00	20602	6407	9117	5813	1472	43410
Apr-00	11770	6319	10455	4060	687	33292
May-00	17655	18463	12305	3963	345	52732
Jun-00	44925	37946	20771	10132	1476	115251
Jul-00	77296	63999	24480	15187	4158	185120
Aug-00	66535	35841	19517	13197	5017	140108
Sep-00	10350	7067	11589	5866	714	35586
Oct-00	2705	0	0	3524	169	6399
Nov-00	6375	1920	167	1939	357	10757
Dec-00	18044	4739	148	9827	1933	34689
Jan-01	8961	6643	306	3439	7	19357
Feb-01	12104	5840	413	4738	249	23344
Mar-01	9359	3393	955	5022	77	18805
Apr-01	3836	1392	0	3725	77	9030
May-01	2267	621	0	3302	90	6280
Jun-01	31309	35031	19672	7838	2141	95991
Jul-01	50997	33980	20650	10499	3334	119460
Aug-01	49055	24248	20927	9909	3350	107488
Sep-01	2898	319	7363	4769	186	15535
Oct-01	808	0	0	3235	44	4088
Nov-01	1545	0	0	1047	93	2685
Dec-01	7472	0	0	7351	505	15328
Jan-02	23954	3915	0	2950	50	30869
Feb-02	34366	7194	9184	5270	523	56538
Mar-02	27523	5518	11211	3970	187	48409
Apr-02	8687	535	9845	4403	163	23633
May-02	6720	10074	4546	4164	176	25680
Jun-02	25952	40777	15782	9963	815	93288
Jul-02	51918	51345	19135	13258	2180	137837
Aug-02	47781	31068	13428	10907	2618	105802
Sep-02	3024	974	0	5499	364	9861
Oct-02	753	0	0	3507	86	4346
Nov-02	3255	2826	0	1030	182	7292
Dec-02	8335	2524	0	8095	984	19937
Jan-03	17035	6380	178	2599	251	26443
Feb-03	18975	3997	356	5205	759	29292
Mar-03	16464	3997	12382	4018	398	37259
Apr-03	6235	1332	536	3573	240	11916
May-03	3104	2694	180	3447	189	9614
Jun-03	35955	48545	14724	7872	2655	109751
Jul-03	65530	42356	20487	11279	5552	145204
Aug-03	58315	30398	19584	10022	4429	122748
Sep-03	10724	14051	4602	5418	390	35185
Oct-03	5060	6628	0	3235	93	15015
Nov-03	3534	3270	0	1849	195	8849
Dec-03	13310	8954	246	7783	1057	31349
Jan-04	21193	6202	887	2469	169	30920
Feb-04	22630	2751	421	5211	232	31245
Mar-04	19750	1700	16892	4331	188	42861
Apr-04	7463	567	11364	3817	76	23287
May-04	7649	1847	202	4028	23	13750
Jun-04	43669	36111	15703	8761	1864	106108
Jul-04	56276	39905	15616	12716	2044	126557
Aug-04	46550	20059	4869	9753	2102	83334
Sep-04	2893	0	0	5344	48	8285
Oct-04	1143	426	0	3106	11	4686
Nov-04	2473	1234	27	1335	24	5093
Dec-04	9313	1915	630	7305	130	19292
Jan-05	28328	8681	318	3073	2183	42584
Feb-05	34297	8543	211	5698	2211	50959
Mar-05	29485	7573	9716	3712	2191	52678
Apr-05	17953	14774	12322	4882	736	50667
May-05	48534	32390	9719	4539	2573	97756
Jun-05	83212	42082	19626	10292	4362	159573
Jul-05	81301	45958	24885	14477	2262	168883
Aug-05	71251	30263	21741	15052	2244	140551
Sep-05	20198	12158	12151	8680	770	53957
Oct-05	4823	2388	126	3795	5	11137
Nov-05	3751	1321	193	3261	10	8536
Dec-05	18891	4407	951	10899	57	35205
Jan-06	59292	10338	592	3257	2512	75991
Feb-06	63754	12505	6626	6422	2541	91849
Mar-06	64764	17538	6973	4837	2663	96774
Apr-06	41883	13691	3840	5137	2833	67383
May-06	76704	32999	11252	8857	5127	134938
Jun-06	67064	38328	21556	12485	2077	141510
Jul-06	82441	45232	27164	17302	2425	174563
Aug-06	75475	31743	21761	15341	2036	146355
Sep-06	15527	12043	11907	9365	807	49649
Oct-06	1262	853	149	4680	33	6977
Nov-06	2510	1310	156	1921	11	5908
Dec-06	11319	3168	1686	11288	62	27522
Jan-07	13171	2716	1406	4102	0	21395
Feb-07	18115	4927	4753	4776	12	32582
Mar-07	18252	4158	11450	3792	2061	39713
Apr-07	7207	3220	7950	3630	4	22010
May-07	8494	8585	313	3894	4	21291
Jun-07	42957	37657	17154	10846	5784	114397
Jul-07	53608	28757	20138	15667	6199	124370
Aug-07	40221	14702	22073	14551	3777	95325
Sep-07	3237	0	300	6629	473	10638
Oct-07	1095	474	0	2879	2	4449
Nov-07	2519	1514	0	1013	5	5050
Dec-07	8543	1666	0	7129	24	17363

APPENDIX D2-1 (Cont)

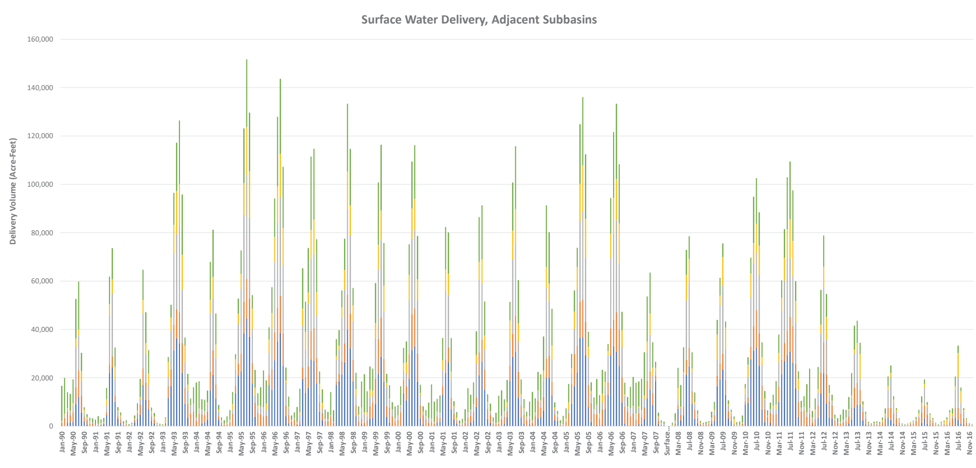
Surface Water Delivery (Acre-Feet)	El Rico GSA	Mid-Kings River GSA	South Fork Kings GSA	Southwest Kings GSA	Tri-County Water Authority GSA	Tulare Lake Subbasin Total
Jan-08	12877	4236	0	2158	249	19521
Feb-08	12794	2358	0	4154	286	19592
Mar-08	12030	2029	15452	3035	260	32806
Apr-08	4310	676	12129	2975	94	20185
May-08	2848	4804	280	2918	14	10863
Jun-08	23201	37252	14023	9327	3063	86866
Jul-08	28911	36960	15430	11570	1795	94666
Aug-08	17737	21618	8115	8066	321	55857
Sep-08	1686	1694	0	4266	28	7674
Oct-08	535	324	0	2614	7	3479
Nov-08	2311	2600	0	966	14	5891
Dec-08	4305	2578	0	6083	77	13042
Jan-09	20714	4035	0	1996	0	26745
Feb-09	21578	3528	0	3511	2	28619
Mar-09	20219	2386	7422	2559	1	32585
Apr-09	6912	583	5834	2571	1	15900
May-09	626	0	0	2805	1	3432
Jun-09	18684	37791	12420	6179	3	75077
Jul-09	29891	44375	14955	9897	7	99125
Aug-09	24119	21353	13859	7115	9	66454
Sep-09	992	0	583	3621	1	5197
Oct-09	662	513	0	2362	0	3537
Nov-09	4030	5151	0	1119	1	10300
Dec-09	4435	2475	0	4964	3	11878
Jan-10	33578	6591	0	4533	503	45205
Feb-10	35716	6121	0	6119	503	48460
Mar-10	33280	5202	7720	5041	503	51746
Apr-10	11965	2285	8767	4939	168	28125
May-10	10826	23142	11452	5874	0	51294
Jun-10	45995	35698	18042	11282	2611	113628
Jul-10	56367	47091	23080	12815	3684	143036
Aug-10	61845	30709	19039	13661	4026	129280
Sep-10	17793	13208	13979	8270	556	53806
Oct-10	417	0	736	5071	0	6224
Nov-10	1053	221	221	3629	0	5126
Dec-10	6255	1797	1065	8405	1	17524
Jan-11	62292	26805	3271	4336	0	96704
Feb-11	63568	19954	3729	5631	17	92899
Mar-11	58959	17047	6734	5266	5	88011
Apr-11	24884	21763	9084	8007	5	63744
May-11	34998	33281	13176	9466	6	90927
Jun-11	63404	33286	18476	10767	26	125958
Jul-11	86173	42788	25299	17245	72	171578
Aug-11	77137	40417	22548	15888	87	156077
Sep-11	31800	13857	13793	9652	12	69114
Oct-11	4824	1194	6244	4587	3	16851
Nov-11	4056	4435	2415	3445	6	14358
Dec-11	18473	12326	750	7661	34	39243
Jan-12	23492	5381	289	6088	0	35250
Feb-12	23705	4034	5923	6199	14	39875
Mar-12	19686	1379	5543	5520	4	32131
Apr-12	7287	460	6581	5292	4	19625
May-12	1402	0	454	5644	5	7504
Jun-12	24802	27755	16731	13201	21	82510
Jul-12	45234	42066	19057	14465	60	120883
Aug-12	45391	30434	18014	12409	72	106320
Sep-12	3441	840	9880	8366	10	22537
Oct-12	777	123	405	5250	2	6556
Nov-12	2219	1192	59	4525	5	8001
Dec-12	8318	1267	508	7047	28	17168
Jan-13	893	1266	330	2519	0	5009
Feb-13	2596	939	7	3906	14	7463
Mar-13	1013	33	8164	3040	4	12254
Apr-13	613	11	3540	3028	4	7196
May-13	717	0	0	3016	5	3738
Jun-13	26176	29510	11863	5136	22	72707
Jul-13	39994	17398	15372	7502	61	80327
Aug-13	31989	12980	4464	6522	74	56030
Sep-13	1222	0	0	4031	11	5264
Oct-13	371	0	0	2910	2	3284
Nov-13	665	0	0	1723	5	2393
Dec-13	3004	99	0	5274	29	8405
Jan-14	31	27	0	2773	0	2831
Feb-14	331	0	7	3338	9	3686
Mar-14	231	138	0	2791	3	3163
Apr-14	120	0	0	2745	3	2869
May-14	141	0	0	2816	3	2959
Jun-14	13183	0	0	3744	14	16941
Jul-14	25975	26500	13175	4647	41	70337
Aug-14	18326	9961	4790	4555	49	37681
Sep-14	246	0	90	3414	7	3757
Oct-14	71	0	0	2751	2	2824
Nov-14	138	0	0	2041	3	2182
Dec-14	681	0	0	4106	19	4806
Jan-15	4	0	0	3439	0	3443
Feb-15	32	0	0	4691	2	4725
Mar-15	45	0	31	3836	3	3915
Apr-15	27	0	11	3764	2	3804
May-15	32	0	0	3840	2	3874
Jun-15	55	0	65	5326	4	5451
Jul-15	14382	10880	9816	6779	10	41868
Aug-15	9458	1549	5162	6539	9	22718
Sep-15	23	0	0	4764	2	4788
Oct-15	17	0	0	3743	1	3761
Nov-15	25	0	0	2725	2	2752
Dec-15	75	0	0	5887	6	5968
Jan-16	0	896	0	2854	0	3750
Feb-16	116	1103	0	2854	0	4073
Mar-16	0	896	0	2854	0	3750
Apr-16	0	299	0	2854	0	3153
May-16	672	2004	1559	2854	0	7089
Jun-16	19693	41699	12988	2854	0	77234
Jul-16	18328	38082	14830	2854	0	74094
Aug-16	20982	5884	13154	2854	0	42874
Sep-16	0	0	0	2854	0	2854
Oct-16	0	0	0	2854	0	2854
Nov-16	0	0	0	2854	0	2854
Dec-16	0	0	0	2854	0	2854



APPENDIX D2-2

Surface Water Delivery (Acre-Feet)	Kaweah Subbasin	Kern County Subbasin	Kings Subbasin	Tule Subbasin	Westside Subbasin
Jan-90	47	1371	641	98	14547
Feb-90	130	3377	1373	244	14780
Mar-90	1444	4469	1141	386	6613
Apr-90	1596	2992	1217	636	6917
May-90	1731	4044	2573	1121	9906
Jun-90	9129	7032	16562	3468	16410
Jul-90	12238	10939	14508	2300	19830
Aug-90	5593	6916	6048	4178	7587
Sep-90	2007	1975	1688	1038	1151
Oct-90	652	1725	781	670	1147
Nov-90	85	936	851	296	1291
Dec-90	41	1201	324	59	1575
Jan-91	8	307	94	53	2212
Feb-91	42	378	461	131	3188
Mar-91	605	178	324	159	1529
Apr-91	760	466	259	269	1647
May-91	4621	1175	2598	2722	4730
Jun-91	22007	3359	20363	4708	11412
Jul-91	24361	4596	25900	5856	12927
Aug-91	9982	2702	6574	5370	7908
Sep-91	3052	1040	1852	547	1387
Oct-91	1344	1418	1184	359	1441
Nov-91	53	485	336	159	972
Dec-91	143	566	763	32	960
Jan-92	7	103	99	82	508
Feb-92	55	251	386	204	558
Mar-92	1716	798	320	249	1368
Apr-92	3133	2152	715	429	3036
May-92	4802	4154	2222	941	7373
Jun-92	17030	6905	22629	5580	12539
Jul-92	10891	7189	11734	4545	12735
Aug-92	7065	3767	6252	4529	9834
Sep-92	2278	1713	1418	842	1429
Oct-92	1139	1486	843	560	1418
Nov-92	35	460	326	248	374
Dec-92	24	270	322	49	366
Jan-93	3	233	45	223	283
Feb-93	24	1115	327	1878	329
Mar-93	11765	4796	3525	6456	2058
Apr-93	16628	6952	15864	5452	5331
May-93	31394	10498	29534	11882	13180
Jun-93	36360	11963	31144	17772	19969
Jul-93	34332	12848	35642	17361	26255
Aug-93	22197	12206	21941	14504	24952
Sep-93	9298	6569	10424	6972	3412
Oct-93	3372	5814	5706	2284	4458
Nov-93	284	4976	3108	248	2854
Dec-93	253	5866	3255	31	6689
Jan-94	293	1859	1457	62	14391
Feb-94	235	4902	2052	154	11245
Mar-94	1174	3746	1735	187	4253
Apr-94	1700	3097	1026	352	4789
May-94	2645	3262	3119	733	4923
Jun-94	14876	7646	24290	5384	15762
Jul-94	21182	10130	21360	9021	19556
Aug-94	11467	5895	10842	5542	12822
Sep-94	2504	1525	2089	759	1917
Oct-94	455	1049	516	434	1230
Nov-94	27	623	151	187	1490
Dec-94	50	801	649	37	2553
Jan-95	62	1517	822	294	3945
Feb-95	107	5076	1466	2446	4999
Mar-95	13717	2946	6844	4178	2134
Apr-95	21008	4724	16379	4430	6216
May-95	22750	7162	26917	6118	9726
Jun-95	38495	12984	35898	13129	22645
Jul-95	44604	16411	43101	19611	27976
Aug-95	36972	16002	33223	19211	24260
Sep-95	17742	8571	13976	8283	5616
Oct-95	3822	5892	2839	3356	7384
Nov-95	171	5241	1991	1162	5016
Dec-95	241	4683	3265	112	7753
Jan-96	257	3830	3497	171	15241
Feb-96	227	4045	2233	2850	9564
Mar-96	17084	4212	8807	5755	4982
Apr-96	14994	8713	16632	6401	10742
May-96	27215	11626	29126	10291	15910
Jun-96	34883	14051	35248	14968	28780
Jul-96	38539	15436	40793	17823	31016
Aug-96	24891	13542	28073	15431	25341
Sep-96	4141	4517	9234	1028	5287
Oct-96	1268	3364	2693	684	4243
Nov-96	43	1779	492	306	1763
Dec-96	33	2734	452	60	2416
Jan-97	465	318	888	96	6174
Feb-97	780	1350	2277	1360	9686
Mar-97	19616	4778	17019	7234	16640
Apr-97	13855	6395	11696	7037	12485
May-97	15904	8934	25906	4524	18409
Jun-97	27570	11860	29858	11890	30312
Jul-97	27017	13740	30387	14320	29306
Aug-97	17755	10410	17428	9734	21987
Sep-97	5995	3886	3381	4308	5058
Oct-97	2392	3114	1834	2352	5550
Nov-97	209	1807	686	391	3755
Dec-97	86	2021	735	57	2950
Jan-98	40	4058	557	53	9421
Feb-98	16	1413	136	180	4800
Mar-98	17198	1462	8816	1500	6959
Apr-98	18553	3193	9764	1807	6464
May-98	21517	5380	17966	4202	7069
Jun-98	26476	7845	22139	8145	12919
Jul-98	39784	14518	35487	15503	28073
Aug-98	32219	14327	32359	12476	23258
Sep-98	18559	8841	16058	6449	7230
Oct-98	4207	4416	3715	2929	6783
Nov-98	184	1743	2377	583	3331
Dec-98	877	2290	4223	202	10884
Jan-99	270	1175	3687	554	15754
Feb-99	128	2220	1732	1655	8688
Mar-99	3039	5126	3462	3523	9463
Apr-99	3354	6552	3010	1742	9135
May-99	9147	10436	16776	6266	16579
Jun-99	21666	14488	28786	10130	25709
Jul-99	28645	16359	31931	12287	27148
Aug-99	18298	9651	19378	10795	17599
Sep-99	3892	4405	8003	1635	3740
Oct-99	1489	6242	3144	537	5503
Nov-99	233	3775	2670	237	2996
Dec-99	186	1789	1369	47	4824
Jan-00	183	2447	1682	75	4298
Feb-00	195	5584	2515	351	7826
Mar-00	13554	5723	3625	3107	6384
Apr-00	10637	5906	5303	4436	8766
May-00	19686	10031	22335	10465	12749
Jun-00	31336	15006	31244	12509	19346
Jul-00	33065	15694	32482	12724	22269
Aug-00	18279	11856	22034	8593	17887
Sep-00	3187	5443	4314	769	3424
Oct-00	618	3815	1001	512	2275
Nov-00	165	2624	1086	226	2571
Dec-00	181	1151	2033	45	6332
Jan-01	96	1721	1304	73	14080
Feb-01	79	836	681	182	8421
Mar-01	1619	2440	1699	222	5282
Apr-01	1845	1588	1697	375	7266
May-01	13061	3564	6552	4061	9234
Jun-01	22013	5679	28434	8687	17537
Jul-01	26342	6281	21764	8711	16982
Aug-01	6921	4870	7429	3397	13782
Sep-01	2808	2297	2379	753	2108
Oct-01	904	1182	867	501	2447
Nov-01	47	561	206	222	1305
Dec-01	58	412	728	44	1826
Jan-02	111	1242	555	77	5044
Feb-02	263	3354	1887	191	10078
Mar-02	1567	2679	2407	232	6151
Apr-02	2279	3694	2782	392	8934
May-02	8056	3793	14135	3426	9804
Jun-02	21134	9403	30090	7238	18587
Jul-02	26501	9237	23318	9796	22521
Aug-02	14993	8456	8492	5606	14048
Sep-02	2807	4270	2133	787	3193
Oct-02	1460	3142	1181	524	2963
Nov-02	54	1076	411	348	1778
Dec-02	127	689	375	57	4261
Jan-03	125	882	459	181	10900
Feb-03	103	2700	1212	218	10555
Mar-03	1043	2788	2060	266	4915
Apr-03	3767	2265	1936	1959	9139
May-03	18843	6246	10425	8209	7639
Jun-03	28702	9500	30798	11859	19955
Jul-03	30699	14946	29784	14417	25924
Aug-03	11713	10773	12405	7635	17902
Sep-03	3771	4893	3616	901	6180
Oct-03	1102	3625	2000	600	3883
Nov-03	224	2201	1216	265	2084
Dec-03	729	2211	1061	53	6090
Jan-04	205	1248	884	83	11775
Feb-04	127	4067	1213	207	5917
Mar-04	3259	7192	4015	252	7697
Apr-04	3828	3913	2446	426	10818
May-04	6348	5772	6833	4041	14128
Jun-04	20114	7846	29563	8286	25508
Jul-04	19954	9223	22297	7586	21170
Aug-04	12796	5486	9468	5573	15280
Sep-04	2383	2398	2093	855	2084
Oct-04	2235	1451	661	569	1365
Nov-04	96	485	345	252	1231
Dec-04	36	392	340	50	3433
Jan-05	37	1723	515	973	4077
Feb-05	142	5371	1397	2875	7664
Mar-05	9329	7917	4535	2312	5803
Apr-05	16557	13449	10234	7101	8779
May-05	22141	11096	23578	9012	7929
Jun-05	36488	14923	33535	15303	24589
Jul-05	36866	15534	36452	19067	28207
Aug-05	29242	14034	26373	16129	26623
Sep-05	7968	9057	11583	4196	6209
Oct-05	1790	7564	4348	715	3728
Nov-05	191	4929	1583	316	4856
Dec-05	574	4297	3944	63	10618
Jan-06	44	3048	619	1536	7565
Feb-06	498	6448	2851	3751	9719
Mar-06	7048	5619	3734	1916	4257
Apr-06	13024	5112	11080	1843	2963
May-06	29347	11068	29089	9981	14873
Jun-06	33094	11030	35571	14724	27155
Jul-06	30714	16449	38124	16978	31089
Aug-06	24962	15057	27330	16460	24540
Sep-06	9862	10336	12634	6849	7608
Oct-06	1096	6974	4504	591	4830
Nov-06	216	5659	1983	261	3936
Dec-06	311	3774	3280	52	8834
Jan-07	261	5025	2830	143	12097
Feb-07	306	2356	2228	298	12803
Mar-07	863	4484	2370	363	10386
Apr-07	985	2811	2165	612	13021
May-07	2965	4835	3624	1350	17784
Jun-07	11494	7256	11801	4407	18668
Jul-07	15168	7529	15169	8696	16893
Aug-07	8858	4901	7301	3060	10555
Sep-07	18477	2571	1890	1228	2441
Oct-07	713	1595	948	818	1590
Nov-07	57	536	396	361	1003
Dec-07	58	366	463	72	896

Surface Water Delivery (Acre-Feet)	APPENDIX D2-2 (Cont) Kaweah Subbasin	Kern County Subbasin	Kings Subbasin	Tule Subbasin	Westside Subbasin
Jan-08	18	152	246	83	902
Feb-08	76	852	802	552	3112
Mar-08	7172	1651	2476	4489	8384
Apr-08	2395	2361	2802	424	9010
May-08	4395	3761	13361	934	10147
Jun-08	21269	6219	24490	10546	10365
Jul-08	24815	7612	26919	9910	9325
Aug-08	9279	5128	8168	1262	6755
Sep-08	3121	3576	2429	849	3966
Oct-08	1277	2028	1254	566	1414
Nov-08	205	549	529	250	602
Dec-08	80	454	359	50	502
Jan-09	228	401	302	81	756
Feb-09	94	767	377	200	680
Mar-09	988	1077	1194	244	2448
Apr-09	2213	2440	1660	416	3365
May-09	16510	4280	6848	10204	6105
Jun-09	19393	6669	23889	3994	7381
Jul-09	23418	6562	28183	11783	5651
Aug-09	13001	6142	12501	9198	2372
Sep-09	3185	3051	2110	827	1515
Oct-09	1964	2051	1283	551	1004
Nov-09	98	627	533	1747	945
Dec-09	52	348	244	48	967
Jan-10	9	193	118	75	1524
Feb-10	91	784	555	203	2815
Mar-10	9084	1151	2912	2390	1932
Apr-10	9661	2259	8354	5168	3111
May-10	27630	5169	20455	9836	6608
Jun-10	31224	10058	26047	8433	19120
Jul-10	32344	15684	23806	11894	18808
Aug-10	24931	13524	24152	12023	13783
Sep-10	7017	9882	8430	3200	6138
Oct-10	1650	5379	3908	511	3096
Nov-10	55	3811	363	226	2129
Dec-10	1501	3942	1547	46	2707
Jan-11	199	4763	2695	829	4520
Feb-11	452	4746	1734	2065	9670
Mar-11	10065	6270	10124	3745	7657
Apr-11	21424	6019	20262	5438	7172
May-11	26993	7494	25764	9322	11941
Jun-11	29531	9935	29828	12067	21540
Jul-11	30783	14434	24313	16092	23798
Aug-11	26314	14932	20716	14640	20960
Sep-11	15653	10223	16679	9216	8234
Oct-11	3935	6062	4893	4634	3188
Nov-11	193	5978	1164	247	2826
Dec-11	101	6460	1375	49	4443
Jan-12	583	3300	1743	82	11629
Feb-12	260	4623	2325	204	16398
Mar-12	442	1161	1600	248	2847
Apr-12	441	2454	2814	1126	4631
May-12	3353	5228	5466	1221	9250
Jun-12	13499	8711	16026	3763	14397
Jul-12	21816	12788	22698	8687	12811
Aug-12	9476	11893	14638	9194	9482
Sep-12	3692	6552	2578	840	3343
Oct-12	3264	5333	1361	559	2483
Nov-12	108	2295	520	247	1604
Dec-12	18	1308	252	49	1642
Jan-13	36	1248	396	82	2969
Feb-13	152	1411	828	204	4297
Mar-13	574	1361	1343	248	3226
Apr-13	1043	2932	2598	419	5102
May-13	2885	4727	4167	923	9255
Jun-13	7655	8186	14386	1376	9966
Jul-13	8922	8924	13925	2653	9178
Aug-13	9089	5862	4616	10351	4590
Sep-13	2433	3503	2168	840	1332
Oct-13	782	2414	1215	559	963
Nov-13	82	597	423	247	375
Dec-13	59	378	269	49	431
Jan-14	109	361	701	82	559
Feb-14	22	840	299	204	616
Mar-14	18	523	202	248	704
Apr-14	63	1566	438	419	1138
May-14	269	2973	990	923	2222
Jun-14	3386	4293	7480	1376	3990
Jul-14	2612	4990	12797	1604	3047
Aug-14	940	4270	4563	1248	1399
Sep-14	647	2565	2645	840	729
Oct-14	287	1166	906	559	381
Nov-14	108	413	376	247	122
Dec-14	22	272	291	49	184
Jan-15	59	336	607	82	70
Feb-15	27	805	325	204	225
Mar-15	114	1076	416	248	433
Apr-15	154	1989	413	419	793
May-15	266	3394	693	923	1440
Jun-15	1336	4267	2704	1376	2637
Jul-15	3306	5141	7295	1604	1975
Aug-15	852	3915	2958	1248	937
Sep-15	610	2046	1250	840	528
Oct-15	287	1166	906	559	381
Nov-15	108	413	376	247	263
Dec-15	22	272	291	49	155
Jan-16	109	361	701	142	559
Feb-16	22	840	299	477	616
Mar-16	18	523	202	2211	704
Apr-16	63	1566	438	3442	1138
May-16	269	2973	990	923	2222
Jun-16	3386	4293	7480	1376	3990
Jul-16	2612	4990	12797	9836	3047
Aug-16	940	4270	4563	4806	1399
Sep-16	647	2565	2645	840	729
Oct-16	287	1166	906	559	381
Nov-16	108	413	376	247	122
Dec-16	22	272	291	49	184

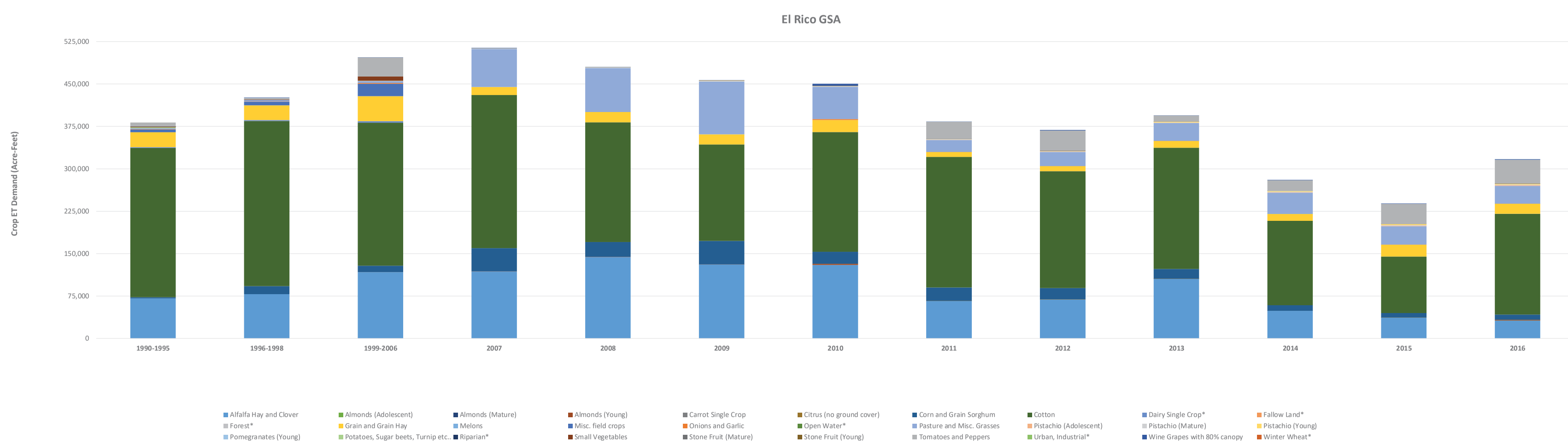


Appendix D3
Summary of Crop Demand

APPENDIX D3-1

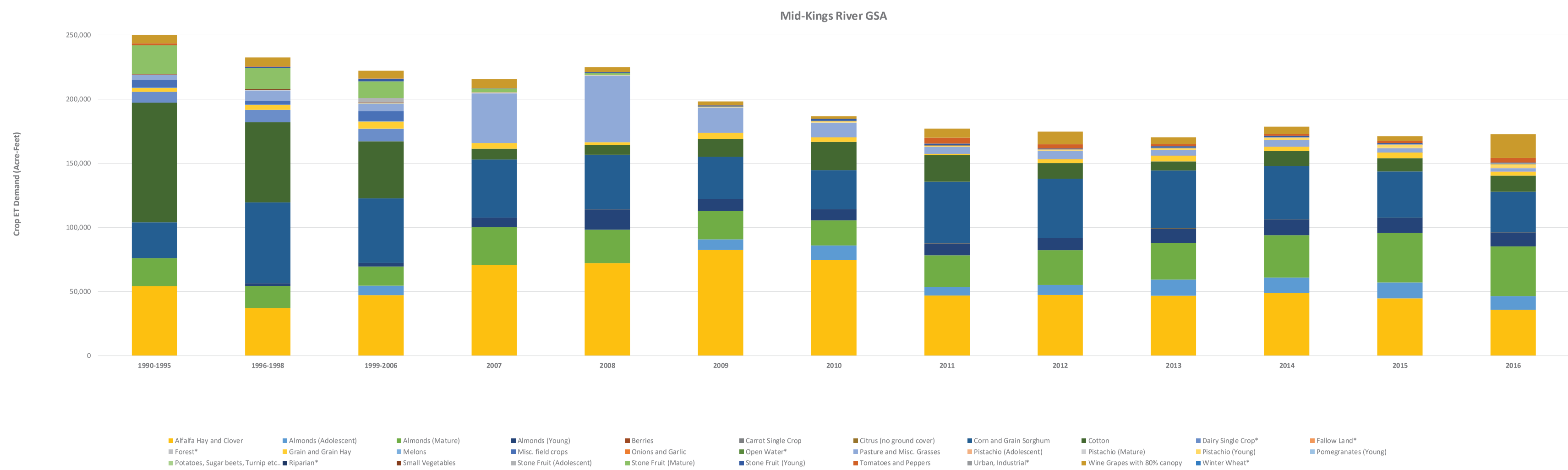
Sum of Crop ET Demand (Acre-Feet/Year) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
El Rico GSA													
Alfalfa Hay and Clover	70729	78296	117038	118221	143932	130955	129971	66396	68927	105292	48866	36930	31810
Almonds (Adolescent)	0	0	0	0	0	0	0	3	2	2	18	5	10
Almonds (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Almonds (Young)	0	0	0	188	146	145	1951	180	194	477	170	185	1163
Carrot Single Crop	0	0	0	0	0	0	0	19	8	1	0	0	16
Citrus (no ground cover)	0	0	0	0	0	0	0	16	0	7	0	2	4
Corn and Grain Sorghum	2018	14258	11703	41343	26375	41546	21187	23395	19850	17015	9740	7639	9086
Cotton	264279	292007	252807	270755	211744	170500	211791	231241	206654	214373	149263	99964	178223
Dairy Single Crop*	1445	1847	2688	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	26296	25753	44136	14205	18440	17878	21292	8497	9155	12247	12207	21158	17961
Melons	0	0	0	0	0	0	0	1	8	2	728	4	93
Misc. field crops	4755	6468	22248	0	4	0	0	0	0	0	0	0	0
Onions and Garlic	446	291	1070	0	0	0	1834	47	105	49	77	146	111
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	1917	2947	3895	67107	77436	93539	57165	21110	24818	31286	36605	32424	31157
Pistachio (Adolescent)	0	0	0	0	0	0	0	211	277	370	687	1003	1370
Pistachio (Mature)	0	0	0	1232	1293	983	897	932	917	847	842	1184	1122
Pistachio (Young)	0	23	221	322	376	619	698	392	735	1140	1492	1535	1315
Pomegranates (Young)	0	0	0	0	91	42	4	81	24	93	148	164	162
Potatoes, Sugar beets, Turnip etc..	1508	0	0	14	0	0	0	4	0	4	0	3	3
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	1430	528	7590	0	0	3	94	23	29	107	103	8	116
Stone Fruit (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	0	0	2	9	44	2	3	85	1	2	40	78
Tomatoes and Peppers	7067	3135	33674	11	2	150	0	30683	36052	10959	19043	35729	42194
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	0	503	334	407	362	47	3559	227	1035	92	546	472	958
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
El Rico GSA Irrigated ET Demand	**380445**	**424208**	**494716**	**513807**	**480209**	**456451**	**450445**	**383463**	**368875**	**394364**	**280539**	**238594**	**316952**
El Rico GSA Total ET Demand	**381890**	**426054**	**497404**	**513807**	**480209**	**456451**	**450445**	**383463**	**368875**	**394364**	**280539**	**238594**	**316952**

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



Sum of Crop ET Demand (Acre-Feet/Year) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	APPENDIX D3-2 2010	2011	2012	2013	2014	2015	2016
Mid-Kings River GSA													
Alfalfa Hay and Clover	54225	37134	47231	70920	72279	82432	74524	46996	47297	46833	49033	44781	35779
Almonds (Adolescent)	0	0	7382	0	0	8287	11414	6655	7948	12571	11964	12357	10700
Almonds (Mature)	21899	17282	14900	29318	25948	22195	19532	24669	27021	28629	33006	38590	38813
Almonds (Young)	0	2093	2798	7469	15899	9090	8694	9270	9515	11128	12224	11764	10892
Berries	0	0	0	0	0	0	0	0	1	6	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	4	7	1	7	0	14
Citrus (no ground cover)	0	0	75	0	32	31	14	370	89	299	102	56	12
Corn and Grain Sorghum	27832	63039	50239	45210	42440	33204	30445	47662	46154	44975	41460	36068	31535
Cotton	93307	62361	44507	8474	7660	13894	22023	20867	12109	7001	11789	10353	12573
Dairy Single Crop*	8529	9826	9984	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	2897	3811	5457	4423	2221	4688	3586	868	3163	4629	3337	4457	3095
Melons	248	92	45	0	0	0	0	2	5	6	0	0	20
Misc. field crops	6082	3065	8059	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	102	0	0	0	0	1	36	65	126	7	109	13	210
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	3717	8128	5877	38630	51880	19656	11431	5495	6343	4322	5084	3241	2570
Pistachio (Adolescent)	0	0	0	0	0	0	0	2	18	55	152	343	350
Pistachio (Mature)	321	254	241	675	270	135	86	83	57	52	45	46	55
Pistachio (Young)	0	34	215	326	374	674	983	947	885	1156	1706	2353	2641
Pomegranates (Young)	0	0	0	0	4	1	1	20	10	46	40	5	13
Potatoes, Sugar beets, Turnip etc..	0	4	0	5	0	5	0	1	0	1	0	1	2
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	595	617	418	24	2	4	158	159	103	164	139	46	147
Stone Fruit (Adolescent)	0	0	3393	0	0	5	126	230	290	171	105	414	416
Stone Fruit (Mature)	22291	16483	13130	2753	1199	102	26	11	80	141	79	95	136
Stone Fruit (Young)	0	1079	2020	237	879	730	1645	958	386	1186	1054	845	560
Tomatoes and Peppers	1355	304	110	2	0	77	0	4695	3145	1754	1343	1699	3679
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	7381	6981	6093	7034	3829	2999	1976	7037	10002	5141	5696	3681	18346
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Mid-Kings River GSA Irrigated ET De	**242254**	**222759**	**212189**	**215500**	**224914**	**198211**	**186699**	**177065**	**174754**	**170274**	**178474**	**171208**	**172557**
Mid-Kings River GSA Total ET Demai	**250784**	**232585**	**222173**	**215500**	**224914**	**198211**	**186699**	**177065**	**174754**	**170274**	**178474**	**171208**	**172557**

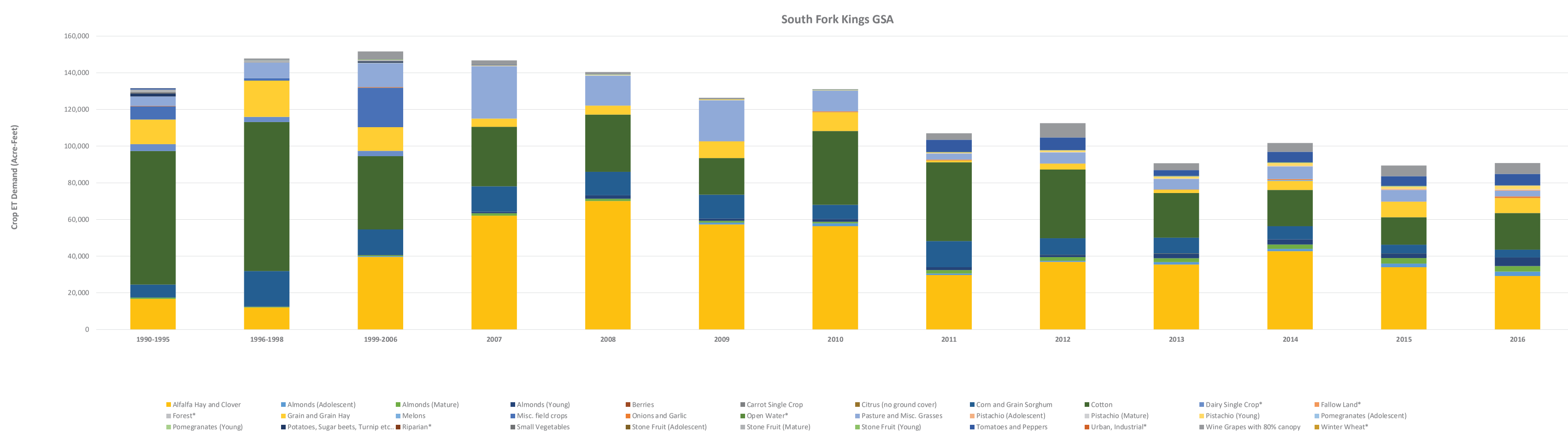
Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D3-3

Sum of Crop ET Demand (Acre-Feet/Year) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
South Fork Kings GSA													
Alfalfa Hay and Clover	16709	11994	39584	62068	70090	57340	56328	29744	36900	35451	42768	33986	29185
Almonds (Adolescent)	0	0	480	0	0	944	1576	777	652	1305	1236	1974	2399
Almonds (Mature)	743	499	472	1396	1211	944	805	1850	1903	2131	2373	2984	3024
Almonds (Young)	0	131	225	812	1861	1270	1646	1631	1226	2518	2843	2414	4672
Berries	0	0	0	0	0	0	0	0	1	0	0	1	0
Carrot Single Crop	0	0	0	0	0	0	0	4	2	7	0	6	26
Citrus (no ground cover)	0	0	17	0	0	0	0	14	3	18	0	2	2
Corn and Grain Sorghum	7027	19269	13851	13800	12846	13062	7622	14201	9097	8717	7123	4889	4232
Cotton	72878	81246	39915	32470	31210	19953	40263	42989	37422	24280	19786	15035	19992
Dairy Single Crop*	3737	2849	2925	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	13435	19790	12933	4435	4864	9156	10285	993	3255	1869	4921	8414	8207
Melons	0	0	0	0	0	0	8	1	2	2	448	0	15
Misc. field crops	7159	1270	21466	0	0	0	0	1	0	0	0	0	0
Onions and Garlic	258	0	289	0	0	8	495	467	112	108	563	71	795
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	5165	8608	13288	28562	16311	22322	11169	3302	5982	5766	6903	6334	3180
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	19	29	64	504	585
Pistachio (Mature)	1	0	0	311	306	176	184	200	199	181	168	162	177
Pistachio (Young)	0	9	83	196	206	442	246	360	878	1028	1600	1130	1957
Pomegranates (Adolescent)	0	0	0	0	0	0	0	0	0	0	5	23	41
Pomegranates (Young)	0	0	0	2	176	19	41	196	121	161	294	393	140
Potatoes, Sugar beets, Turnip etc..	1518	0	676	0	0	5	0	0	0	119	0	3	1
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	762	3	0	8	0	13	18	23	49	69	7	62	44
Stone Fruit (Adolescent)	0	0	188	0	0	0	0	1	1	0	2	0	9
Stone Fruit (Mature)	1463	1135	688	9	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	67	175	26	38	67	167	47	69	61	60	28	28
Tomatoes and Peppers	660	117	0	207	3	17	26	6642	6816	3119	5802	5246	6122
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	205	816	4390	2477	1278	644	153	3578	7838	3765	4771	5792	5920
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
South Fork Kings GSA Irrigated ET D	**127983**	**144955**	**148720**	**146777**	**140400**	**126381**	**131035**	**107022**	**112547**	**90701**	**101735**	**89454**	**90754**
South Fork Kings GSA Total ET Dema	**131720**	**147804**	**151645**	**146777**	**140400**	**126381**	**131035**	**107022**	**112547**	**90701**	**101735**	**89454**	**90754**

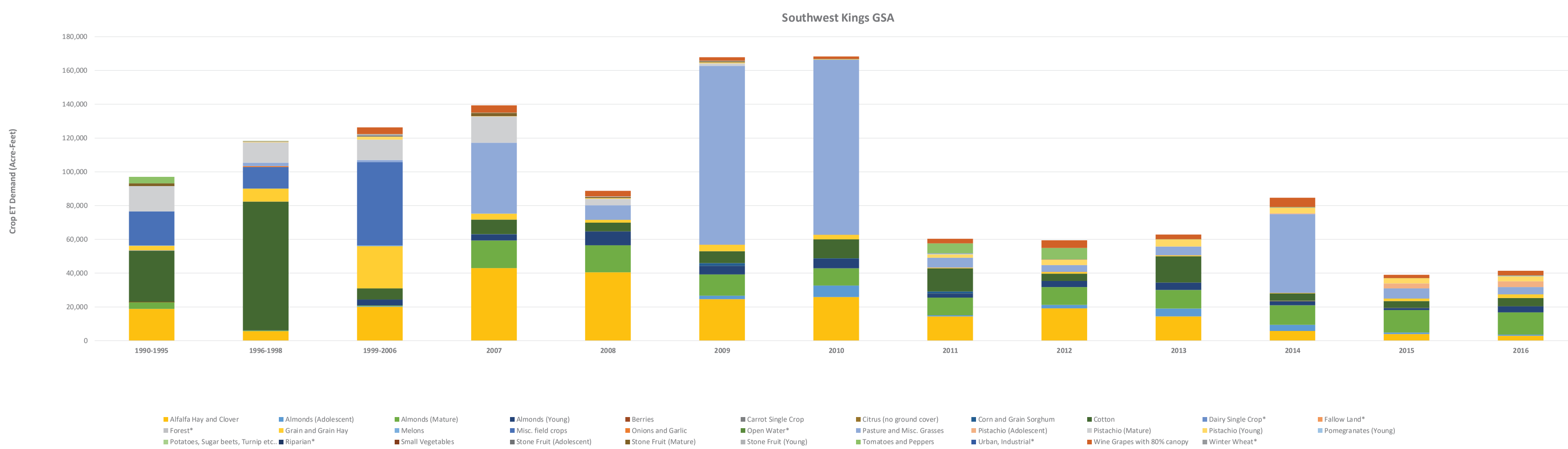
Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D3-4

Sum of Crop ET Demand (Acre-Feet/Year) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Southwest Kings GSA													
Alfalfa Hay and Clover	18759	5587	20110	43026	40528	24609	25791	14378	19154	14389	5716	3975	2961
Almonds (Adolescent)	0	0	251	0	0	1987	6874	691	2030	4651	3718	819	604
Almonds (Mature)	4150	497	497	16316	15963	12694	10200	10456	10526	10960	11577	13295	13247
Almonds (Young)	0	63	3457	3590	8199	4939	5669	2319	3629	4328	2374	1340	3474
Berries	47	0	0	0	0	0	0	0	0	0	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	1	0	0	0	0	1
Citrus (no ground cover)	0	0	0	0	10	15	0	1	6	12	197	13	13
Corn and Grain Sorghum	0	45	0	170	47	1654	219	1271	82	188	89	10	80
Cotton	30305	76227	6616	8666	5111	7109	11217	13730	4226	15517	4291	4063	4891
Dairy Single Crop*	145	0	55	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	2788	7652	24977	3452	1759	3814	2758	328	1041	533	231	1387	2180
Melons	165	0	423	0	0	0	14	0	1	0	6	0	1
Misc. field crops	20277	12708	49397	0	1	0	0	0	0	0	4	0	0
Onions and Garlic	0	555	0	0	0	3	45	113	186	3	143	36	26
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	0	2040	1192	41974	8570	105889	103590	5801	3878	5081	46667	6062	4311
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	1	105	387	2863	3399
Pistachio (Mature)	14907	12101	12101	15614	3811	1532	68	68	64	55	20	20	20
Pistachio (Young)	0	328	1744	208	396	675	390	2026	3269	4168	3397	3156	2931
Pomegranates (Young)	0	0	0	9	30	30	3	596	56	74	30	5	430
Potatoes, Sugar beets, Turnip etc..	0	0	0	0	0	0	0	7	0	0	0	0	1
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	47	0	0	1	1	0	61	23	30	2	14	8	8
Stone Fruit (Adolescent)	0	0	658	0	0	23	12	0	0	0	0	0	0
Stone Fruit (Mature)	1596	257	0	1799	688	482	38	0	0	0	0	0	0
Stone Fruit (Young)	0	164	806	200	307	376	64	3	7	3	70	0	1
Tomatoes and Peppers	3889	191	6	42	0	2	0	5793	6709	6	321	16	120
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	0	0	4055	4280	3334	2002	1284	2777	4565	2829	5430	1925	2694
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Southwest Kings GSA Irrigated ET De	**96929**	**118416**	**126291**	**139347**	**88756**	**167834**	**168296**	**60381**	**59459**	**62904**	**84684**	**38993**	**41393**
Southwest Kings GSA Total ET Dema	**97074**	**118416**	**126346**	**139347**	**88756**	**167834**	**168296**	**60381**	**59459**	**62904**	**84684**	**38993**	**41393**

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D3-5

Sum of Crop ET Demand (Acre-Feet/Year) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tri-County Water Authority GSA													
Alfalfa Hay and Clover	12097	2022	1204	5806	6923	750	1941	3106	2180	2254	1941	3166	659
Almonds (Adolescent)	0	0	0	0	0	0	0	0	0	0	0	0	0
Almonds (Young)	0	0	0	4	21	1	4	30	16	8	9	76	5
Carrot Single Crop	0	0	0	0	0	0	0	9	0	32	0	0	0
Citrus (no ground cover)	0	0	0	0	0	0	0	4	0	0	0	0	0
Corn and Grain Sorghum	0	3839	0	895	319	1	5	706	160	294	51	13	2
Cotton	2410	13544	18387	505	2786	616	2089	143	115	306	431	952	136
Dairy Single Crop*	433	747	768	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	4751	27805	22522	7057	21279	12220	7349	2832	755	227	585	1519	1785
Melons	0	0	0	0	0	0	0	0	0	0	0	22	0
Misc. field crops	2177	6785	20095	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	0	0	0	0	0	0	6	40	9	0	1	0	4
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	0	4	4	42701	36886	47791	45951	27710	16730	19878	49684	19952	18152
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pistachio (Mature)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pistachio (Young)	0	0	1	38	18	44	78	4	3	5	87	57	180
Pomegranates (Young)	0	0	0	0	2	6	4	8	0	1	25	1	1
Potatoes, Sugar beets, Turnip etc..	15578	0	0	0	0	0	0	17	0	3	0	0	0
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	0	0	0	0	0	0	10	1	1	48	1	2	2
Stone Fruit (Mature)	1	0	0	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	0	0	1	0	0	0	0	0	0	0	0	0
Tomatoes and Peppers	0	0	0	0	0	0	0	38	3	8	46	102	53
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	0	0	0	5	91	0	7	6	16	6	7	5	1
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigated ET Demand	**37015**	**53999**	**62214**	**57010**	**68324**	**61429**	**57443**	**34654**	**19988**	**23072**	**52867**	**25868**	**20980**
Total ET Demand	**37449**	**54746**	**62982**	**57010**	**68324**	**61429**	**57443**	**34654**	**19988**	**23072**	**52867**	**25868**	**20980**

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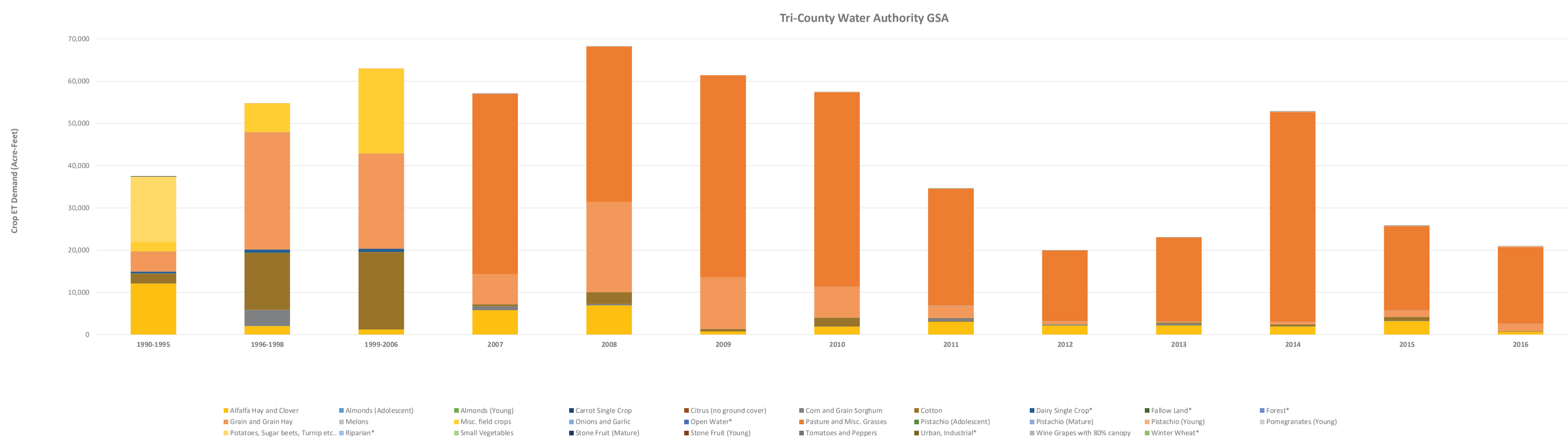

Sum of Crop ET Demand (Acre-Feet/Year) Tulare Lake Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tulare Lake Subbasin													
Alfalfa Hay and Clover	172519	135032	225167	300041	333752	296086	288555	160621	174457	204219	148325	122839	100395
Almonds (Adolescent)	0	0	8113	0	0	11218	19864	8127	10631	18529	16937	15155	13714
Almonds (Mature)	26791	18278	15869	47030	43122	35832	30537	36976	39450	41720	46956	54869	55084
Almonds (Young)	0	2287	6480	12062	26125	15445	17964	13431	14580	18458	17621	15779	20206
Berries	47	0	0	0	0	0	0	0	2	6	0	1	0
Carrot Single Crop	0	0	0	0	0	0	0	37	16	41	7	6	56
Citrus (no ground cover)	0	0	91	0	42	46	14	405	99	335	300	74	32
Corn and Grain Sorghum	36877	100450	75793	101418	82027	89467	59478	87236	75344	71190	58462	48619	44935
Cotton	463179	525386	362232	320870	258511	212071	287383	308970	260527	261476	185559	130368	215815
Dairy Single Crop*	14290	15268	16421	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	50167	84811	110025	33572	48563	47755	45271	13518	17369	19505	21282	36934	33228
Melons	413	92	468	0	0	0	21	3	16	10	1182	27	128
Misc. field crops	40450	30296	121265	0	5	0	0	1	0	0	4	0	0
Onions and Garlic	807	846	1359	0	0	12	2417	731	538	167	893	266	1146
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	10799	21726	24256	218974	191082	289198	229306	63417	57751	66333	144942	68014	59370
Pistachio (Adolescent)	0	0	0	0	0	0	0	213	315	559	1290	4713	5704
Pistachio (Mature)	15229	12354	12341	17831	5680	2825	1236	1283	1237	1135	1075	1412	1374
Pistachio (Young)	0	394	2265	1091	1370	2454	2395	3729	5770	7498	8281	8231	9024
Pomegranates (Adolescent)	0	0	0	0	0	0	0	0	0	0	5	23	41
Pomegranates (Young)	0	0	0	11	303	99	52	901	210	376	537	567	746
Potatoes, Sugar beets, Turnip etc..	18604	4	676	19	0	10	0	29	0	127	0	7	7
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	
Small Vegetables	2835	1147	8009	33	3	20	340	227	212	390	264	126	317
Stone Fruit (Adolescent)	0	0	4238	0	0	28	138	232	291	171	106	414	425
Stone Fruit (Mature)	25350	17875	13818	4560	1886	584	64	11	80	141	79	95	136
Stone Fruit (Young)	0	1310	3001	466	1234	1217	1879	1010	547	1250	1186	913	667
Tomatoes and Peppers	12971	3747	33791	261	5	246	26	47851	52725	15847	26555	42793	52168
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	7586	8301	14872	14203	8893	5692	6980	13625	23455	11832	16450	11874	27920
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Tulare Lake Subbasin Irrigated ET De	**884626**	**964336**	**1044130**	**1072442**	**1002603**	**1010305**	**993918**	**762584**	**735624**	**741315**	**698299**	**564117**	**642636**
Tulare Lake Subbasin GSA Total ET D	**898916**	**979604**	**1060551**	**1072442**	**1002603**	**1010305**	**993918**	**762584**	**735624**	**741315**	**698299**	**564117**	**642636**

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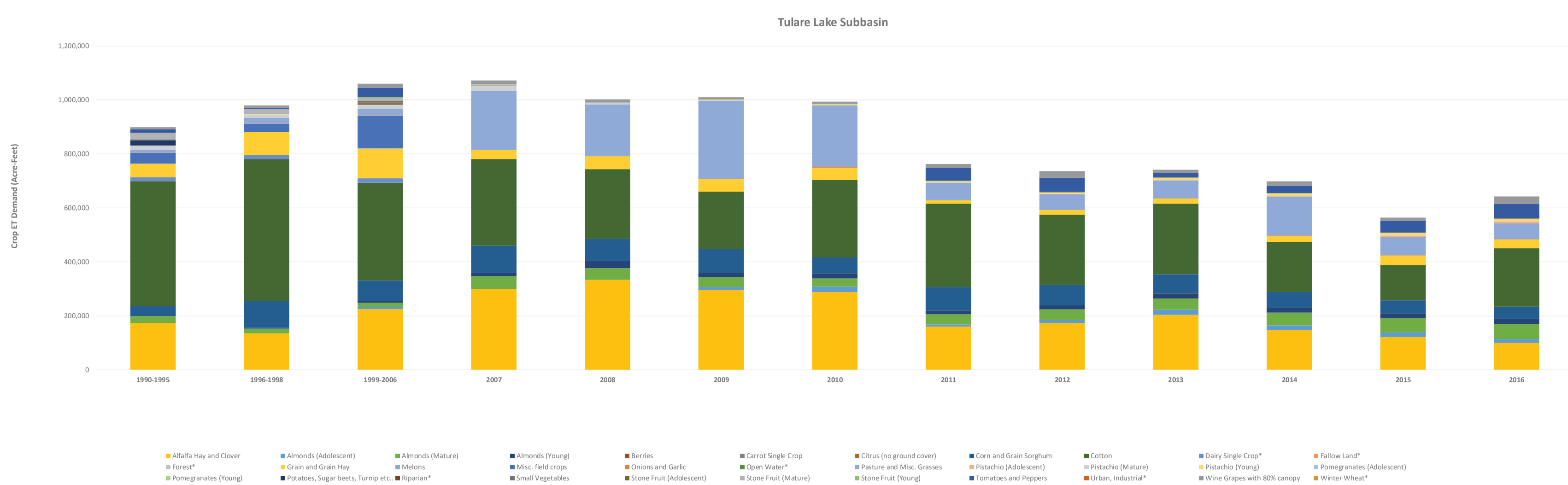

APPENDIX D3-7

Sum of Crop Acreage (Acres) Kaweah Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kaweah Subbasin													
Alfalfa Hay and Clover	115486	105689	121989	178448	170164	180822	168599	133463	140002	132011	125440	118685	111593
Almonds (Adolescent)	0	0	2151	0	0	3352	5331	2218	2912	4107	3639	4441	8087
Almonds (Mature)	10994	8841	7642	6331	5140	3927	3359	5959	6632	7023	8956	10024	10922
Almonds (Young)	0	551	277	5010	10534	5981	7005	4784	4303	5354	7935	12728	14258
Berries	0	20	20	0	0	0	0	0	1	1	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	91	6	0	10	1	14
Citrus (no ground cover)	0	0	0	14	32	52	14	41	35	178	247	18	26
Corn and Grain Sorghum	68793	111613	113052	70905	83423	58024	56330	117213	123778	124980	125613	109204	88983
Cotton	171670	113435	96213	40721	27603	33648	55438	51177	38387	29695	28395	19132	31086
Dairy Single Crop*	17748	22327	23914	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	12438	13462	14290	11846	873	3831	3221	1298	3410	4757	2453	4427	2548
Melons	253	167	167	0	0	1	0	4	2	21	0	3	151
Misc. field crops	4124	2758	3400	0	2	2	0	0	0	0	0	0	0
Onions and Garlic	758	404	404	0	0	0	59	297	43	2	16	7	492
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	5210	4802	6452	62054	114029	39268	40513	16032	26257	23092	22644	19504	19446
Pistachio (Adolescent)	0	0	0	0	0	0	0	421	701	1303	2697	6183	6637
Pistachio (Mature)	3309	3097	3097	7106	5394	4376	3529	3368	2888	2586	2512	3113	2640
Pistachio (Young)	0	495	1990	508	928	1646	1688	2718	4237	5070	5543	3449	3661
Pomegranates (Young)	0	0	0	1	28	2	0	16	9	76	24	22	81
Potatoes, Sugar beets, Turnip etc..	1361	2217	1983	18	0	2	0	332	180	9	634	478	580
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	3100	5686	5606	142	2	7	3	281	783	1251	1226	1248	1160
Stone Fruit (Adolescent)	0	0	3787	0	0	45	68	44	272	852	1000	191	70
Stone Fruit (Mature)	5897	3165	2730	433	84	18	0	66	9	25	244	328	60
Stone Fruit (Young)	0	975	222	83	602	359	606	770	1131	749	864	472	255
Tomatoes and Peppers	1732	4634	3894	31	2	36	0	2646	855	1553	1216	3151	3897
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	2062	2591	2667	4852	3006	1600	1390	4039	4940	2914	2975	2190	11487
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Kaweah Subbasin Irrigated ET Dema	**407187**	**384603**	**392034**	**388504**	**421846**	**336999**	**347154**	**347277**	**361772**	**347610**	**344283**	**318999**	**318135**
Kaweah Subbasin Total ET Demand	**424935**	**406930**	**415948**	**388504**	**421846**	**336999**	**347154**	**347277**	**361772**	**347610**	**344283**	**318999**	**318135**

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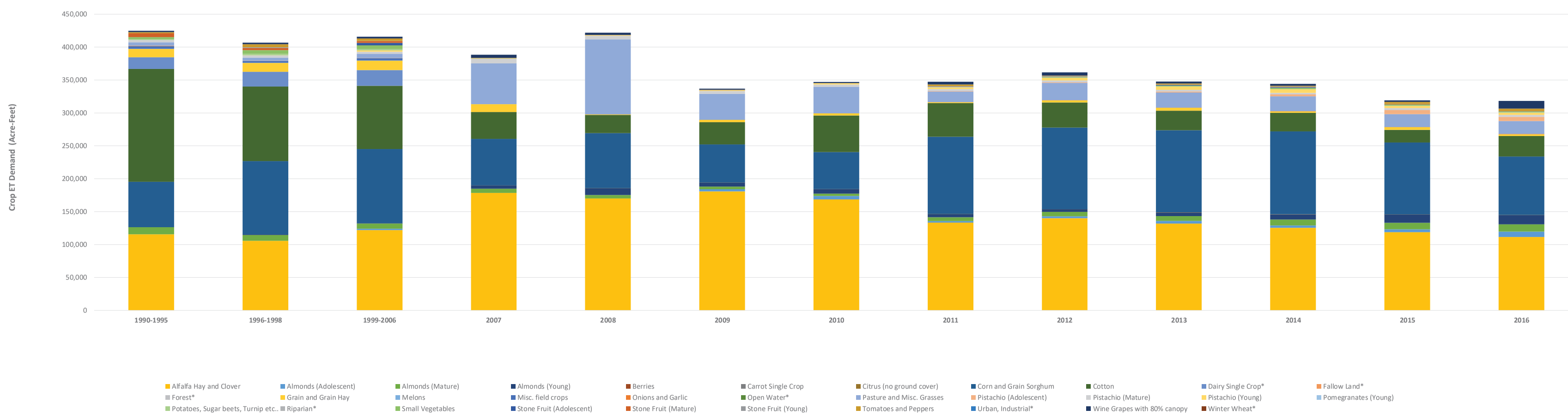
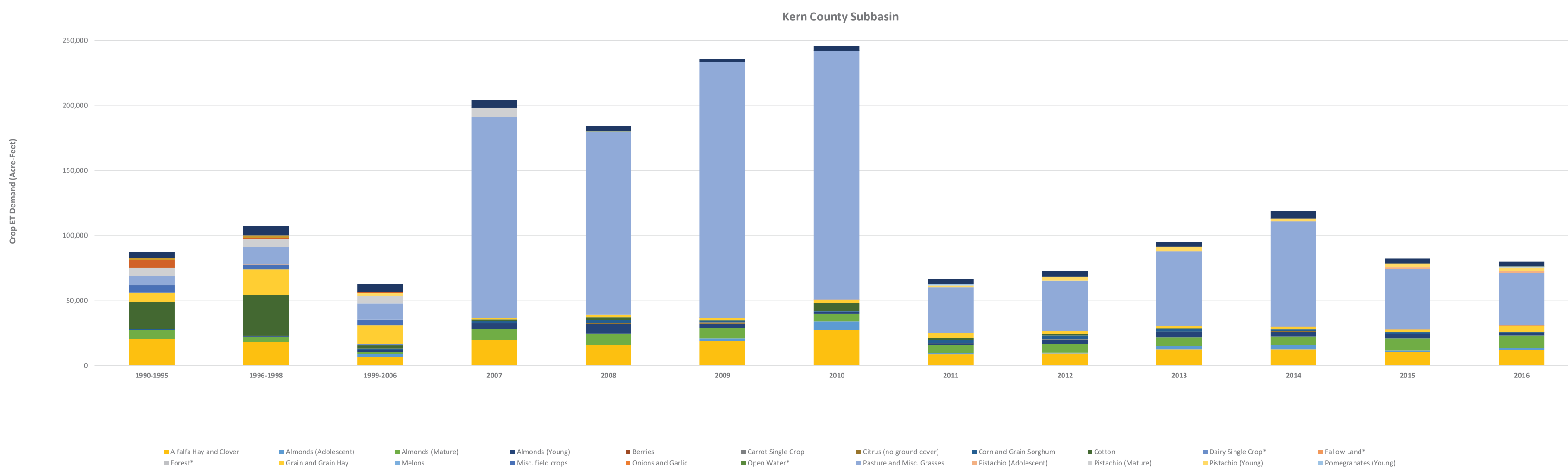
Kaweah Subbasin



APPENDIX D3-8

Sum of Crop ET Demand (Acre-Feet/Year) Kern County Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kern County Subbasin													
Alfalfa Hay and Clover	20321	18273	6736	19380	15803	18878	27373	8596	9207	12561	12467	10488	12071
Almonds (Adolescent)	0	0	2266	0	0	2222	6474	833	571	2331	3094	1258	1413
Almonds (Mature)	6857	3611	1401	8966	8694	7583	6160	6105	6889	6838	6847	9333	9610
Almonds (Young)	0	583	1555	4243	7634	3583	1592	1620	3251	4381	3710	3081	2335
Berries	0	0	0	0	0	0	0	0	0	18	0	0	0
Carrot Single Crop	188	0	0	0	0	0	0	1	0	10	5	3	5
Citrus (no ground cover)	0	0	0	0	440	935	0	6	64	7	510	4	3
Corn and Grain Sorghum	603	475	1135	1640	2267	1302	562	2488	3062	2200	1269	1586	371
Cotton	20621	31026	2324	1387	2337	829	5767	1798	1127	192	351	89	181
Dairy Single Crop*	3	0	1239	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	7623	20168	14436	881	1817	1460	2931	3387	2394	2208	1878	1953	4984
Melons	0	0	0	0	0	1	0	0	31	12	2	0	6
Misc. field crops	5473	3458	4354	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	230	99	0	0	0	1	16	92	127	18	28	60	181
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	7088	13517	12338	154954	140349	196576	190751	35338	38717	56959	80646	46771	40224
Pistachio (Adolescent)	0	0	0	0	0	0	0	0	0	2	77	966	1205
Pistachio (Mature)	5993	5796	5758	6465	674	2	0	0	0	0	0	0	0
Pistachio (Young)	0	476	2322	266	174	174	300	1350	2464	3525	2055	2939	2940
Pomegranates (Young)	0	0	0	0	63	0	0	921	158	42	35	16	679
Potatoes, Sugar beets, Turnip etc..	272	0	0	0	0	2	0	1	2	0	6	17	2
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	38	0	88	0	2	0	19	6	19	14	9	17	19
Stone Fruit (Adolescent)	0	0	58	0	0	0	0	0	0	0	0	0	7
Stone Fruit (Mature)	5735	877	723	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	19	2	4	86	44	10	30	11	18	174	22	85
Tomatoes and Peppers	1667	1763	0	0	0	2	0	185	178	37	53	63	283
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	4578	7112	5979	5806	4185	2166	3657	3862	4212	3889	5651	3603	3413
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Kern County Subbasin Irrigated ET D	**87287**	**107253**	**61474**	**203992**	**184526**	**235758**	**245611**	**66619**	**72486**	**95264**	**118867**	**82269**	**80017**
Kern County Subbasin Total ET Dem	**87290**	**107253**	**62713**	**203992**	**184526**	**235758**	**245611**	**66619**	**72486**	**95264**	**118867**	**82269**	**80017**

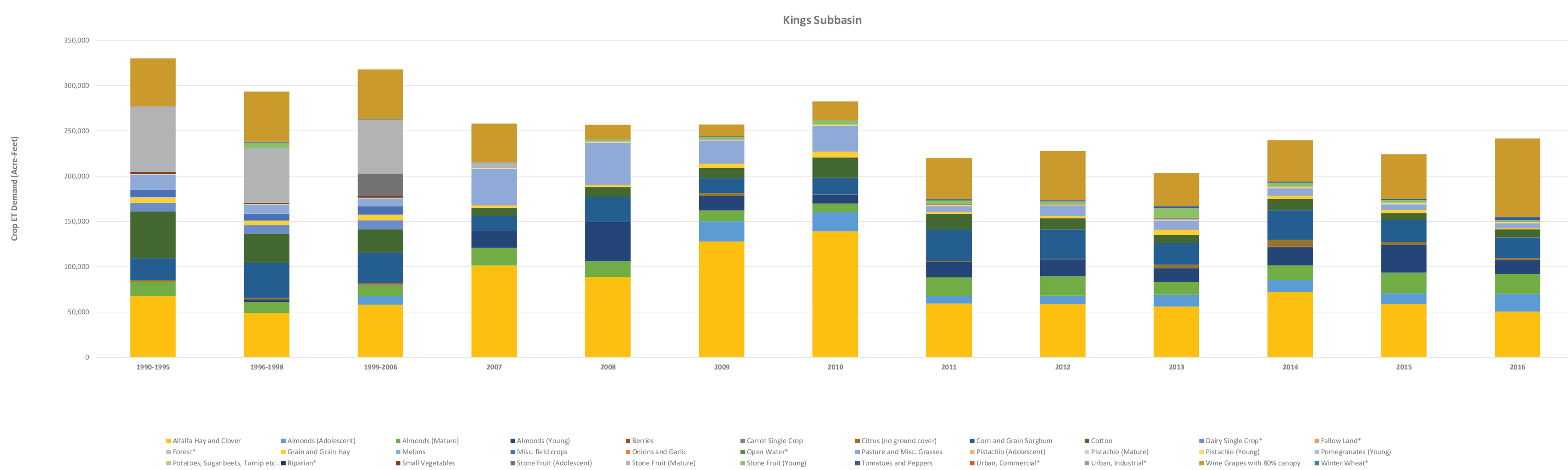
Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D3-9

Sum of Crop ET Demand (Acre-Feet/Year) Kings Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kings Subbasin													
Alfalfa Hay and Clover	67617	49074	58132	101357	88588	127908	139012	59444	58992	55996	72022	58974	50444
Almonds (Adolescent)	0	0	9525	0	0	22385	21317	7909	9004	13168	13348	11819	19720
Almonds (Mature)	15841	12188	11683	19642	17328	11842	9567	20922	21449	13995	16138	22835	21754
Almonds (Young)	0	2461	812	19323	43483	16082	9544	17088	18720	15125	20298	30152	15595
Berries	0	8	8	0	0	0	0	1	5	38	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	48	5	7	126	0	30
Citrus (no ground cover)	1912	2002	2002	249	313	2861	192	694	496	3915	8050	3278	1915
Corn and Grain Sorghum	24180	38518	33574	15458	27487	16580	18626	34985	32268	24209	32503	24496	22755
Cotton	51696	32000	25728	9225	10830	11344	22446	17615	12690	8521	12370	7650	9240
Dairy Single Crop*	9546	9561	9791	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	5766	4894	6019	2412	1933	4827	6546	1719	2379	5936	3092	3579	1179
Melons	671	297	215	0	5	27	6	1	15	48	11	14	42
Misc. field crops	7835	7572	9345	0	0	2	0	0	0	0	0	0	0
Onions and Garlic	0	0	188	47	103	162	67	312	130	116	692	190	420
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	16557	10047	8269	40480	46696	25318	28303	6182	11512	9898	7730	5879	5061
Pistachio (Adolescent)	0	0	0	0	0	0	0	4	13	4	27	50	50
Pistachio (Mature)	558	353	353	289	229	212	192	192	188	187	184	183	111
Pistachio (Young)	0	2	37	453	385	955	571	1349	1006	949	1302	943	1353
Pomegranates (Young)	0	0	0	25	38	67	71	189	187	119	107	97	60
Potatoes, Sugar beets, Turnip etc..	0	99	754	2	0	5	0	27	1	1	1	8	0
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	2596	1703	1291	15	61	5	24	127	212	945	102	32	84
Stone Fruit (Adolescent)	0	0	24935	0	0	19	185	261	517	747	529	673	329
Stone Fruit (Mature)	72220	60018	59160	5770	1126	223	144	42	51	41	111	84	48
Stone Fruit (Young)	0	6313	620	439	2253	2798	4964	4060	2371	10498	4070	2798	1273
Tomatoes and Peppers	117	1037	711	33	9	327	51	1407	1078	2452	1235	1090	3304
Urban, Commercial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	53016	55408	54892	42775	15880	12995	20652	45308	54690	36332	45665	49431	86809
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Kings Subbasin Irrigated ET Demand	**320581**	**283996**	**308252**	**257993**	**256747**	**256945**	**282481**	**219886**	**227981**	**203247**	**239711**	**224256**	**241575**
Kings Subbasin Total ET Demand	**330127**	**293556**	**318043**	**257993**	**256747**	**256945**	**282481**	**219886**	**227981**	**203247**	**239711**	**224256**	**241575**

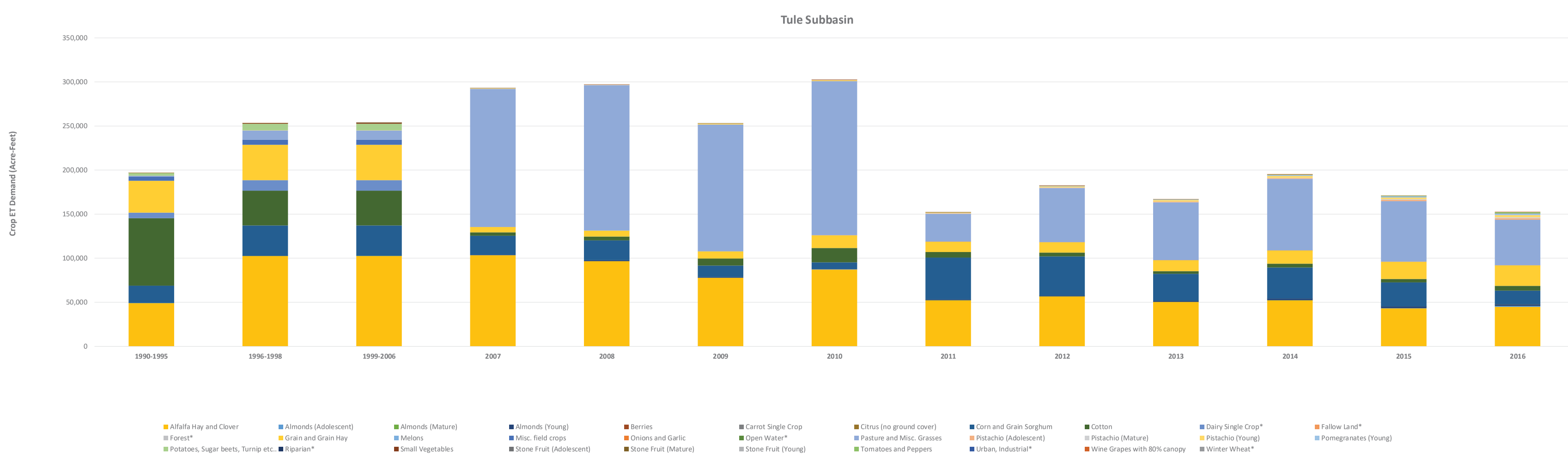
Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



APPENDIX D3-10

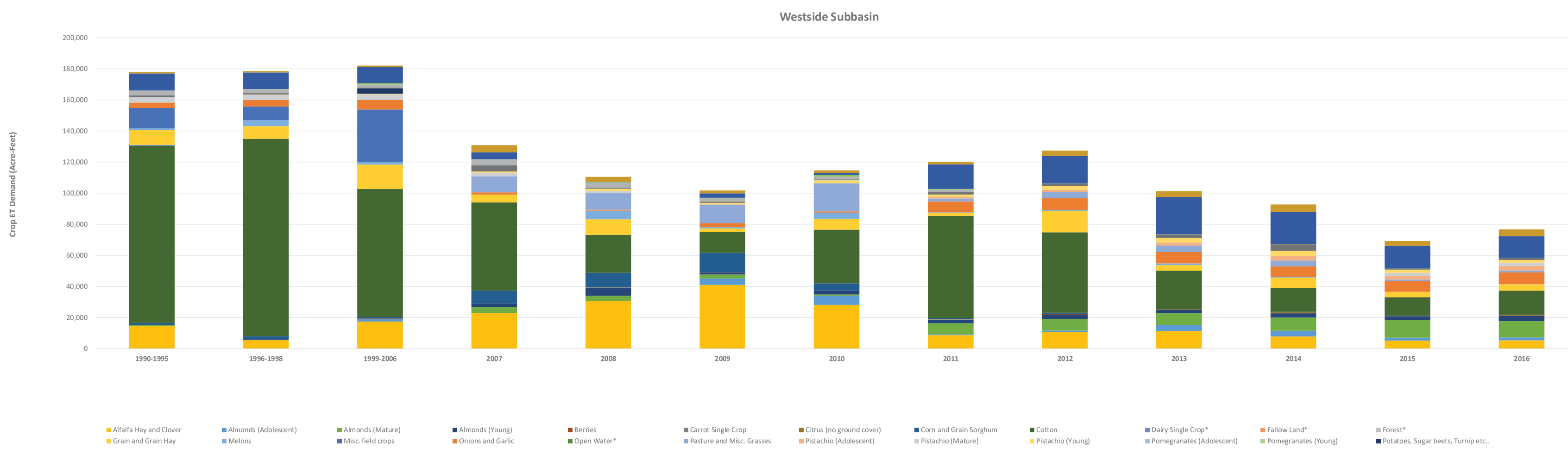
Sum of Crop ET Demand (Acre-Feet/Year) Tule Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tule Subbasin													
Alfalfa Hay and Clover	48995	102696	102695	103253	96627	77757	87117	52421	56712	50482	52317	42961	44851
Almonds (Adolescent)	0	0	6	0	0	104	83	13	8	45	113	223	943
Almonds (Mature)	152	45	45	0	0	0	0	12	1	1	1	22	22
Almonds (Young)	0	2	0	479	1195	833	245	820	590	1052	1679	1995	1722
Berries	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrot Single Crop	0	0	0	0	0	0	0	4	2	1	0	2	61
Citrus (no ground cover)	0	0	0	0	0	0	0	17	1	11	15	7	4
Corn and Grain Sorghum	19772	34425	34425	21765	22365	13040	7925	47549	44687	30636	35347	27359	15720
Cotton	76583	39418	39418	3865	4411	7859	16222	6149	4469	3160	4387	3940	5296
Dairy Single Crop*	6246	12030	12030	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	36255	40079	40077	6075	6753	8386	14365	11806	11631	12553	15122	19560	23291
Melons	20	0	0	0	0	7	0	2	4	2	96	5	40
Misc. field crops	4512	5890	5893	0	0	0	0	0	0	0	0	0	0
Onions and Garlic	4	0	0	1	0	0	147	73	183	1	9	36	105
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	1030	10450	10450	156596	164915	143596	174809	31502	61326	65535	80914	68705	51541
Pistachio (Adolescent)	0	0	0	0	0	0	0	575	558	722	1073	1324	1792
Pistachio (Mature)	0	0	0	301	218	135	108	107	106	106	105	929	1021
Pistachio (Young)	0	50	201	490	528	1184	1246	793	1182	1770	2221	1795	2525
Pomegranates (Young)	0	0	0	0	17	12	3	189	545	585	1024	1409	1596
Potatoes, Sugar beets, Turnip etc..	3015	7388	7388	0	0	2	0	4	3	2	11	21	3
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	0	916	916	1	1	7	326	15	53	49	88	68	378
Stone Fruit (Adolescent)	0	0	58	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Mature)	33	0	0	0	0	0	0	0	0	0	0	0	0
Stone Fruit (Young)	0	15	0	5	50	6	1	25	22	1	30	29	5
Tomatoes and Peppers	4	40	40	3	0	5	0	234	239	159	597	518	1466
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	183	157	157	88	237	83	252	314	476	81	269	304	346
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Tule Subbasin Irrigated ET Demand	**190557**	**241571**	**241770**	**292921**	**297316**	**253017**	**302850**	**152624**	**182797**	**166953**	**195419**	**171213**	**152727**
Tule Subbasin Total ET Demand	**196803**	**253600**	**253800**	**292921**	**297316**	**253017**	**302850**	**152624**	**182797**	**166953**	**195419**	**171213**	**152727**

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



Sum of Crop ET Demand (Acre-Feet/Year) Westside Subbasin	1990-1995	1996-1998	1999-2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Westside Subbasin													
Alfalfa Hay and Clover	14783	5463	17452	22840	30645	40982	28245	8690	10822	11407	7847	5227	5318
Almonds (Adolescent)	0	0	1353	0	0	4098	5704	471	870	3772	3691	1847	1898
Almonds (Mature)	530	0	0	3808	3528	2660	877	7155	7400	7542	8563	11411	10450
Almonds (Young)	0	343	474	2571	5132	1461	2712	2247	2802	2334	2597	2396	3486
Berries	29	22	27	0	0	0	0	0	462	0	0	0	71
Carrot Single Crop	0	0	0	0	0	0	0	183	2	5	10	99	9
Citrus (no ground cover)	30	23	64	0	124	53	0	241	0	430	927	90	491
Corn and Grain Sorghum	1249	2078	1093	8137	9361	12433	4512	806	779	23	75	20	115
Cotton	113990	127022	82287	56779	24486	13325	34546	65685	51753	24591	15497	11995	15476
Dairy Single Crop*	354	0	0	0	0	0	0	0	0	0	0	0	0
Fallow Land*	0	0	0	0	0	0	0	0	0	0	0	0	0
Forest*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grain and Grain Hay	9494	8102	15647	4992	9968	2311	6890	1659	13750	3591	6523	3310	4086
Melons	1280	3829	1681	4	5492	824	4069	545	615	1099	584	235	126
Misc. field crops	13047	8983	33812	0	0	0	33	0	0	0	0	0	0
Onions and Garlic	3528	4074	5993	1365	678	2444	685	7017	7569	7310	6608	6697	7539
Open Water*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture and Misc. Grasses	0	7	320	10430	10890	12191	18149	1854	3863	4268	3807	1098	1211
Pistachio (Adolescent)	0	0	0	0	0	0	0	1128	1498	1959	2858	2443	2926
Pistachio (Mature)	3533	3399	3392	2354	1261	11	6	6	6	3	0	1971	2172
Pistachio (Young)	0	95	399	796	1355	1077	1795	1444	2313	2857	3446	2046	1707
Pomegranates (Adolescent)	0	0	0	0	0	0	0	0	0	35	0	0	0
Pomegranates (Young)	0	0	0	45	90	43	139	91	65	49	2	30	42
Potatoes, Sugar beets, Turnip etc..	0	0	3407	326	0	0	0	92	0	0	0	0	7
Riparian*	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Vegetables	1154	951	498	3536	674	458	488	1335	1405	2014	4046	616	1302
Stone Fruit (Adolescent)	0	0	191	0		182	101	112	83	35	112	0	0
Stone Fruit (Mature)	3100	2553	1822	3750	3010	2099	1713	1511	3	1	20	0	0
Stone Fruit (Young)	0	72	841	174	419	391	1171	527	95	119	68	2	41
Tomatoes and Peppers	10971	10604	10367	4457	172	2860	1108	15693	17844	24101	20685	14607	13747
Urban, Commercial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban, Industrial*	0	0	0	0	0	0	0	0	0	0	0	0	0
Wine Grapes with 80% canopy	907	877	1050	4524	3216	1815	1743	1842	3387	3819	4781	3205	4462
Winter Wheat*	0	0	0	0	0	0	0	0	0	0	0	0	0
Westside Subbasin Irrigated ET Dem	**177626**	**178498**	**182172**	**130889**	**110499**	**101717**	**114687**	**120333**	**127387**	**101365**	**92746**	**69345**	**76682**
Westside Subbasin Total ET Demand	**177980**	**178498**	**182172**	**130889**	**110499**	**101717**	**114687**	**120333**	**127387**	**101365**	**92746**	**69345**	**76682**

Notes: Fields with an Asterisk (*) are not Irrigated; Annual Total is by Calendar Year



Appendix D4
Annualized Specified Pumping by Well Field

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
Angiola	E1	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E10	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E11	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E13	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E14	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E15	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E16	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E17	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E18	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E19	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	E21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E4	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E5	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	E7	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G1	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G11	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G13	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G14	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G16	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G17	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G18	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G19	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G2(NEW)	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G20	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G21	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G22	0.00	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	G3	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G5	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	G7	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W11	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W12	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W13	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	W15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W6	802.33	371.37	531.65	94.54	260.14	0.00	0.00	0.00	0.00	0.00	107.68	368.95	421.22	356.02	425.48	10.51	2.24	432.82	361.13	419.98	250.76	125.95	215.42	339.20	307.72	335.78	322.74
Angiola	W7	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W8	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
Angiola	W9	1,604.65	742.73	1,063.30	189.08	520.29	0.00	0.00	0.00	0.00	0.00	215.37	737.90	842.44	712.03	850.95	21.02	4.48	865.63	722.27	839.96	501.51	251.90	430.85	678.40	615.44	671.56	645.49
El Rico	ER_C-16	1,800.27	2,870.99	1,808.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,571.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_C-33	2,310.31	1,917.00	2,319.99	0.00	723.00	81.00	0.00	0.00	0.00	0.00	0.00	0.00	635.00	567.00	1,894.00	0.00	0.00	1,774.02	451.00	177.17	0.00	0.00	676.60	692.36	721.93	0.00	0.00
El Rico	ER_G-9	0.00	557.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	611.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_Heck1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,155.63	976.07	2,999.27	2,409.04
El Rico	ER_HR-190	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,754.98	2,495.81	1,925.97	905.10	7.48	2,119.00	1,963.66	1,667.61	1,279.25	1,120.47
El Rico	ER_HR-28	0.00	835.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,611.30	972.50	449.34	1,175.75	0.00	0.00	1,045.76	1,002.92	914.27	503.12	0.00	1,240.01	868.40	865.22	653.07	211.39
El Rico	ER_HR-29	0.00	739.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,116.93	1,132.31	424.33	1,056.00	0.00	0.00	979.28	755.17	742.50	376.96	3.11	792.86	654.05	533.04	436.01	408.77
El Rico	ER_HR-30	0.00	872.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,018.00	1,042.20	431.86	1,236.00	0.00	0.00	1,031.59	1,209.69	788.33	400.12	3.22	881.46	704.78	668.79	562.82	501.81
El Rico	ER_M-137	2,847.89	2,264.10	2,855.99	247.00	1,829.00	42.98	0.00	0.00	0.00	0.00	204.00	2,001.81	1,470.62	1,297.66	2,097.00	0.00	0.00	2,047.10	2,261.11	2,271.83	896.08	6.20	2,050.50	1,369.69	1,879.81	1,526.53	1,849.82
El Rico	ER_M-140	2,150.06	1,811.41	2,157.00	261.00	1,459.00	35.01	0.00	0.00	0.00	0.00	1,102.84	2,286.25	1,710.31	1,045.01	1,756.00	0.00	0.00	1,875.32	2,064.27	1,891.50	1,143.24	52.52	1,846.08	1,408.40	570.87	411.26	0.00
El Rico	ER_M-141	1,176.07	885.72	1,180.00	146.00	573.00	21.00	0.00	0.00	0.00	0.00	860.64	1,162.00	798.00	543.00	805.00	0.00	0.00	727.97	69.14	655.19	342.10	2.60	0.00	0.00	0.00	0.00	0.00
El Rico	ER_M-143	1,017.51	883.69	1,022.00	131.00	1,690.00	24.00	0.00	0.00	0.00	0.00	580.31	1,240.48	843.00	493.00	590.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_M-144	1,837.75	1,248.17	1,844.00	241.00	1,186.00	35.01	0.00	0.00	0.00	0.00	1,117.95	1,782.20	1,041.81	502.87	1,101.00	0.00	0.00	1,086.25	928.44	833.34	242.64	5.58	865.23	791.49	658.50	185.54	683.66
El Rico	ER_M-145	1,268.00	1,065.48	1,268.00	172.00	878.00	24.00	0.00	0.00	0.00	0.00	820.56	1,334.00	999.00	606.00	783.00	0.00	0.00	898.42	967.08	820.42	476.67	3.57	1,210.60	1,085.95	1,041.87	912.18	636.02
El Rico	ER_M-146	1,125.00	980.69	1,125.00	145.00	875.00	30.00	0.00	0.00	0.00	0.00	865.15	1,713.00	1,076.00	692.00	555.00	0.00	0.00	1,074.51	1,038.96	517.93	332.79	0.00	1,041.64	781.67	494.71	404.75	351.36
El Rico	ER_M-147	2,298.75	1,695.17	2,304.99	205.00	1,411.00	40.00	0.00	0.00	0.00	0.00	944.77	2,163.00	1,509.00	995.00	1,501.00	0.00	0.00	1,368.64	1,389.19	1,215.32	429.98	13.42	1,015.01	938.89	1,700.98	1,777.19	1,779.69
El Rico	ER_M-148	3,241.85	2,353.72	3,250.99	362.00	2,009.00	55.00	0.00	0.00	0.00	0.00	1,553.20	2,601.99	2,049.00	1,251.00	2,180.99	0.00	0.00	2,229.32	2,555.65	2,400.02	1,366.79	41.82	2,535.94	2,111.49	2,253.66	2,289.41	2,275.77
El Rico	ER_M-149	2,739.24	2,182.51	2,746.99	264.00	1,663.00	47.00	0.00	0.00	0.00	0.00	1,592.32	2,389.99	1,937.00	1,032.00	2,080.00	0.00	0.00	1,755.84	1,804.78	495.83	1,394.04	49.18	2,045.42	2,154.85	1,995.12	657.24	0.00
El Rico	ER_M-150	2,509.06	2,156.20	2,515.99	283.00	1,045.00	14.00	0.00	0.00	0.00	0.00	1,097.00	2,673.99	1,866.00	1,149.00	2,161.00	0.00	0.00	2,094.07	2,558.80	2,194.59	1,186.13	50.26	2,225.49	2,046.19	1,761.41	1,642.53	1,503.20
El Rico	ER_M-151	2,081.75	792.00	2,088.00	234.00	1,300.00	0.00	0.00	0.00	0.00	0.00	103.98	431.00	0.00	0.00	419.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_M-153	2,282.17	1,905.10	2,288.99	300.00	1,270.00	27.00	0.00	0.00	0.00	0.00	0.00	1,375.00	1,417.00	419.00	1,811.00	0.00	0.00	1,536.96	1,878.58	1,621.68	629.88	6.61	1,835.05	2,307.41	2,093.23	1,684.08	1,388.40
El Rico	ER_M-154	2,199.44	1,761.58	2,205.99	275.00	1,222.00	25.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	240.05	1,615.00	0.00	0.00	1,509.29	1,523.09	1,568.91	618.14	6.45	448.82	0.00	0.00	789.05	1,514.80

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
El Rico	ER_M-158	2,232.55	1,527.82	2,238.99	132.00	1,323.00	0.00	0.00	0.00	0.00	0.00	0.00	661.00	1,400.00	846.00	1,190.00	0.00	0.00	677.03	1,736.03	1,542.60	616.54	16.26	825.51	0.00	0.00	0.00	0.00
El Rico	ER_M-159	0.00	75.00	908.00	101.00	361.00	825.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_M-161	0.00	0.00	1,840.00	375.00	1,728.00	42.98	0.00	0.00	0.00	0.00	129.11	3,048.72	1,916.85	661.65	2,271.99	0.00	0.00	1,259.21	1,953.95	1,996.68	841.78	7.98	1,943.88	1,984.78	318.00	0.00	0.00
El Rico	ER_M-163	0.00	0.00	1,680.00	318.00	1,778.00	966.00	0.00	0.00	0.00	0.00	173.73	2,395.99	1,344.00	619.00	1,481.00	0.00	0.00	1,210.58	1,728.49	1,099.94	513.17	4.13	1,317.26	523.36	0.00	0.00	0.00
El Rico	ER_M-166	0.00	0.00	1,671.00	346.00	1,758.00	42.98	0.00	0.00	0.00	0.00	593.35	2,699.66	2,148.02	1,280.59	2,262.99	0.00	0.00	2,247.74	2,390.46	2,402.21	725.28	6.82	2,328.07	1,810.63	0.00	0.00	0.00
El Rico	ER_M-168	0.00	0.00	1,254.00	320.00	1,546.00	32.02	0.00	0.00	0.00	0.00	325.06	2,667.79	1,735.12	592.18	1,117.00	0.00	0.00	1,672.00	2,185.50	1,940.01	784.63	0.04	2,027.28	2,070.43	1,386.28	1,832.52	1,772.13
El Rico	ER_M-169	0.00	0.00	1,381.00	316.00	1,526.00	30.03	0.00	0.00	0.00	0.00	325.67	2,724.11	1,755.43	645.10	2,174.00	0.00	0.00	1,733.90	2,405.69	1,549.94	257.02	4.94	1,077.09	1,111.80	1,011.80	913.28	0.00
El Rico	ER_M-170	0.00	0.00	254.00	304.00	1,534.00	32.02	0.00	0.00	0.00	0.00	307.88	2,575.19	1,683.01	747.92	2,075.00	0.00	0.00	1,731.22	2,450.65	2,231.45	862.97	7.96	2,152.31	2,235.27	2,145.84	2,026.97	1,951.97
El Rico	ER_M-171	0.00	0.00	147.00	1,413.00	1,510.00	28.00	0.00	0.00	0.00	0.00	343.99	2,442.99	1,501.00	666.00	756.00	0.00	0.00	1,526.34	2,208.94	2,000.90	537.82	29.32	0.00	0.00	0.00	0.00	0.00
El Rico	ER_M-172	0.00	0.00	0.00	0.00	772.00	0.00	0.00	0.00	0.00	0.00	253.00	2,315.99	1,447.00	141.00	1,546.00	0.00	0.00	1,179.42	1,821.88	1,344.49	655.27	6.37	1,674.70	1,562.70	1,539.75	1,396.80	1,251.10
El Rico	ER_M-175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	235.20	1,674.00	1,046.00	389.00	1,134.00	0.00	0.00	854.99	1,165.23	1,061.06	280.26	1.45	674.27	648.82	539.98	405.57	0.06
El Rico	ER_M-176	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.54	1,577.00	1,125.00	431.00	1,102.00	0.00	0.00	862.71	924.46	618.59	215.46	2.88	821.85	625.79	517.70	511.23	485.09
El Rico	ER_M-178	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,946.00	1,348.00	554.00	1,566.00	0.00	0.00	1,008.86	1,816.84	1,504.51	550.40	5.14	1,412.16	1,476.51	1,344.94	939.62	0.00
El Rico	ER_M-179	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.00	247.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_M-181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	166.07	1,374.00	872.00	337.00	982.00	0.00	0.00	738.93	931.46	880.21	346.94	3.47	38.47	0.00	0.00	0.00	0.00
El Rico	ER_R-26	2,265.99	411.00	2,265.99	222.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.00	514.00	411.00	0.00	0.00	999.00	746.36	255.13	0.00	0.00	1,221.08	1,143.98	948.86	653.64	174.78
El Rico	ER_R-27	1,861.00	34.00	1,861.00	296.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	443.00	0.00	0.00	0.00	831.00	238.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_R-33	0.00	787.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.00	436.00	1,203.00	0.00	0.00	1,440.66	1,668.12	156.32	0.00	0.00	2.00	0.00	0.00	0.00	0.00
El Rico	ER_R-35	2,144.00	471.00	2,144.00	279.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	154.00	30.00	865.00	0.00	0.00	1,351.84	1,004.22	0.00	0.00	0.00	1,435.08	888.81	0.00	0.00	0.00
El Rico	ER_R-47	1,859.48	1,610.93	1,863.00	121.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,228.00	1,344.00	520.00	1,640.00	0.00	0.00	6.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_S-111	90.00	239.00	90.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_S-113	90.00	763.27	90.00	0.00	360.00	0.00	0.00	0.00	0.00	0.00	0.00	822.00	660.00	171.00	678.00	0.00	0.00	359.45	636.40	532.75	230.80	2.08	525.67	384.38	470.03	367.38	263.73
El Rico	ER_S-120	3,124.06	2,198.62	3,132.99	366.22	706.00	43.00	0.00	0.00	0.00	0.00	162.29	2,702.99	1,663.00	604.00	1,984.00	0.00	0.00	1,888.04	2,234.46	1,852.52	691.55	6.36	1,787.12	1,656.47	1,153.40	842.51	351.44
El Rico	ER_S-127	2,904.44	2,011.31	2,911.99	348.00	1,759.00	49.03	0.00	0.00	0.00	0.00	319.14	2,693.46	1,654.08	563.24	1,964.00	0.00	0.00	1,847.00	1,906.27	416.61	830.46	7.27	2,028.06	2,000.17	1,434.00	0.00	0.00
El Rico	ER_S-160	1,615.41	1,776.86	1,622.00	255.00	928.00	20.00	0.00	0.00	0.00	0.00	0.00	1,017.00	1,337.00	487.00	1,657.00	0.00	0.00	908.71	1,722.46	1,049.80	0.00	13.15	1,006.31	934.65	652.22	43.90	370.48
El Rico	ER_S-162	2,015.00	1,912.27	2,015.00	502.00	1,738.00	56.00	0.00	0.00	0.00	0.00	282.02	3,407.99	2,171.00	786.00	2,689.99	0.00	0.00	2,433.37	2,850.05	1,979.59	530.13	7.00	1,926.89	1,854.70	1,649.31	1,422.80	1,393.60
El Rico	ER_S-164	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,461.00	314.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_S-165	1,045.00	1,445.69	1,045.00	220.00	1,030.00	0.00	0.00	0.00	0.00	0.00	74.60	2,489.99	1,641.00	592.00	2,034.00	0.00	0.00	1,639.21	1,711.75	520.57	796.53	10.19	574.24	551.17	394.73	0.00	0.00
El Rico	ER_S-167	1,626.00	1,618.86	1,626.00	384.00	1,888.00	52.00	0.00	0.00	0.00	0.00	152.49	3,048.99	1,893.00	684.00	2,262.99	0.00	0.00	2,065.85	1,245.14	0.00	0.00	0.00	0.00	1,440.79	1,077.44	1,535.36	311.72
El Rico	ER_S-173	0.00	2,085.34	0.00	106.00	2,092.00	63.00	0.00	0.00	0.00	0.00	0.00	2,325.99	2,373.99	886.00	2,969.99	0.00	0.00	1,859.87	2,717.95	2,087.83	998.67	10.23	2,932.26	3,120.53	3,114.65	3,063.55	1,652.10
El Rico	ER_S-174	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,529.99	2,101.00	779.00	2,558.99	0.00	0.00	2,185.60	2,743.38	2,424.90	966.68	7.94	1,877.19	563.24	730.78	603.26	502.54
El Rico	ER_S-188	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	985.80	1,507.20	1,185.16	288.20	3.33	750.92	311.28	679.15	409.23	196.40
El Rico	ER_S-191	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	258.84	0.00	0.00	0.00	0.00	0.00	238.00	0.00	0.00
El Rico	ER_S-192	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,099.00	2,470.89	1,076.58	0.00	2,565.67	2,601.49	2,322.96	2,055.21	1,804.77
El Rico	ER_S-193	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,983.06	2,102.49	1,079.61	9.36	2,559.21	2,639.88	2,346.56	2,241.24	2,036.11
El Rico	ER_S-194	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,558.77	2,582.76	1,082.20	9.02	2,216.67	1,910.75	910.07	358.99	2.97
El Rico	ER_S-195	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,460.00	2,699.86	1,153.29	10.14	2,836.87	3,126.31	2,966.75	2,880.80	2,816.01
El Rico	ER_S-196	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,325.00	2,731.97	1,106.82	9.67	2,402.58	2,731.07	2,569.80	2,426.92	2,298.25
El Rico	ER_S-198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,213.84	2,609.13	1,148.39	0.00	2,777.98	2,751.41	2,415.86	2,114.48	1,830.73
El Rico	ER_S-199	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	676.34	2,409.49	1,142.78	10.16	2,677.37	2,887.71	2,794.52	2,505.17	2,553.13
El Rico	ER_S-200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,168.99	1,105.84	0.00	2,759.92	2,870.49	2,742.45	2,169.81	1,614.97
El Rico	ER_S-201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	748.95	1,142.04	10.57	1,918.94	2,450.16	2,382.50	1,667.81	2,142.77
El Rico	ER_S-202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	544.42	15.16	3,460.57	3,338.14	2,617.87	1,693.30	1,718.73
El Rico	ER_S-203	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	230.77	15.70	3,884.90	4,107.45	4,368.74	4,445.74	4,282.34
El Rico	ER_S-205	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,781.11	5,081.66	4,185.44	3,486.88	5,161.08
El Rico	ER_S-206	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,533.13	4,681.16	4,513.79	3,703.62
El Rico	ER_S-209	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,196.76	3,963.35	3,437.13	3,401.15
El Rico	ER_S-211	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,256.46	4,387.34	4,068.25	3,619.99
El Rico	ER_S-213	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,064.55	3,900.73	3,966.16
El Rico	ER_S-214	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,635.46	4,518.85	4,306.07
El Rico	ER_S-215	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,909.40	3,886.35	3,975.84
El Rico	ER_S-216	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,425.40	4,537.42	4,416.25
El Rico	ER_S-217	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,757.98	4,318.93	4,497.61
El Rico	ER_S-218	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,118.39	4,278.81	4,292.27
El Rico	ER_S-219	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	498.85	4,477.82	4,406.65
El Rico	ER_S-220	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,283.65	4,397.68
El Rico	ER_S-221	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,924.61	3,970.97
El Rico	ER_S-222	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,122.29	3,786.41
El Rico	ER_S-223	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	766.91	3,935.35
El Rico	ER_S-224	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,925.50
El Rico	ER_S-225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,580.64
El Rico	ER_S-226	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,928.44
El Rico	ER_S-227	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,191.19
El Rico	ER_S-228	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,146.70
El Rico	ER_S-229	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	864.59
El Rico	ER_S-70	2,569.10	2,001.72	2,574.99	314.00	1,537.00	15.00	0.00	0.00	0.00	0.00	0.00	1,928.00	1,664.00	559.00	1,956.00	0.00	0.00	1,608.48	2,251.61	1,886.48	486.25	90.47	1,655.35	1,622.35	1,081.70	622.95	0.00
El Rico	ER_SR-13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	314.00	186.00	484.00	0.00	0.00	424.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_SR-14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	208.00	1,430.00	0.00	0.00	585.19	1,471.77	399.48	0.00	0.00	0.00	789.73	1,810.23	1,103.14	0.00
El Rico	ER_SR-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	826.00	544.00	1,209.00	0.00	0.00	1,203.67	1,687.76	295.48	0.00	0.00	0.00	381.63	1,020.65	237.17	0.00
El Rico	ER_SR-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	181.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_SR-8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	429.00	453.00	270.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_T-155	3,088.17	2,219.82	3,096.99	362.00	1,759.00	45.00	0.00	0.00	0.00	0.00	0.00	1,761.00	2,039.00	774.00	2,166.00	0.00	0.00	2,213.87	2,242.79	1,778.14	947.64	7.04	1,646.97	2,306.66	1,547.05	1,031.41	0.00
El Rico	ER_T-156	2,771.68	668.00	2,775.99	42.00	498.00	53.00	0.00	0.00	0.00	0.00	0.00	2,541.99	1,238.00	53.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_T-157	3,306.20	2,238.96	3,312.99	384.00	777.00	0.00	0.00	0.00	0.00	0.00	0.00	2,203.99	1,890.00	719.00	1,344.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
El Rico	ER_T-177	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	928.17	975.13	389.17	707.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Rico	ER_T-182	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,705.00	1,842.00	664.00	1,235.00	0.00	0.00	2,364.40	523.65	0.00	118.30	2.38	518.39	756.61	221.34	0.00	0.00
El Rico	ER_T-61	3,222.89	1,635.00	3,227.99	303.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	424.18	523.48	874.00	0.00	0.00	0.00	1,318.20	305.96	0.00	0.00	1,302.55	0.00	0.00	0.00	0.00
Creighton Ranch	CR_CR-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,626.79	1,849.41	1,705.15	1,320.74
Creighton Ranch	CR_CR-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	433.41	538.08	437.91	289.92
Creighton Ranch	CR_CR-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	170.04	523.12	512.68	511.33
Creighton Ranch	CR_CR-7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,022.41	1,342.09	1,098.35	830.86
Creighton Ranch	CR_EC-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	964.80	1,521.00	436.50	2,028.60	0.00	0.00	1,361.81	1,442.77	1,011.40	468.42	3.94	825.11	735.16	834.01	767.03	681.29
Creighton Ranch	CR_EC-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,816.20	1,339.20	437.40	1,433.70	0.00	0.00	752.12	811.61	953.34	353.70	2.89	849.40	897.20	817.27	540.13	517.71
Creighton Ranch	CR_EC-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,686.60	1,033.20	262.80	1,071.90	0.00	0.00	775.64	980.13	486.81	192.35	3.54	1,528.18	999.18	897.40	790.45	691.30
Creighton Ranch	CR_EC-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,782.90	1,187.10	88.20	715.50	0.00	0.00	757.83	1,016.12	887.14	327.42	2.73	925.07	886.85	819.55	780.30	706.68
Creighton Ranch	CR_EC-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	742.50	358.20	1,557.90	0.00	0.00	1,378.09	1,865.43	1,654.84	638.59	0.00	1,507.24	1,543.45	1,420.86	1,348.86	1,157.05
Creighton Ranch	CR_EC-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	474.30	430.20	1,954.80	0.00	0.00	1,449.81	2,367.72	2,217.50	701.82	2.38	1,973.90	2,059.83	2,022.39	1,912.80	279.52
Creighton Ranch	CR_EC-7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,329.30	0.00	0.00	1,545.86	2,080.28	2,066.13	674.60	6.43	834.67	1,737.98	1,554.98	1,247.94	1,058.44
Creighton Ranch	CR_S-100	484.00	1,074.20	484.00	110.00	314.00	15.02	0.00	0.00	0.00	0.00	0.00	1,197.05	875.26	261.80	1,050.00	0.00	0.00	923.62	1,118.45	963.91	363.81	3.60	1,104.47	1,106.76	778.83	0.00	0.00
Creighton Ranch	CR_S-103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	534.00	0.00	0.00	705.72	1,531.18	1,498.63	612.45	5.52	1,625.00	1,620.42	1,502.45	1,447.79	553.63
Creighton Ranch	CR_S-105	708.30	768.38	708.30	149.40	355.50	29.72	0.00	0.00	0.00	0.00	73.37	1,603.90	1,026.61	283.76	770.40	0.00	0.00	1,231.92	1,223.44	363.33	100.91	2.13	567.39	165.91	0.00	0.00	0.00
Creighton Ranch	CR_S-106	324.00	568.80	324.00	121.50	342.00	36.00	0.00	0.00	0.00	0.00	199.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Creighton Ranch	CR_S-108	1,727.10	1,190.05	1,727.10	231.30	1,715.40	2.70	0.00	0.00	0.00	0.00	0.00	1,631.12	1,249.14	314.31	1,623.60	0.00	1.83	1,204.17	1,722.36	1,942.71	804.47	28.36	1,572.01	980.71	669.79	615.39	1,481.35
Creighton Ranch	CR_S-109	1,227.32	1,847.11	1,227.60	244.80	1,749.60	51.30	0.00	0.00	0.00	0.00	204.62	1,324.71	772.55	316.10	1,602.90	0.00	62.02	1,180.48	1,599.53	1,427.47	615.08	27.28	1,294.39	1,561.03	873.80	859.07	1,343.12
Creighton Ranch	CR_S-110	698.12	2,335.62	698.40	0.00	0.00	48.61	0.00	0.00	0.00	0.00	343.99	1,954.25	1,495.75	487.94	2,233.79	0.00	0.00	1,657.27	2,046.15	1,234.31	700.55	16.33	1,647.26	1,635.60	1,468.44	1,304.75	1,317.23
Creighton Ranch	CR_S-114	928.80	1,416.78	928.80	165.60	1,148.40	33.31	0.00	0.00	0.00	0.00	261.45	1,418.76	966.67	384.07	1,386.90	107.10	2.05	989.20	1,273.28	1,170.74	462.43	16.27	434.15	454.04	361.08	274.32	176.55
Creighton Ranch	CR_S-115	666.90	1,254.50	666.90	114.30	817.20	23.38	0.00	0.00	0.00	0.00	185.45	1,221.72	704.39	311.38	1,257.30	89.10	0.00	891.02	1,171.90	894.20	453.19	49.00	1,020.84	946.69	819.85	543.40	507.17
Creighton Ranch	CR_S-116	544.50	1,058.24	544.50	93.60	673.20	19.80	0.00	0.00	0.00	0.00	205.84	1,075.84	803.80	305.65	1,145.70	88.20	1.61	747.45	530.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Creighton Ranch	CR_S-117	449.10	1,125.46	449.10	0.00	724.50	21.58	0.00	0.00	0.00	0.00	140.88	1,006.30	706.05	252.59	1,020.60	72.00	1.21	765.57	374.45	291.06	127.03	1.15	815.08	892.15	822.96	753.26	663.00
Creighton Ranch	CR_S-119	513.90	1,080.96	513.90	105.30	762.30	22.50	0.00	0.00	0.00	0.00	339.04	1,780.48	1,407.59	272.69	1,035.00	0.00	0.00	781.30	1,021.43	830.78	349.24	3.50	721.75	919.82	919.48	770.81	915.08
Creighton Ranch	CR_S-121	847.67	1,873.11	847.80	161.10	469.80	37.80	0.00	0.00	0.00	0.00	67.28	1,963.80	1,543.50	435.60	1,830.60	0.00	0.00	1,680.41	1,933.83	1,435.48	553.40	5.57	1,595.17	1,629.63	1,328.48	1,101.72	874.44
Creighton Ranch	CR_S-122	2,289.44	1,427.02	2,295.89	272.70	516.60	38.70	0.00	0.00	0.00	0.00	0.00	1,411.20	1,286.10	379.80	853.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Creighton Ranch	CR_S-123	508.37	1,211.83	508.50	95.40	1,029.60	127.80	0.00	0.00	0.00	0.00	227.00	1,639.80	1,062.00	295.20	1,207.80	0.00	0.00	1,125.99	1,361.89	1,066.67	395.97	4.23	1,169.63	1,288.35	1,285.32	978.43	1,006.36
Creighton Ranch	CR_S-124	757.80	511.20	757.80	117.90	1,155.60	35.10	0.00	0.00	0.00	0.00	264.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	719.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Creighton Ranch	CR_S-125	1,151.10	1,813.87	1,151.10	201.33	1,332.90	31.51	0.00	0.00	0.00	0.00	335.24	2,151.89	1,446.94	524.45	1,735.20	111.60	1.20	1,420.40	1,714.76	1,417.40	687.57	33.42	1,603.42	1,483.27	1,278.20	1,084.70	1,174.88
Creighton Ranch	CR_S-129	468.90	1,062.90	468.90	119.70	351.90	26.07	0.00	0.00	0.00	0.00	0.00	1,038.39	989.14	276.02	1,067.40	0.00	0.00	997.00	1,387.29	1,195.67	447.46	0.00	1,177.31	1,141.83	1,174.67	1,119.90	1,135.92
Creighton Ranch	CR_S-130	476.00	700.52	476.00	110.00	298.00	22.99	0.00	0.00	0.00	0.00	0.00	1,009.59	830.71	229.05	780.00	0.00	0.00	191.76	924.84	203.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Creighton Ranch	CR_S-131	311.40	1,239.39	311.40	123.30	335.70	24.27	0.00	0.00	0.00	0.00	0.00	1,011.77	978.22	283.66	1,216.80	0.00	0.00	1,014.61	1,284.51	1,152.84	449.99	4.01	1,256.76	1,404.28	1,256.95	1,118.88	990.26
Creighton Ranch	CR_S-132	1,333.24	836.22	1,337.40	141.30	358.20	29.72	0.00	0.00	0.00	0.00	0.00	1,127.70	930.20	240.93	709.20	0.00	0.00	1,361.83	1,332.57	1,340.85	513.02	4.58	1,373.03	1,394.13	1,306.25	1,205.36	1,196.98
Creighton Ranch	CR_S-134	345.60	1,211.96	345.60	66.60	511.20	15.31	0.00	0.00	0.00	0.00	0.00	333.32	901.23	287.95	1,387.80	0.00	1.70	995.66	1,358.11	1,217.67	496.88	4.70	980.34	958.35	1,108.44	1,043.79	648.49
Creighton Ranch	CR_S-135	549.00	1,267.62	549.00	138.00	394.00	30.03	0.00	0.00	0.00	0.00	0.00	1,372.00	1,061.00	305.07	1,111.00	0.00	0.00	773.37	701.81	454.06	347.44	3.81	1,070.52	730.93	863.08	835.17	890.83
Creighton Ranch	CR_S-138	1,602.46	1,463.52	1,607.40	196.20	342.00	26.10	0.00	0.00	0.00	0.00	0.00	1,140.30	1,193.40	328.45	1,539.90	0.00	0.00	1,248.92	1,700.89	1,542.83	510.08	10.12	1,457.37	1,035.02	1,300.24	1,288.59	1,304.07
Creighton Ranch	CR_S-183	0.00	1,593.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	801.00	1,554.30	370.80	2,181.59	0.00	0.00	1,765.58	1,797.71	1,785.59	710.78	18.40	1,503.65	1,560.04	1,370.94	691.79	342.08
Creighton Ranch	CR_S-187	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,312.39	1,696.80	1,498.09	538.34	4.52	1,216.82	898.60	748.61	435.77	0.00
Creighton Ranch	CR_S-189	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	676.47	1,397.26	507.94	4.93	1,251.80	864.87	1,089.38	1,090.70	1,085.31
Creighton Ranch	CR_S-197	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,375.06	3,016.17	1,130.32	9.76	2,937.88	2,980.16	3,049.06	3,425.72	3,342.29
Creighton Ranch	CR_S-204	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,989.78	5,174.18	4,814.78	4,644.04	4,492.56
Creighton Ranch	CR_S-207	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	460.40	5,700.81	4,838.66	4,195.61	2,838.11
Creighton Ranch	CR_S-208	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,429.56	5,504.19	5,132.88	4,673.93	4,034.77
Creighton Ranch	CR_S-210	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,853.51	4,542.36	3,990.52	3,818.24
Creighton Ranch	CR_S-212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	341.65	4,909.10	4,612.65	4,075.88
Creighton Ranch	CR_S-79	1,079.66	1,386.12	1,080.00	142.20	273.60	19.80	0.00	0.00	0.00	0.00	0.00	421.20	1,057.50	237.74	1,513.80	0.00	0.00	1,255.70	1,616.90	1,390.51	499.91	6.25	1,480.50	1,529.03	1,431.37	1,366.64	1,175.41
Creighton Ranch	CR_S-80	738.00	830.23	738.00	121.50	118.80	0.00	0.00	0.00	0.00	0.00	0.00	400.50	636.30	240.30	900.90	0.00	0.00	753.18	798.32	343.46	313.21	2.57	744.00	736.72	721.53	582.38	141.32
Creighton Ranch	CR_S-81	1,371.38	1,280.23	1,375.20	159.30	339.30	25.20	0.00	0.00	0.00	0.00	0.00	1,034.10	1,034.10	310.50	1,264.50	0.00	0.00	1,093.82	1,233.06	916.40	301.90	3.08	1,304.50	1,210.52	934.69	789.60	676.48
Creighton Ranch	CR_S-82	906.86	1,271.32	909.90	63.90	346.50	23.40	0.00	0.00	0.00	0.00	0.00	819.00	801.00	274.13	1,414.80	0.00	0.00	884.21	985.61	971.44	204.58	8.16	320.34	358.49	355.36	300.10	302.90
Creighton Ranch	CR_S-83	1,645.63	442.80	1,650.60	165.60	168.30	12.60	0.00	0.00	0.00	0.00	0.00	6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Creighton Ranch	CR_S-84	1,746.68	1,157.21	1,751.40	197.10	415.80	28.80	0.00	0.00	0.00	0.00	0.00	1,094.40	573.30	172.80	903.60	0.00	0.00	1,224.11	1,380.55	855.35	416.28	4.44	1,638.18	1,755.27	1,418.07	890.68	644.51
Creighton Ranch	CR_S-88	414.00	1,271.67	414.00	0.00	342.90	25.20	0.00	0.00	0.00	0.00	0.00	1,073.70	1,019.70	279.90	1,264.50	0.00	0.00	1,137.49	2,337.77	1,382.07	768.63	6.34	2,118.27	2,076.08	1,631.52	1,872.64	1,919.45
Creighton Ranch	CR_S-92	406.80	911.70	406.80	106.20	283.50	20.70	0.00	0.00	0.00	0.00	0.00	805.50	639.00	180.00	876.60	0.00	0.00	930.40	1,204.58	78.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_001	2,016.23	1,449.20	898.28	204.16	1,072.20	77.47	157.42	0.00	0.00	247.35	511.99	96.71	137.48	1,030.94	330.71	14.42	0.00	571.89	193.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_002	1,343.58	1,129.61	773.27	276.09	1,236.20	84.51	232.23	0.00	0.00	223.41	300.51	298.76	922.95	331.81	608.88	102.08	0.00	568.81	424.68	488.77	22.38	0.04	511.54	784.41	661.26	269.84	269.84
Corcorian ID	CID_003	2,295.40	2,455.53	1,798.95	272.49	737.44	2.14	61.66	0.00	0.00	255.57	468.39	957.97	1,569.26	871.26	554.29	0.00	0.00	1,334.59	925.45	845.58	281.71	41.63	208.52	0.00	0.00	0.00	0.00
Corcorian ID	CID_004	1,103.53	87.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_005	739.82	589.79	486.41	34.03	284.93	0.00	46.86	0.00	0.00	23.03	131.08	381.60	411.78	284.75	233.00	38.68	55.15	542.51	510.74	271.16	0.00	0.00	210.74	378.57	233.77	562.40	562.40
Corcorian ID	CID_006	554.73	449.73	364.07	26.09	243.38	0.00	45.95	0.00	0.00	102.98	216.29	421.32	598.01	79.91	346.99	99.29	83.11	928.85	590.30	271.35	0.00	0.00	80.23	297.22	683.04	580.99	580.99
Corcorian ID	CID_007	1,472.15	845.16	684.22	66.14	812.91	59.64	416.42	412.17	0.00	619.70	68.04	1,241.44	1,434.43	1,397.27	1,250.77	97.77	0.00	305.84	561.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_008	613.99	509.01	379.24	46.12	287.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_009	544.71	450.01	463.61	86.54	196.62	10.93	10.05	0.00	0.00	3.12	7.90	241.43	759.95	390.53	582.83	0.41	0.00	515.74	518.44	559.73	99.80	0.00	781.35	317.26	150.07	70.00	70.00
Corcorian ID	CID_010	627.86	634.04	535.86	20.58	386.64	0.00	50.68	0.00	0.00	166.19	91.94	560.84	611.82	401.46	637.43	49.50	27.84	563.95	514.06	426.49	144.73	0.05	629.21	743.55	626.48	843.38	843.38
Corcorian ID	CID_011	1,095.87	852.03	699.44	24.83	487.89	0.00	20.24	0.00	0.00	181.05	167.53	281.89	3.23	600.15	1,188.49	88.36	107.58	939.77	800.67	1,339.42	372.23	33.88	235.38	0.05	0.00	0.00	0.00
Corcorian ID	CID_012	2,646.53	2,904.86	2,402.93	731.41	2,376.85	172.13	961.47	832.87	159.92	1,247.80	0.00	0.00	0.00	1,249.09	1,340.48	495.63	552.67	2,241.76	1,920.72	1,547.25	482.90	218.98	929.05	1,794.97	1,578.69	1,413.54	1,413.54
Corcorian ID	CID_013	688.46	424.26	301.06	24.57	278.99	0.00	2.00	0.00	0.00	47.82	129.14	32.96	240.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_014	1,064.50	823.87	638.99	0.00	514.76	0.00	100.05	0.00	0.00	88.62	133.40	247.50	383.97	604.77	439.13	85.99	0.00	1,680.93	417.98	1,111.68	333.57	27.58	1,025.94	1,168.49	765.75	12.56	12.56
Corcorian ID	CID_015	983.35	681.20	471.33	35.58	420.81	0.00	84.55	0.00	0.00	102.53	108.71	631.10	613.15	336.36	580.81	58.85	12.85	465.51	172.01	151.65	0.01	660.30	307.92	122.48	0.00	0.00	0.00
Corcorian ID	CID_016	533.37	547.86	425.90	23.03	351.59	36.12	28.90	0.00	0.00	77.11	106.72	88.60	0.12	52.11	199.39	7.69	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_017	1,278.44	1,386.96	975.15	176.79	1,293.32	206.88	499.85	261.66	0.00	818.02	1,242.18	1,747.47	1,247.56	488.25	448.95	408.94	101.82	1,389.98	1,473.27	1,463.99	133.79	38.17	1,244.58	1,309.51	1,183.41	980.85	980.85

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
Corcorian ID	CID_018	943.66	749.64	701.03	152.18	949.61	64.22	0.00	0.00	0.00	389.81	552.60	674.14	968.82	810.87	919.52	489.30	96.06	1,480.59	1,008.63	729.60	264.65	240.75	1,249.10	1,122.97	980.39	887.85	887.85
Corcorian ID	CID_019	1,141.43	1,055.25	797.10	130.18	733.06	0.00	116.50	0.00	0.00	258.48	146.36	940.79	750.55	896.51	1,415.36	306.71	199.99	1,279.65	1,343.86	929.27	154.62	81.15	1,217.95	1,479.14	1,039.33	1,226.58	1,226.58
Corcorian ID	CID_020	1,682.59	1,222.03	743.03	73.31	1,142.60	87.36	155.47	0.00	0.00	127.25	523.92	1,049.50	1,208.63	1,367.01	1,039.10	273.64	197.83	843.20	988.20	641.34	300.74	119.40	1,241.00	1,151.67	1,028.68	772.84	772.84
Corcorian ID	CID_021	973.70	1,019.30	717.27	161.22	1,259.62	42.20	283.41	765.16	116.83	574.45	1,003.18	1,414.21	600.80	1,031.67	1,343.40	264.05	220.09	1,377.89	1,046.65	649.39	393.76	12.50	974.52	792.87	797.92	128.61	128.61
Corcorian ID	CID_022	992.52	810.03	693.96	141.75	643.68	75.24	111.76	0.00	0.00	43.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_023	858.00	744.13	547.71	0.00	558.21	26.48	116.26	0.00	0.00	400.61	518.95	462.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_024	1,836.70	2,033.55	1,689.40	368.63	2,092.55	105.69	290.01	980.44	130.41	924.59	1,393.04	1,348.60	1,555.08	523.66	1,441.63	175.26	169.60	1,959.05	1,197.09	2,036.26	709.24	21.26	1,397.81	213.99	1,318.92	195.89	195.89
Corcorian ID	CID_025	2,200.45	1,742.98	1,395.37	237.66	1,347.50	141.01	330.06	599.95	134.92	599.76	1,311.78	1,680.88	1,414.68	951.18	1,395.77	369.19	311.44	2,117.80	1,833.45	1,897.24	401.36	506.80	1,865.98	1,963.80	1,541.33	1,589.06	1,589.06
Corcorian ID	CID_026	2,054.10	1,752.35	2,044.83	332.41	1,992.01	313.63	186.98	755.01	229.09	735.74	1,095.24	1,398.85	1,363.25	309.84	1,420.85	693.28	217.92	2,049.11	1,398.39	1,446.66	108.73	235.06	1,581.51	1,821.77	1,704.64	1,538.76	1,538.76
Corcorian ID	CID_027	1,346.31	1,366.56	837.69	112.16	1,086.54	79.80	538.93	671.98	0.00	369.42	704.45	1,400.45	1,106.74	693.76	388.57	366.41	76.24	332.03	645.93	1,061.16	153.59	125.36	949.56	768.78	500.00	514.07	514.07
Corcorian ID	CID_028	1,759.43	2,454.37	1,851.81	384.68	2,660.59	150.14	845.41	514.20	94.87	1,819.92	2,777.40	3,244.34	1,540.61	2,267.13	2,119.73	347.32	671.10	2,370.25	2,101.08	1,720.37	158.47	0.00	0.00	1,149.04	1,854.99	1,267.36	1,267.36
Corcorian ID	CID_029	1,869.41	2,096.46	1,683.73	321.28	2,311.90	282.17	567.92	372.23	83.58	1,331.91	2,515.63	2,623.93	1,646.22	1,753.96	1,496.24	790.66	0.20	618.44	340.29	0.00	68.66	0.00	0.00	677.62	1,008.13	194.65	194.65
Corcorian ID	CID_030	1,033.99	234.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_031	744.47	606.00	617.43	125.94	688.72	64.45	0.00	0.00	0.00	243.97	433.74	311.91	522.61	794.13	451.74	113.97	132.28	423.17	340.78	185.08	0.00	0.63	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_032	2,478.85	1,769.45	1,965.95	543.81	1,931.68	161.50	804.49	732.98	247.42	1,111.84	0.00	0.00	0.00	301.13	633.74	271.47	0.00	0.00	1,496.72	1,712.44	847.98	65.61	1,540.00	1,633.14	1,514.64	1,385.37	1,385.37
Corcorian ID	CID_033	1,379.94	899.71	1,359.42	306.02	1,413.69	150.67	288.74	0.00	0.00	734.29	1,294.95	1,373.09	1,628.69	1,515.12	1,217.83	337.36	125.60	1,773.95	1,764.90	694.03	630.17	133.66	1,365.41	812.42	22.00	453.53	453.53
Corcorian ID	CID_034	1,618.32	1,291.57	1,024.49	120.41	1,097.03	105.03	37.67	0.00	0.00	480.87	771.69	1,259.83	507.95	654.28	999.16	129.75	62.81	1,283.75	847.22	659.79	115.26	0.00	1,091.28	1,129.49	1,225.34	1,204.38	1,204.38
Corcorian ID	CID_035	1,295.37	1,693.60	1,493.93	333.89	1,721.01	111.08	512.54	273.14	215.25	1,426.21	1,590.00	499.62	0.00	985.65	2,204.94	509.33	437.62	2,442.24	2,187.69	2,419.10	871.86	58.45	1,869.01	496.05	0.00	0.00	0.00
Corcorian ID	CID_036	993.71	1,106.31	1,222.96	292.35	1,126.13	165.28	472.55	253.53	0.00	699.75	1,053.95	1,700.40	1,307.80	1,160.17	897.62	304.18	251.08	1,215.38	1,130.81	1,395.02	1,055.11	316.34	1,239.06	1,380.37	1,078.82	1,278.24	1,278.24
Corcorian ID	CID_037	1,344.64	1,981.76	1,250.45	260.64	1,723.95	150.68	600.69	341.34	65.27	128.13	419.34	741.83	1,268.20	1,484.38	1,878.90	582.54	351.38	1,532.13	1,230.39	1,151.86	538.73	23.36	612.84	0.00	-0.02	0.00	0.00
Corcorian ID	CID_038	2,139.10	2,553.65	2,343.27	360.78	2,614.25	224.79	776.11	378.39	0.00	1,367.84	1,564.95	2,101.25	2,025.91	1,740.78	1,318.42	645.71	484.89	2,221.00	2,099.24	2,049.18	810.60	27.00	1,906.51	1,063.32	2.80	369.57	369.57
Corcorian ID	CID_039	588.86	605.10	338.75	22.95	135.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_040	926.15	1,394.96	2,165.44	856.73	2,185.85	430.57	435.13	222.54	4.40	496.27	226.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_041	1,728.95	1,941.95	1,528.32	166.00	1,191.76	19.27	183.57	60.48	0.00	365.75	330.60	283.99	276.67	239.43	708.61	112.37	26.96	454.23	371.59	370.87	92.05	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_042	1,692.50	864.41	1,239.68	250.66	1,566.67	118.48	210.11	0.00	0.00	616.36	1,002.06	1,448.33	1,428.97	1,081.34	867.66	303.24	288.09	1,578.76	1,448.04	627.67	501.39	152.11	1,365.87	1,229.59	121.05	467.66	467.66
Corcorian ID	CID_043	284.50	1,025.86	788.77	0.00	945.45	0.00	188.63	0.00	0.00	450.51	352.45	735.51	786.59	229.17	743.31	634.30	278.22	1,412.90	1,390.02	1,292.64	351.27	61.51	1,094.73	1,052.46	1,104.45	1,163.51	1,163.51
Corcorian ID	CID_044	2,029.22	2,100.06	1,637.63	709.97	1,802.08	547.81	731.24	162.90	29.33	484.21	922.29	1,556.49	455.60	1,084.36	758.02	104.03	57.82	637.83	1,063.14	1,054.04	174.91	8.30	272.36	121.12	0.02	0.00	0.00
Corcorian ID	CID_045	1,224.74	1,179.34	928.36	211.27	1,088.56	110.45	292.71	464.68	0.00	936.86	1,366.65	1,420.29	1,187.86	1,415.47	757.22	403.80	260.08	1,157.39	555.50	0.03	52.14	21.44	376.24	8.26	0.00	233.10	233.10
Corcorian ID	CID_046	989.39	998.34	534.12	129.56	997.58	218.11	218.98	14.94	0.00	533.14	1,338.92	971.73	1,018.56	505.35	471.23	357.23	286.09	522.10	319.19	1,059.49	388.39	16.28	727.21	0.00	0.00	133.84	133.84
Corcorian ID	CID_047	734.05	533.05	64.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_048	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_049	1,536.11	1,242.17	1,007.51	476.14	1,683.34	172.65	513.42	502.13	102.50	962.82	61.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_050	836.66	847.12	348.50	457.36	1,775.01	319.22	759.79	617.50	114.57	166.79	0.00	772.26	1,706.63	938.81	1,506.57	365.02	464.85	1,370.48	2,063.72	1,776.53	859.53	351.17	1,995.65	1,794.20	1,651.95	1,581.65	1,581.65
Corcorian ID	CID_051	1,263.69	903.10	610.18	13.28	758.27	1.42	166.40	0.00	0.00	168.74	286.75	750.62	883.60	695.86	1,150.74	63.77	0.00	1,168.23	643.60	730.05	776.54	0.00	328.34	498.59	883.24	1,006.86	1,006.86
Corcorian ID	CID_052	1,991.91	995.68	1,036.49	0.00	749.17	80.23	149.37	87.23	0.00	0.69	414.45	750.07	1,464.56	704.16	1,556.32	127.65	0.00	1,189.35	1,446.50	831.86	576.55	72.77	1,394.98	0.36	769.40	1,783.85	1,783.85
Corcorian ID	CID_053	1,836.83	1,344.56	1,165.61	99.22	832.81	0.00	98.02	762.31	0.00	539.91	907.06	1,523.06	1,816.36	676.03	1,526.97	409.15	309.93	1,543.69	1,958.95	1,697.35	534.79	186.30	2,064.82	1,397.63	1,401.31	812.65	812.65
Corcorian ID	CID_054	1,451.67	1,174.62	1,135.27	279.69	1,492.00	217.17	413.17	229.71	121.84	743.08	1,167.10	873.06	544.35	920.54	963.95	257.76	122.34	1,244.66	1,464.17	727.87	526.74	12.28	714.45	1,678.15	1,507.17	1,201.17	1,201.17
Corcorian ID	CID_055	2,365.41	1,436.58	1,476.88	441.19	1,386.77	121.08	275.37	679.83	0.00	564.72	1,197.01	2,607.04	1,613.90	2,007.08	1,746.33	132.10	565.44	1,492.46	1,945.02	1,958.99	1,268.44	210.35	1,910.51	2,189.52	1,816.23	1,667.14	1,667.14
Corcorian ID	CID_056	738.47	899.22	907.33	30.66	525.20	0.00	90.85	0.00	0.00	137.20	146.30	240.95	112.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_057	608.80	531.36	439.66	31.84	571.42	0.00	112.63	0.00	0.00	206.13	124.98	141.95	937.95	465.40	896.06	269.11	382.14	992.97	817.96	677.84	93.08	45.76	655.66	806.32	455.50	190.09	190.09
Corcorian ID	CID_058	782.84	1,487.40	1,445.57	72.68	1,461.54	8.37	275.47	0.00	0.00	592.73	566.75	701.85	1,246.44	1,368.91	2,152.07	435.74	390.39	657.44	1,068.66	767.14	71.18	0.00	220.51	1,016.28	541.40	0.00	0.00
Corcorian ID	CID_059	1,064.65	789.51	878.63	29.92	859.07	0.00	126.21	0.00	0.00	183.55	89.17	444.63	631.08	483.03	1,203.38	83.63	156.67	1,246.42	794.91	608.13	329.65	238.86	887.67	434.38	581.54	1,126.40	1,126.40
Corcorian ID	CID_060	1,186.15	836.46	764.81	24.75	564.07	0.00	59.39	0.00	0.00	148.74	141.85	305.96	524.69	548.08	718.07	15.28	78.66	688.72	627.04	743.75	165.17	43.44	506.06	385.22	555.47	1,243.15	1,243.15
Corcorian ID	CID_061	1,839.79	1,763.78	1,343.82	96.53	1,166.08	0.00	42.90	0.00	0.00	225.47	161.15	749.72	1,345.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_062	1,510.19	1,402.87	851.17	74.78	567.56	0.00	48.19	0.00	0.00	300.69	85.41	49.06	444.21	304.33	526.07	64.98	2.41	164.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_063	2,116.83	2,169.74	1,729.88	664.94	1,792.09	275.77	981.68	887.72	167.38	1,181.73	0.00	0.00	0.00	1,438.93	1,750.63	550.79	538.72	1,868.28	1,484.65	1,675.69	1,293.54	203.43	965.59	280.73	0.03	0.00	0.00
Corcorian ID	CID_064	2,074.68	1,327.64	1,123.30	543.00	1,087.03	2.46	512.08	662.32	126.51	746.76	0.00	0.00	0.00	883.95	1,208.47	440.98	383.93	699.74	0.00	1,510.93	548.35	329.55	1,622.10	816.65	1,052.12	822.86	822.86
Corcorian ID	CID_065	1,942.43	1,804.73	2,012.33	8.49	1,601.31	235.59	660.05	338.52	68.98	7.07	56.60	809.67	361.00	912.87	570.92	294.10	290.66	1,146.88	112.93	27.01	0.87	14.62	706.91	728.36	433.30	489.35	489.35
Corcorian ID	CID_066	898.36	2,125.69	1,738.59	341.96	2,000.57	224.44	632.38	306.49	102.26	1,174.19	1,328.18	1,311.76	1,753.59	1,384.98	1,760.36	518.70	352.57	1,539.70	1,329.17	615.29	680.97	44.63	627.21	1,497.67	1,680.60	1,581.47	1,581.47
Corcorian ID	CID_067	501.07	1,786.21	1,343.64	0.90	1,171.53	362.37	630.97	259.32	60.60	1,063.45	1,475.18	2,016.68	1,693.56	1,248.29	738.11	541.95	256.87	1,379.68	708.03	1,415.60	600.85	44.10	1,440.96	1,606.41	1,662.27	1,577.51	1,577.51
Corcorian ID	CID_068	686.17	2,321.54	2,221.60	590.11	2,542.92	257.96	448.15	331.17	75.84	732.05	1,387.50	1,606.13	2,023.64	2,071.91	2,455.38	783.78	483.49	2,285.23	2,022.20	1,924.91	891.60	122.02	2,103.11	1,980.63	1,948.43	2,031.33	2,031.33
Corcorian ID	CID_069	660.62	1,174.00	1,257.34	83.78	910.55	0.00	118.40	0.00	0.00	322.60	254.88	834.92	1,318.93	1,334.52	1,335.06	142.86	151.90	1,038.21	966.18	1,481.98	581.05	59.73	1,369.45	1,773.00	1,234.69	1,662.08	1,662.08
Corcorian ID	CID_070	184.97	275.55	165.35	27.69	107.46	4.60	21.23	134.21	15.16	14.33	0.00	22.15	257.37	230.30	197.92	17.42	7.54	189.28	10.66	14.26	63.64	6.27	0.00	124.92	124.32	137.06	137.06
Corcorian ID	CID_071	0.00	118.15	142.04	0.00	103.91	9.51	56.51	153.38	17.39	32.98	93.47	255.58	240.42	184.43	216.73	27.04	10.50	59.65	0.00	21.80	106.99	12.30	320.79	344.77	231.63	240.45	240.45
Corcorian ID	CID_072	0.00	95.97	109.90	36.91	29.04	7.31	8.98	22.36	0.00	9.99	104.91	119.09	80.83	0.00	3.58	7.98	6.65	0.00	0.00	0.00	-0.90	0.89	0.01	0.00	0.00	0.04	0.04
Corcorian ID	CID_073	0.00	142.84	310.98	67.77	234.63	11.31	11.59	0.00	0.00	122.98	180.62	243.11	343.09	202.04	163.85	22.48	16.64	226.31	202.17	0.00	60.93	100.01	0.00	196.04	85.09	0.00	0.00
Corcorian ID	CID_074	0.00	0.00	364.26	397.13	1,245.96	125.65	293.08	0.00	0.00	622.39	620.98	1,253.41	1,834.78	1,616.65	2,471.79	1,059.92	512.47	2,121.78	2,147.19	1,894.95	865.95	105.57	330.88	0.57	0.00	0.00	0.00
Corcorian ID	CID_075	0.00	0.00	251.55	225.46	989.02	0.00	105.87	0.00	0.00	305.79	314.55	1,173.34	1,238.55	1,362.63	1,757.47	111.55	91.83	978.03	819.89	843.24	0.00	0.00	2.00	959.89	1,013.14	1,098.97	1,098.97
Corcorian ID	CID_076	0.00	0.00	0.00	0.00	234.89	111.78	634.61	541.05	0.00	272.51	610.40	1,860.09	1,638.49	1,356.17	1,835.78	425.89	380.38	2,196.13	2,152.32	1,863.13	790.24	97.44	1,954.80	2,143.33	219.61	0.36	0.36
Corcorian ID	CID_077	0.00	0.00	0.00	0.00	0.00	0.00	0.00	123.51	0.00	237.17	187.97	225.90	298.14	320.75	99.52	57.46	74.24	140.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_078	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,668.87	1,369.61	1,606.41	1,482.16	308.50	144.84	982.56	962.93	729.61	0.00	81.84	1,049.74	1,049.20	1,186.57	72.24	72.24
Corcorian ID	CID_079	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,735.25	1,734.52	1,824.40	1,342.88	325.61	197.09	1,309.95	1,359.77	1,443.55	340.79	170.81	1,080.45	550.07	746.57	907.46	907.46
Corcorian ID	CID_080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,660.37	1,583.12	1,635.26	1,523.73	347.82	282.27	1,443.19	871.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_081	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	487.72	1,518.23	1,538.22	152.23	78.55	1,271.28	1,444.23	1,641.26	313.71	99.39	444.08	722.62	1,122.74	1,585.55	1,585.55
Corcorian ID	CID_082	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	315.07	1,287.24	245.95	186.05	1,239.63	492.18	922.72	497.22	18.21	1,269.58	1,409.00	1,376.68	1,127.54	1,127.54
Corcorian ID	CID_083	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.59	663.41	437.53	112.73	1,368.03	1,577.93	1,328.94	465.39	222.46	1,239.53	1,601.77	1,425.61	869.57	869.57
Corcorian ID	CID_084	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	125.95	183.58	93.35	834.67	947.18	988.60	223.77	37.16	540.41	0.01	49.57	987.79	987.79
Corcorian ID	CID_085	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	534.63	296.53	1,886.07	1,778.62	1,746.80	709.95	220.89	1,615.89	1,673.35	1,168.21	0.00	0.00
Corcorian ID	CID_086	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	160.70	1,036.72	330.95	1,000.21	397.67	5.91	816.21	398.68	0.04	0.00	0.00
Corcorian ID	CID_087	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	378.71	1,827.95	1,247.36	1,274.21	211.04	224.24	1,023.00	1,371.43	1,466.07	1,521.31	1,521.31
Corcorian ID	CID_088	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,263.58	1,261.12	1,461.71	246.31	0.00	1,146.15	1,440.28	1,179.16	1,313.66	1,313.66
Corcorian ID	CID_089	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	349.93	538.06	1,434.87	454.84	0.00	1,193.74	1,389.61	0.03	0.00	0.00
Corcorian ID	CID_090	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	607.56	1,291.87	467.41	0.00	342.47	1,557.85	1,126.84	1,427.48	1,427.48
Corcorian ID	CID_091	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	859.04	1,767.72	592.13	0.01	1,413.28	2,641.50	1,826.26	1,869.65	1,869.65

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
Corcorian ID	CID_092	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	859.35	1,550.38	437.84	244.98	1,141.08	1,105.51	1,066.16	1,298.44	1,298.44
Corcorian ID	CID_093	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	741.70	1,487.20	372.01	165.25	750.50	1,032.04	999.00	1,253.67	1,253.67
Corcorian ID	CID_094	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	896.47	1,692.61	626.91	145.20	1,171.04	1,738.69	1,475.47	1,674.79	1,674.79
Corcorian ID	CID_095	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	627.84	1,662.93	573.14	87.26	1,072.90	1,293.26	1,510.39	1,427.72	1,427.72
Corcorian ID	CID_096	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.47	54.99	317.46	3,420.23	2,889.80	3,510.53	3,510.53
Corcorian ID	CID_097	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	155.44	3,085.52	2,159.80	2,290.52	2,290.52
Corcorian ID	CID_098	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,056.92	1,361.42	1,473.69	1,473.69
Corcorian ID	CID_099	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,209.37	517.23	517.23
Corcorian ID	CID_100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,885.47	1,884.87	1,884.87
Corcorian ID	CID_101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.34	975.48	975.48
Corcorian ID	CID_102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corcorian ID	CID_105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Westlands WD	WWD_18S19E-18Q01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_18S19E-19K01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_18S19E-20E01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_18S19E-20F01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_18S19E-28M02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_18S19E-29D01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_18S19E-31N01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-04M01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-05K01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-07N02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-08N04	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-10E02	550.08	725.53	680.15	461.72	573.98	338.21	360.23	325.08	253.81	400.51	512.10	606.57	629.47	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.18	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-15D02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-15D03	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-15E02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-15N01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-18C01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-19K01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-26D03	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-26E03	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-27D01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-27M01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-28K02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-29A01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-29A02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-29A03	328.85	485.30	444.10	316.62	391.76	250.01	282.69	247.40	199.56	283.18	410.21	459.73	477.57	329.33	290.74	199.55	205.46	399.29	552.81	580.16	372.56	215.27	401.83	520.17	556.07	566.97	556.07
Westlands WD	WWD_19S19E-29J01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-30L01	655.02	887.19	827.97	461.72	671.23	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-30M01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-30M02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-31A01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-31D03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_19S19E-31N03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_19S19E-32K01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-33E01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_19S19E-33Q02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S18E-24H01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S18E-25E01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S18E-26K01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S18E-35D02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S18E-35E03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S18E-36C03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S18E-36D05	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-02A01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-02D01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-02E02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-02J01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-02N01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-04D02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-04D03	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-04H01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-06N04	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-07D01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-07G01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-07G02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-08M01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-09D02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-09D03	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-09N02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
Westlands WD	WWD_20S19E-10E01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-11D03	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-11E01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-14A01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-14E01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-14F01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-14H01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-17M01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-17M02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-18D02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-19D03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-19N01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-19N02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-19R01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-20D01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-20D02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-20D03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-23K01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-26C01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-31D01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_20S19E-35D02	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_20S19E-35M01	686.94	957.05	941.26	461.72	765.21	338.21	360.23	325.08	253.81	413.11	512.10	660.00	688.37	378.27	364.24	199.55	205.46	470.25	653.10	659.00	378.80	215.27	497.87	600.17	728.11	711.26	728.11
Westlands WD	WWD_21S17E-24J01	324.49	578.77	528.71	222.32	333.06	76.85	59.76	85.38	112.32	176.41	280.46	342.34	301.91	155.73	140.09	21.62	7.59	219.12	303.24	431.66	160.11	0.00	247.66	478.21	647.24	652.89	647.24
Westlands WD	WWD_21S18E-01B02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-01N01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-02C03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-02D03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-03G01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-09L01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-10B01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-11C01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-11D03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-11N01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-11Q01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-14M07	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-15M02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-16N01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-16P01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-17N03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-18R01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-22B05	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-22E01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-23B02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-23D07	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-23E01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-26N01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-27B01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-27E01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-27K02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-28G06	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-28Q02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-29E02	324.49	578.77	528.71	222.32	333.06	76.85	59.76	85.38	112.32	176.41	280.46	342.34	301.91	155.73	140.09	21.62	7.59	219.12	303.24	431.66	160.11	0.00	247.66	478.21	647.24	652.89	647.24
Westlands WD	WWD_21S18E-29N02	324.49	578.77	528.71	222.32	333.06	76.85	59.76	85.38	112.32	176.41	280.46	342.34	301.91	155.73	140.09	21.62	7.59	219.12	303.24	431.66	160.11	0.00	247.66	478.21	647.24	652.89	647.24
Westlands WD	WWD_21S18E-31H01	324.49	578.77	528.71	222.32	333.06	76.85	59.76	85.38	112.32	176.41	280.46	342.34	301.91	155.73	140.09	21.62	7.59	219.12	303.24	431.66	160.11	0.00	247.66	478.21	647.24	652.89	647.24
Westlands WD	WWD_21S18E-32R01	324.49	578.77	528.71	222.32	333.06	76.85	59.76	85.38	112.32	176.41	280.46	342.34	301.91	155.73	140.09	21.62	7.59	219.12	303.24	431.66	160.11	0.00	247.66	478.21	647.24	652.89	647.24
Westlands WD	WWD_21S18E-33G01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-33N02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-35D01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-35Q01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S18E-35Q02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-06B01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-07D01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-07N02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-17E01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-17Q01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-18N03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-19C03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-20D01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-30D04	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_21S19E-30D05	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-01E02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-01K01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-02G05	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-03B01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00

Annualized Specified Pumping

Well field	Well_ID	1990 (AF/Y)	1991 (AF/Y)	1992 (AF/Y)	1993 (AF/Y)	1994 (AF/Y)	1995 (AF/Y)	1996 (AF/Y)	1997 (AF/Y)	1998 (AF/Y)	1999 (AF/Y)	2000 (AF/Y)	2001 (AF/Y)	2002 (AF/Y)	2003 (AF/Y)	2004 (AF/Y)	2005 (AF/Y)	2006 (AF/Y)	2007 (AF/Y)	2008 (AF/Y)	2009 (AF/Y)	2010 (AF/Y)	2011 (AF/Y)	2012 (AF/Y)	2013 (AF/Y)	2014 (AF/Y)	2015 (AF/Y)	2016 (AF/Y)
Westlands WD	WWD_22S18E-04H01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-05B01	324.49	578.77	528.71	222.32	333.06	76.85	59.76	85.38	112.32	176.41	280.46	342.34	301.91	155.73	140.09	21.62	7.59	219.12	303.24	431.66	160.11	0.00	247.66	478.21	647.24	652.89	647.24
Westlands WD	WWD_22S18E-10A01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-10C01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-11C02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-11C03	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-11G01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-12R01	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_22S18E-13K02	311.52	472.04	476.59	181.10	319.20	90.51	81.94	82.06	67.59	130.95	153.24	309.43	288.00	200.33	216.07	35.99	56.71	149.91	276.10	338.57	136.64	34.49	310.36	401.68	562.00	523.80	562.00
Westlands WD	WWD_FARM_24_141	951.61	864.42	802.36	423.25	712.63	212.87	419.18	510.96	243.94	496.07	558.07	770.78	779.45	759.89	763.70	239.73	166.23	639.83	707.60	747.47	496.10	212.44	632.85	857.61	918.01	900.73	918.01
Westlands WD	WWD_FARM_25_012	613.28	515.09	548.89	17.77	269.36	16.44	41.24	119.70	65.89	127.75	104.06	441.50	427.47	413.57	529.14	116.35	52.19	289.39	509.78	542.56	89.33	4.46	311.87	800.63	1,036.48	1,023.31	1,036.67
Westlands WD	WWD_FARM_25_044	613.28	515.09	548.89	17.77	269.36	16.44	41.24	119.70	65.89	127.75	104.06	441.50	427.47	413.57	529.14	116.35	52.19	289.39	509.78	542.56	89.33	4.46	311.87	800.63	1,036.48	1,023.31	1,036.67
Westlands WD	WWD_FARM_26_001	275.60	386.59	450.92	156.07	326.58	44.00	104.66	157.88	36.72	316.41	86.83	162.60	181.16	157.15	177.76	9.55	0.00	89.14	208.00	178.48	2.45	0.00	23.43	190.50	369.83	287.40	369.83
Westlands WD	WWD_FARM_26_003	275.60	386.59	450.92	156.07	326.58	44.00	104.66	157.88	36.72	316.41	86.83	162.60	181.16	157.15	177.76	9.55	0.00	89.14	208.00	178.48	2.45	0.00	23.43	190.50	369.83	287.40	369.83
Westlands WD	WWD_FARM_26_008	275.60	386.59	450.92	156.07	326.58	44.00	104.66	157.88	36.72	316.41	86.83	162.60	181.16	157.15	177.76	9.55	0.00	89.14	208.00	178.48	2.45	0.00	23.43	190.50	369.83	287.40	369.83
Westlands WD	WWD_FARM_26_015	275.60	386.59	450.92	156.07	326.58	44.00	104.66	157.88	36.72	316.41	86.83	162.60	181.16	157.15	177.76	9.55	0.00	89.14	208.00	178.48	2.45	0.00	23.43	190.50	369.83	287.40	369.83
Westlands WD	WWD_FARM_26_029	275.60	386.59	450.92	156.07	326.58	44.00	104.66	157.88	36.72	316.41	86.83	162.60	181.16	157.15	177.76	9.55	0.00	89.14	208.00	178.48	2.45	0.00	23.43	190.50	369.83	287.40	369.83
City of Hanford	Hanford_02	102.40	99.06	105.88	111.91	120.67	118.07	142.15	143.82	129.29	147.07	151.50	156.30	269.50	233.05	299.93	328.43	299.61	334.24	305.46	3.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_11	113.39	112.69	122.58	128.31	140.26	137.11	168.62	167.88	159.18	179.28	184.81	192.29	234.03	230.14	275.32	184.07	266.40	311.91	324.67	291.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_18	186.85	181.48	191.61	204.13	219.22	215.95	254.91	256.53	234.21	263.63	270.19	280.47	520.85	405.58	331.20	317.92	336.53	559.96	854.08	615.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_31	261.74	251.86	263.87	280.59	299.14	294.73	340.76	344.91	307.34	348.05	356.58	368.32	822.26	681.10	697.40	548.66	670.78	707.48	349.60	91.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_32	96.22	95.54	103.07	107.80	116.74	115.68	141.62	140.22	130.28	147.78	151.05	157.56	225.24	134.37	210.78	314.05	158.14	249.19	280.72	154.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_33	206.19	193.86	204.59	218.47	235.94	226.56	269.86	276.06	243.13	274.60	286.68	291.22	587.13	73.84					13.89	426.27	487.42	935.72	285.66	312.93	48.94	31.23	11.56
City of Hanford	Hanford_34	614.68	597.66	631.99	667.18	710.53	705.48	816.25	819.50	741.51	838.28	855.84	887.24	1,846.51	1,293.61	1,238.78	1,121.06	1,770.59	1,731.57	1,188.37	888.77	233.03	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_35	285.27	272.85	287.83	305.56	327.44	319.54	372.41	377.61	337.77	381.36	393.84	404.11	842.03	1,097.87	1,122.26	1,277.45	854.27	464.84	832.93	403.41	347.71	315.84	288.32	278.63	25.49	58.73	68.08
City of Hanford	Hanford_36	211.55	201.39	212.34	226.34	242.33	236.11	276.88	283.06	249.97	282.84	292.62	299.34	629.07	626.07	628.28	901.04	795.99	178.64	995.84	451.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_37																73.90	435.65	374.67	266.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City of Hanford	Hanford_38	100.71	97.15	105.18	110.65	120.04	116.39	143.06	145.01	129.90	149.22	154.17	159.32	241.52	179.08	116.58	163.01	200.08	223.35	322.31	174.12	283.19	262.46	377.34	430.89	146.21	139.46	5.52
City of Hanford	Hanford_40	404.29	393.17	416.59	438.20	466.63	461.04	535.33	535.83	485.52	548.53	562.80	581.17	1,192.58	1,109.49	1,047.04	862.25	123.37	1,717.66	1,523.56	525.05	601.79	446.13	456.49	814.28	1,077.77	361.24	536.60
City of Hanford	Hanford_41	700.43	682.01	725.15	766.28	818.86	810.69	968.71	974.11	871.39	993.08	1,014.91	1,053.27	1,998.41	357.39	1,593.93	1,953.86	1,871.00	1,941.46	1,909.83	1,060.98	0.00	0.00	0.00	0.00	0.00	0.00	126.92
City of Hanford	Hanford_42	676.84	646.25	684.73	728.22	782.32	760.35	899.56	916.40	815.26	924.48	956.39	981.47	1,916.88	1,433.44	1,197.86	0.00	0.00	0.00	707.22	1,259.53	994.28	1,246.09	1,592.03	1,671.66	1,921.12	1,343.45	1,222.72
City of Hanford	Hanford_43																			80.08	97.72	4.07	96.72	192.33	511.79	520.62	1,265.51	964.64
City of Hanford	Hanford_44																			0.00	67.06	1,326.56	2,300.01	2,306.05	497.23	1,769.99	1,601.15	1,432.46
City of Hanford	Hanford_45(16)	592.06	571.40	602.83	637.05	679.68	669.17	775.47	779.09	701.87	792.49	813.78	839.64	1,789.82	678.50	378.47	433.81	391.24	404.94	0.00	1,182.88	2,173.71	1,624.04	1,697.82	1,836.68	1,207.41	3,184.25	1,505.65
City of Hanford	Hanford_46(8)	387.84	394.83	424.30	442.70	477.72	480.41	581.43	567.39	543.16	611.14	619.96	653.80	908.09	0.55						962.51	1,337.10	643.47	602.00	997.27	1,119.86	926.88	620.64
City of Hanford	Hanford_47(22)	254.40	252.00	271.68	284.61	305.69	303.22	373.64	371.65	338.02	387.11	394.79	412.43	634.56	2.17	1.27	0.17	0.28	0.00	0.00	0.00	127.95	1,195.99	1,034.26	1,497.96	811.55	617.40	694.24
City of Hanford	Hanford_48(25)	296.46	296.08	315.90	330.28	351.96	354.39	423.87	416.57	382.60	436.75	440.52	464.36	834.77	564.41	547.16	711.74	229.77	503.55	344.90	0.00	307.79	951.61	782.60	1,647.20	639.09	246.90	957.11
City of Hanford	Hanford_49	389.12	379.55	405.57	427.31	457.80	453.78	543.29	545.98	490.71	557.99	571.50	591.86	1,064.12	48.56		440.11	356.84	522.45	637.00	361.32	0.00	0.00	0.00	0.00	0.00	0.00	47.23
City of Lemoore	LEM_02	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	0.00	75.87	0.00	360.17	0.00
City of Lemoore	LEM_04	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	446.96	836.73	1,068.20	360.96	4.38
City of Lemoore	LEM_05	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	0.00	86.80	268.55	382.28	60.44
City of Lemoore	LEM_06	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	1,811.88	1,454.78	886.18	599.81	947.31
City of Lemoore	LEM_07	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	185.36	589.68	101.76	461.95	427.91
City of Lemoore	LEM_08	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	292.25	357.47	315.26	423.81	600.92	616.80	601.25	611.47	501.97	548.90	560.06	132.40	75.87	0.00	360.17	0.00
City of Lemoore	LEM_09	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	211.56	191.52	228.92	394.94	559.85	540.33	450.23	538.57	625.12	548.15	528.96	136.28	75.87	0.00	360.17	0.00
City of Lemoore	LEM_10	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	526.94	1,420.70	2,072.97	2,416.84	2,570.42	2,298.46	2,205.27	574.32	590.44	594.39	634.47	620.90	594.92	593.46	1,809.74	1,482.52	1,784.18	862.75	1,541.31
City of Lemoore	LEM_11	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	3,175.77	4,259.05	1,243.12	574.32	590.44	594.39	634.47	620.90	594.92	593.46	661.39	622.93	713.77	506.67	599.20
City of Lemoore	LEM_12	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	473.76	2,597.27	1,461.96	2,834.40	574.32	590.44	594.39	634.47	620.90	594.92	593.46	972.56	873.70	126.17	543.30	535.47
City of Lemoore	LEM_13	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	853.49	1,279.86	1,636.77	862.22	1,445.57
City of Lemoore	LEM_14	290.78	282.54	299.17	316.07	337.92	333.04	390.89	392.77	339.74	309.35	261.46	215.75	178.77	233.66	284.18	574.32	590.44	594.39	634.47	620.90	594.92	593.46	841.73	460.35	1,056.74	709.06	799.97
Apex Ranch	APEX_RW-1	--	--	--	--	--	--	--	--	--	--	--	--	0	105.2	182.4	0	1387.8	1263.8	1087	1535.4	1269	0	1808.8	994	59.6	0	0
Apex Ranch	APEX_RW-2	--	--	--	--	--	--	--	--	--	--	--	--	0	105.2	182.4	0	1387.8	1263.8	1087	1535.4	1269	0	1808.8	994	59.6	0	0
Apex Ranch	APEX_RW-3	--	--	--	--	--	--	--	--	--	--	--	--	0	105.2	182.4	0	1387.8	1263.8	1087	1535.4	1269	0	1808.8	994	59.6	0	0
Apex Ranch	APEX_RW-4	--	--	--	--	--	--	--	--	--	--	--	--	0	105.2	182.4	0	1387.8	1263.8	1087	1535.4	1269	0	1808.8	994	59.6	0	0
Apex Ranch	APEX_RW-5	--	--	--	--	--	--	--	--	--	--	--	--	0	105.2	182.4	0	1387.8	1263.8	1087	1535.4	1269	0	1808.8	994	59.6	0	0

Appendix D5
Observed and Simulated Target Well Hydrographs

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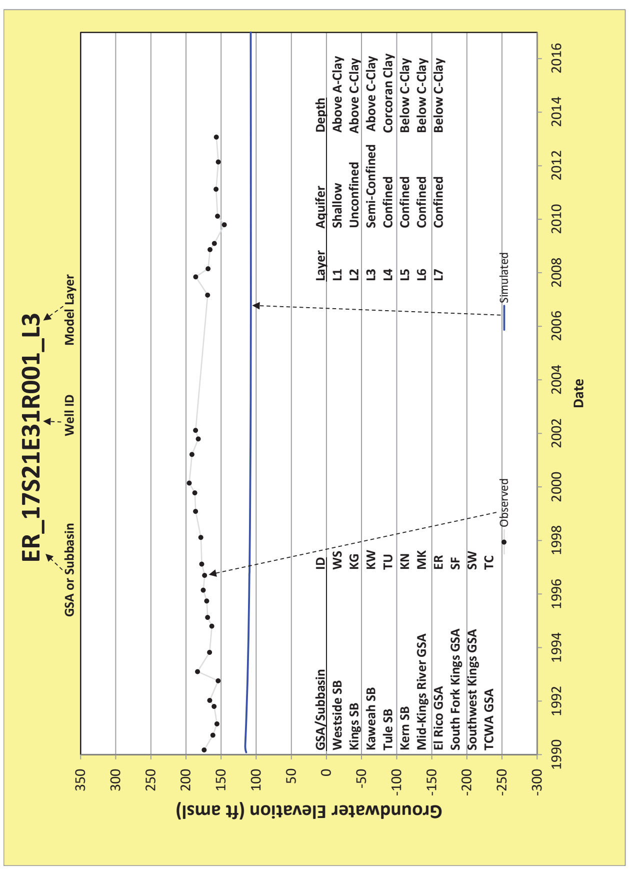
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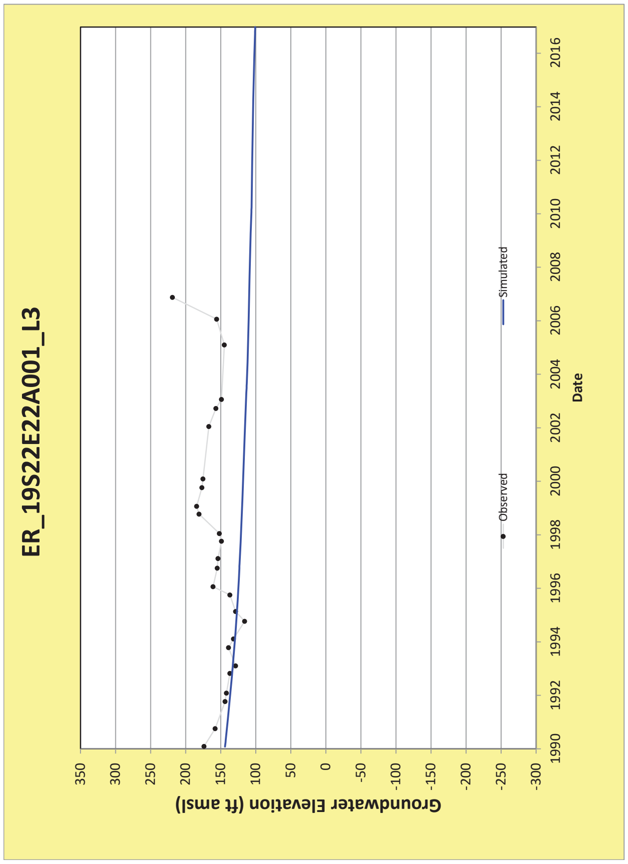
GSA or Subbasin
Well ID
Model Layer
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
GSA/Subbasin | ID
Westside SB | WS
Kings SB | KG
Kaweah SB | KW
Tule SB | TU
Kern SB | KN
Mid-Kings River GSA | MK
El Rico GSA | ER
South Fork Kings GSA | SF
Southwest Kings GSA | SW
TCWA GSA | TC
Layer | Aquifer | Depth
L1 | Shallow | Above A-Clay
L2 | Unconfined | Above C-Clay
L3 | Semi-Confined | Above C-Clay
L4 | Confined | Corcoran Clay
L5 | Confined | Below C-Clay
L6 | Confined | Below C-Clay
L7 | Confined | Below C-Clay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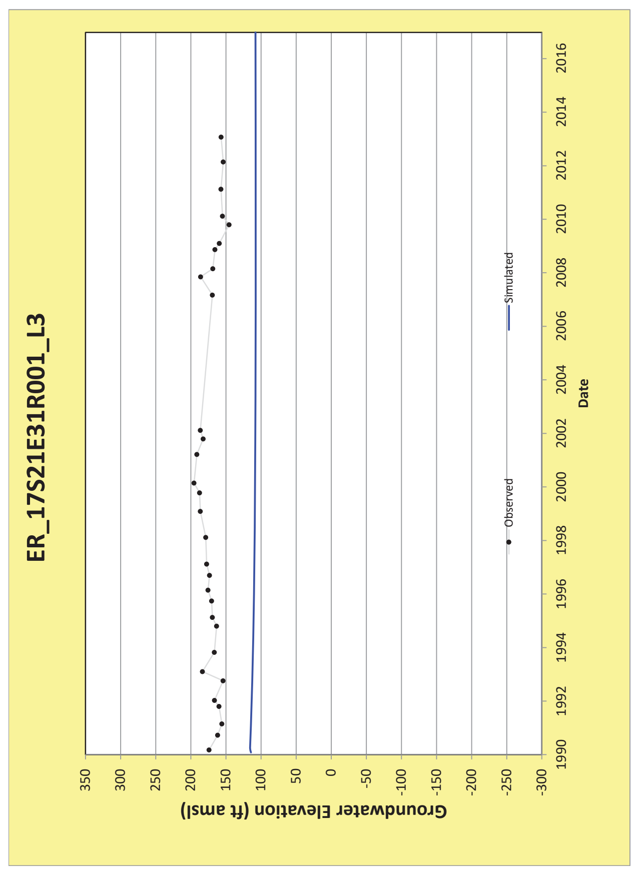
Date
Observed
Simulated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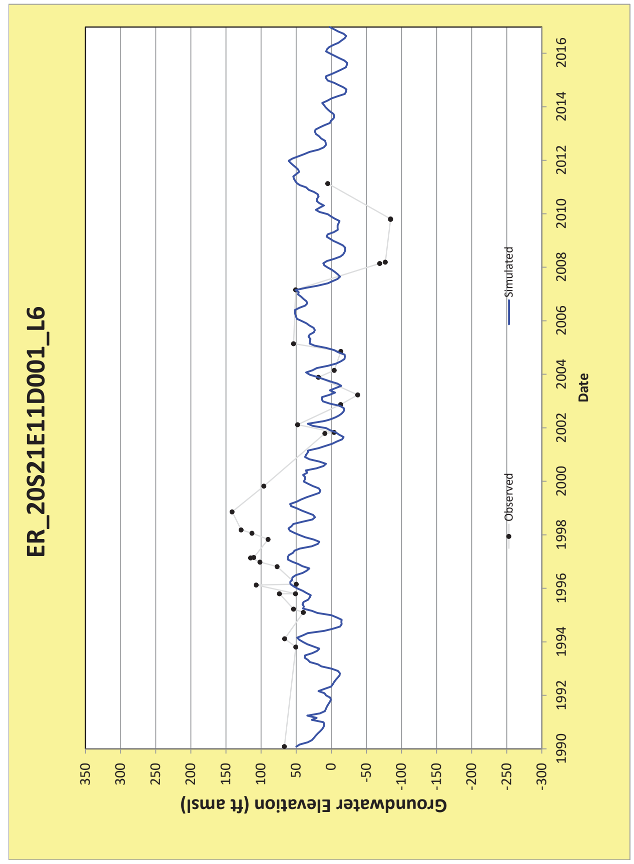
Date
Observed
Simulated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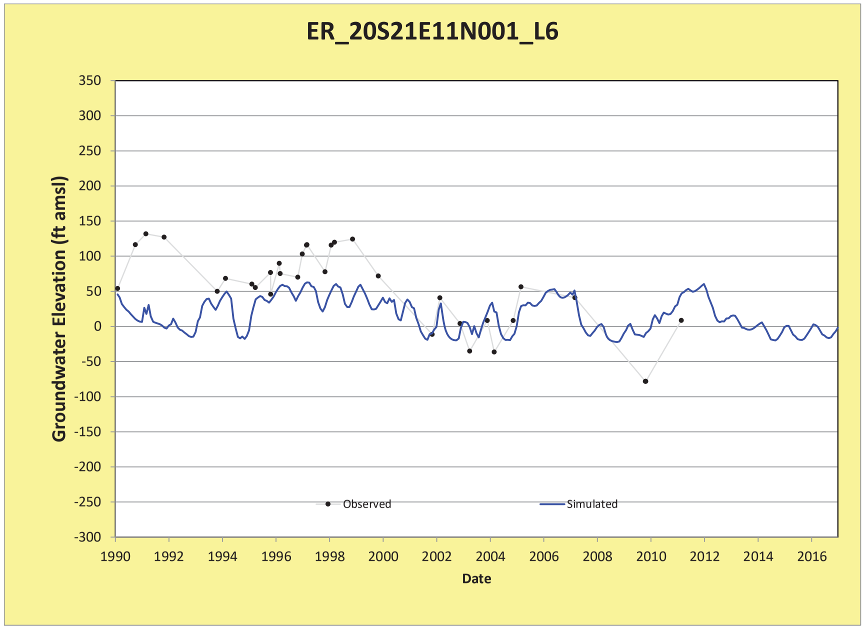
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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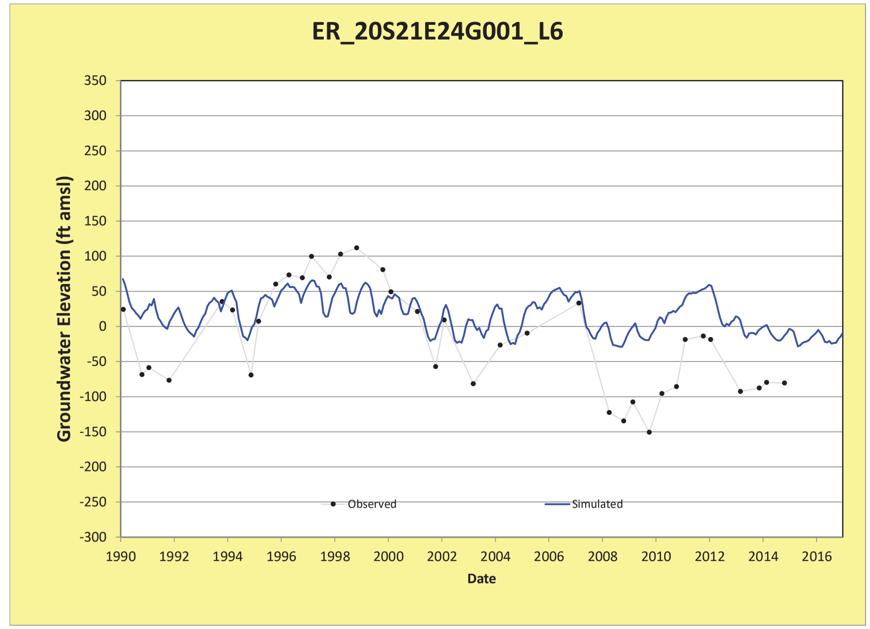
Date
Observed
Simulated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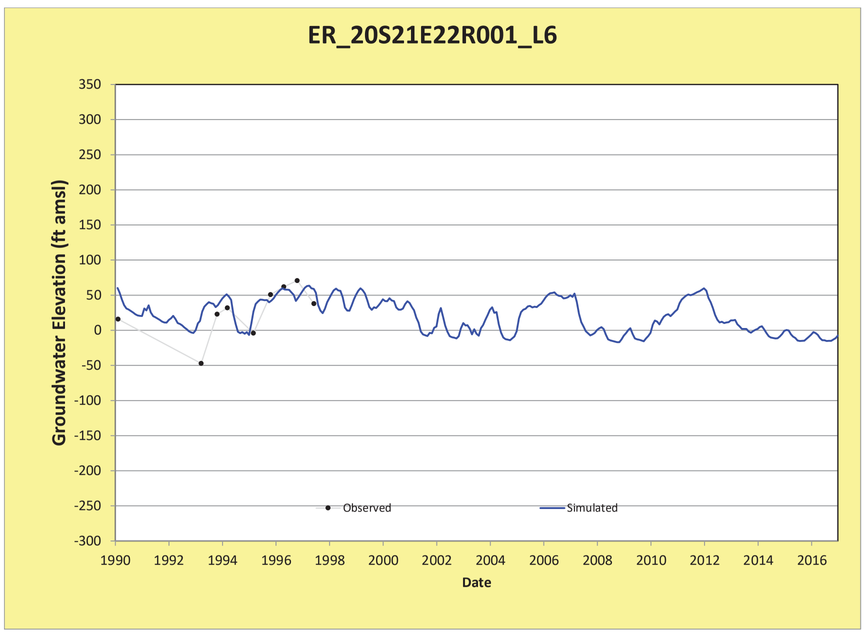
Date
Observed
Simulated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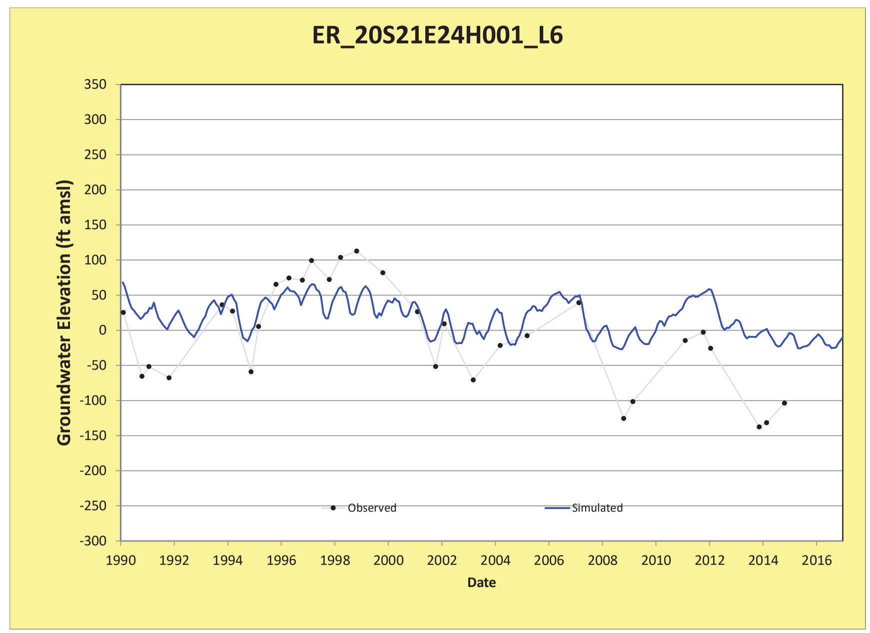
Date
Observed
Simulated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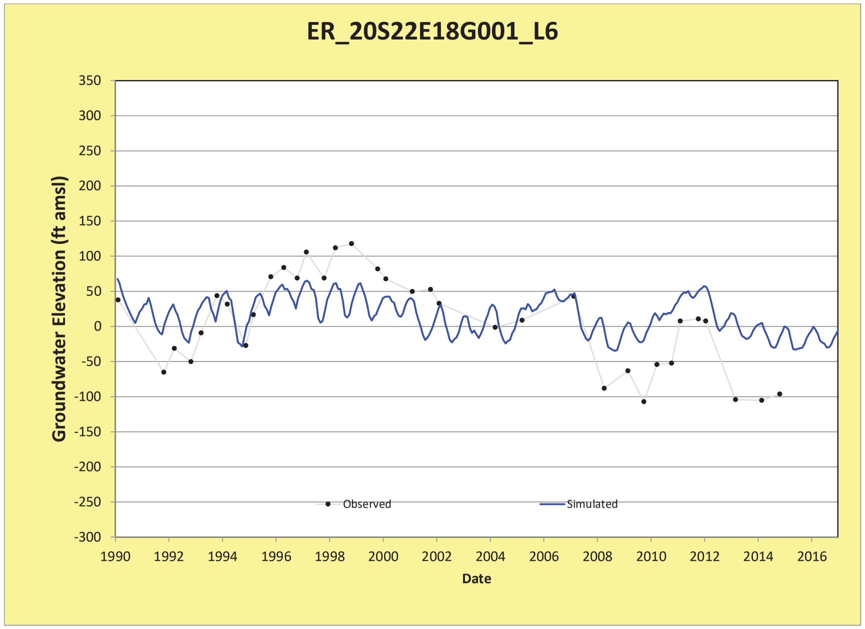
Date
Observed
Simulated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Date
Observed
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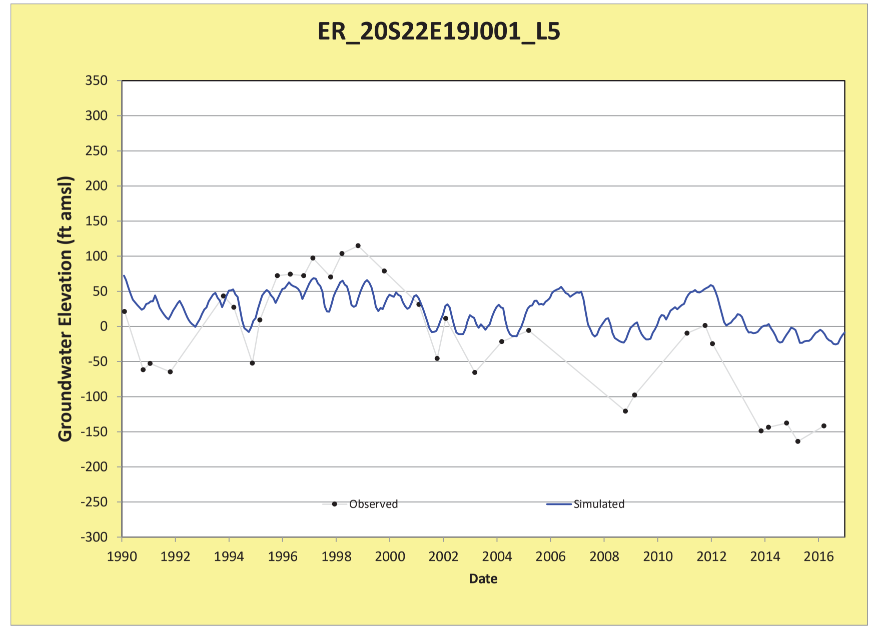
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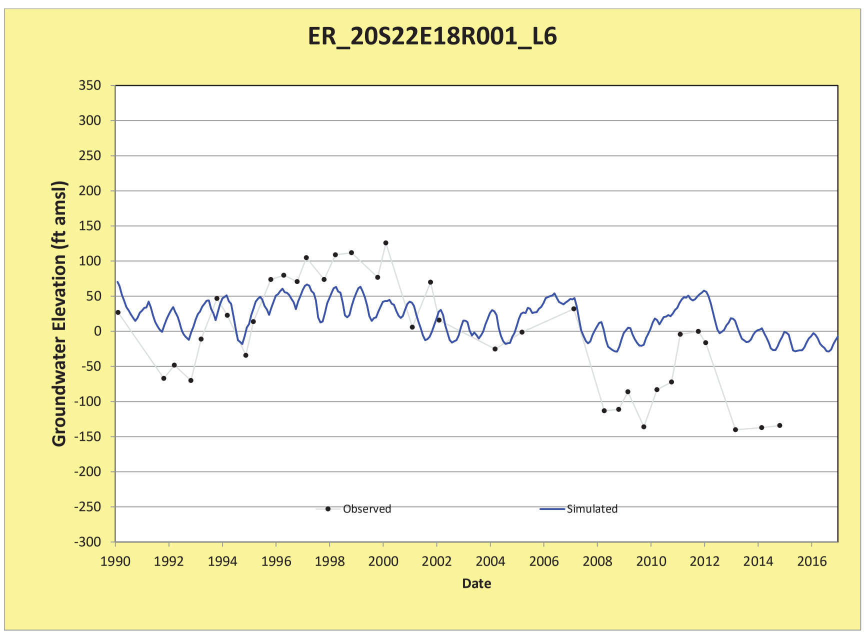
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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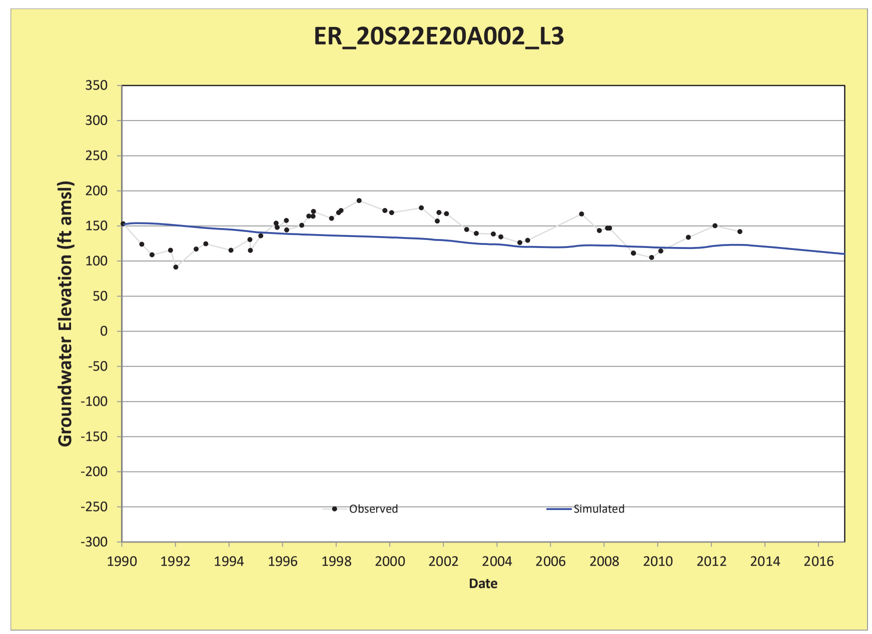
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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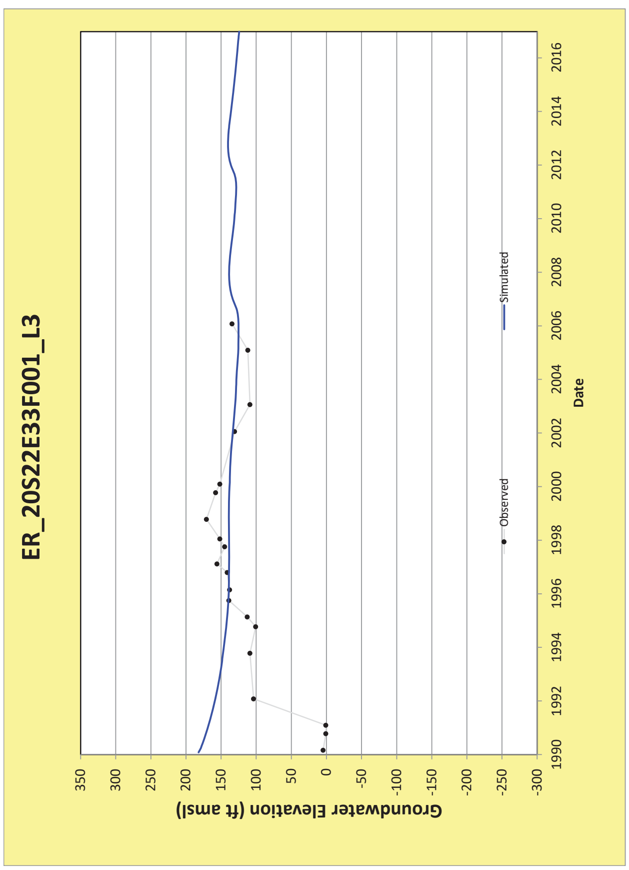
Date
Observed
Simulated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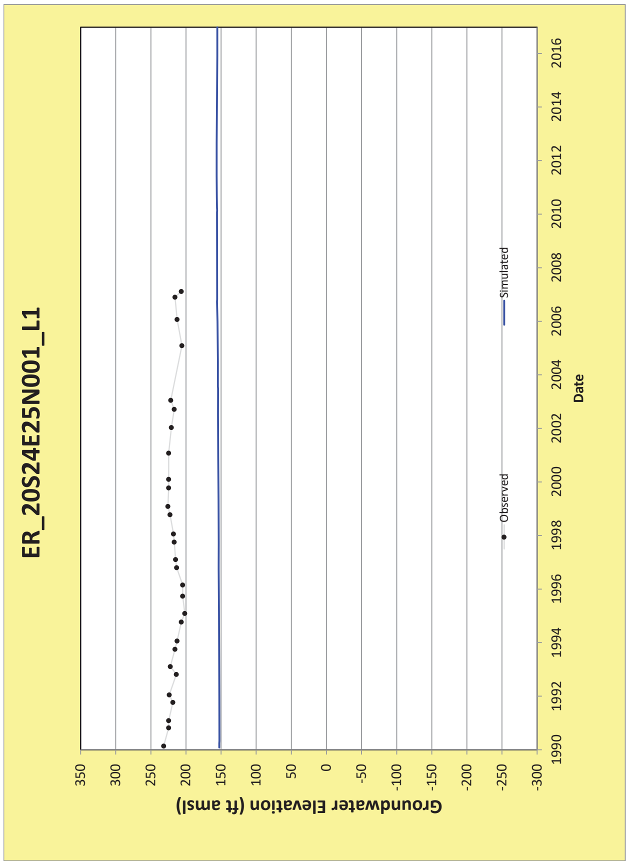
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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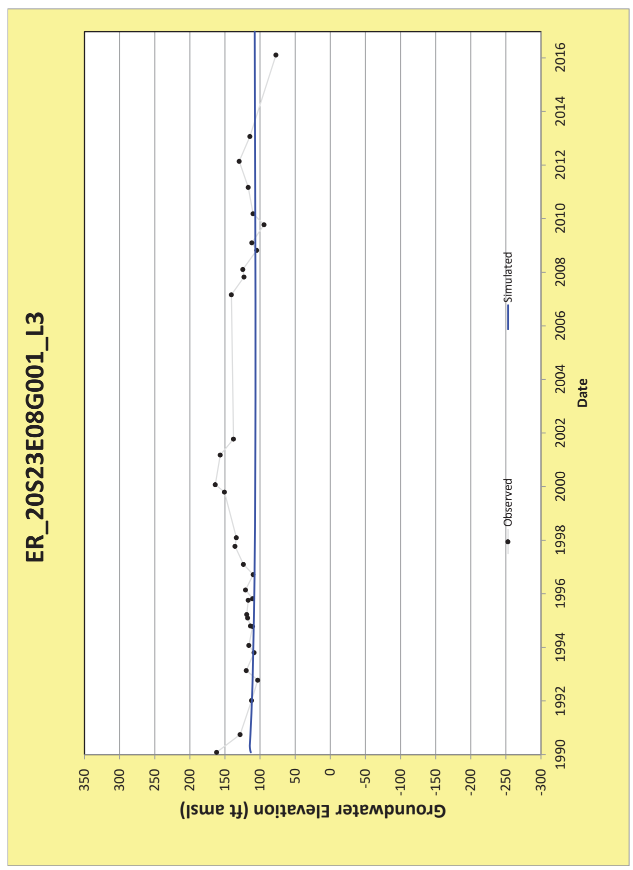
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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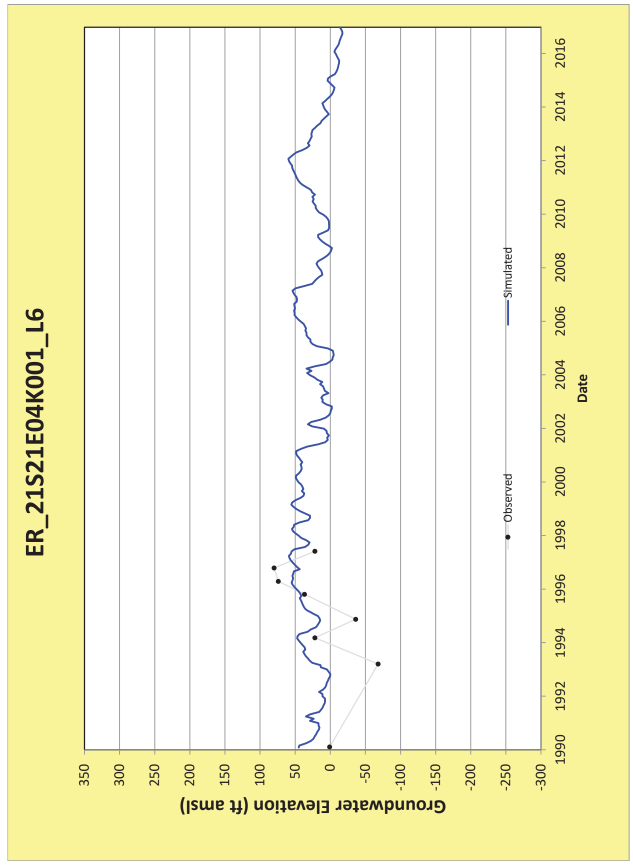
Date
Observed
Simulated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Observed
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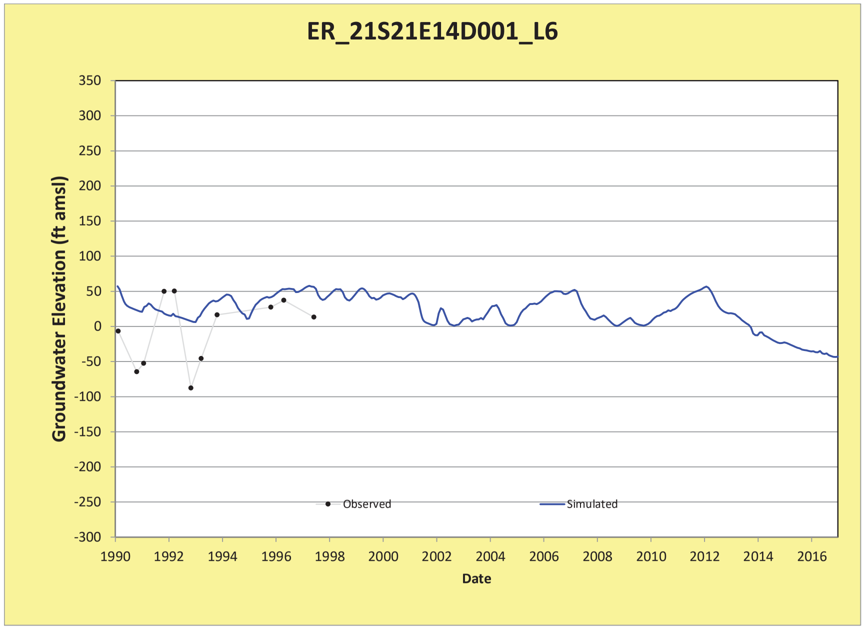
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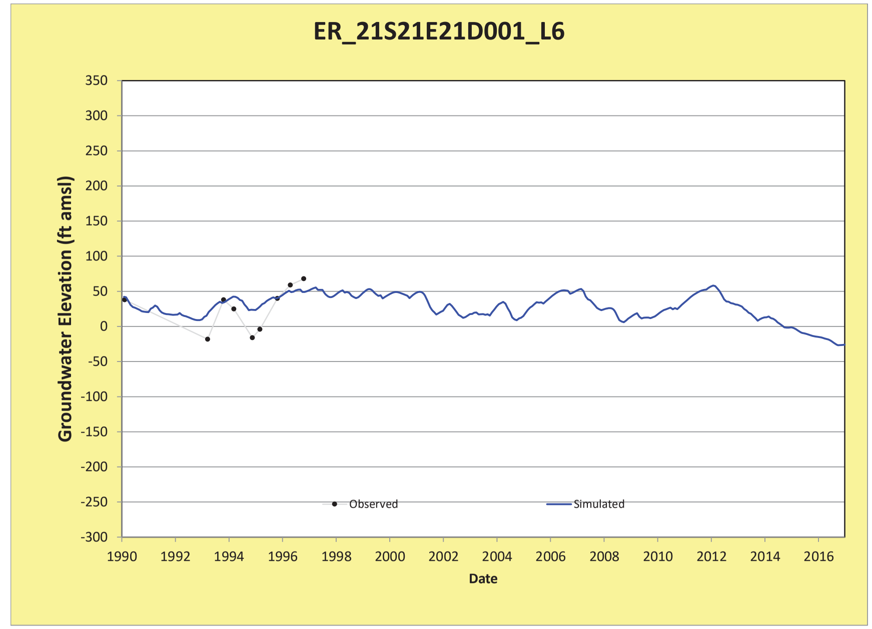
Observed
Simulated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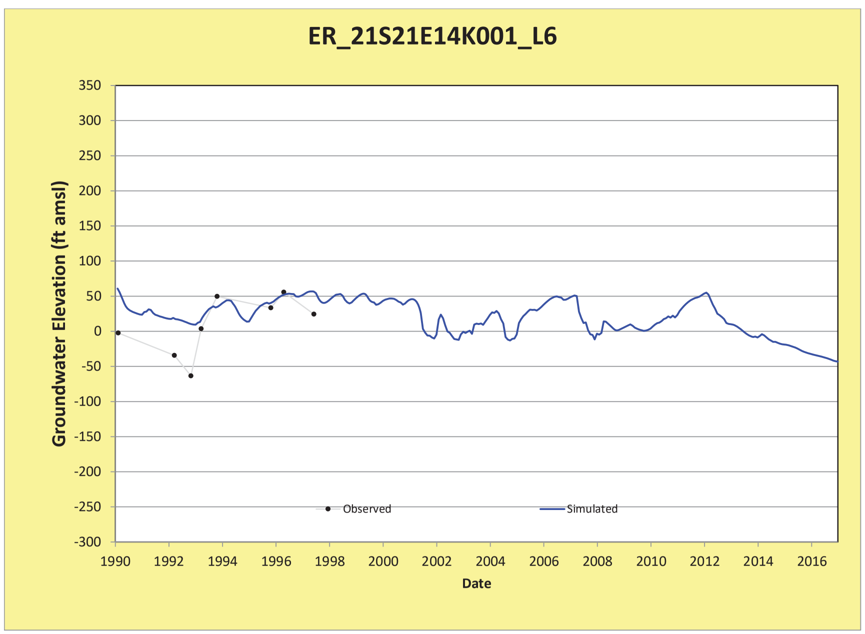
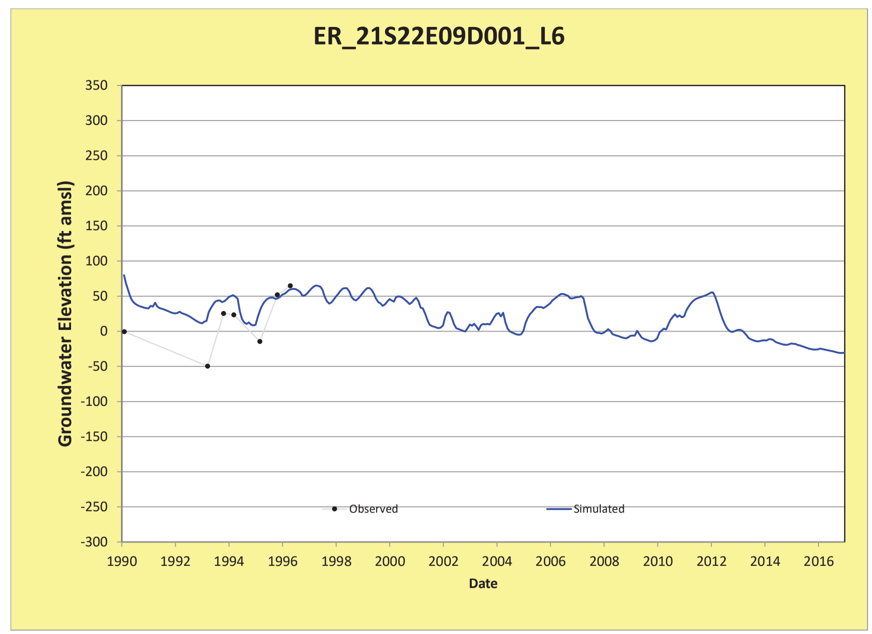
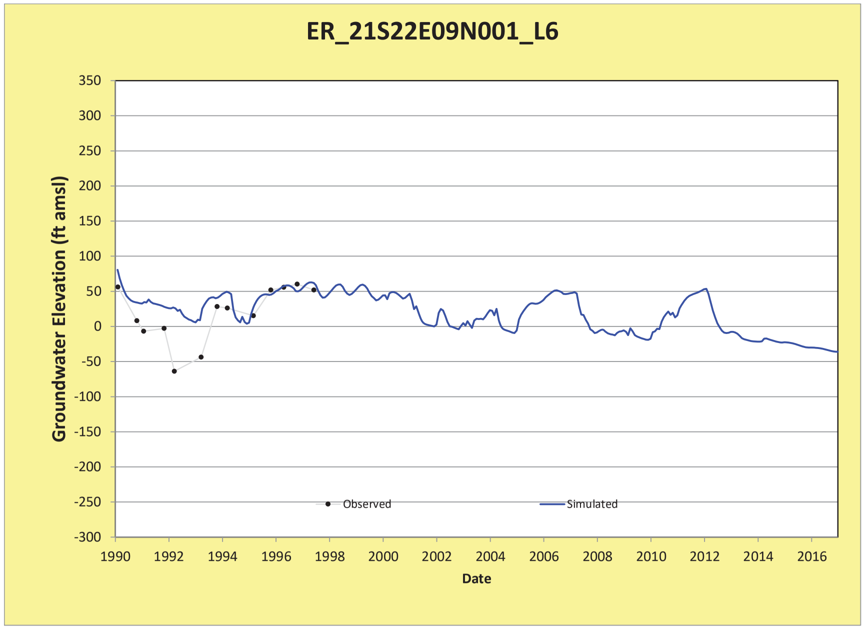
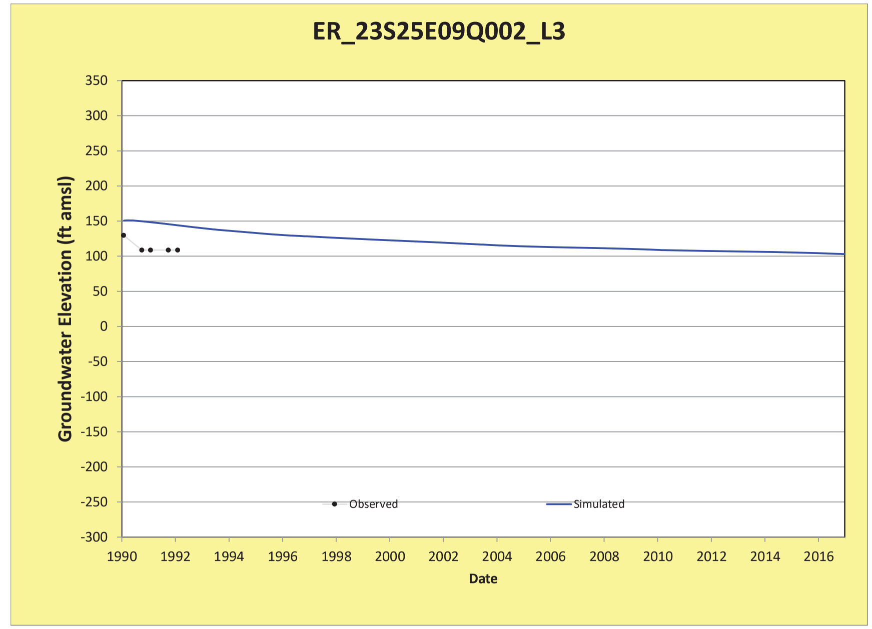
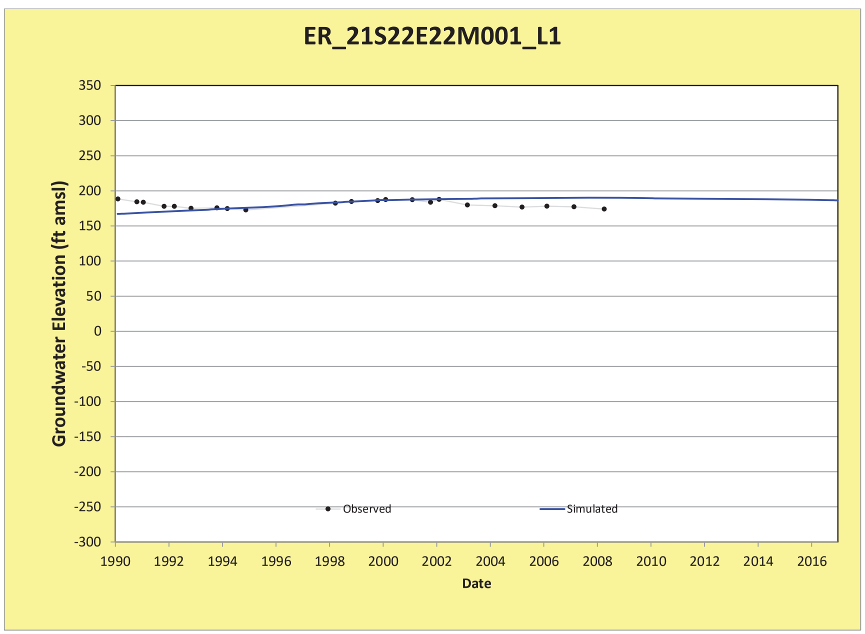
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

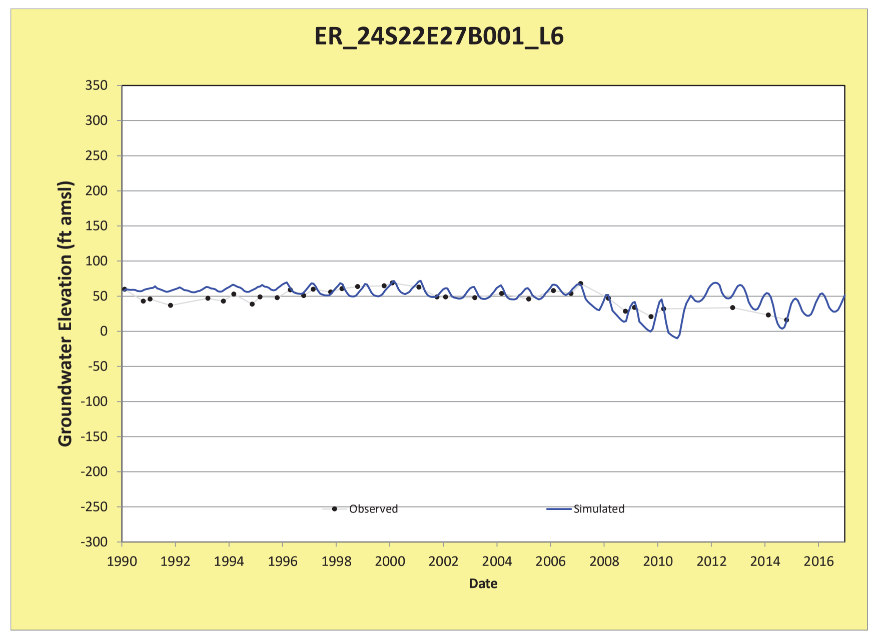

ER_21S21E14K001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

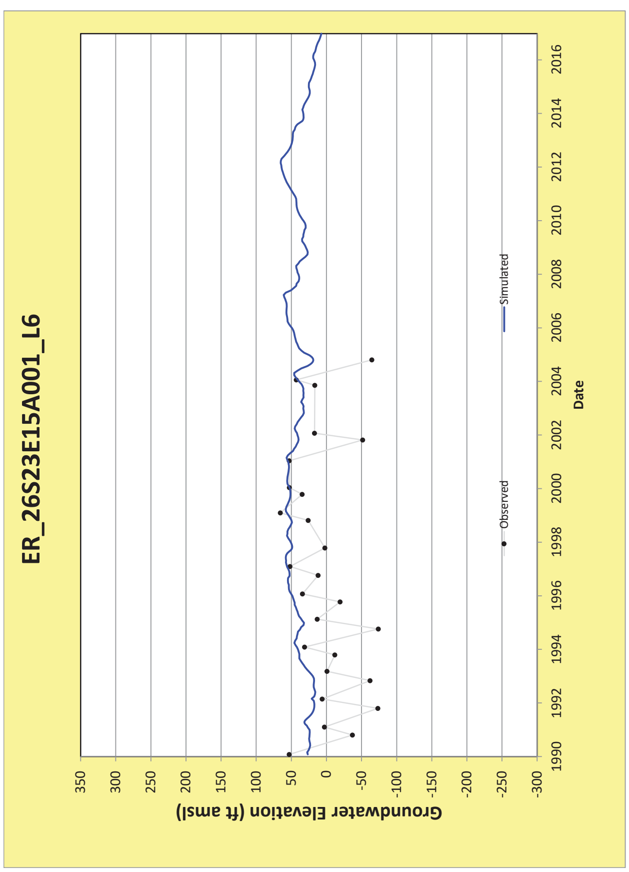

ER_21S22E09D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

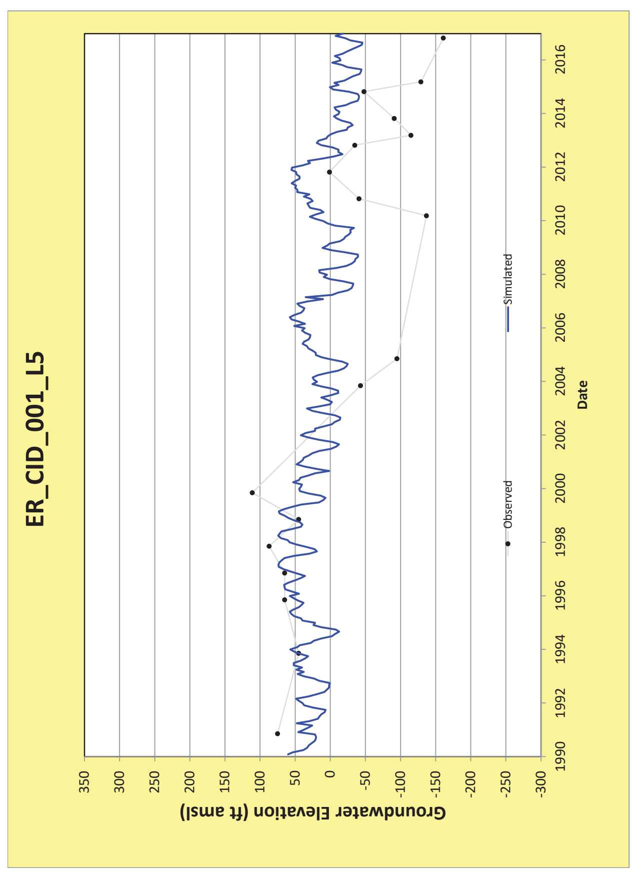

ER_21S22E09N001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

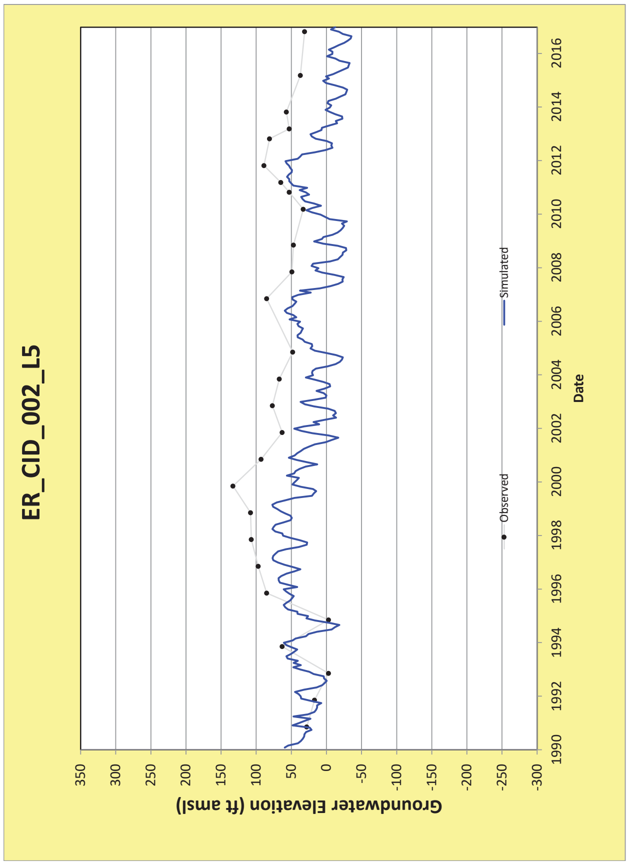

ER_23S25E09Q002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

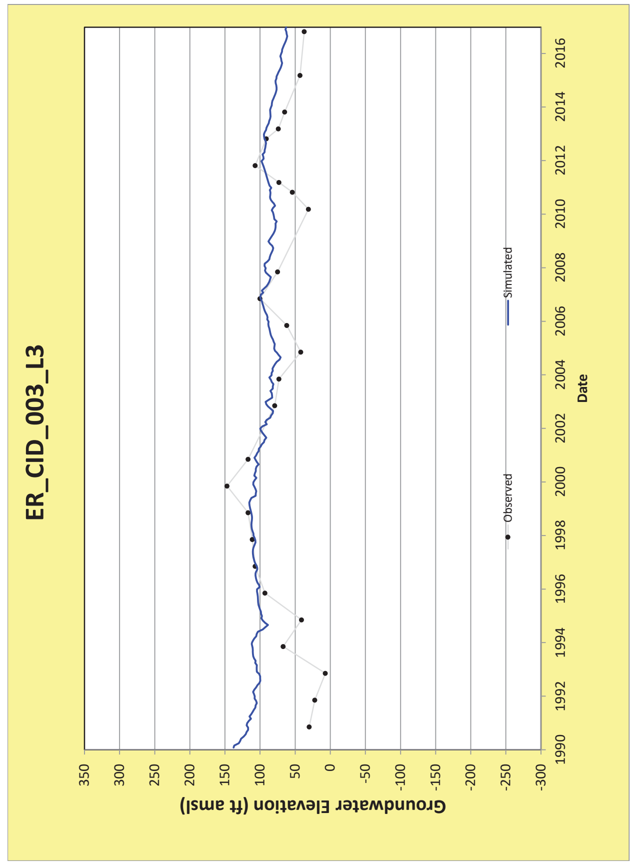

ER_21S22E22M001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

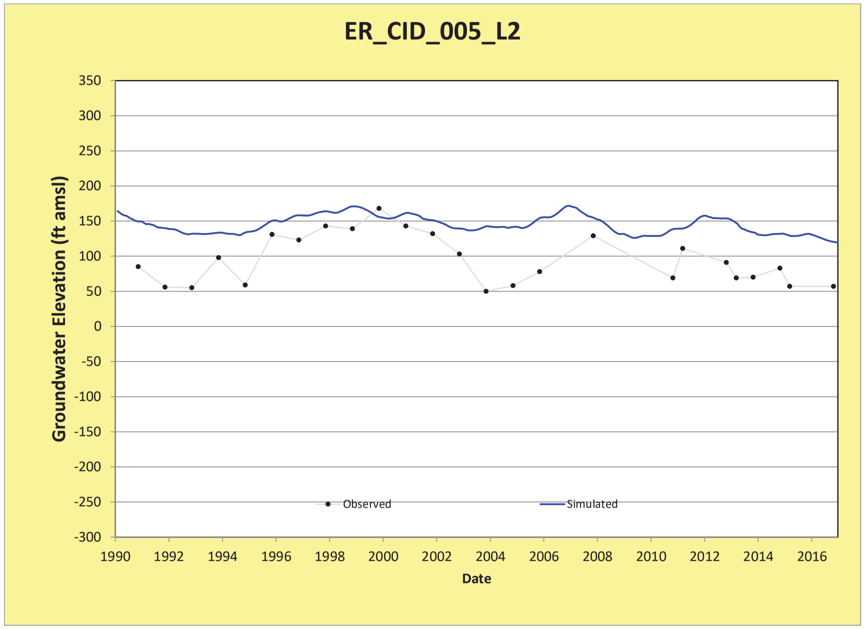

ER_24S22E27B001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

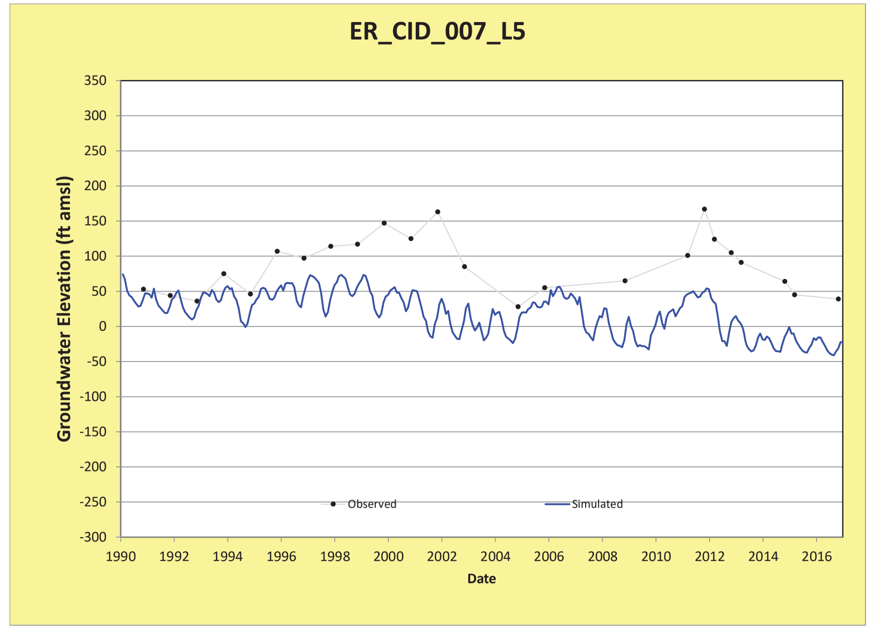

ER_26S23E15A001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

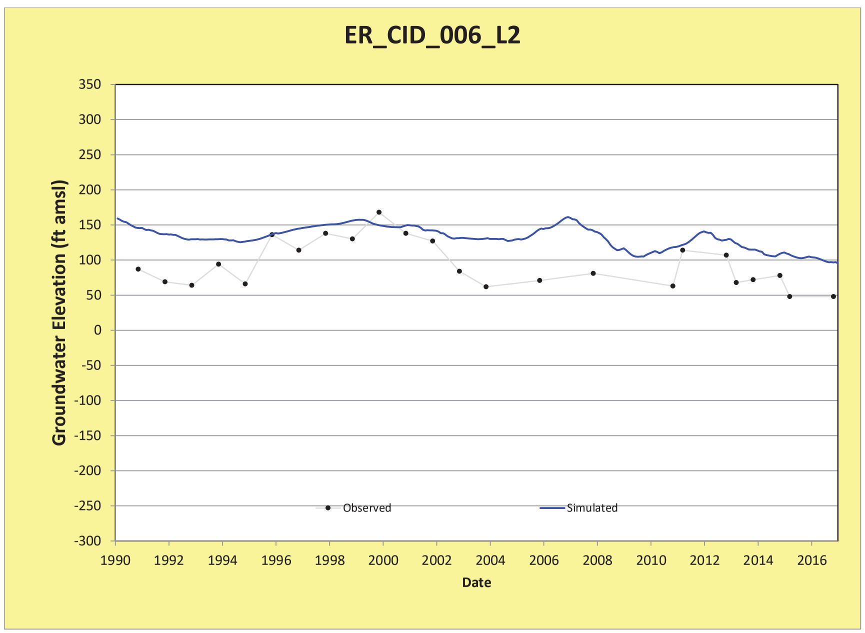

ER_CID_001_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

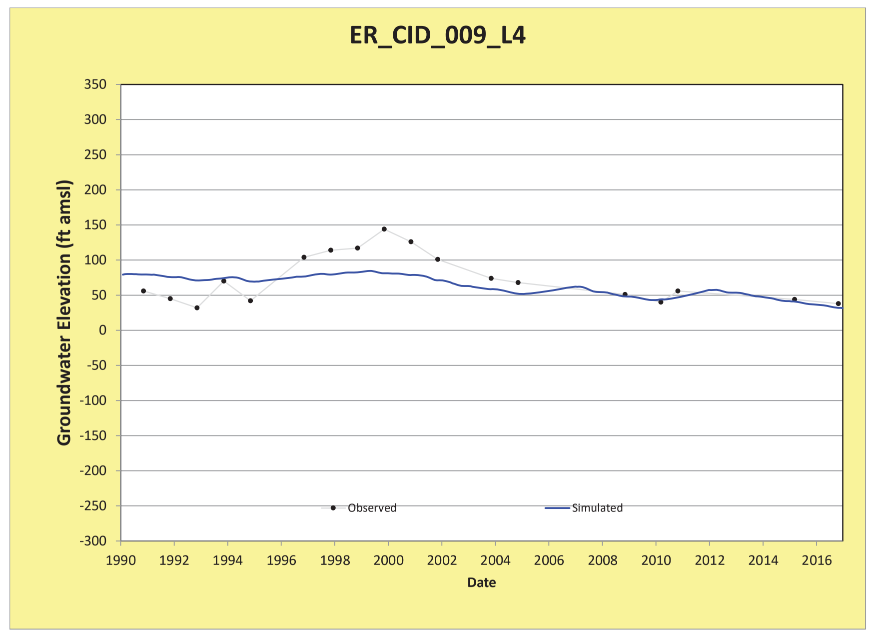

ER_CID_002_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

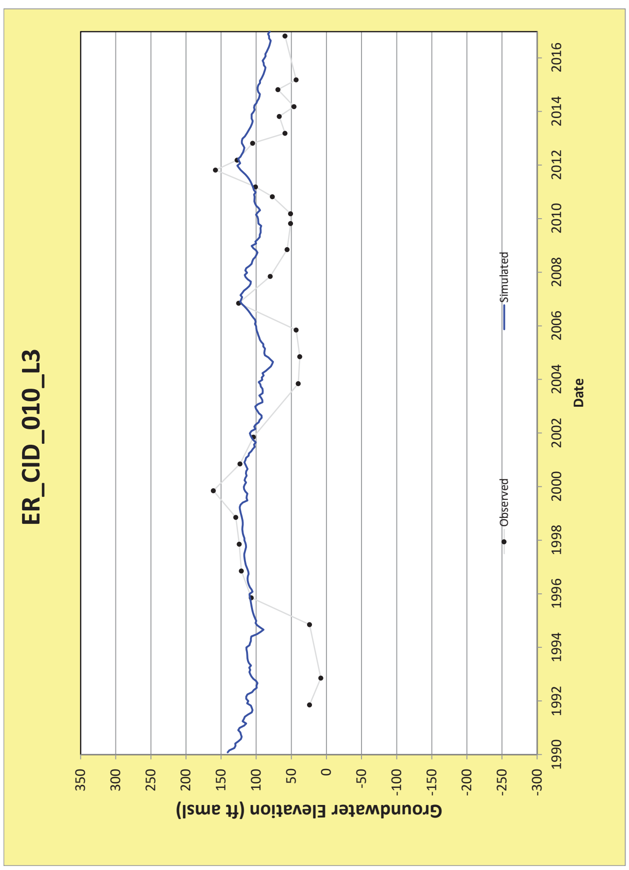

ER_CID_003_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

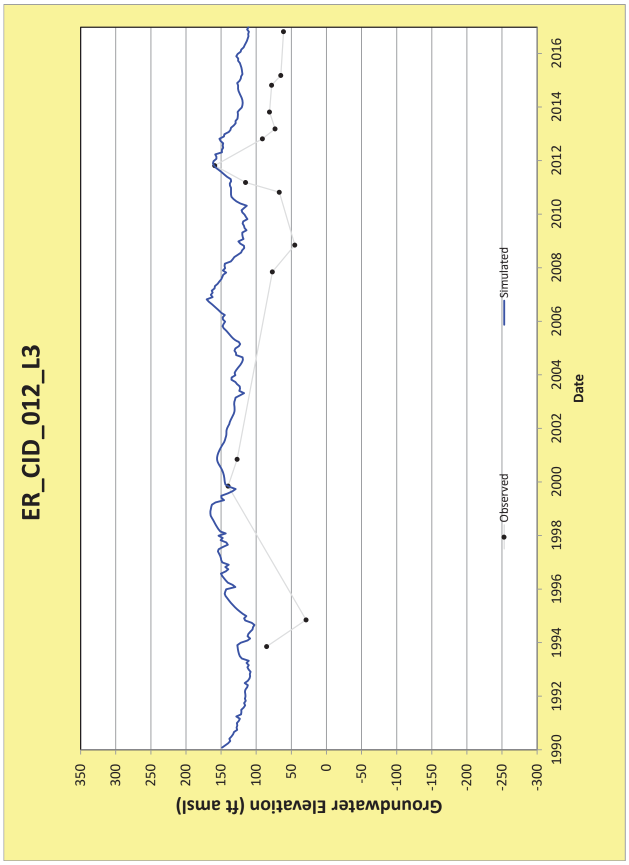

ER_CID_005_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

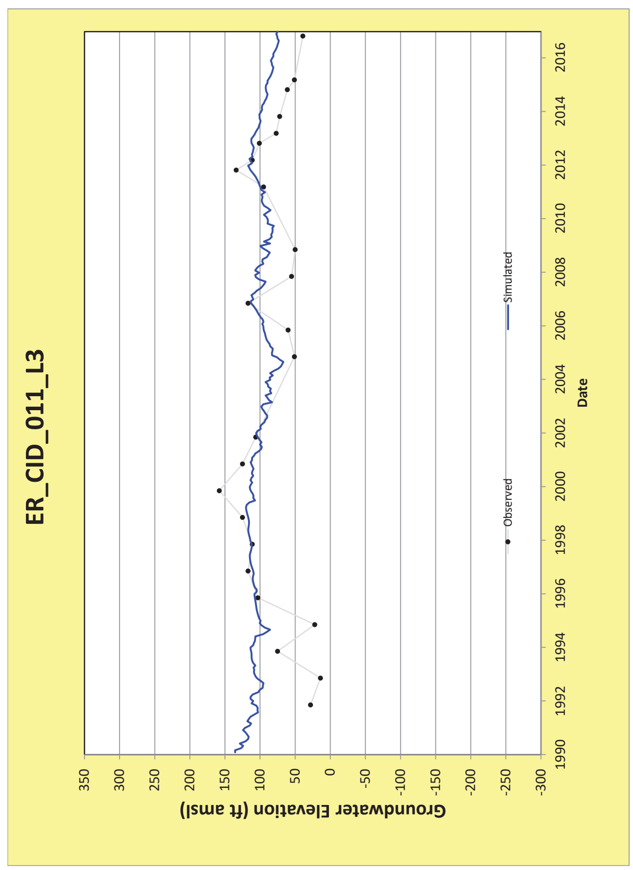

ER_CID_007_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

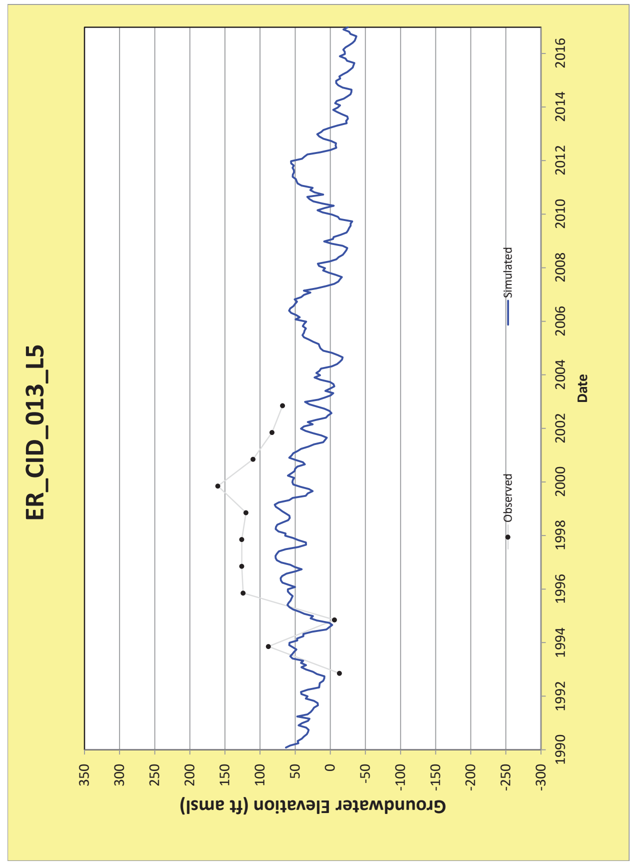

ER_CID_006_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

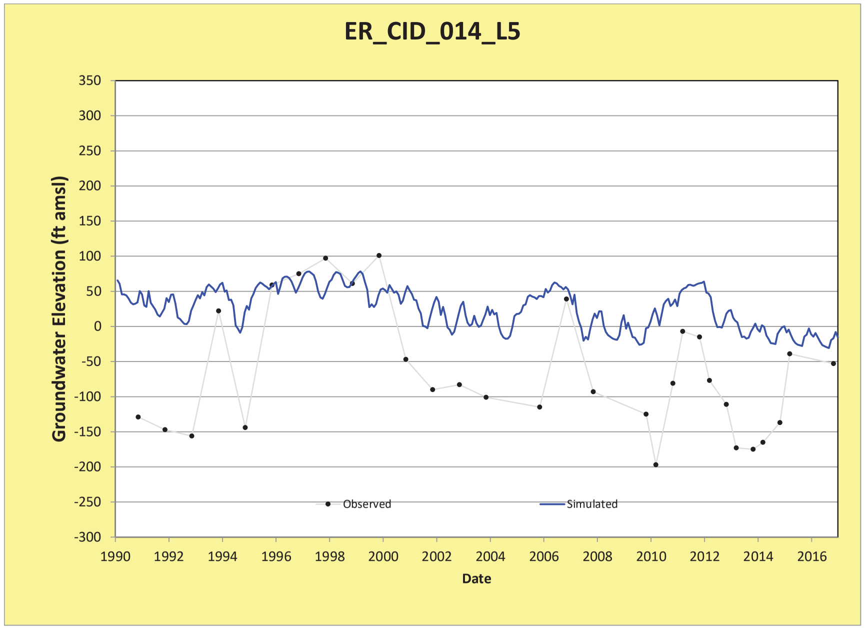

ER_CID_009_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

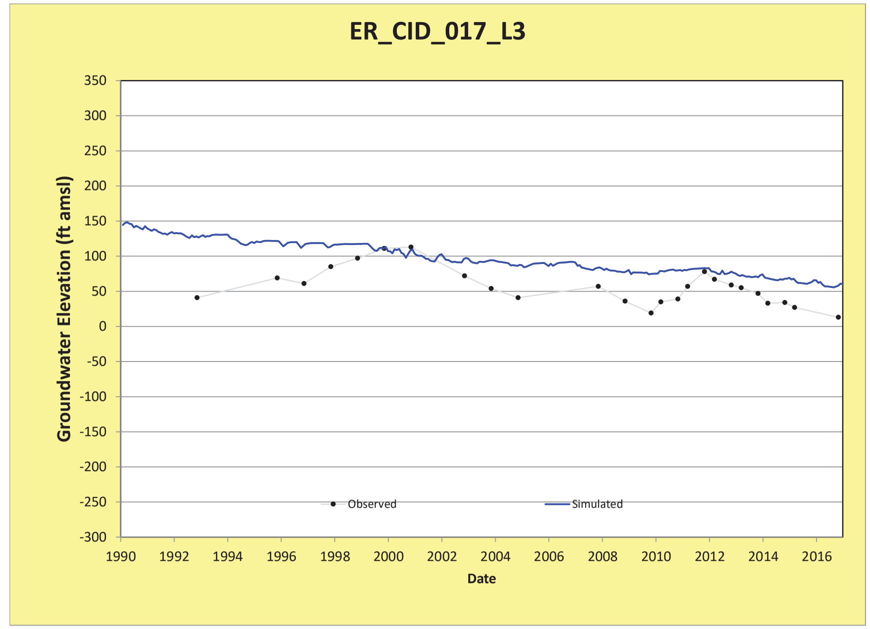

ER_CID_010_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

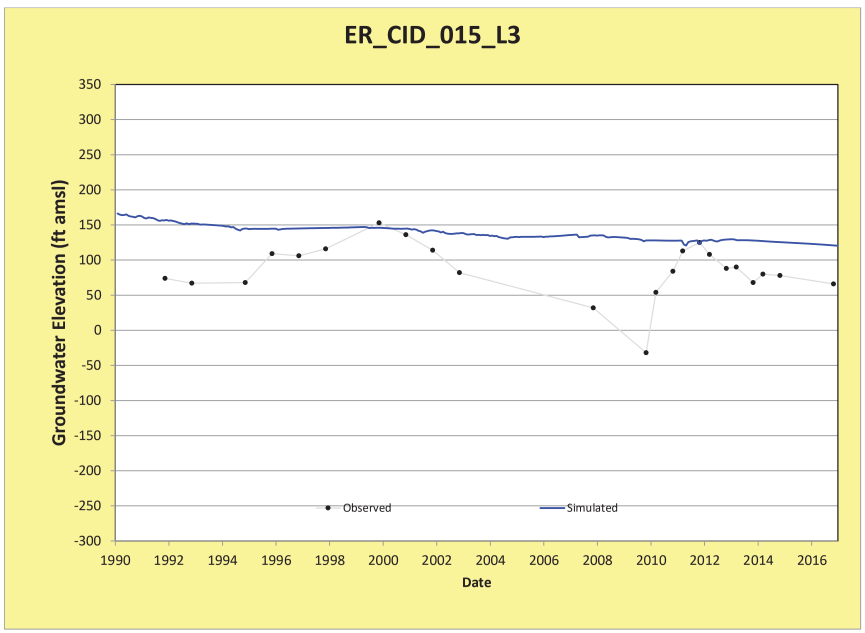

ER_CID_012_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

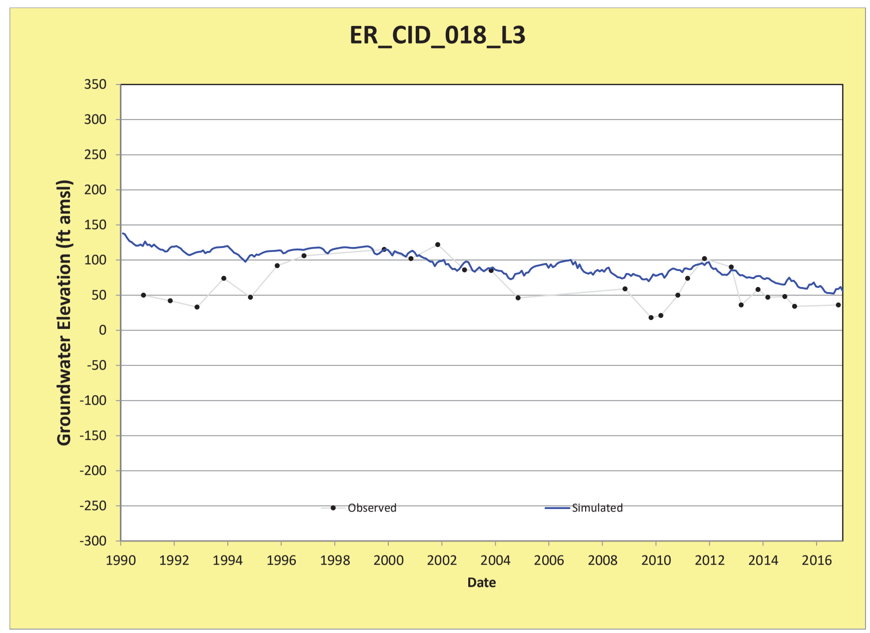

ER_CID_011_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_013_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

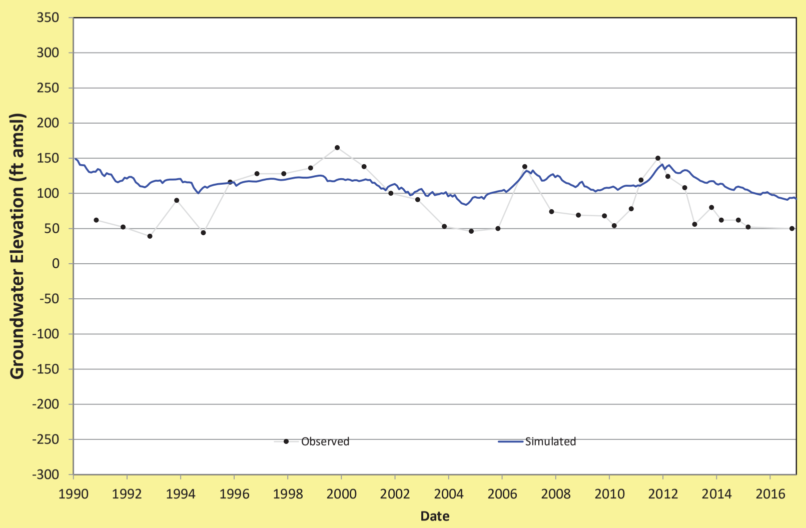

ER_CID_014_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_017_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

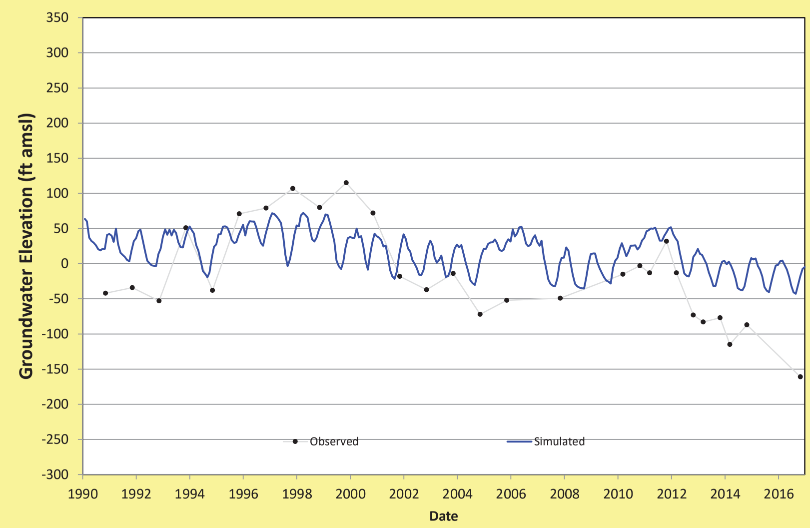

ER_CID_015_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_018_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

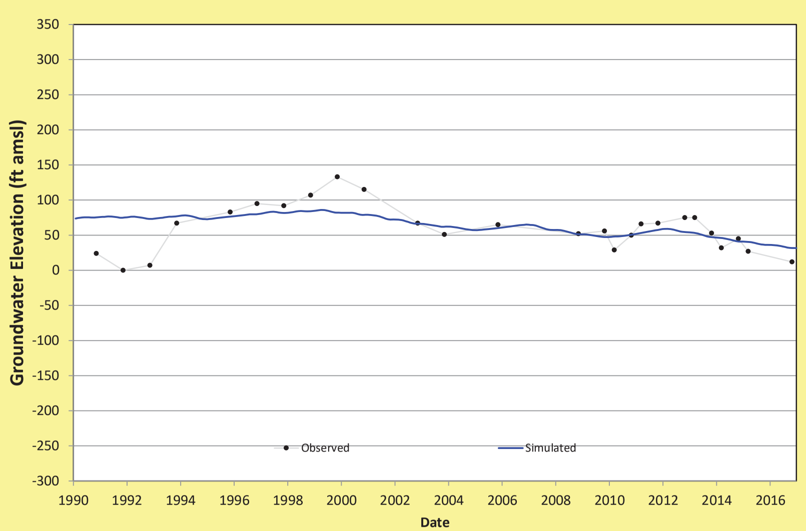
ER_CID_019_L3



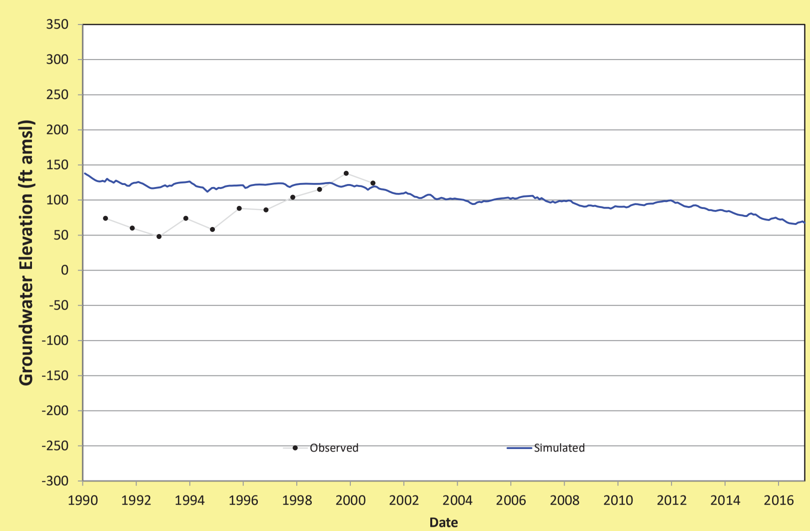
ER_CID_021_L5

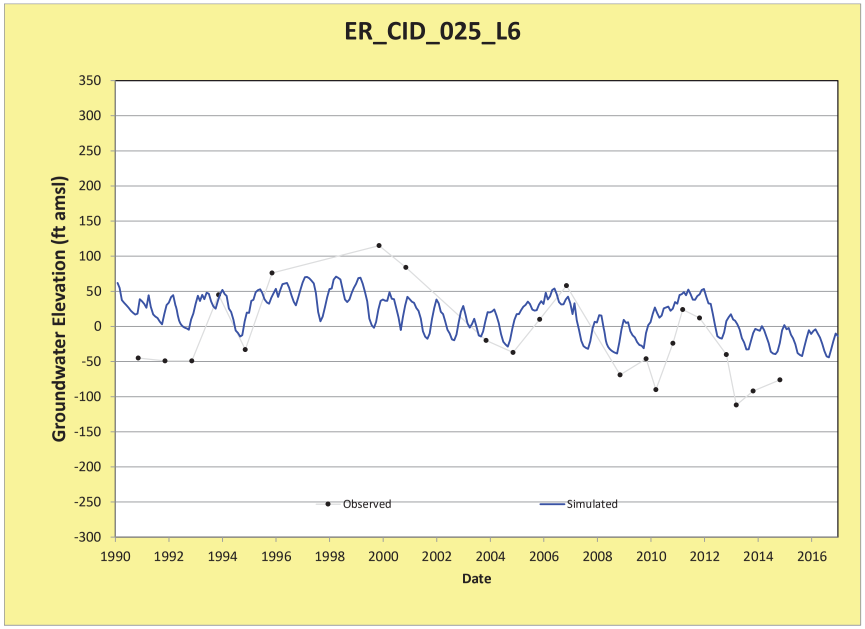


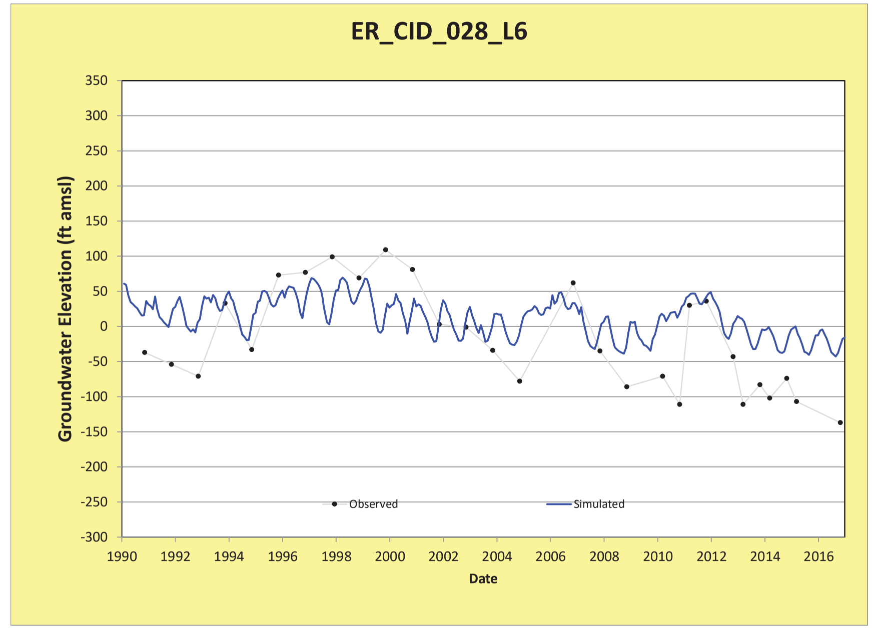
ER_CID_020_L4

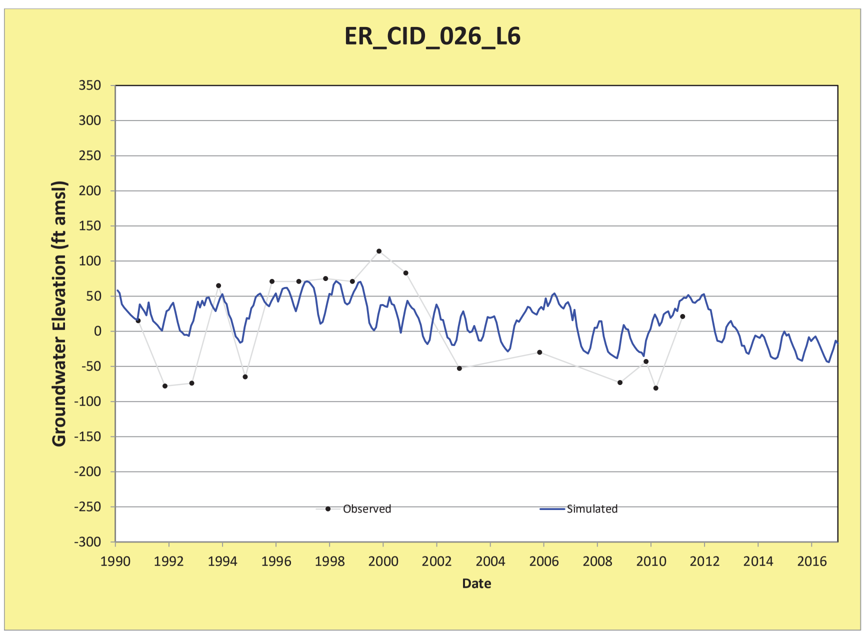


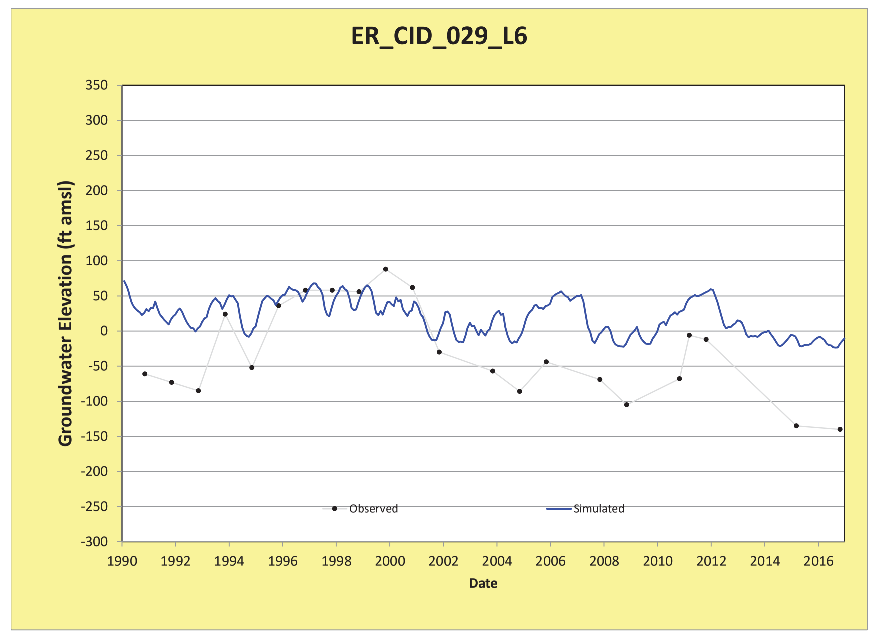
ER_CID_022_L3




ER_CID_025_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_028_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_026_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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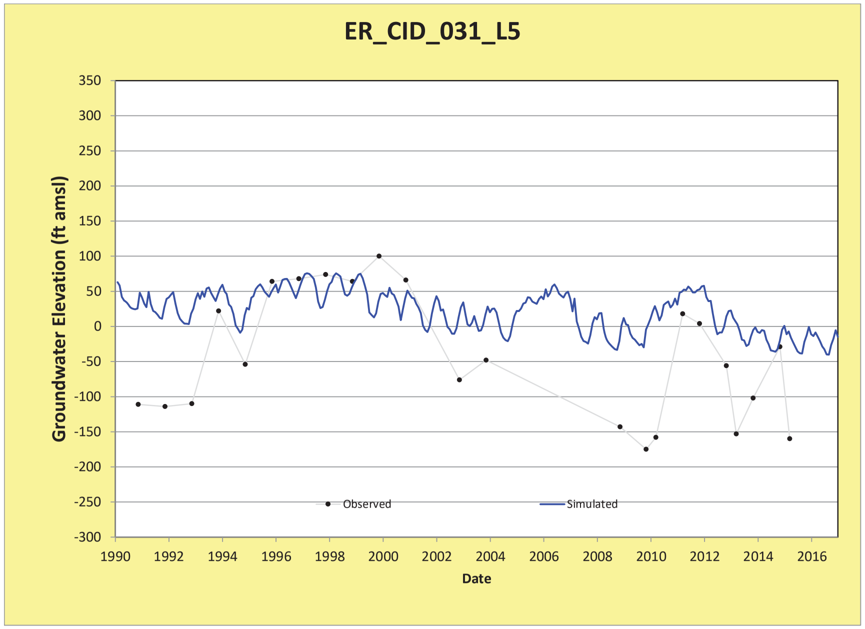
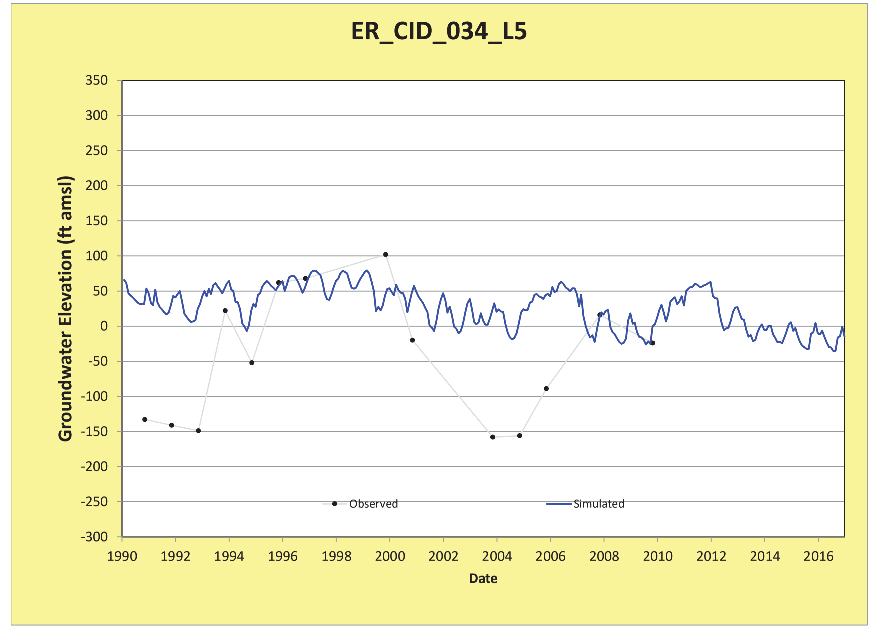
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_031_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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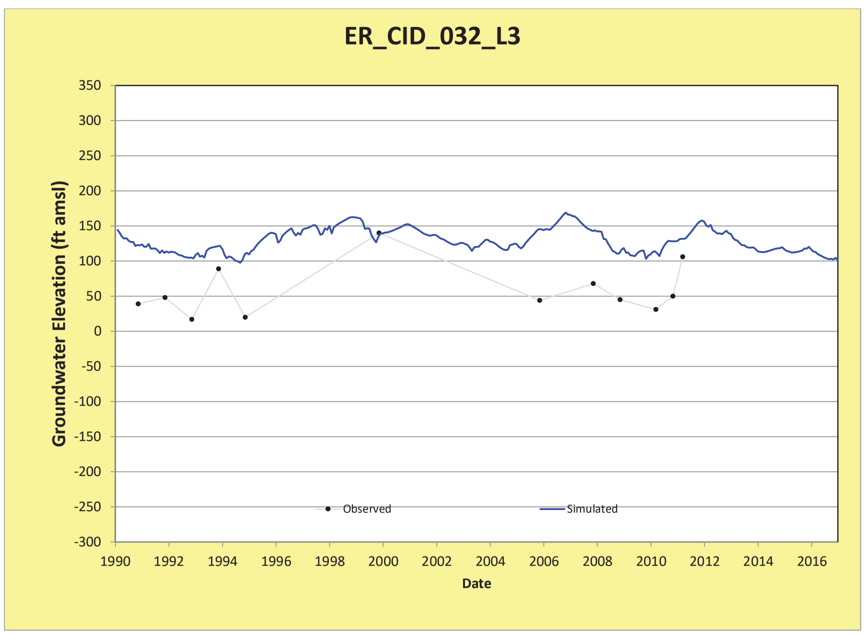
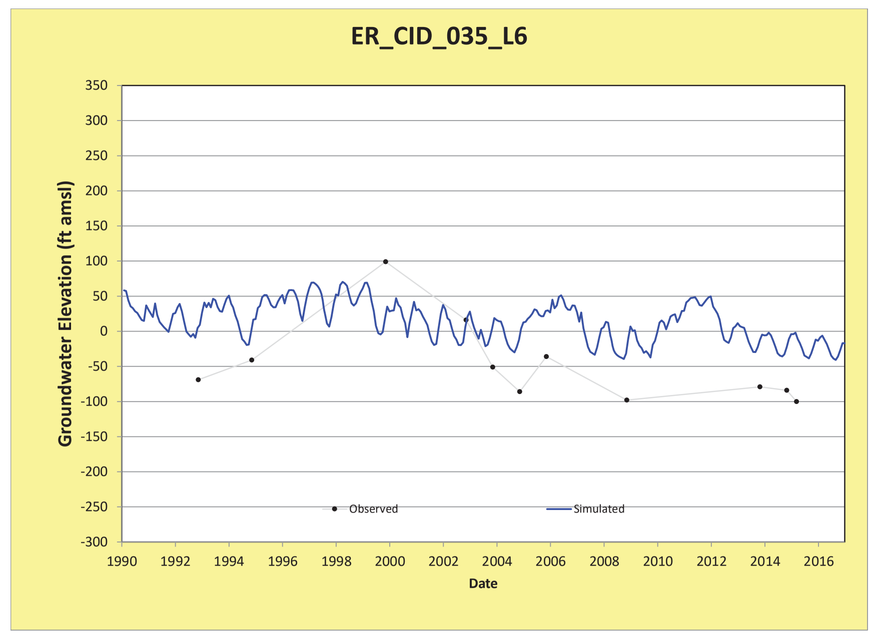
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_032_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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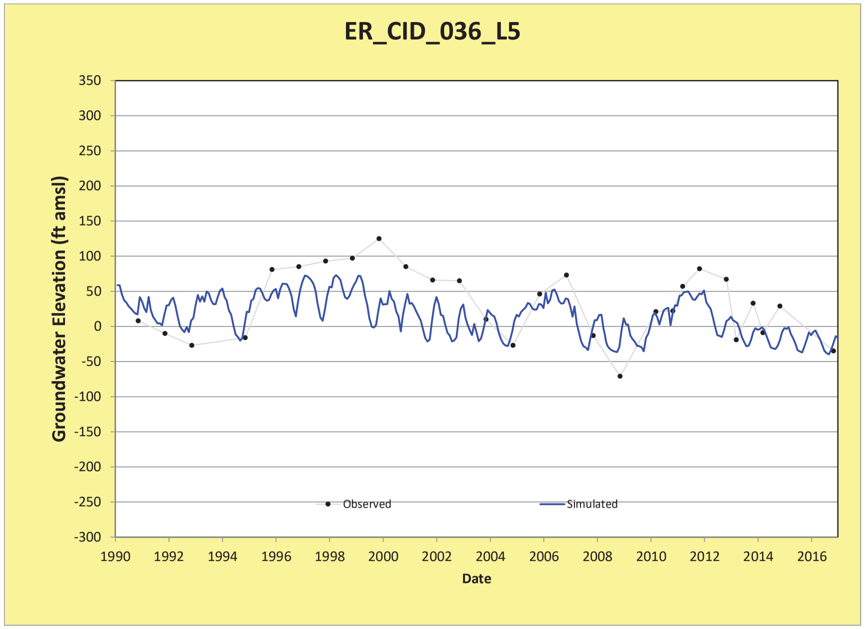
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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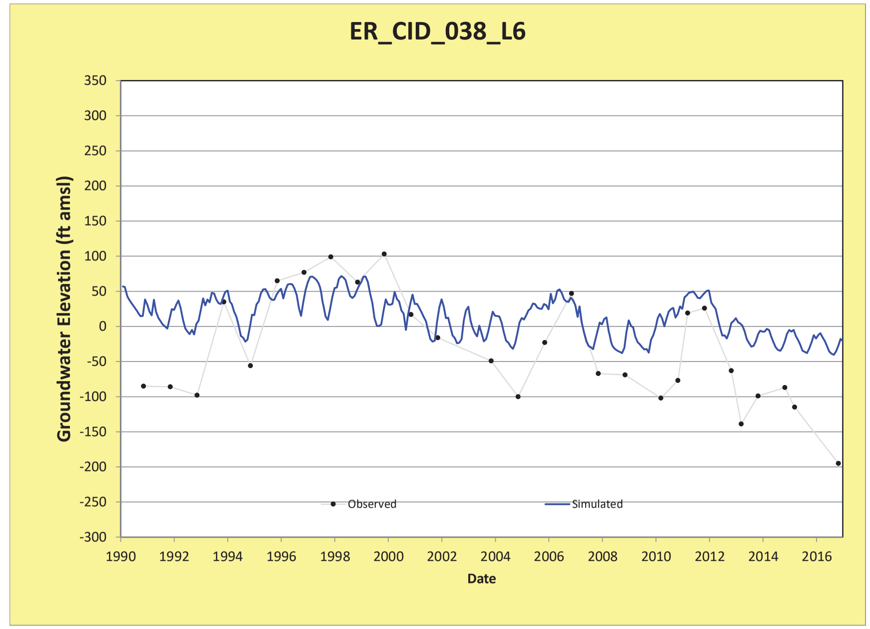
Date
Observed
Simulated


ER_CID_038_L6
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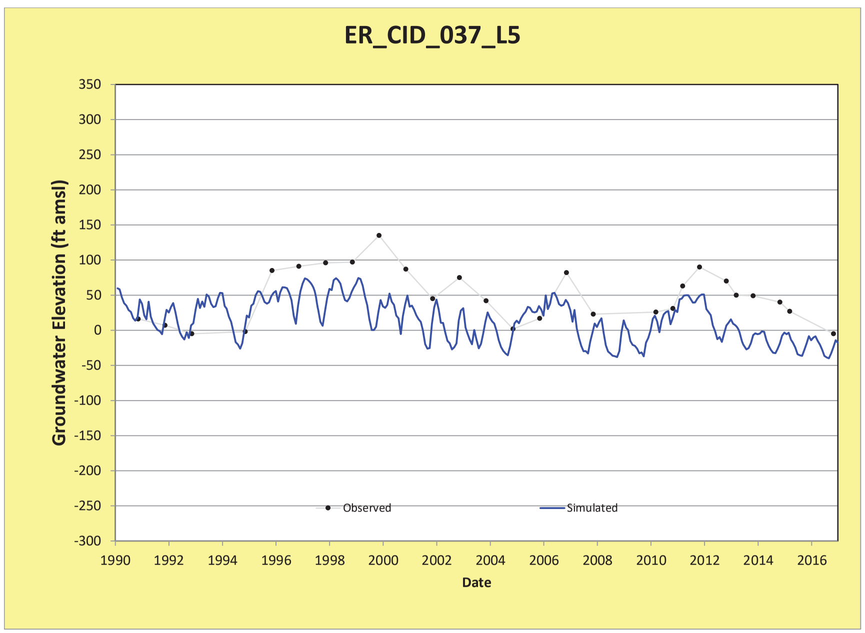
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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100
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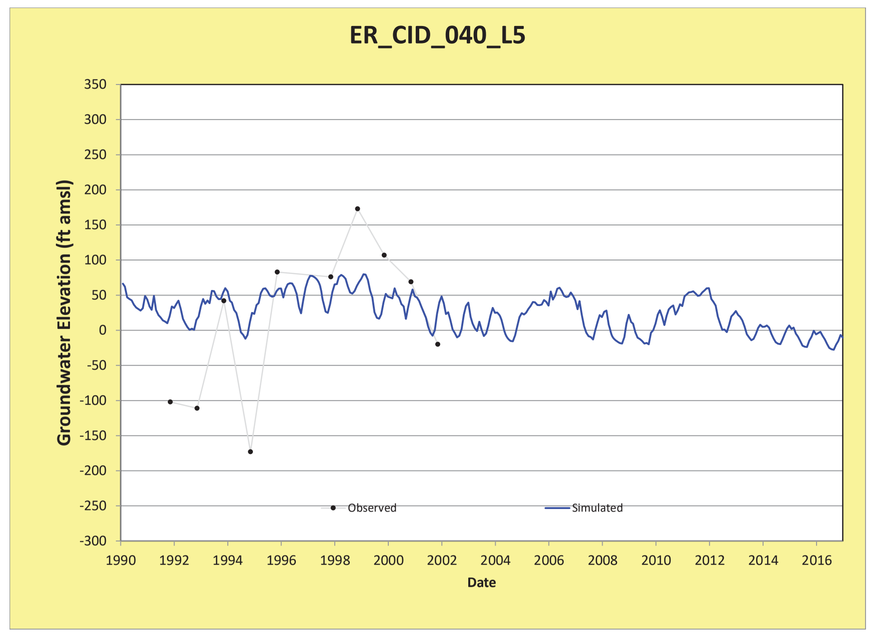
Date
Observed
Simulated


ER_CID_040_L5
Groundwater Elevation (ft amsl)
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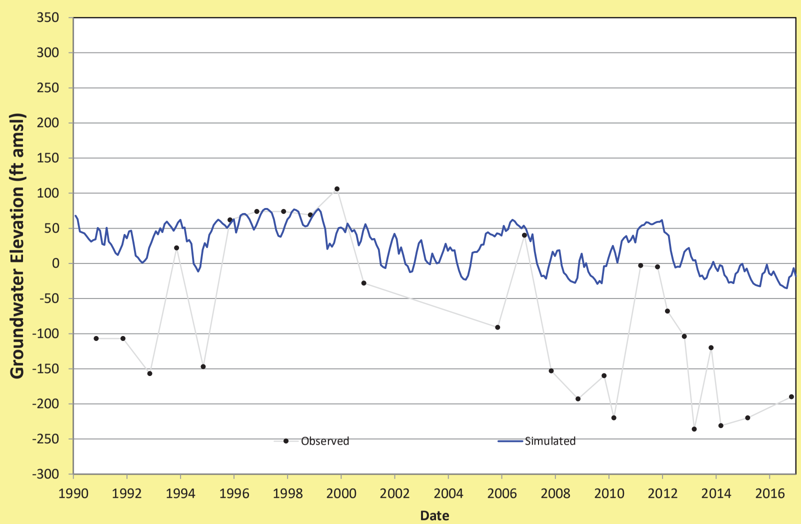
Date
Observed
Simulated

ER_CID_043_L5



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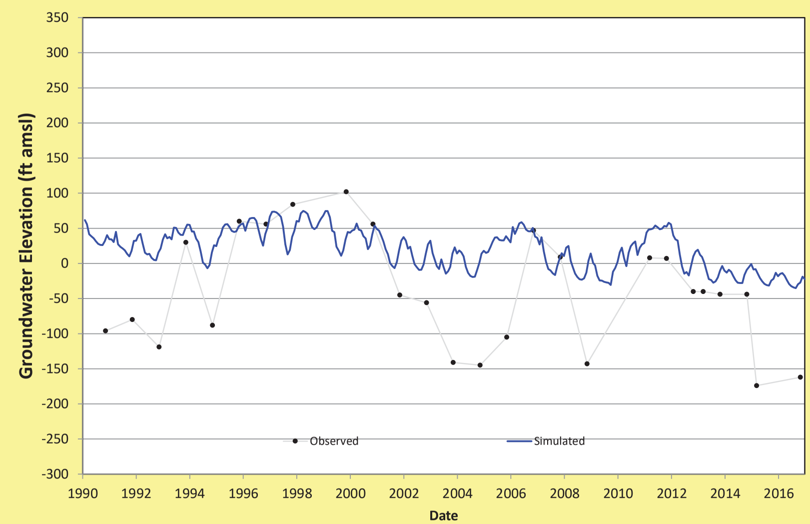

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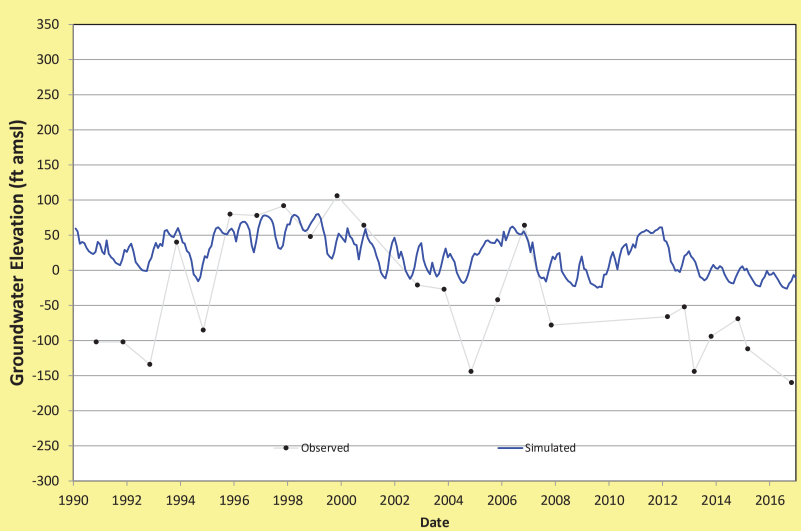
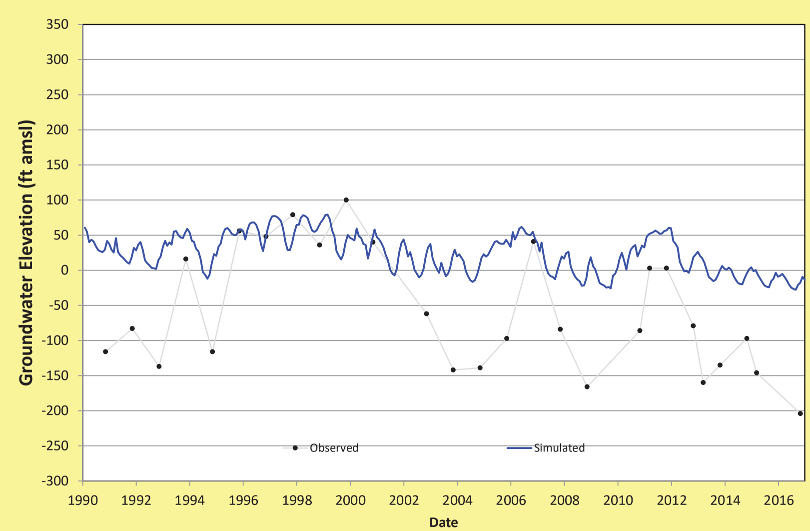
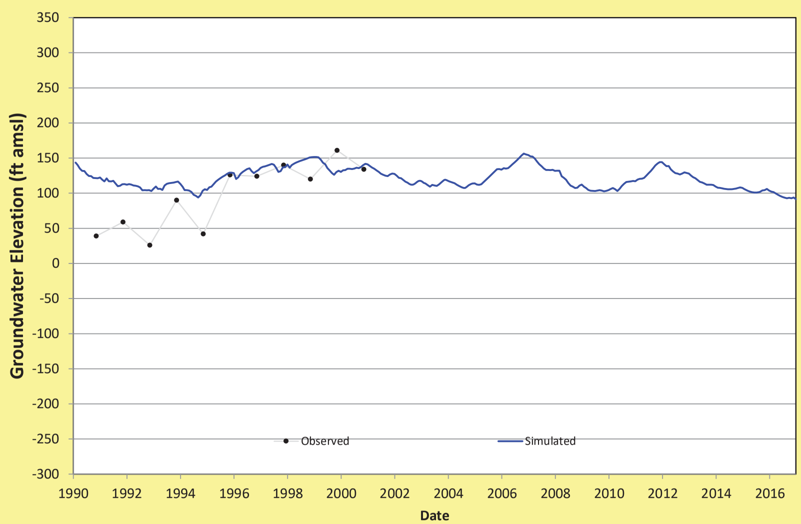


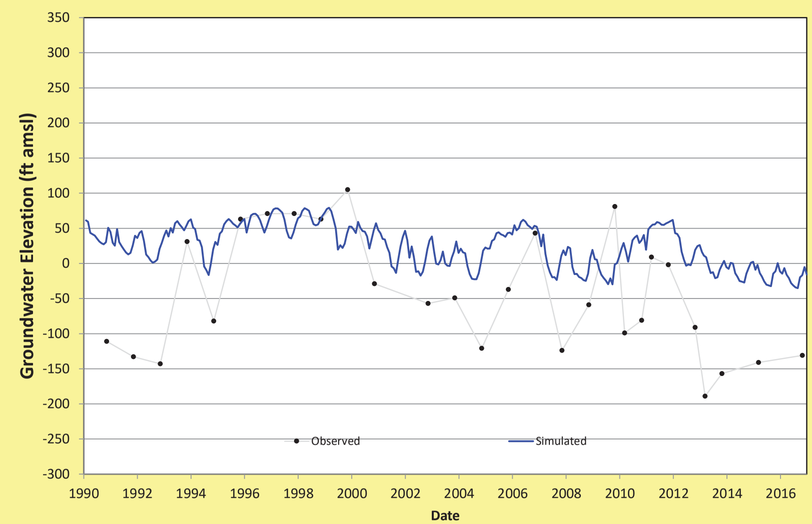
ER_CID_046_L5



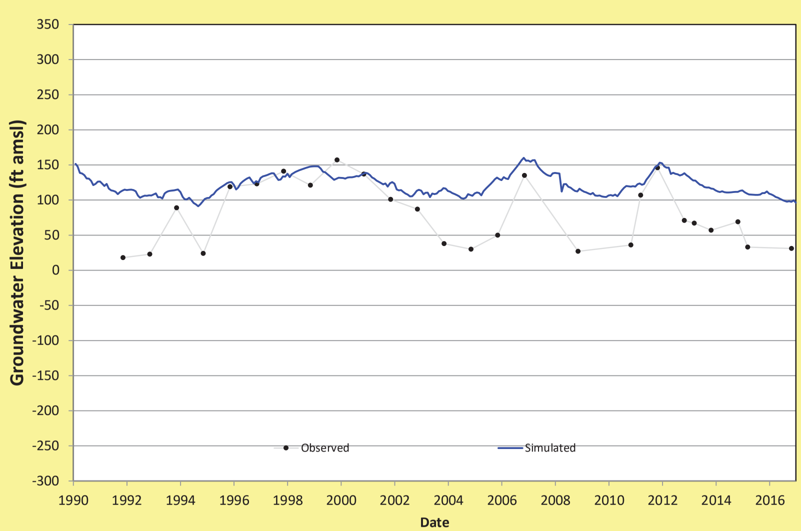
ER_CID_049_L3



ER_CID_051_L5



ER_CID_050_L3



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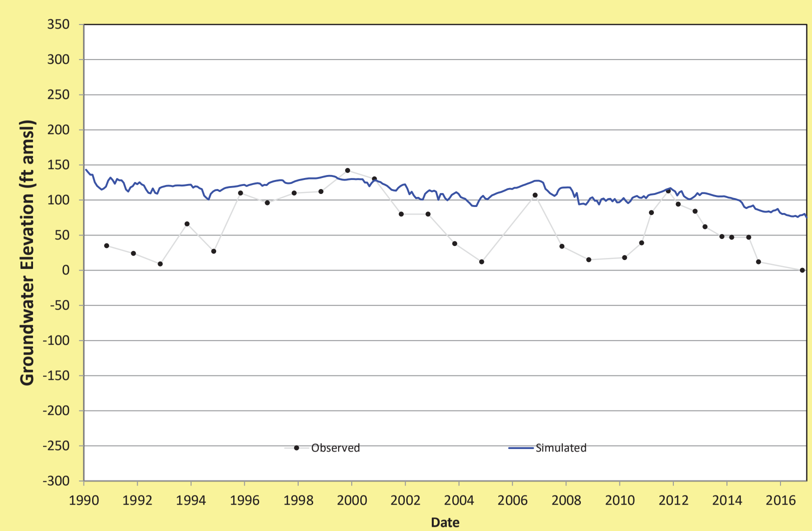
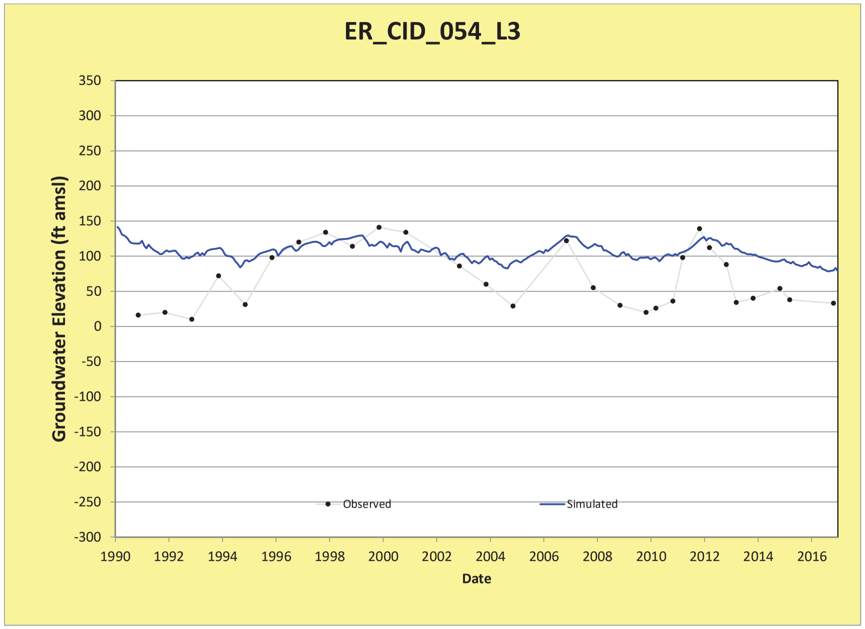
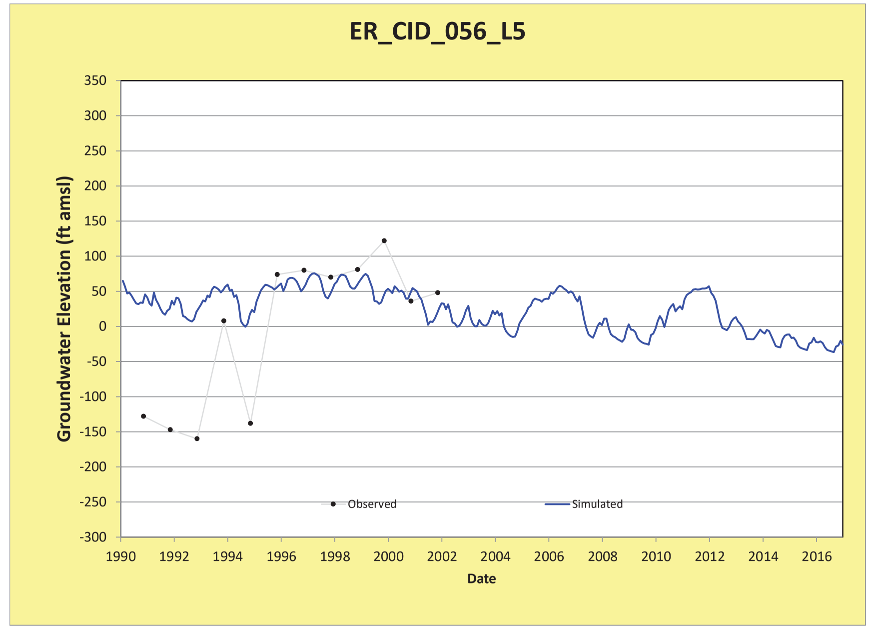
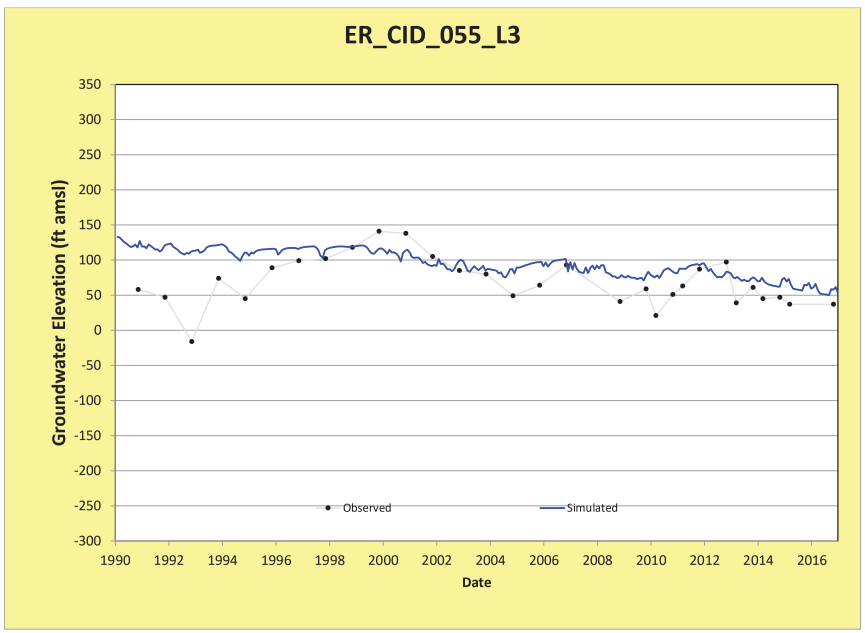
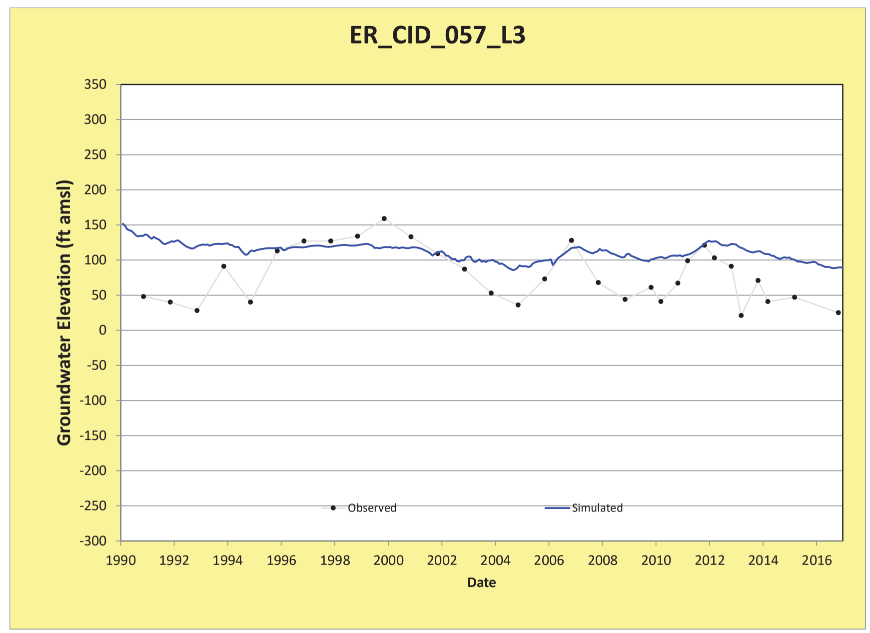
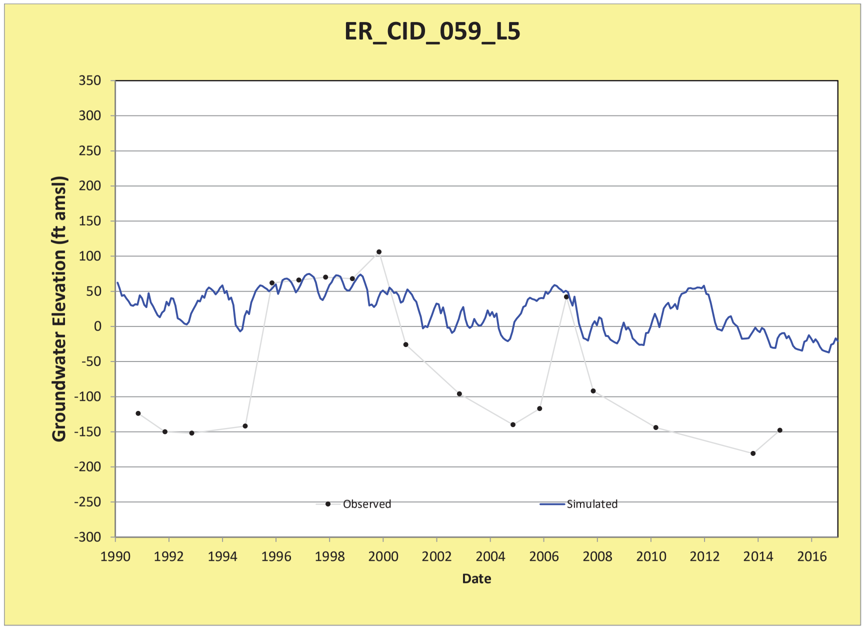


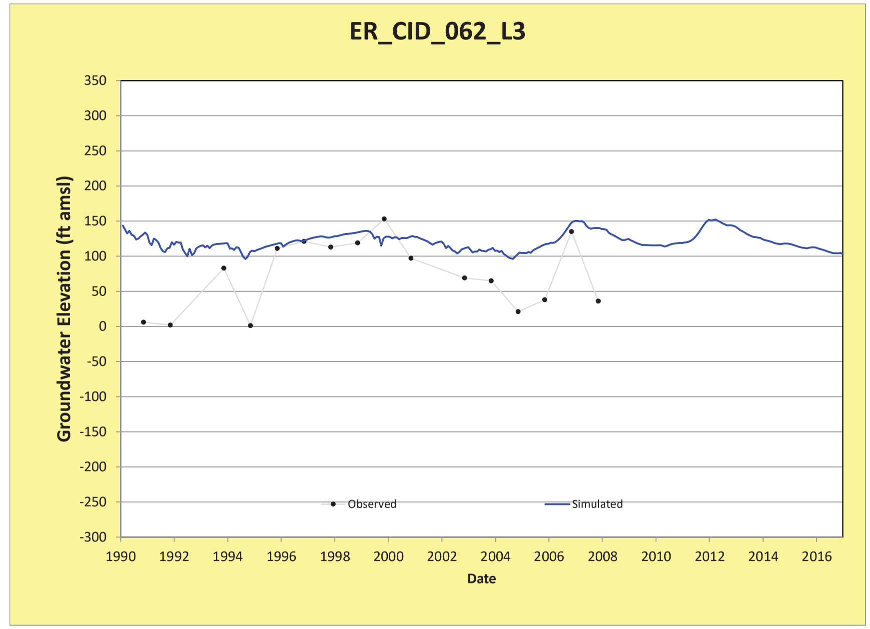

ER_CID_054_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

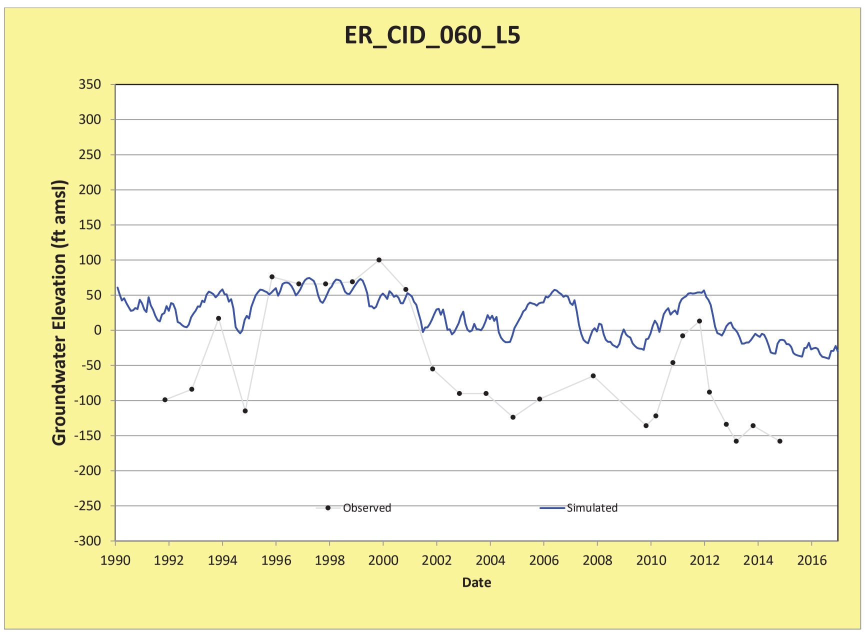

ER_CID_056_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

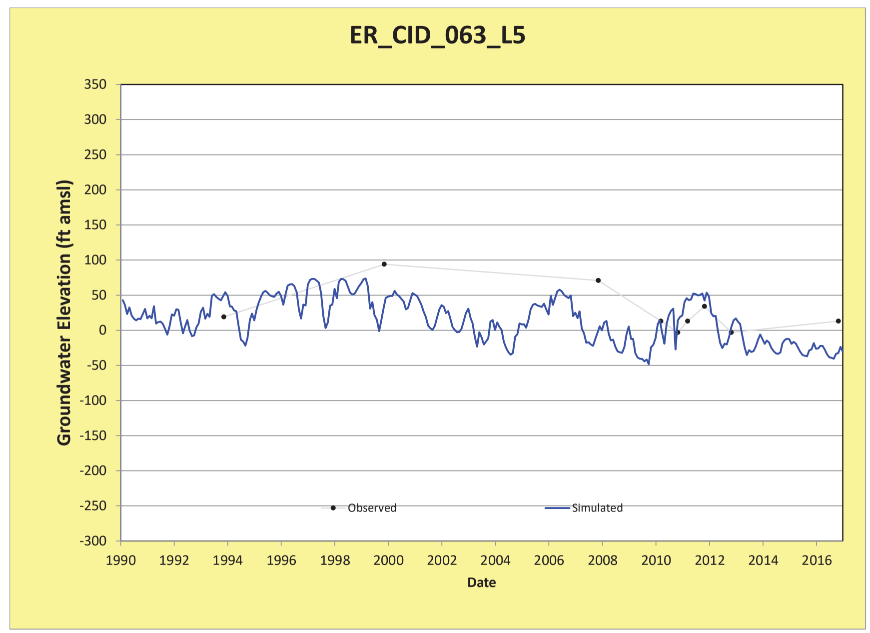

ER_CID_055_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

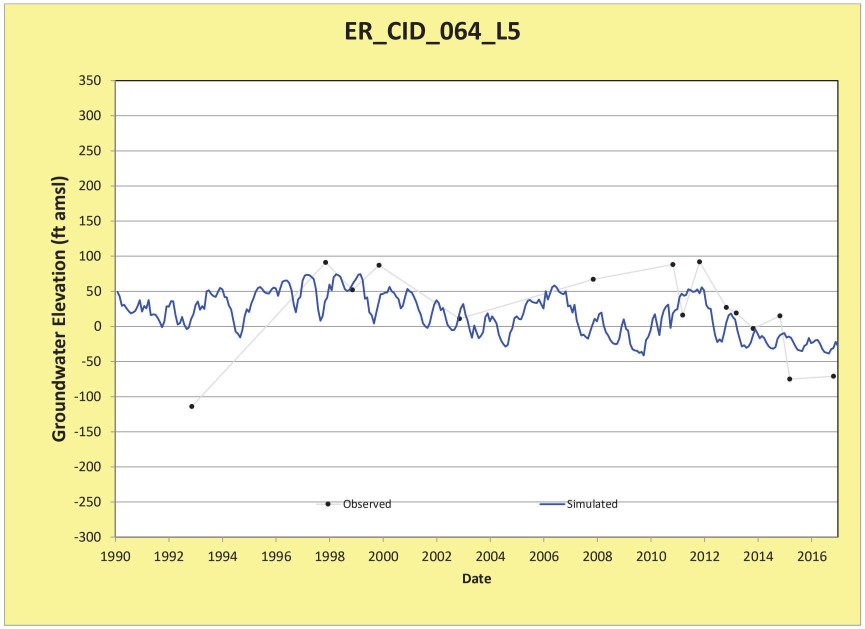

ER_CID_057_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_059_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_062_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_060_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_063_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_064_L5
Groundwater Elevation (ft amsl)
350
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1990
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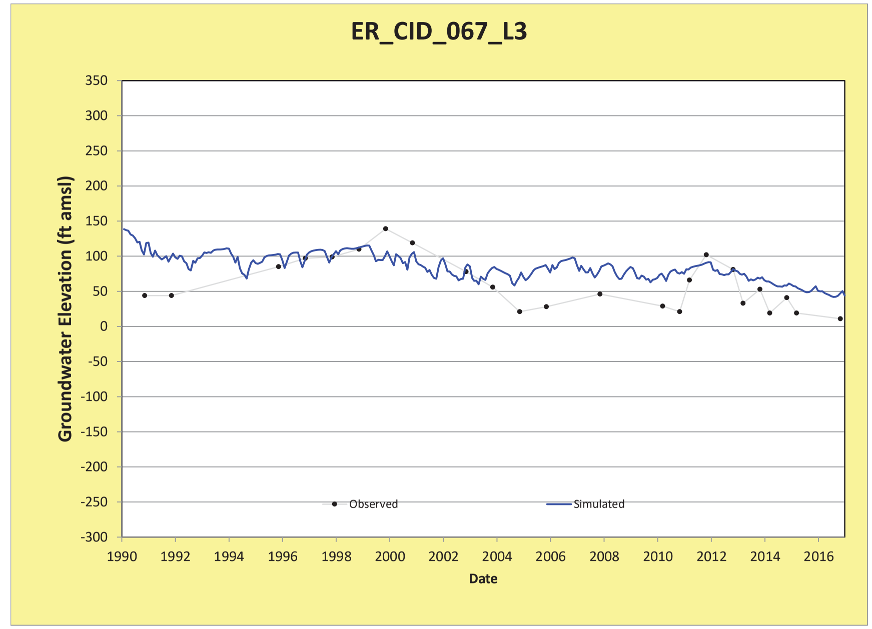
2016
Date
Observed
Simulated


ER_CID_067_L3
Groundwater Elevation (ft amsl)
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250
200
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100
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-200
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2012
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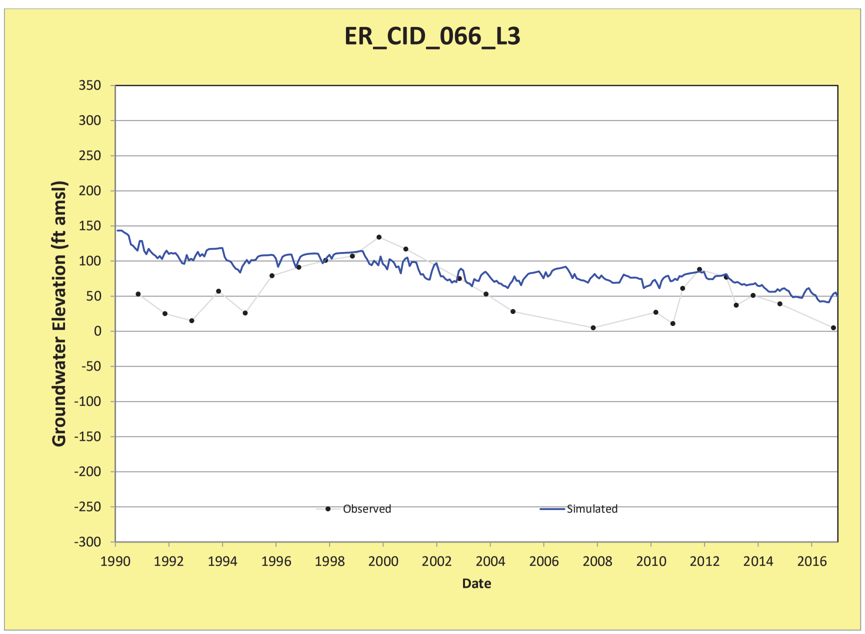
2016
Date
Observed
Simulated


ER_CID_066_L3
Groundwater Elevation (ft amsl)
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250
200
150
100
50
0
-50
-100
-150
-200
-250
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2012
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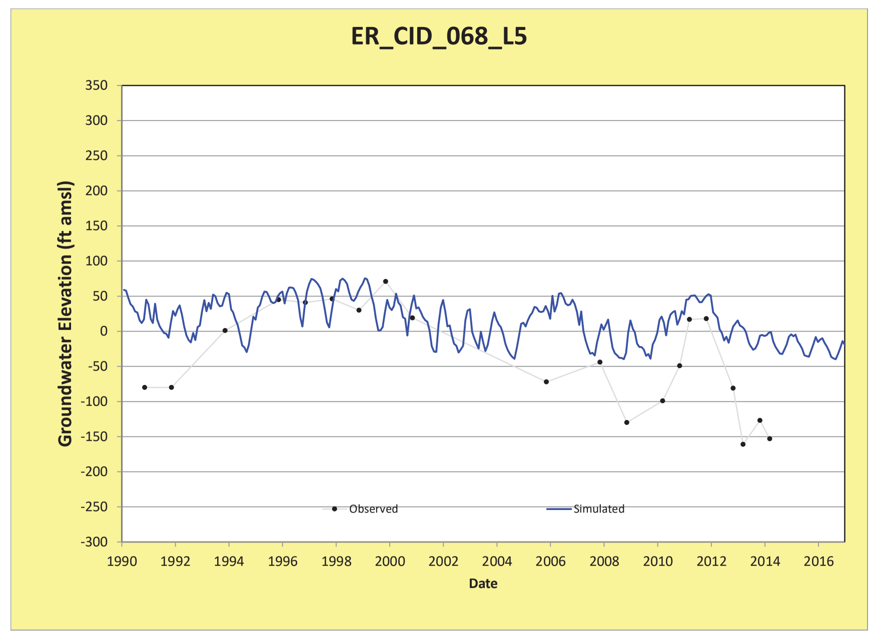
2016
Date
Observed
Simulated


ER_CID_068_L5
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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2010
2012
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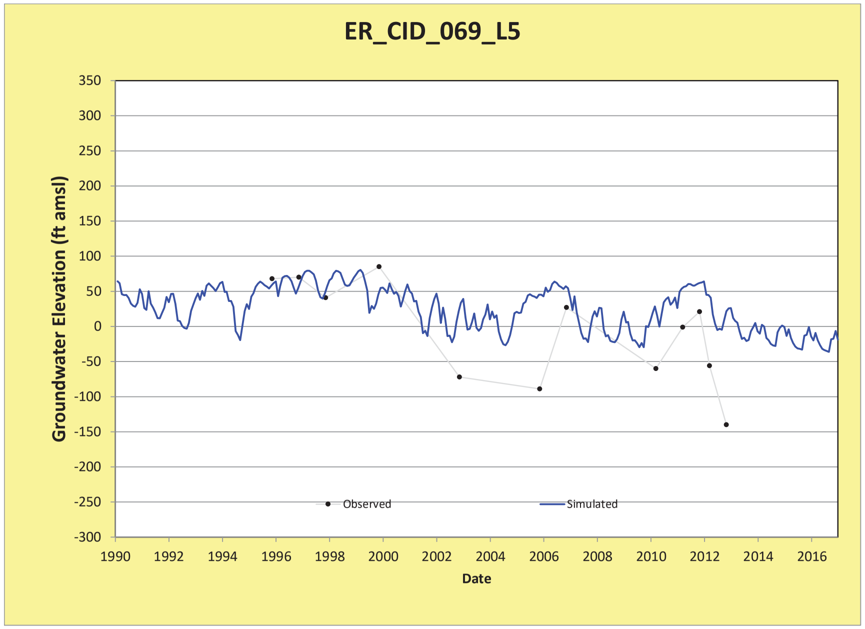
2016
Date
Observed
Simulated


ER_CID_069_L5
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
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0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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2000
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2010
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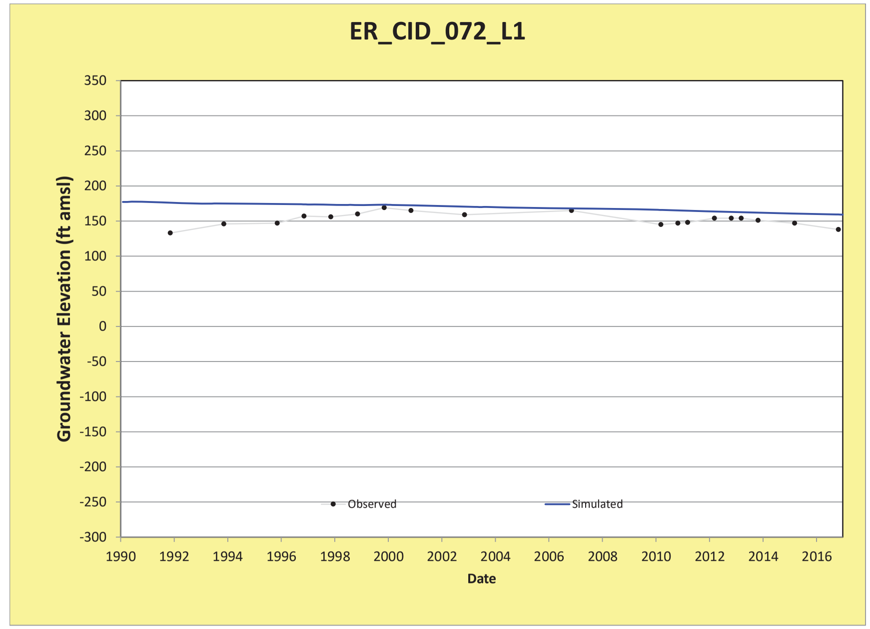
2016
Date
Observed
Simulated


ER_CID_072_L1
Groundwater Elevation (ft amsl)
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300
250
200
150
100
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0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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2000
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2004
2006
2008
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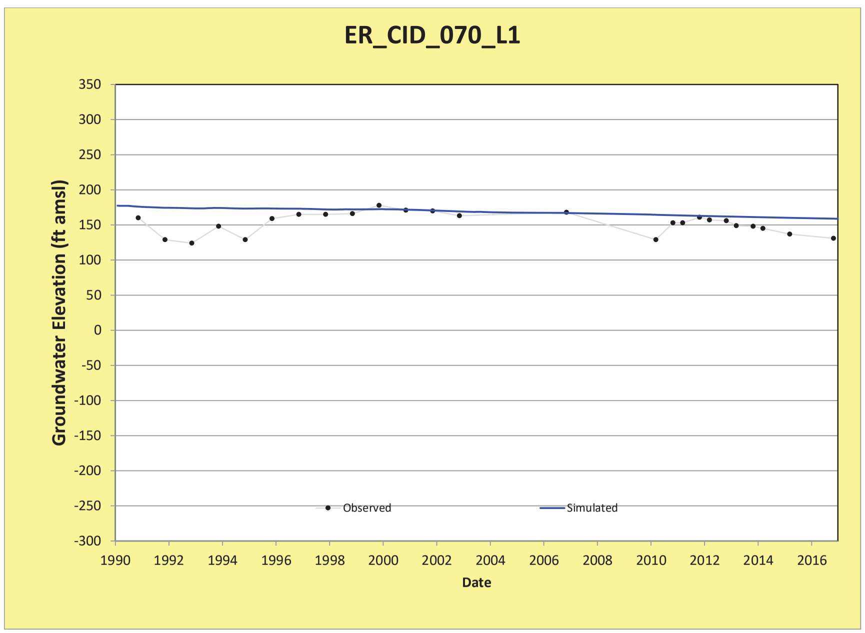
2012
2014
2016
Date
Observed
Simulated


ER_CID_070_L1
Groundwater Elevation (ft amsl)
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300
250
200
150
100
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0
-50
-100
-150
-200
-250
-300
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1996
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2000
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2010
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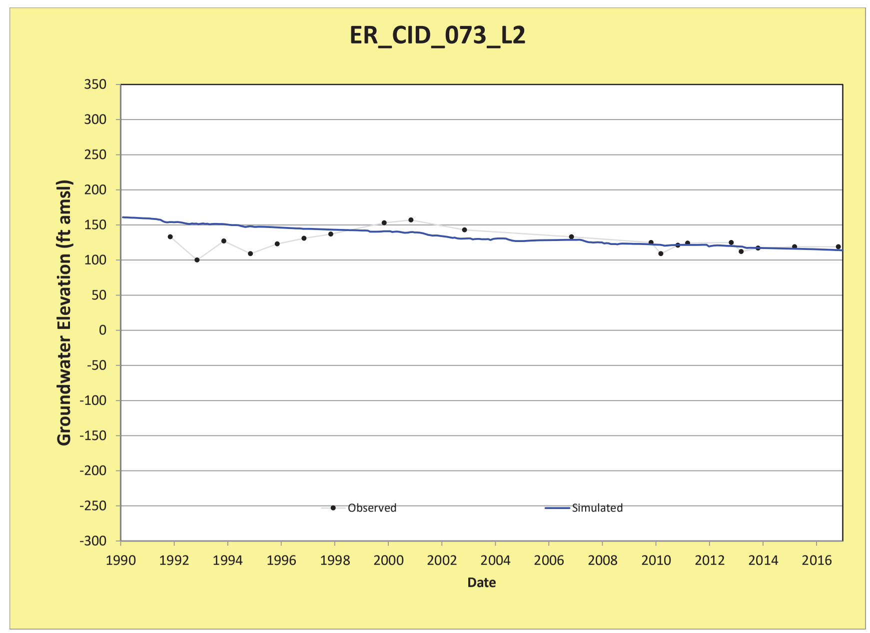
2014
2016
Date
Observed
Simulated


ER_CID_073_L2
Groundwater Elevation (ft amsl)
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200
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100
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-200
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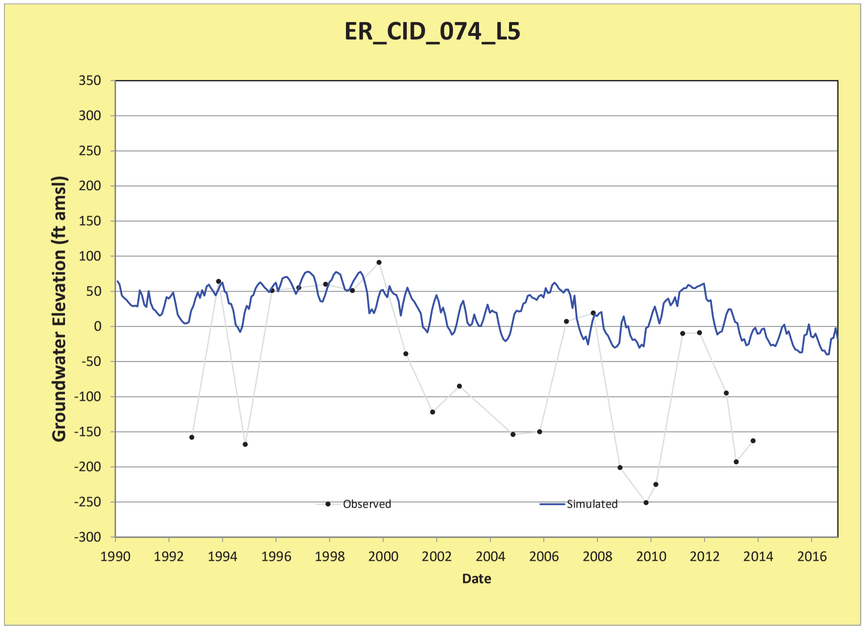
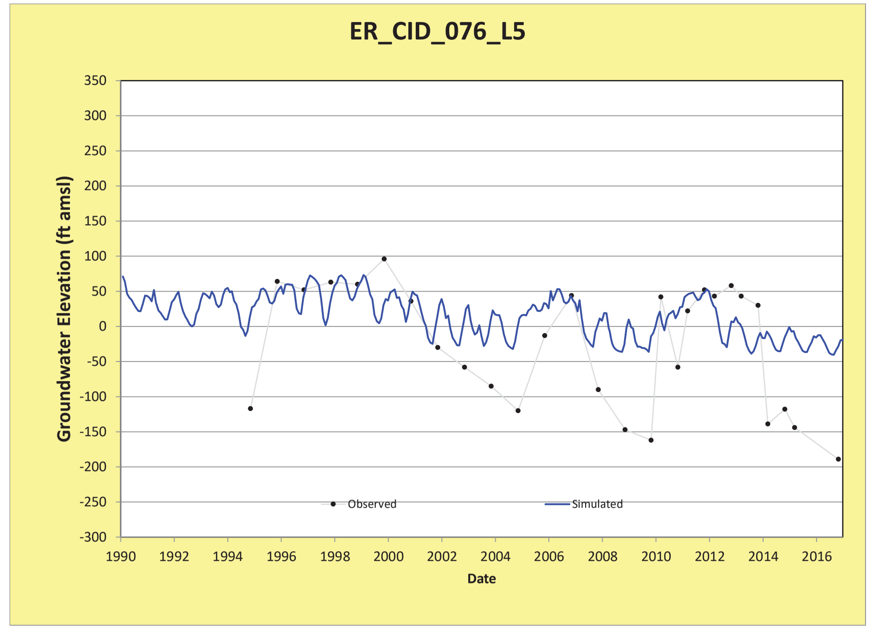
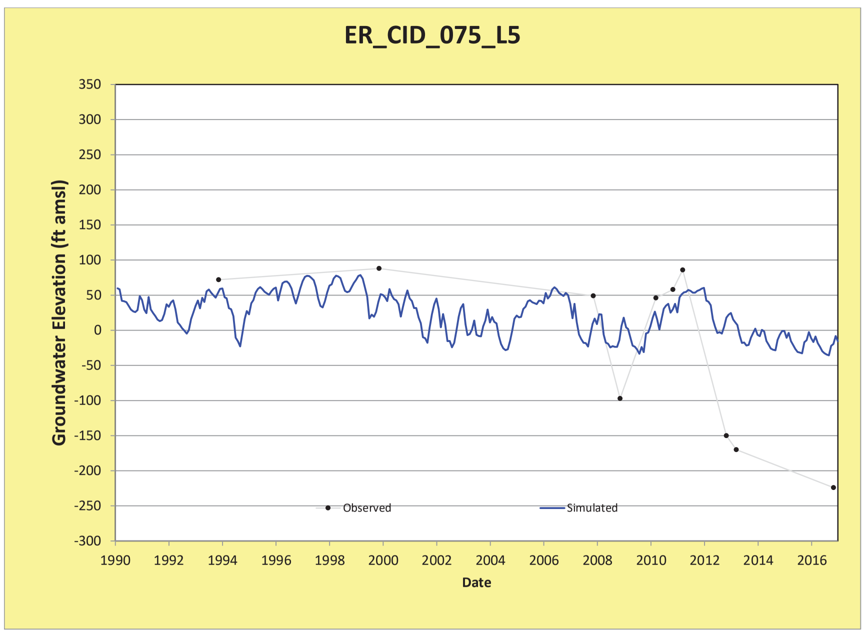
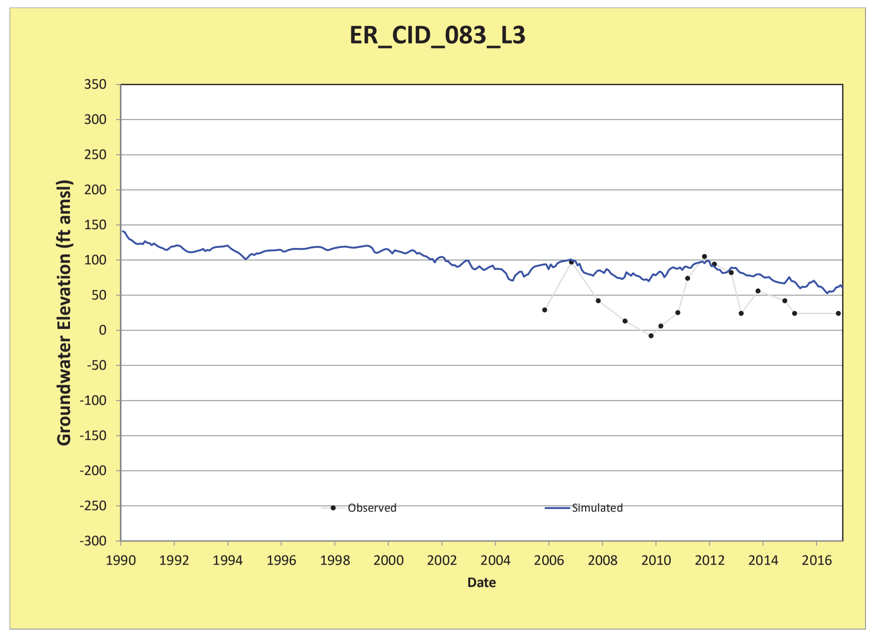
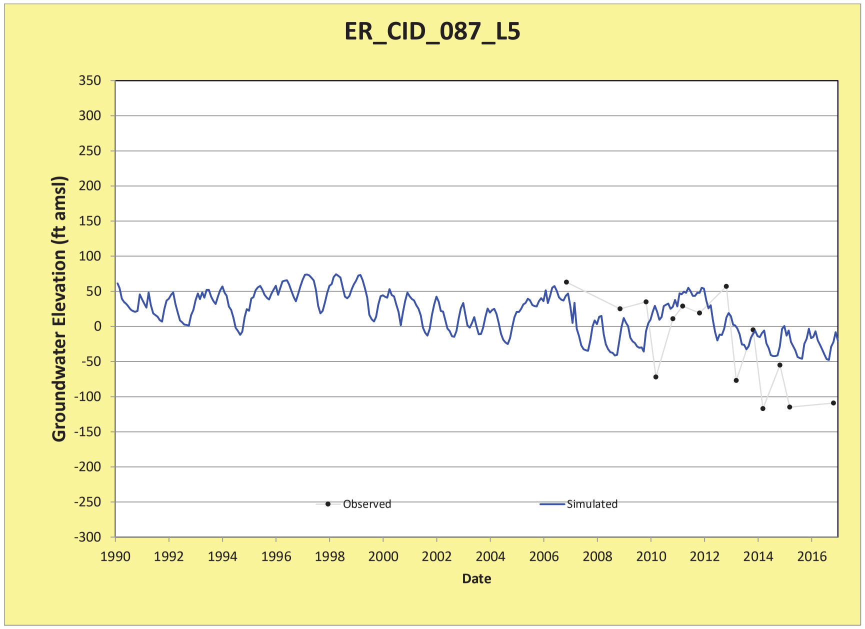
2012
2014
2016
Date
Observed
Simulated

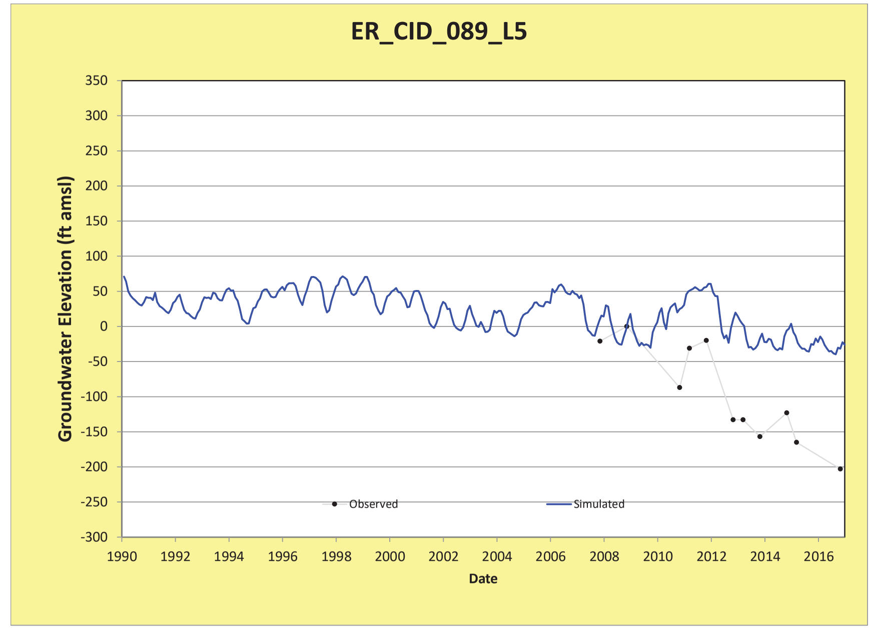

ER_CID_074_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

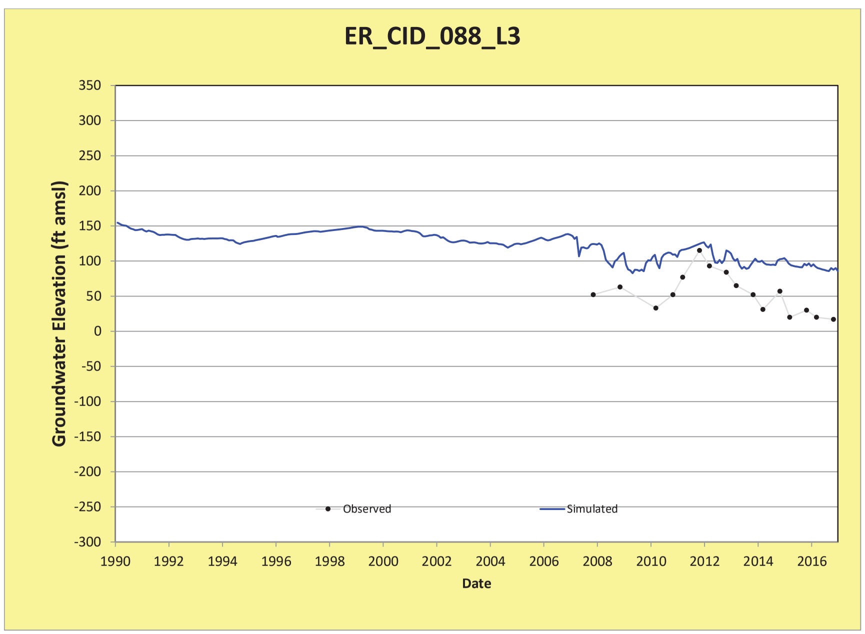

ER_CID_076_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

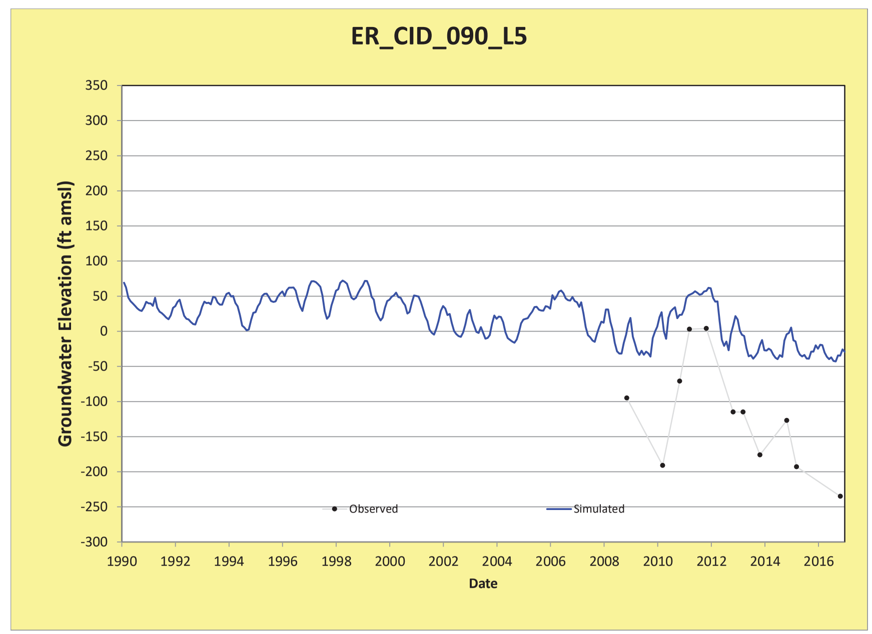

ER_CID_075_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

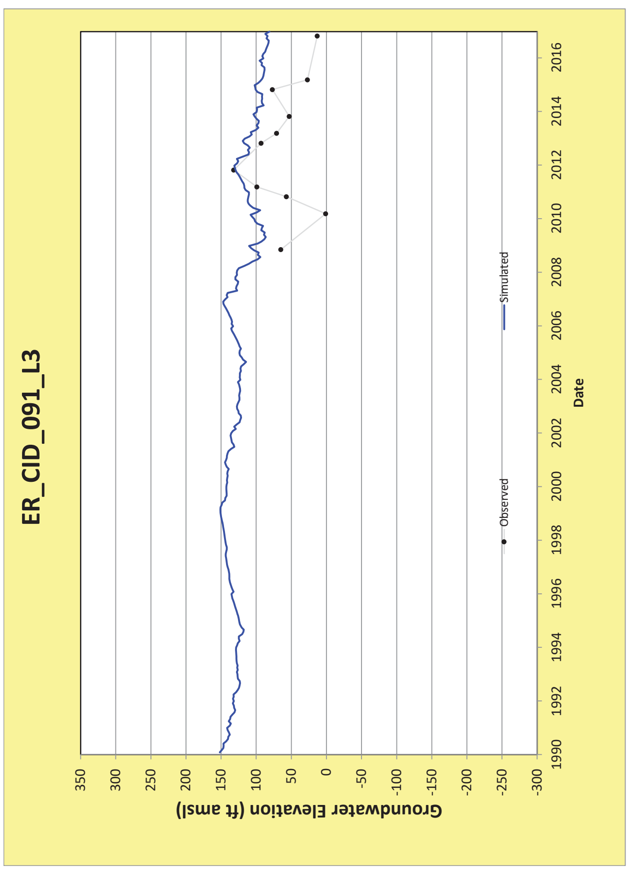

ER_CID_083_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_087_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_089_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_088_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_090_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_CID_091_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
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0
-50
-100
-150
-200
-250
-300
1990
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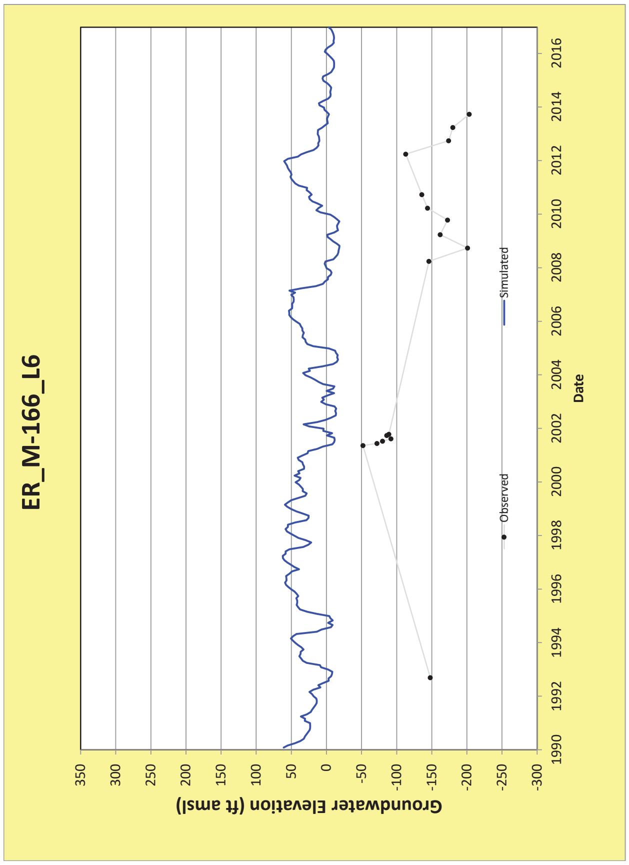
Date
Observed
Simulated


ER_M-166_L6
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
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-200
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1996
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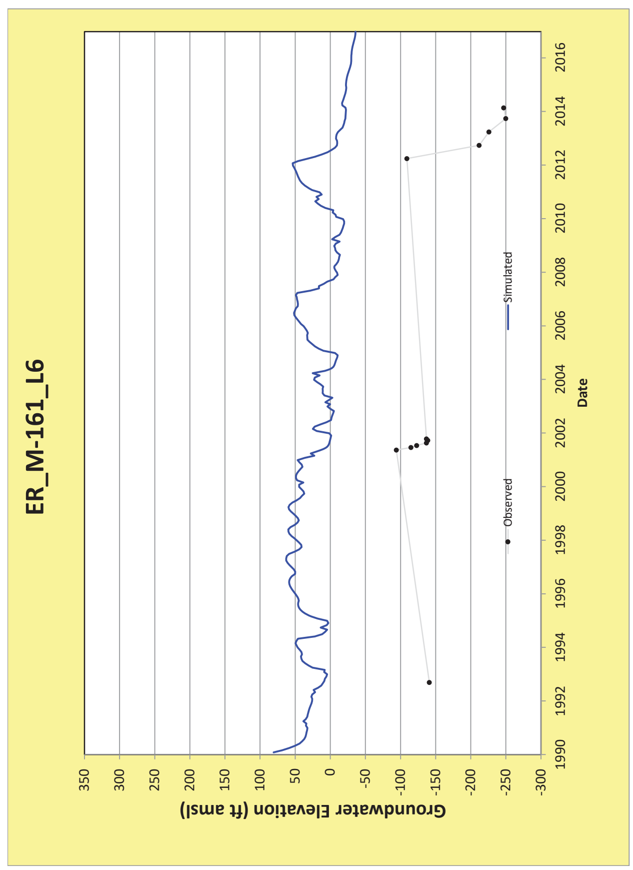
2012
2014
2016
Date
Observed
Simulated


ER_M-161_L6
Groundwater Elevation (ft amsl)
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300
250
200
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100
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-200
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1996
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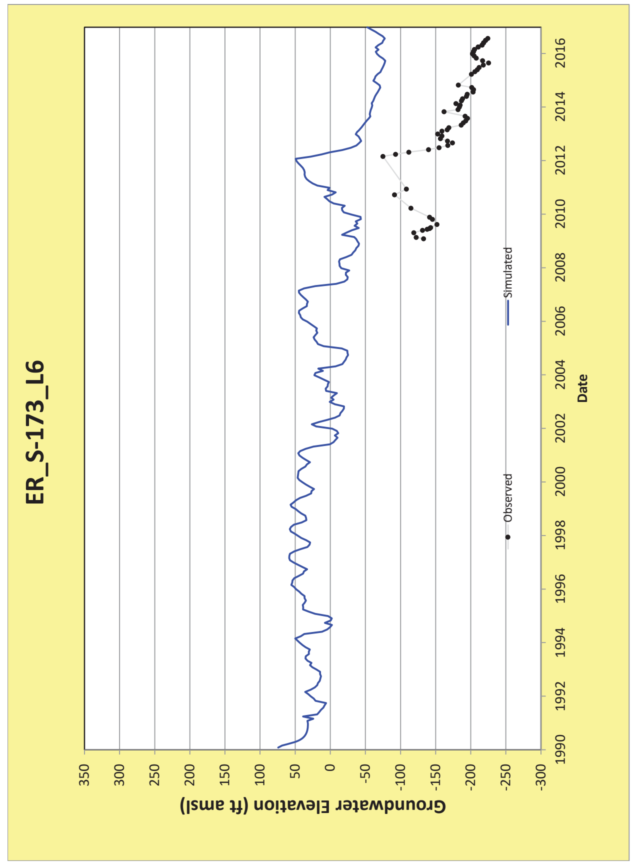
Date
Observed
Simulated


ER_S-173_L6
Groundwater Elevation (ft amsl)
350
300
250
200
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100
50
0
-50
-100
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-200
-250
-300
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1994
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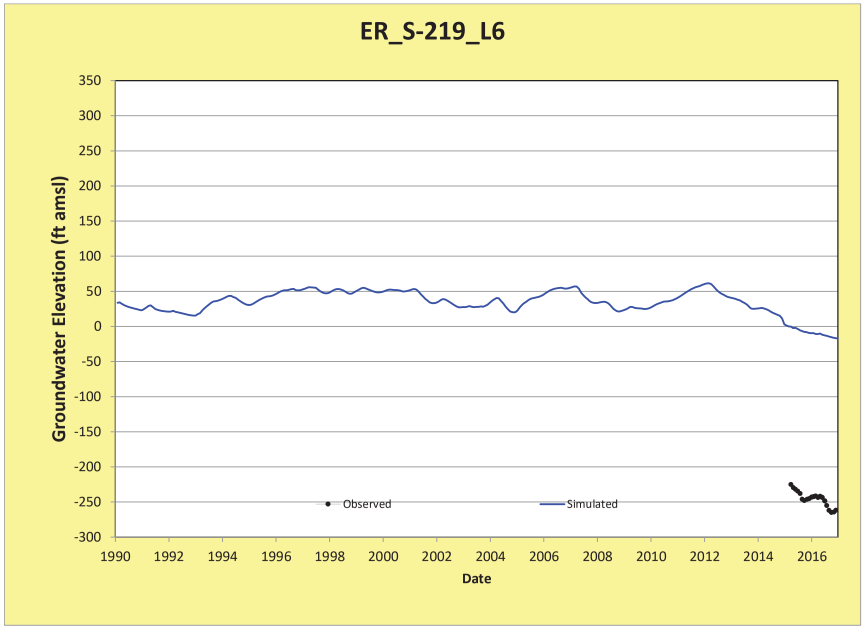
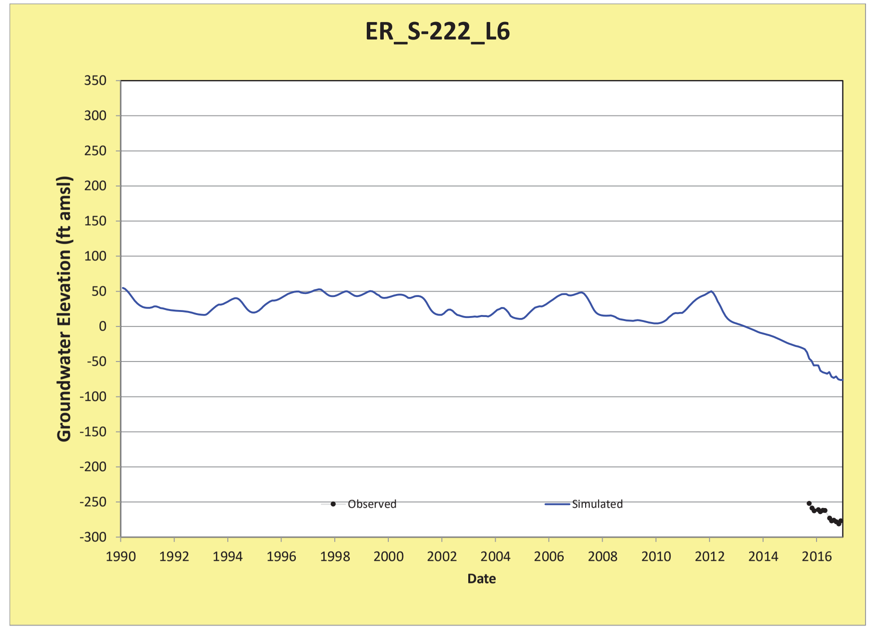
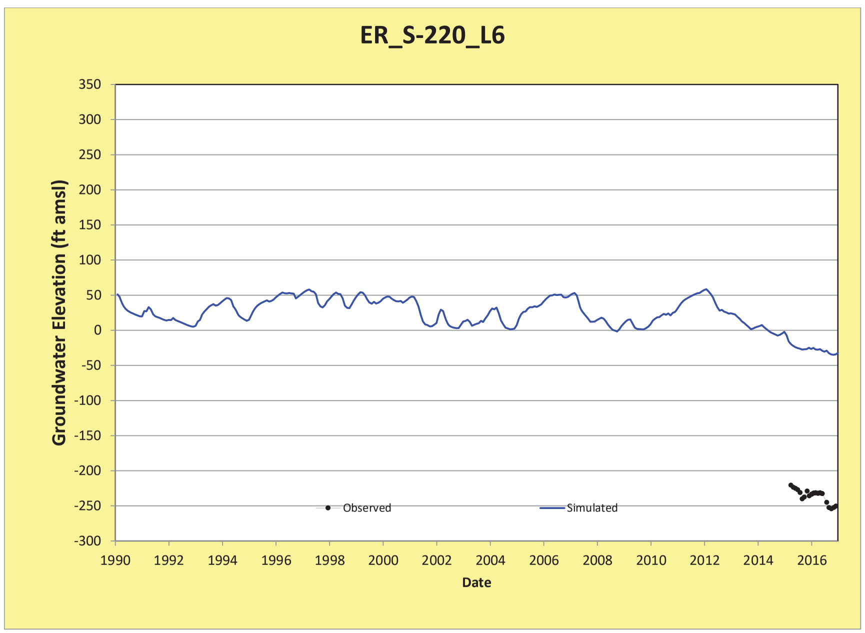
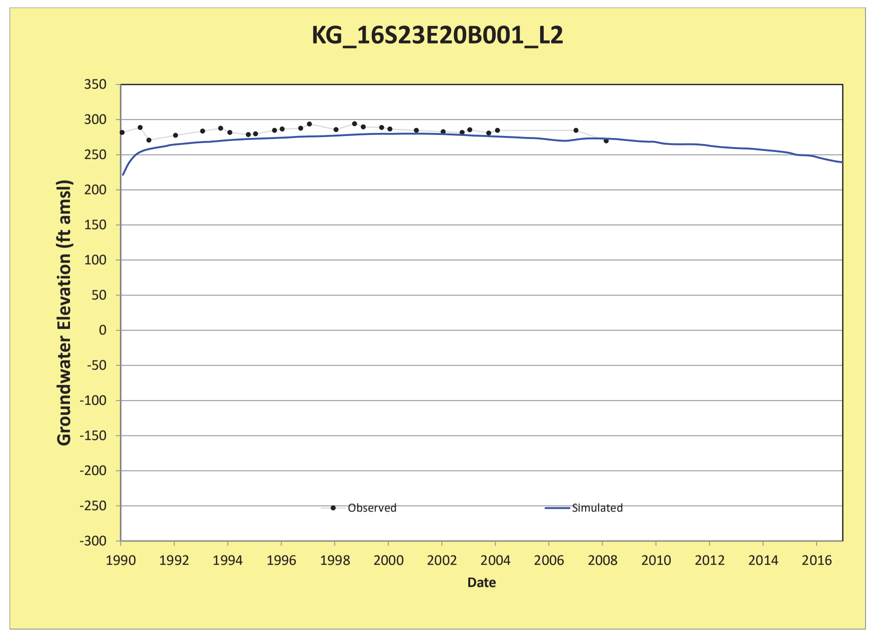
2012
2014
2016
Date
Observed
Simulated

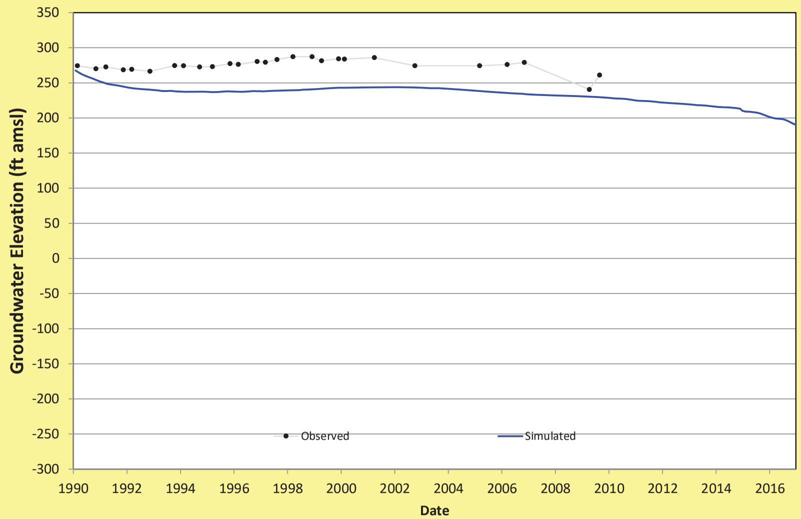

ER_S-219_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


ER_S-222_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

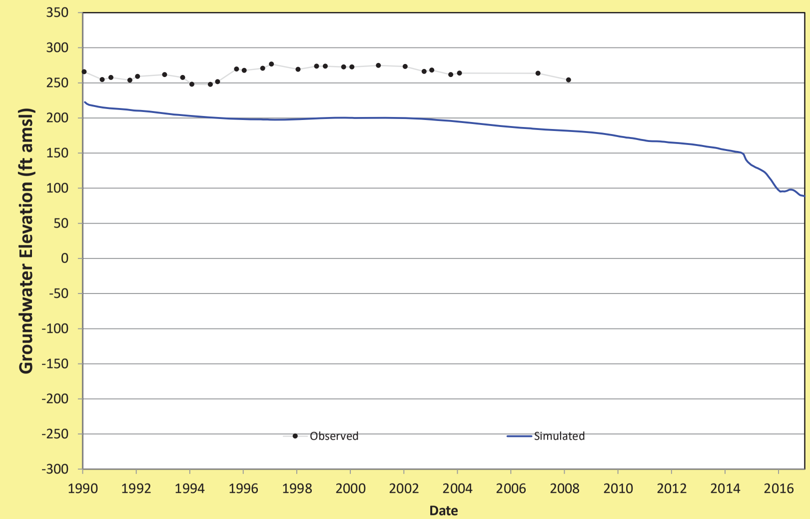

ER_S-220_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_16S23E20B001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

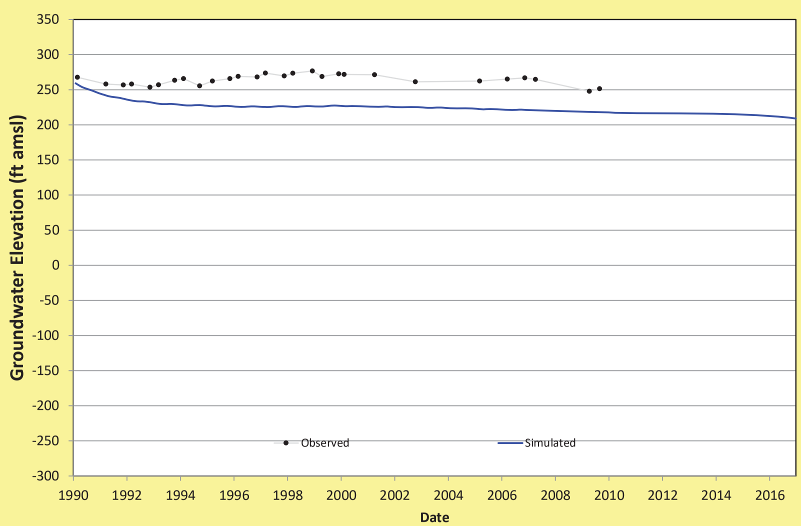
KG_16S23E21N001_L1



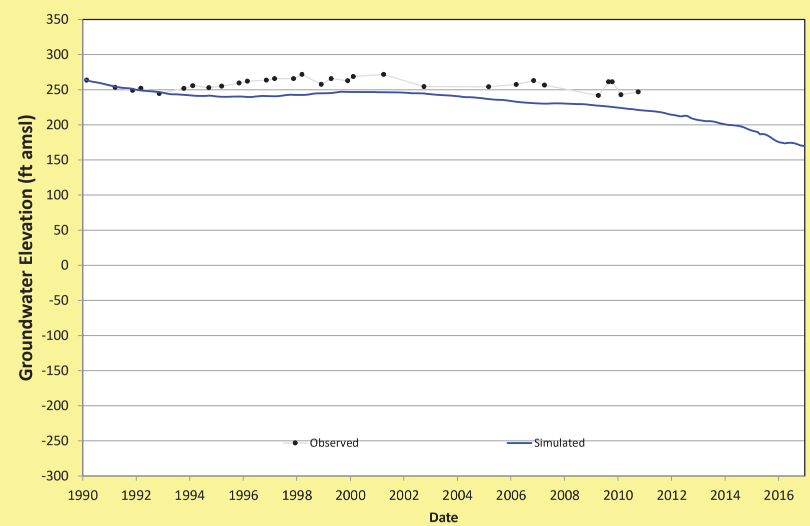
KG_16S23E33B001_L2

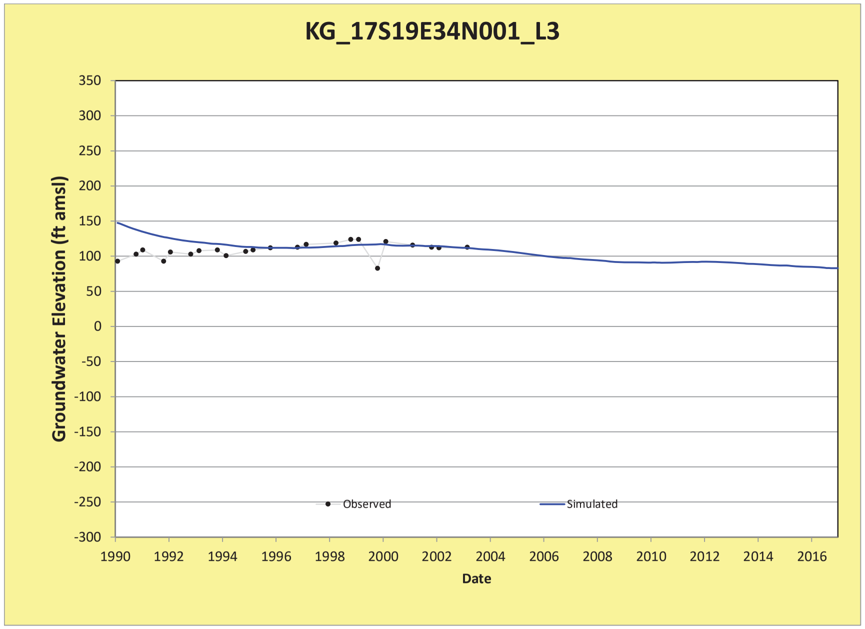


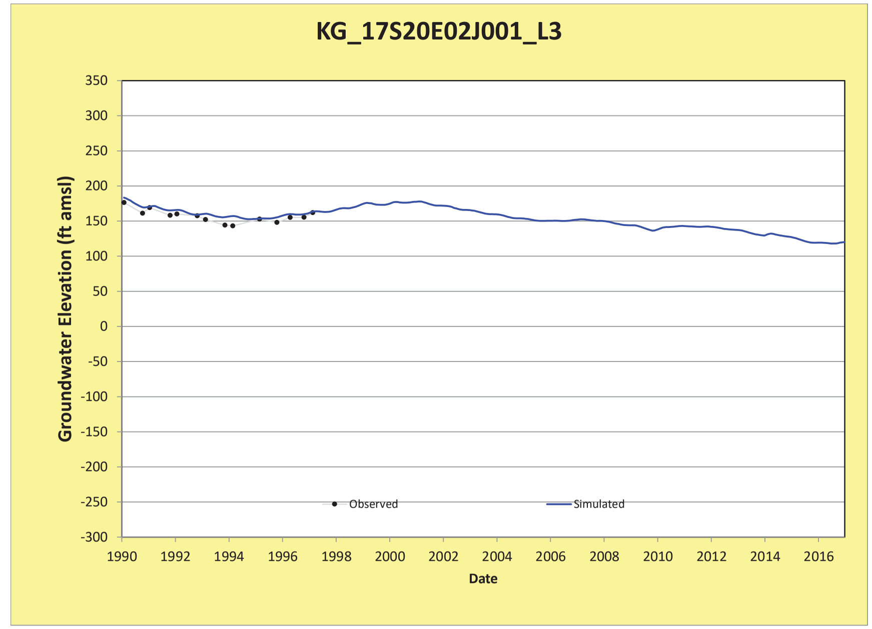
KG_16S23E32B001_L1



KG_16S23E33H001_L1




KG_17S19E34N001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S20E02J001_L3
Groundwater Elevation (ft amsl)
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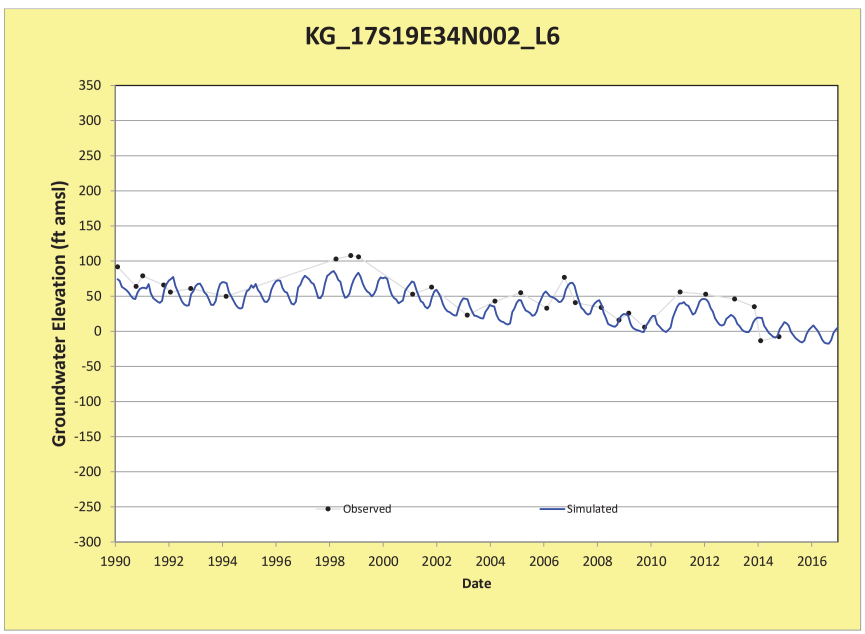
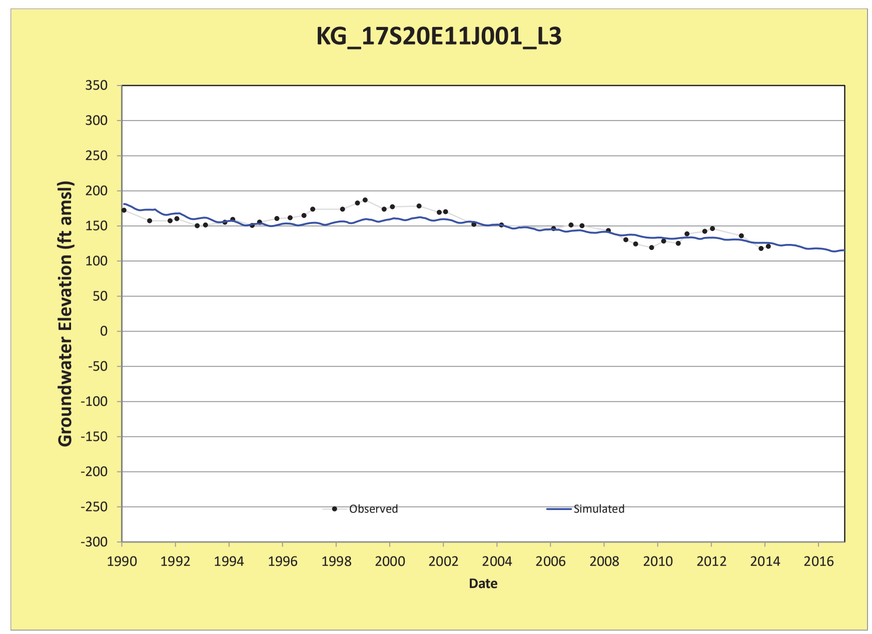
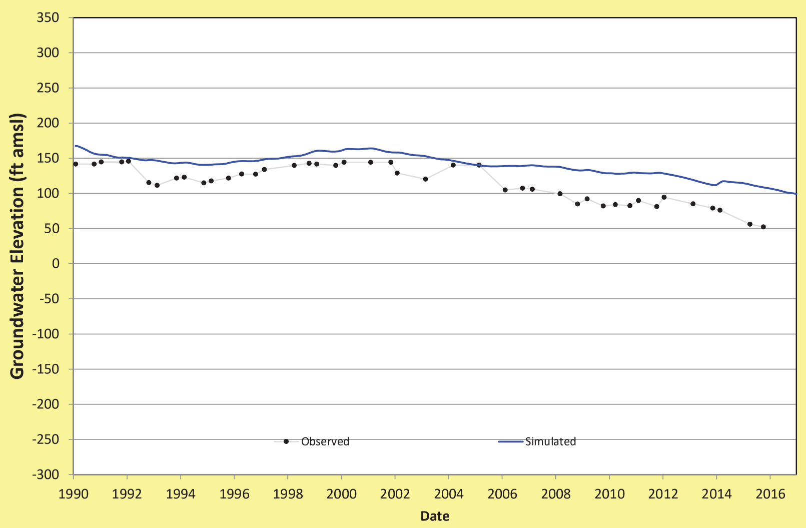
Observed
Simulated


KG_17S19E34N002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S20E11J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

KG_17S20E20D001_L3



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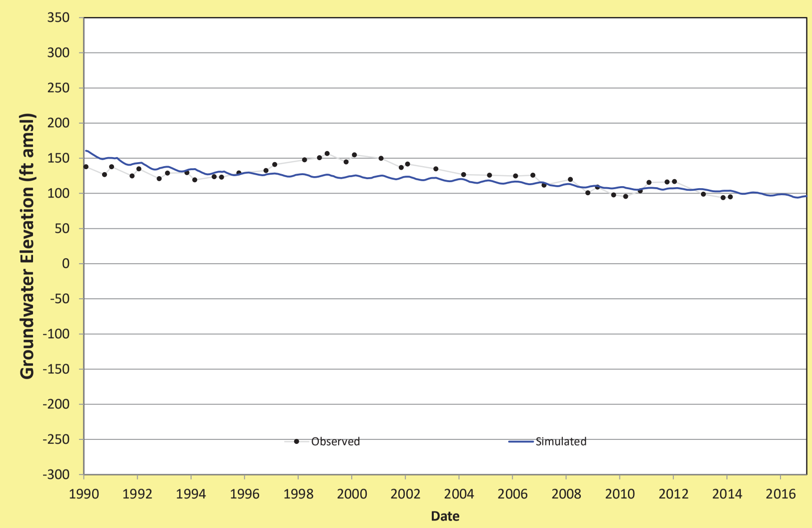
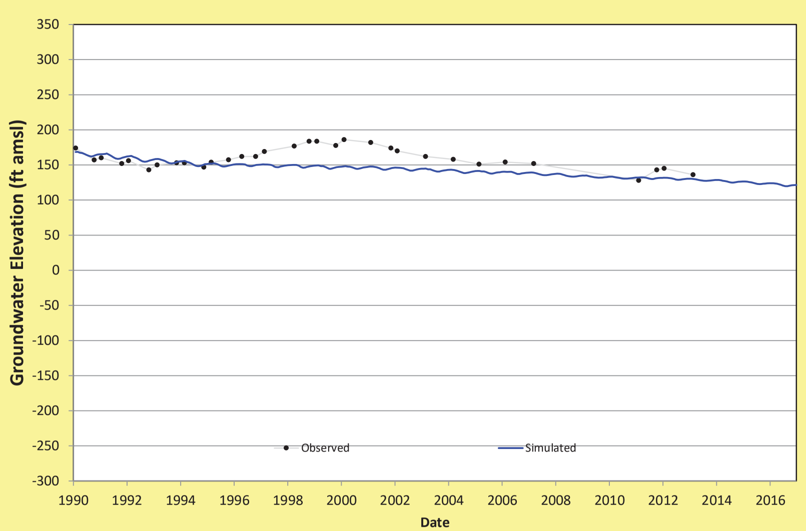
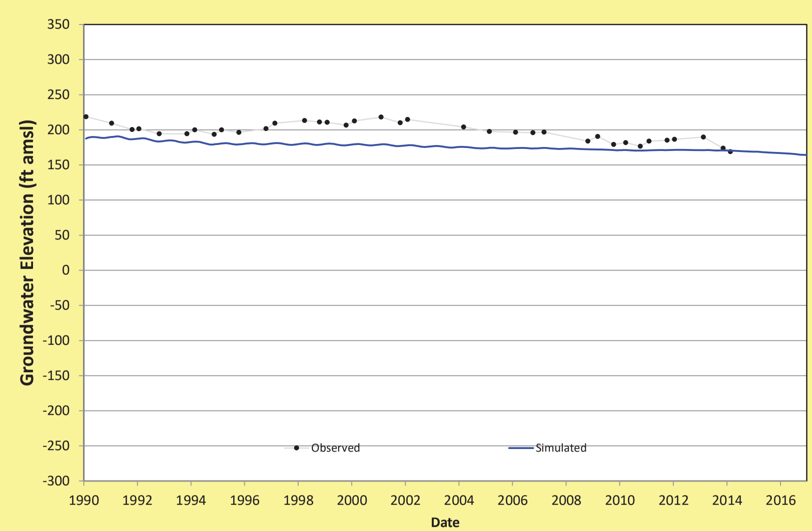
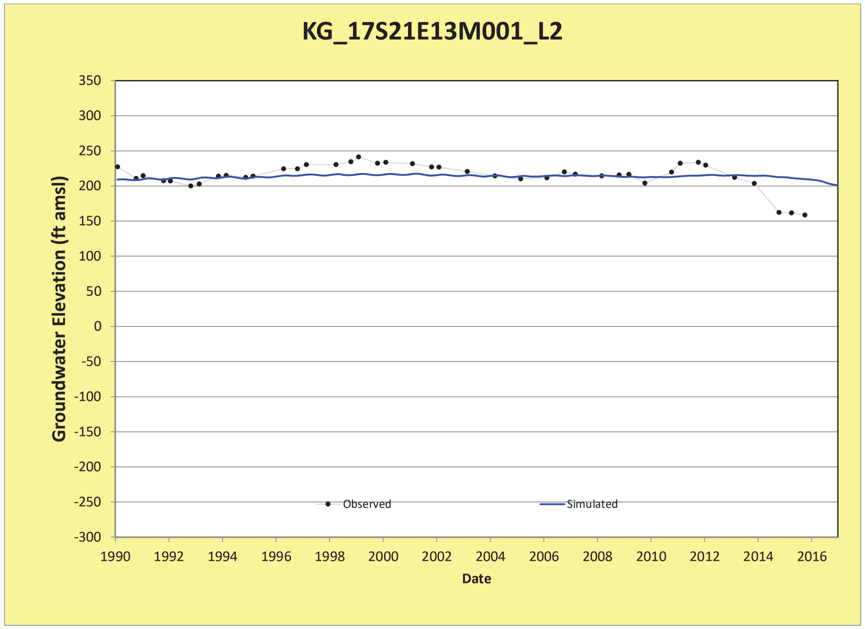


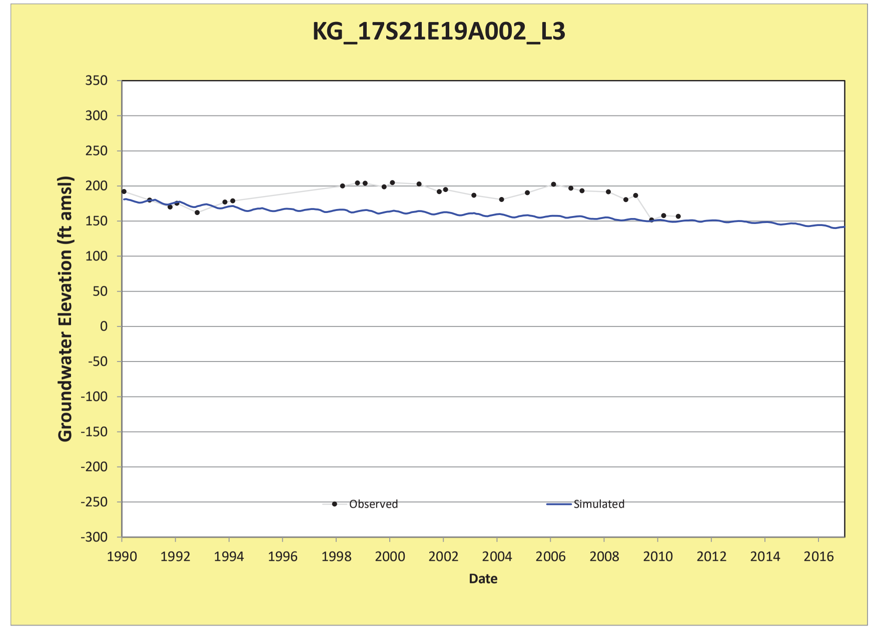
KG_17S20E24N001_L3

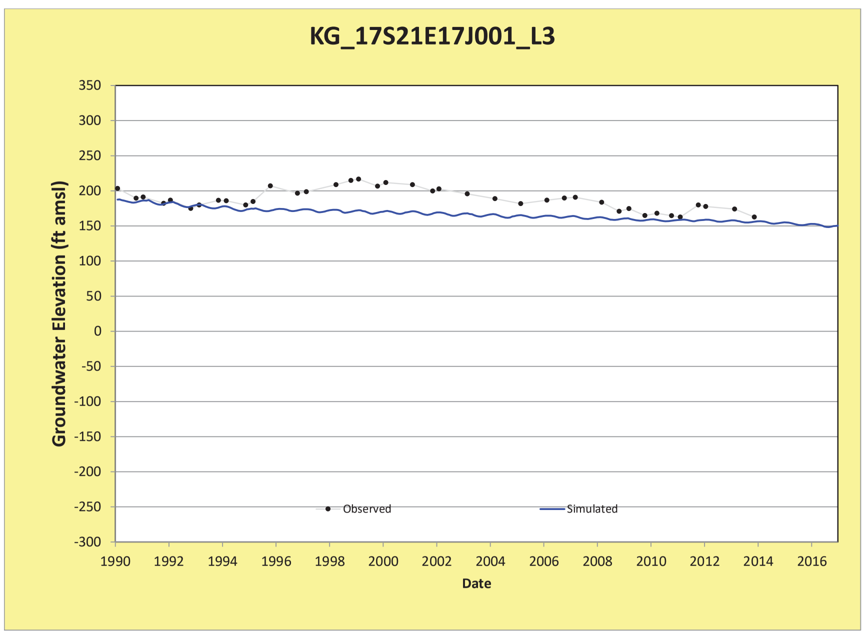


KG_17S21E11K001_L2




KG_17S21E13M001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S21E19A002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S21E17J001_L3
Groundwater Elevation (ft amsl)
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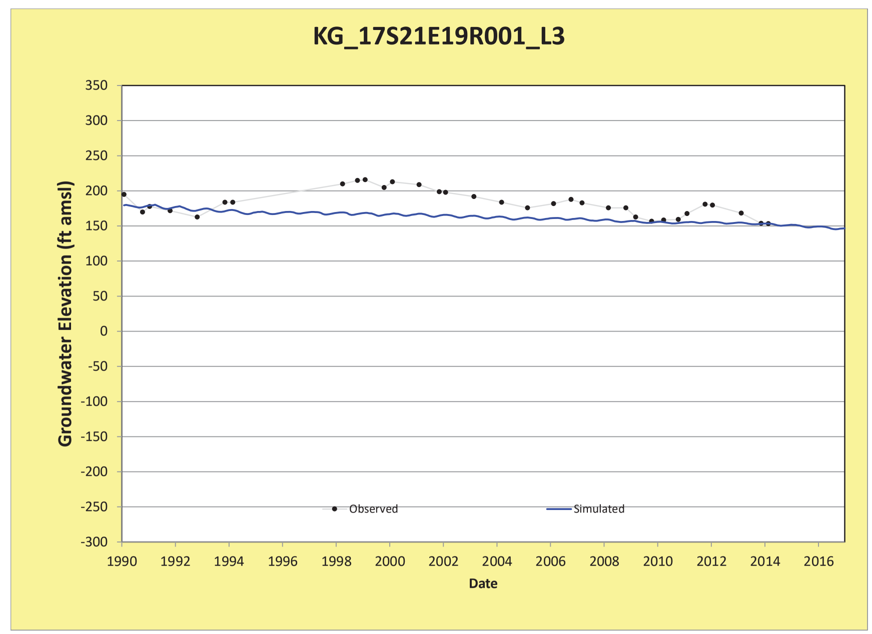
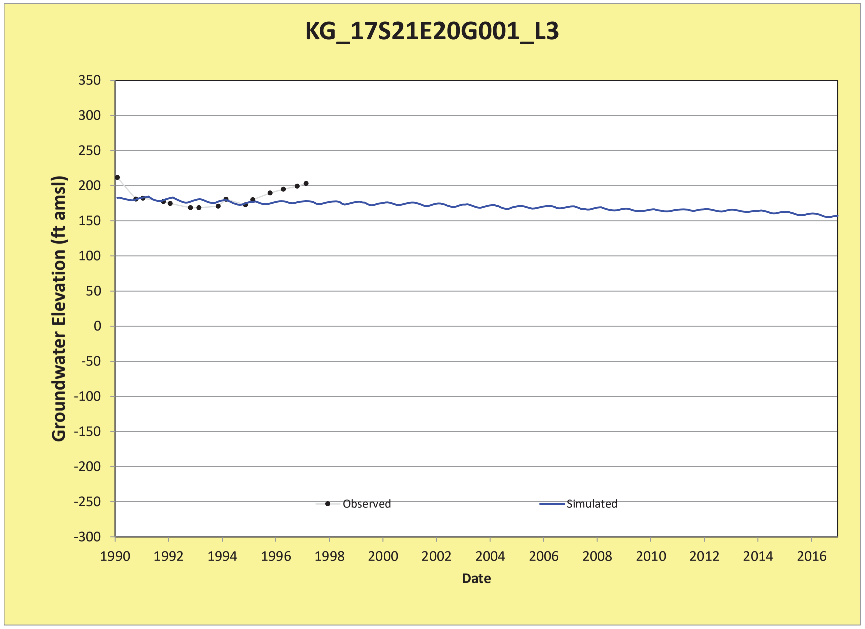
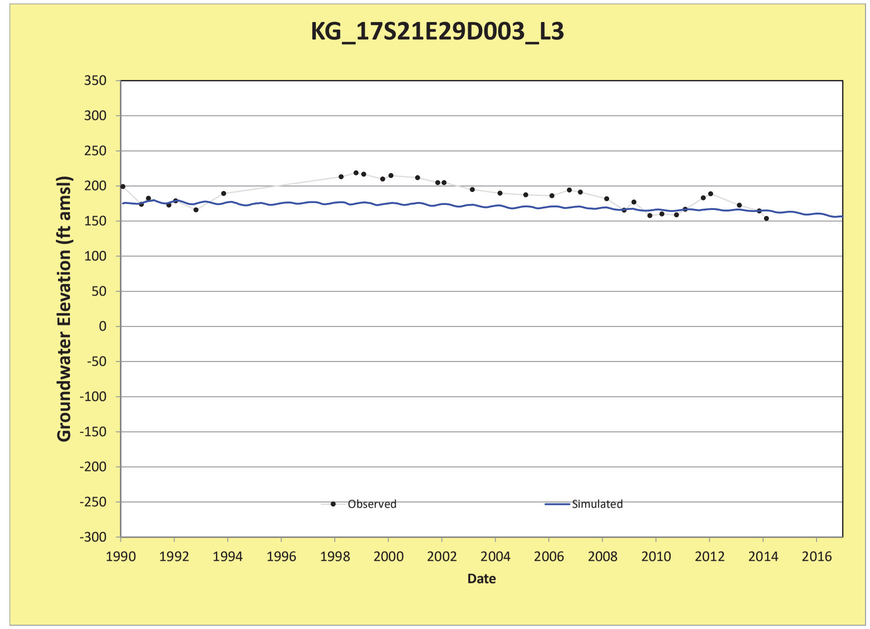
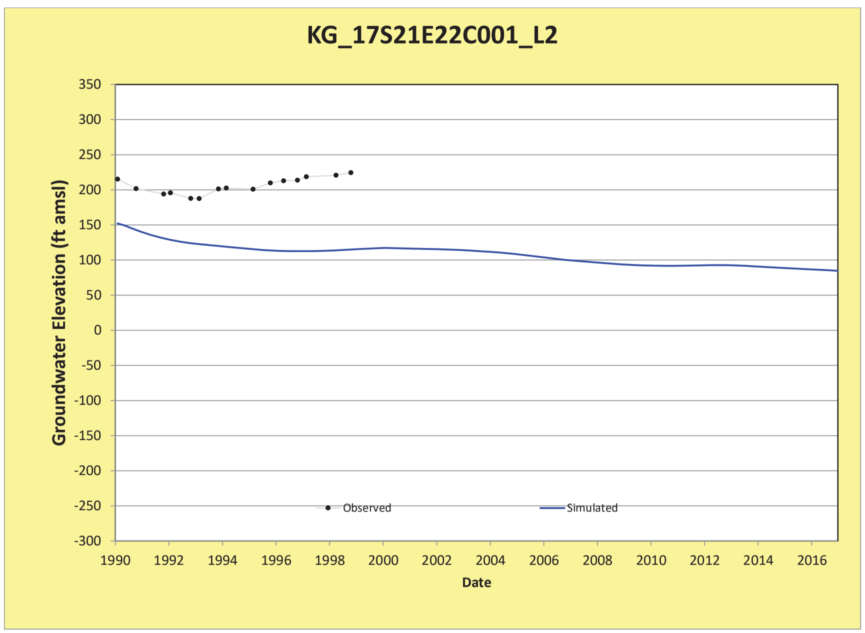
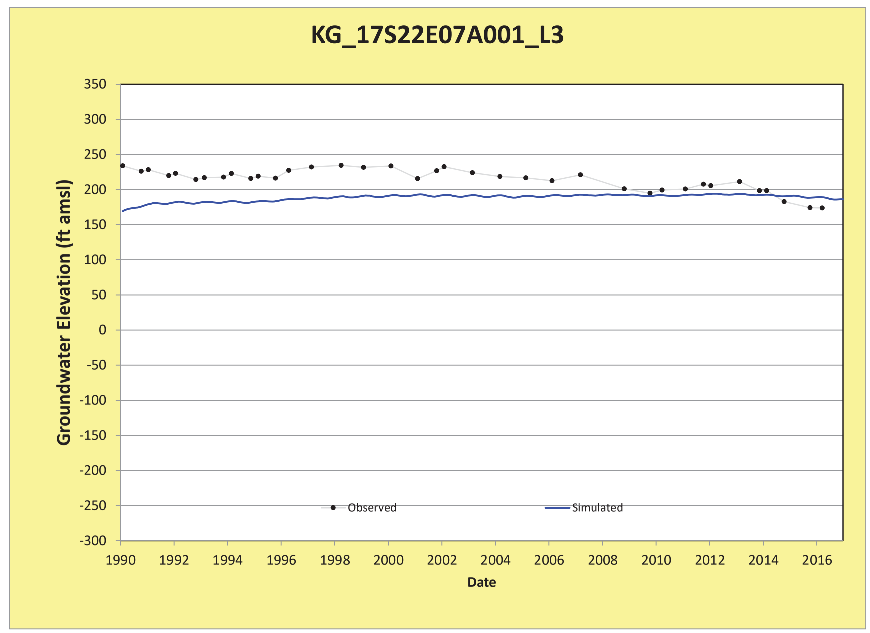
Observed
Simulated

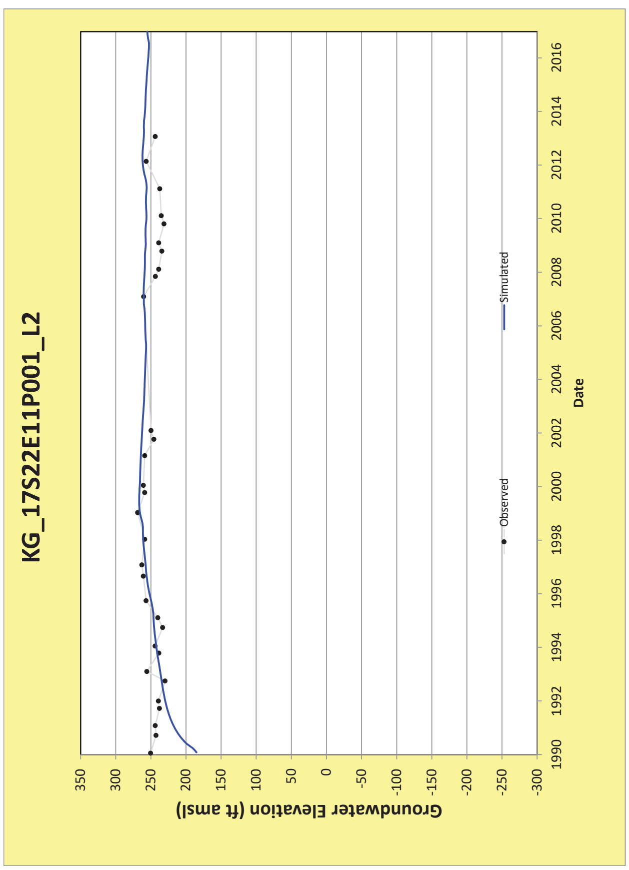

KG_17S21E19R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S21E20G001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S21E29D003_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S21E22C001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S22E07A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S22E11P001_L2
Groundwater Elevation (ft amsl)
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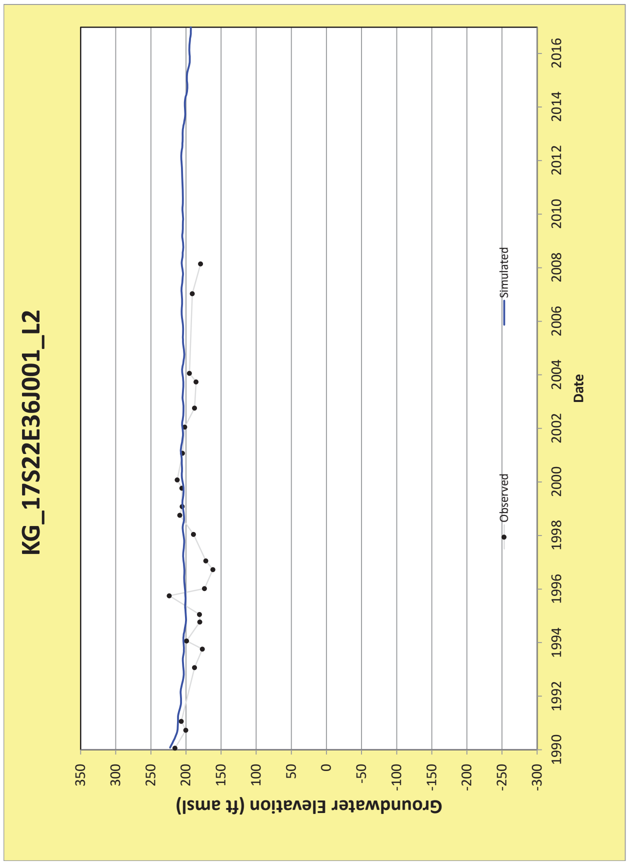
Date
Observed
Simulated


KG_17S22E36J001_L2
Groundwater Elevation (ft amsl)
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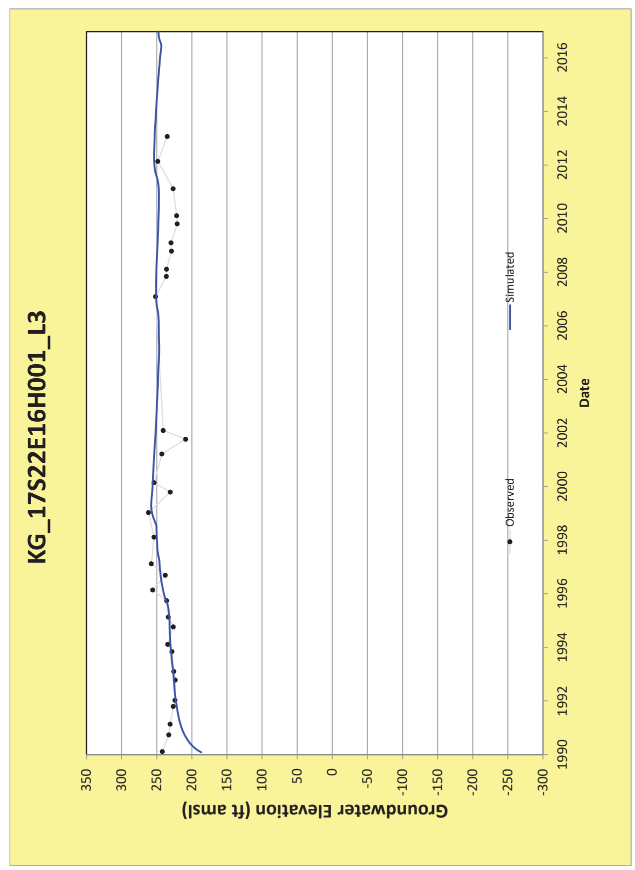
Date
Observed
Simulated


KG_17S22E16H001_L3
Groundwater Elevation (ft amsl)
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-200
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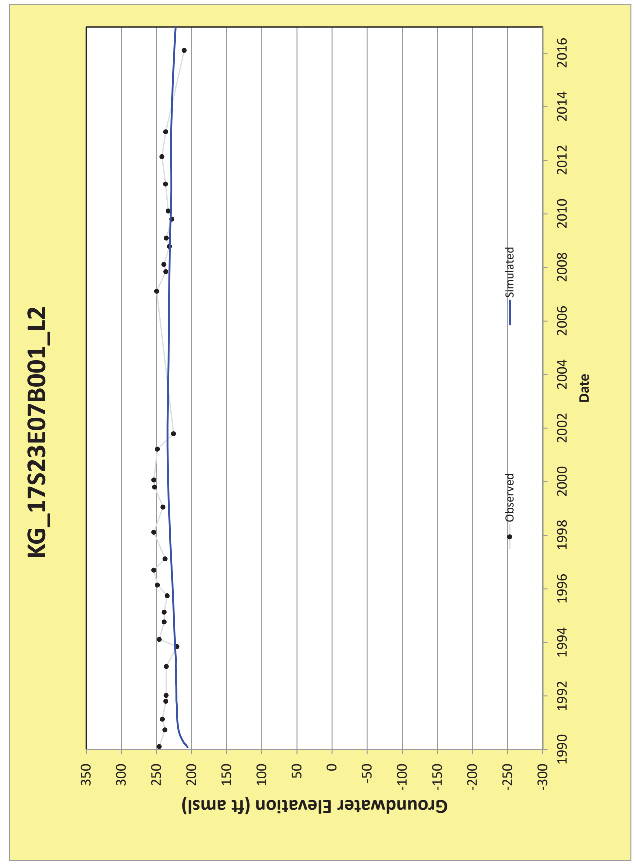
Date
Observed
Simulated


KG_17S23E07B001_L2
Groundwater Elevation (ft amsl)
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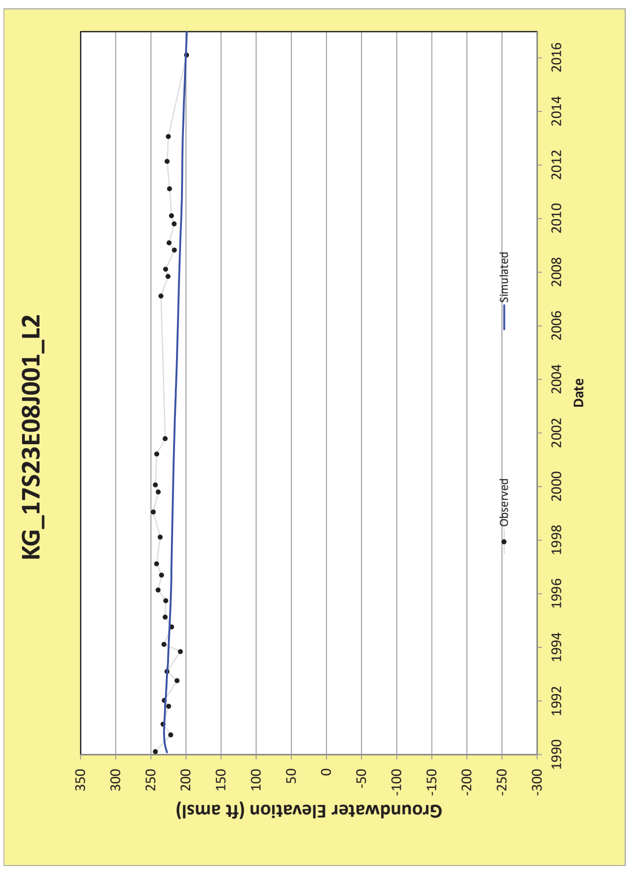
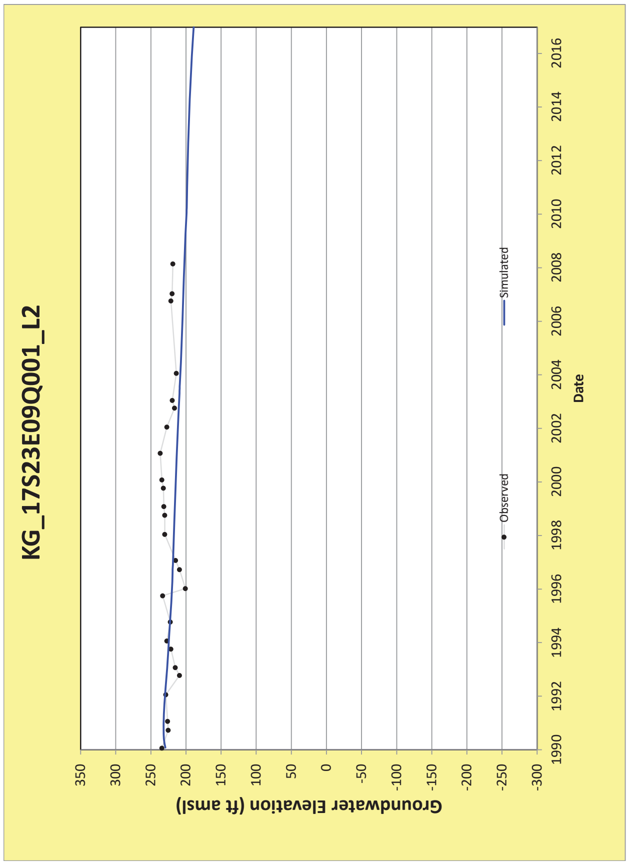
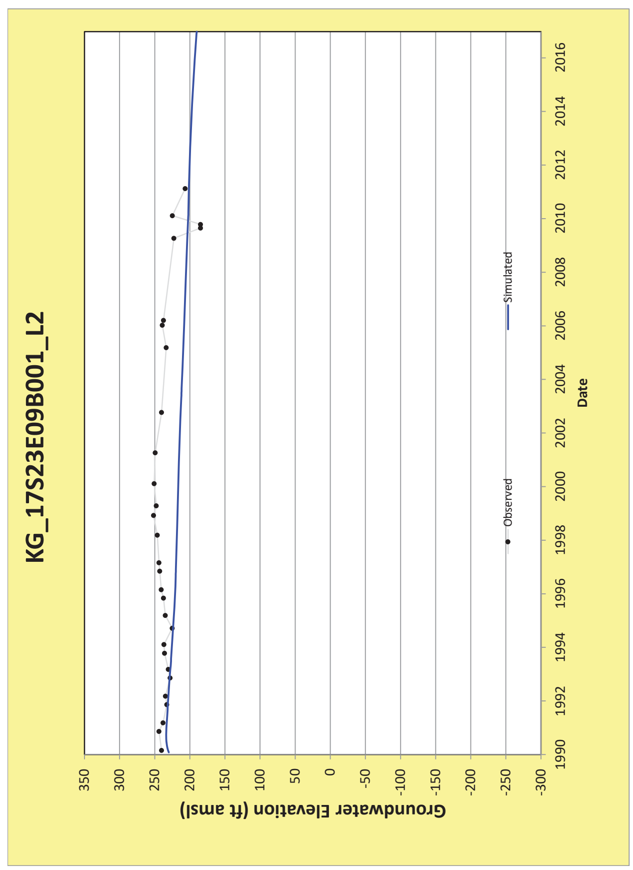
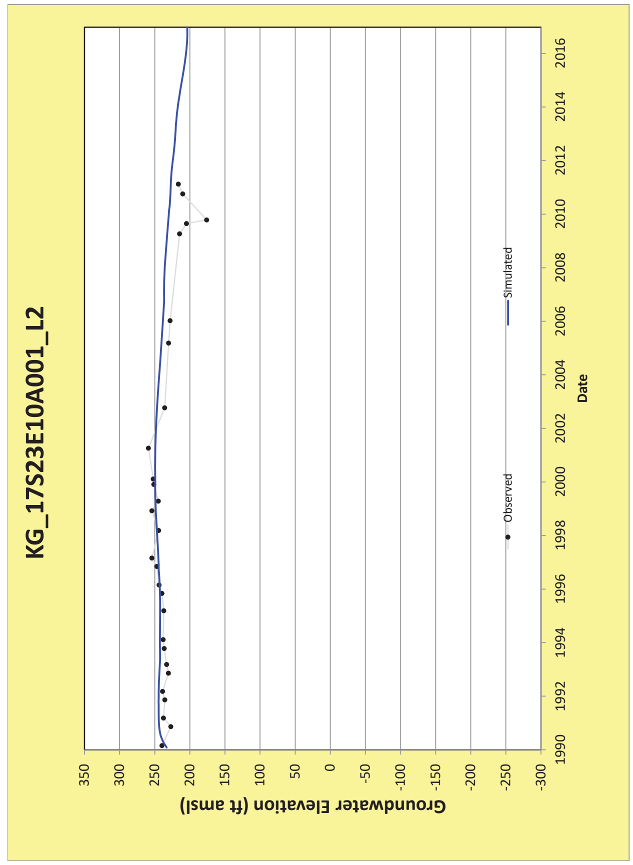
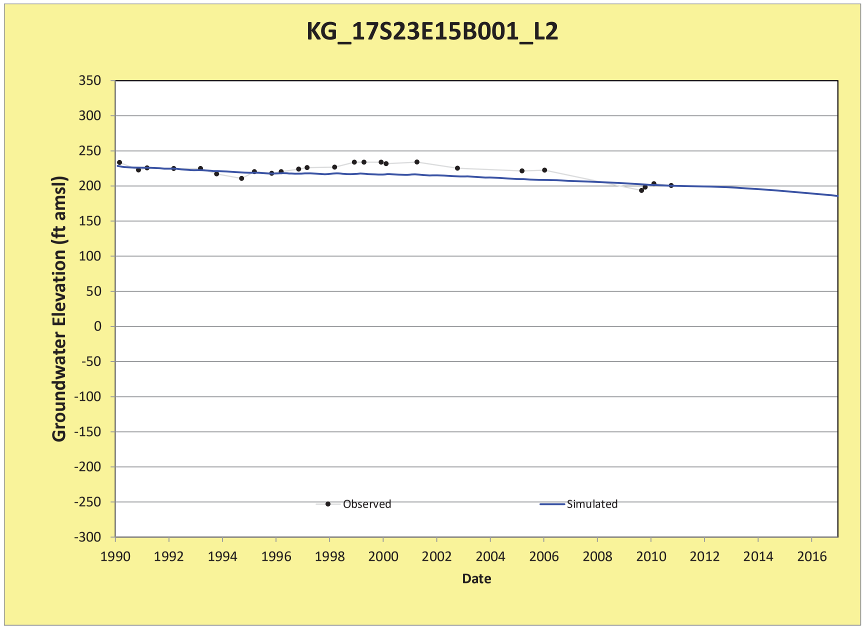
Date
Observed
Simulated

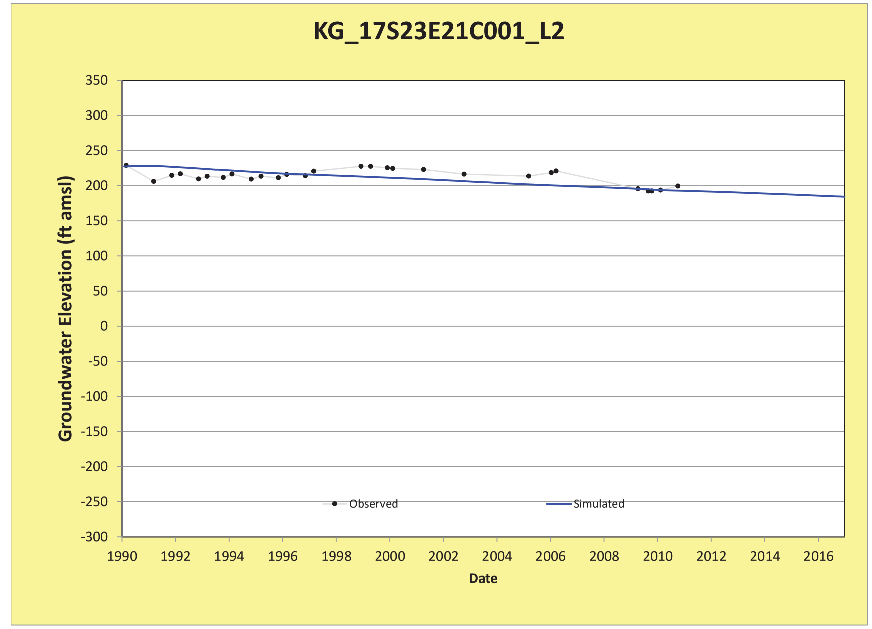

KG_17S23E08J001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

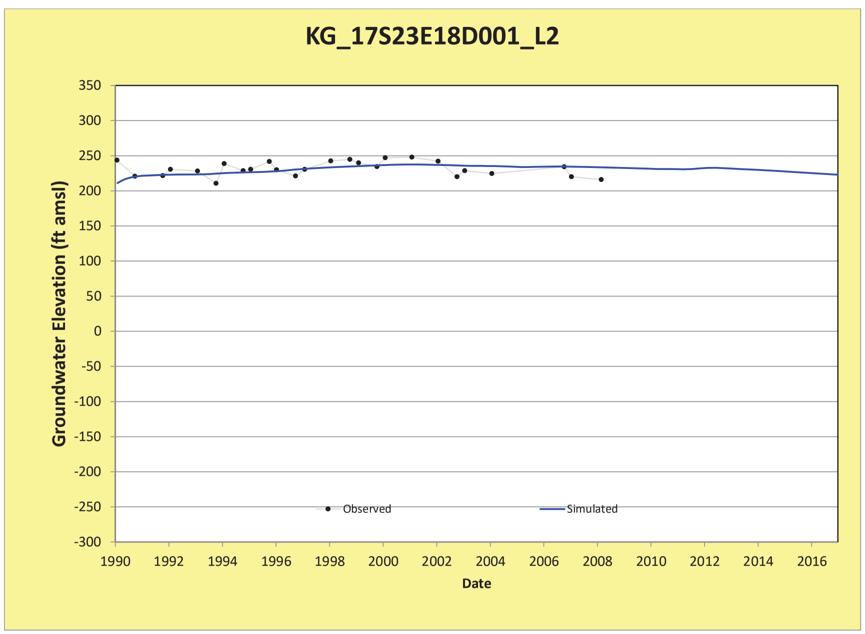

KG_17S23E09Q001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

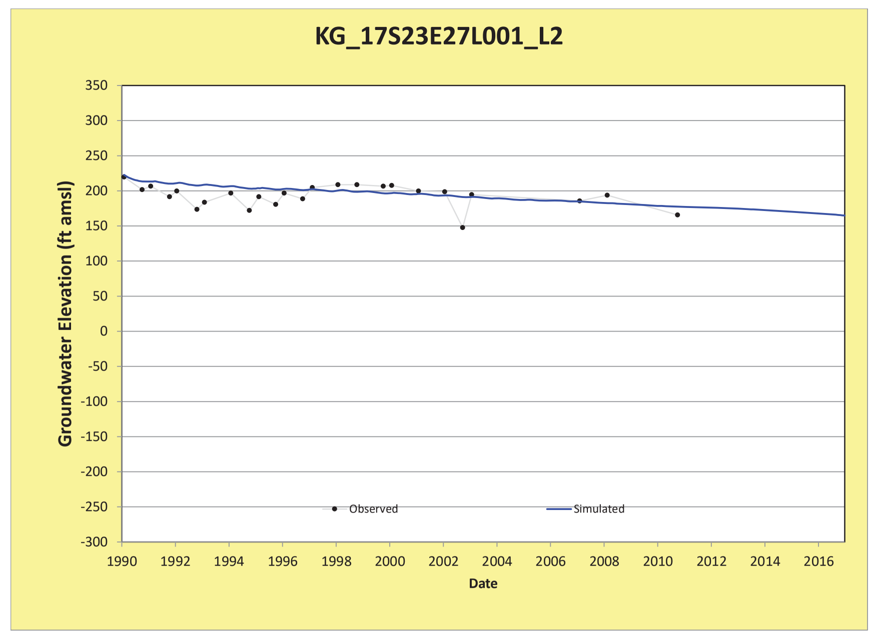

KG_17S23E09B001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

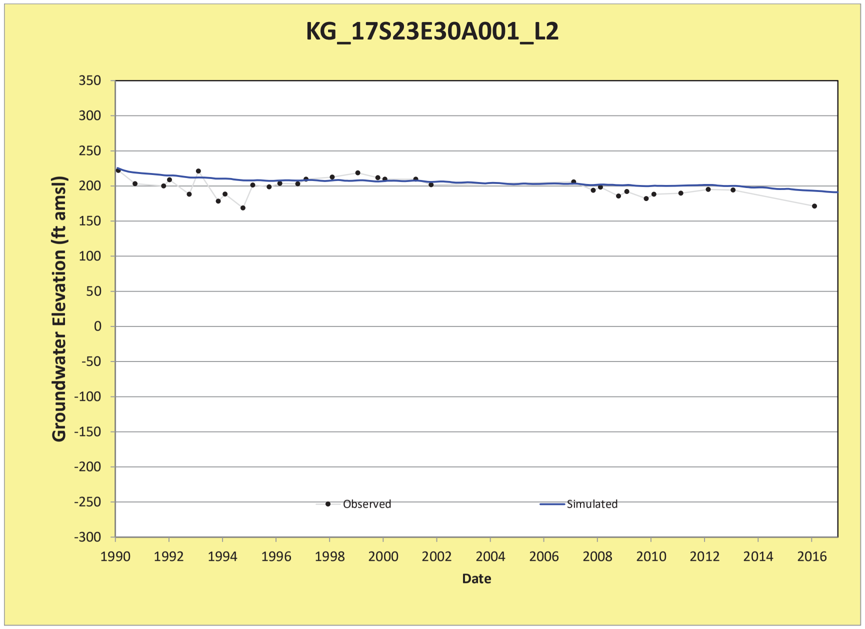

KG_17S23E10A001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S23E15B001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S23E21C001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S23E18D001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S23E27L001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_17S23E30A001_L2
Groundwater Elevation (ft amsl)
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300
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200
150
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0
-50
-100
-150
-200
-250
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2012
2014
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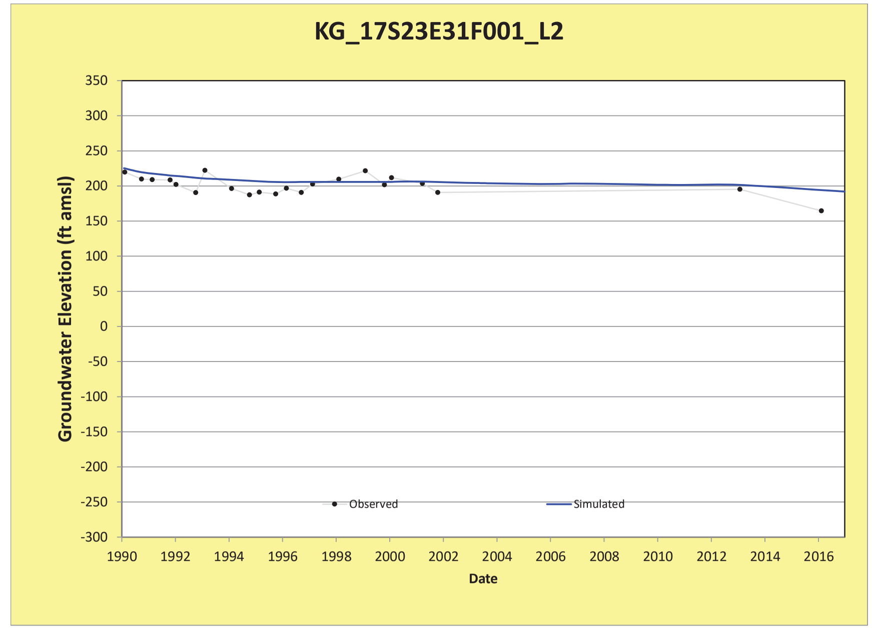
Date
Observed
Simulated


KG_17S23E31F001_L2
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
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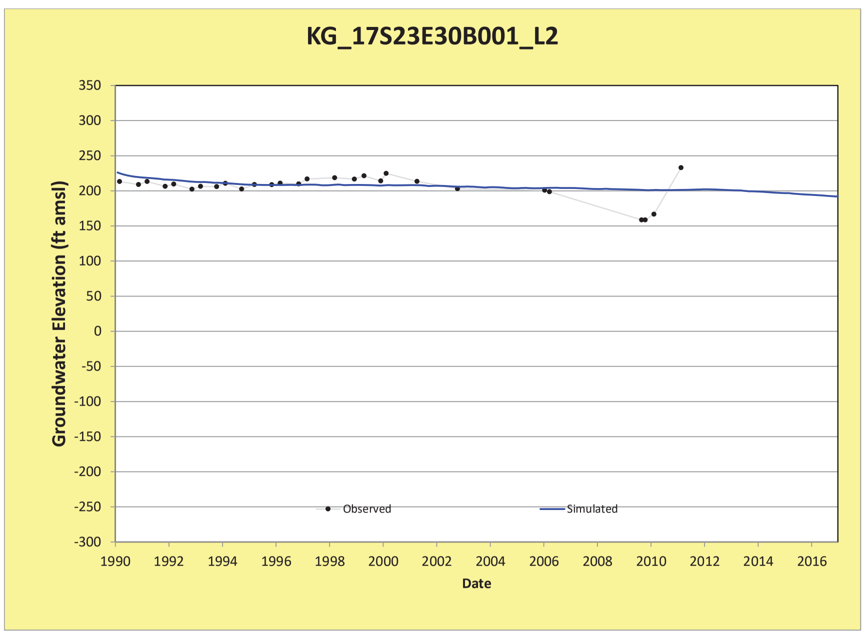
Date
Observed
Simulated


KG_17S23E30B001_L2
Groundwater Elevation (ft amsl)
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-200
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Date
Observed
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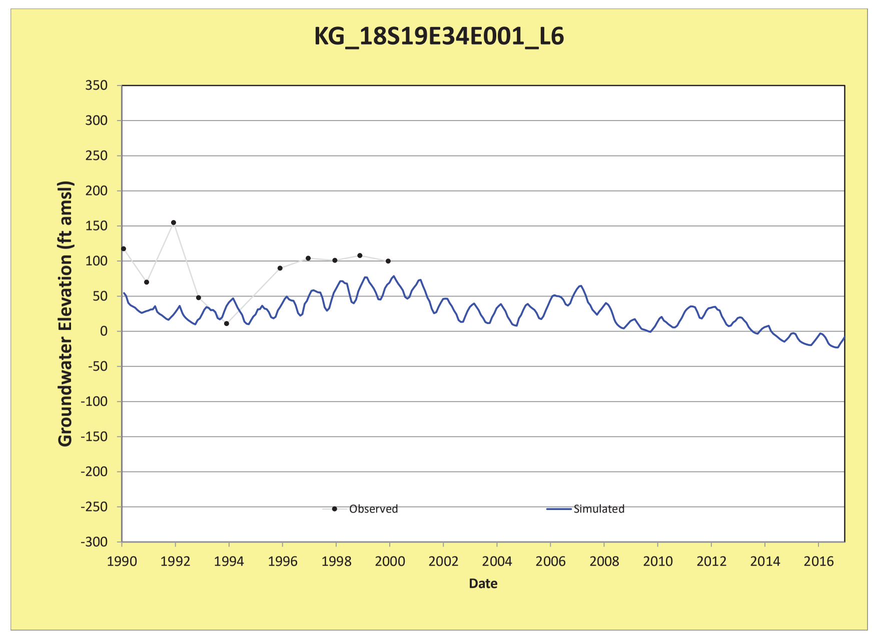
KG_18S19E34E001_L6
Groundwater Elevation (ft amsl)
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200
150
100
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0
-50
-100
-150
-200
-250
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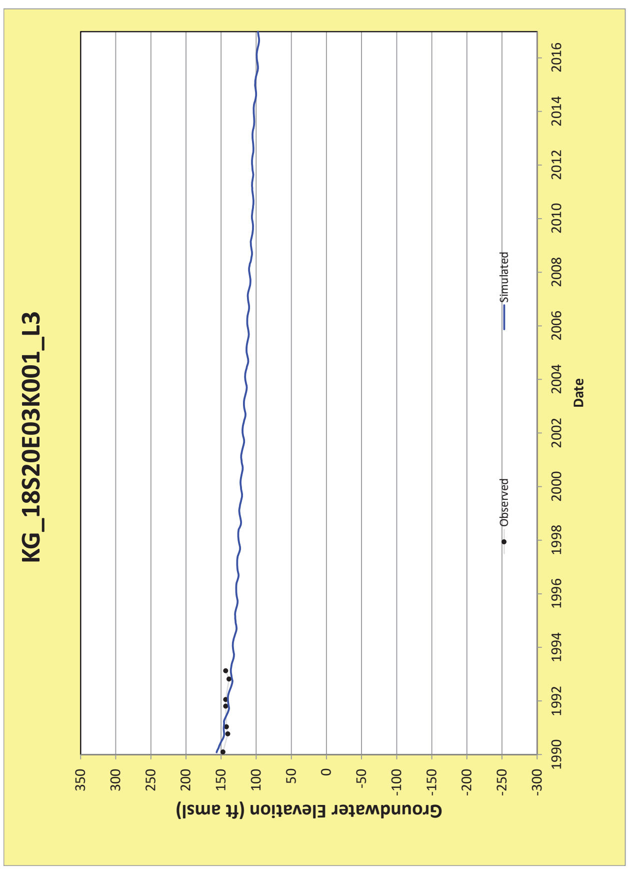
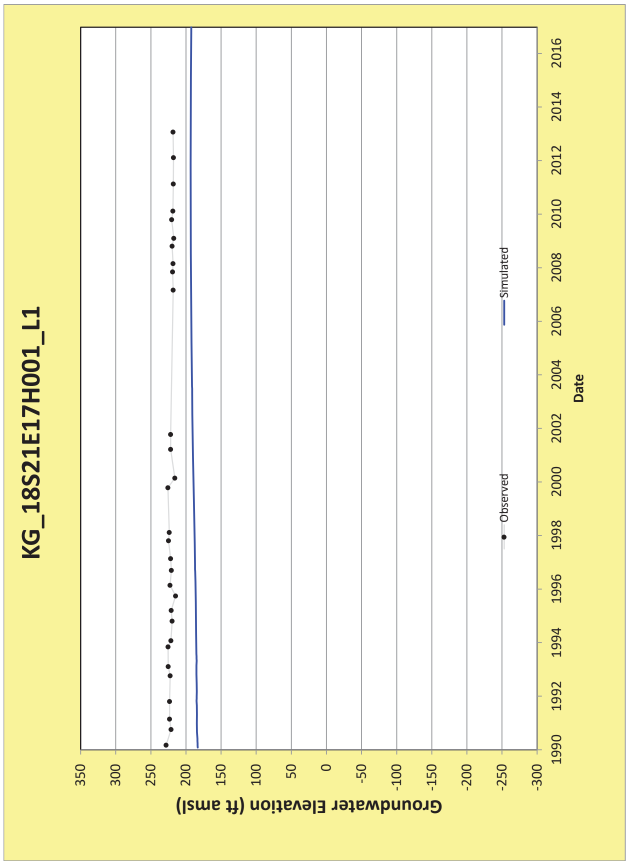
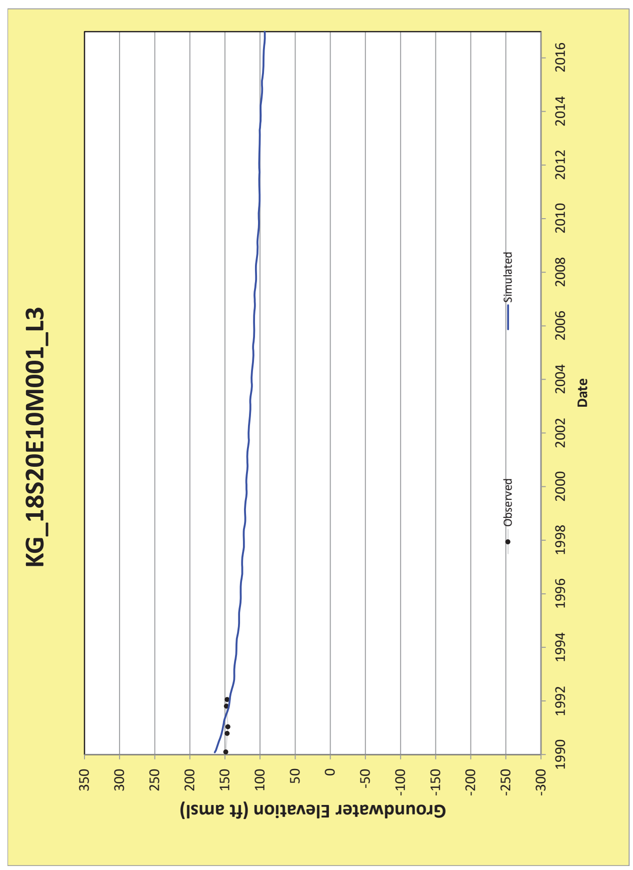
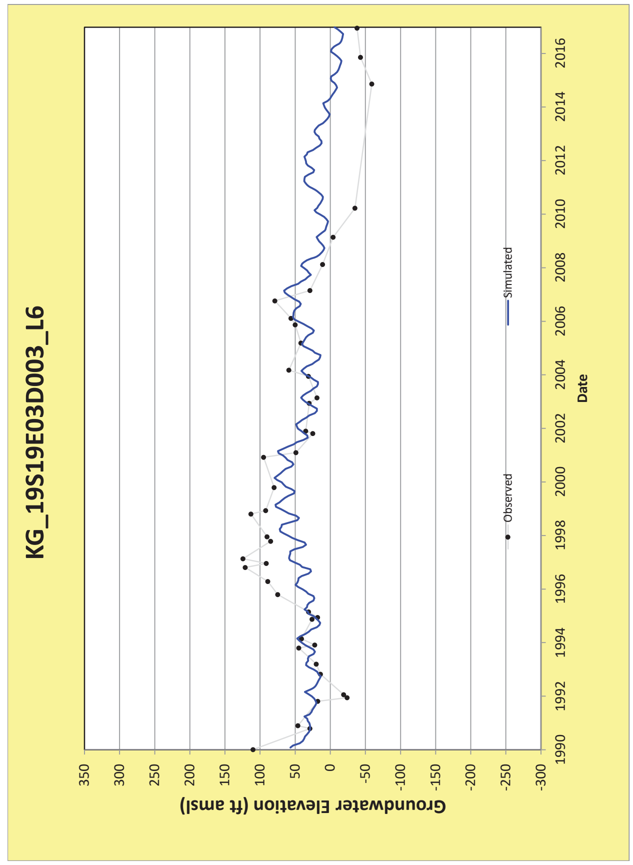
Date
Observed
Simulated


KG_18S20E03K001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_18S21E17H001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_18S20E10M001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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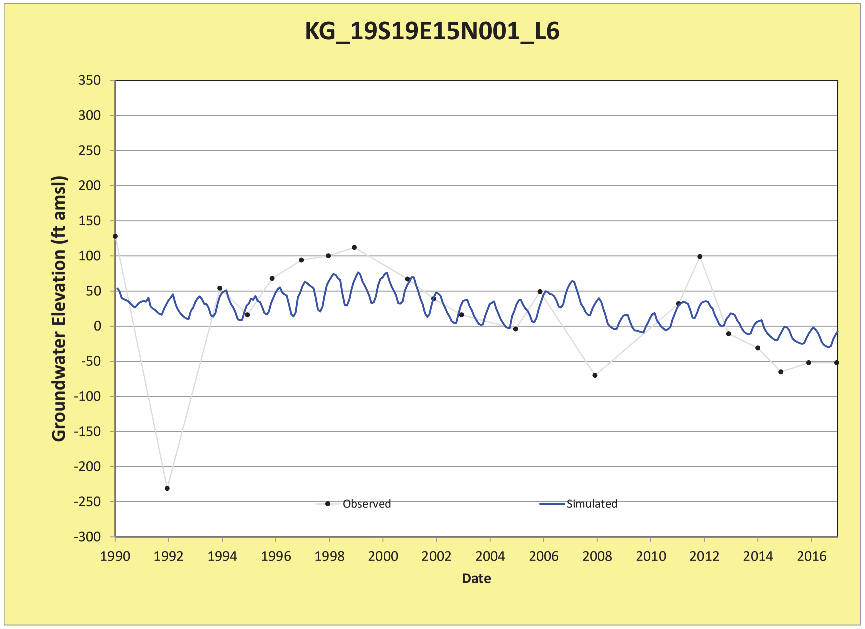
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_19S19E15N001_L6
Groundwater Elevation (ft amsl)
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50
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-50
-100
-150
-200
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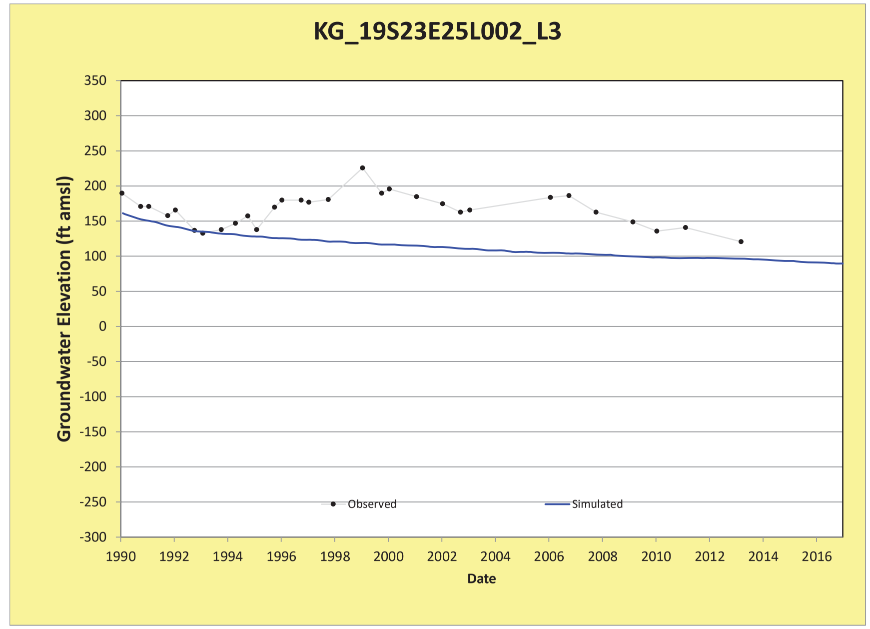
Date
Observed
Simulated


KG_19S23E25L002_L3
Groundwater Elevation (ft amsl)
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-50
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-150
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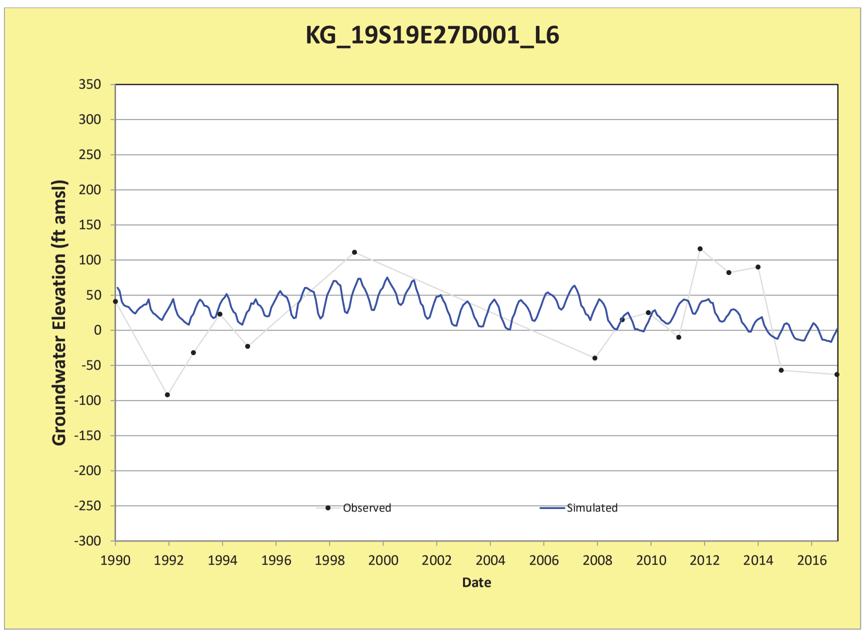
Observed
Simulated


KG_19S19E27D001_L6
Groundwater Elevation (ft amsl)
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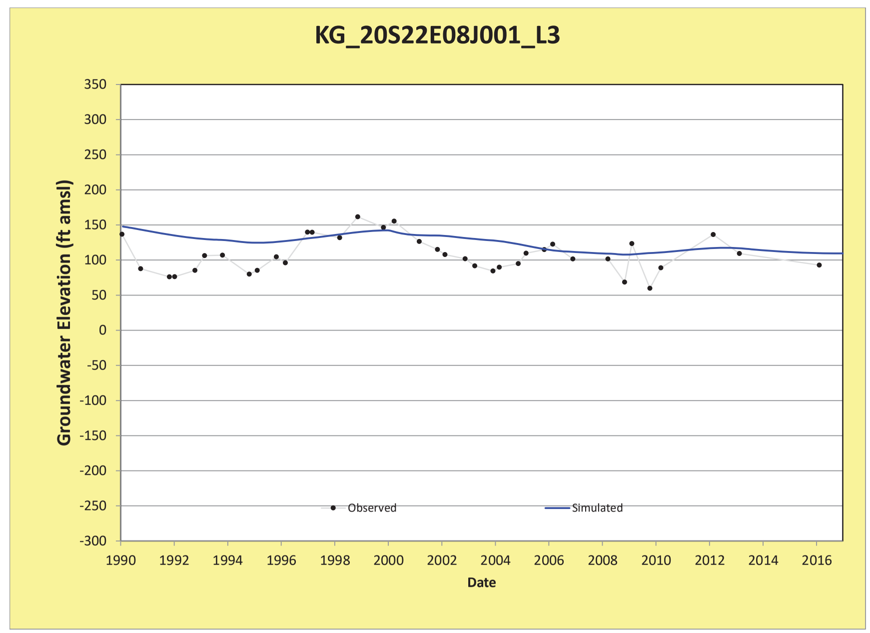
Date
Observed
Simulated


KG_20S22E08J001_L3
Groundwater Elevation (ft amsl)
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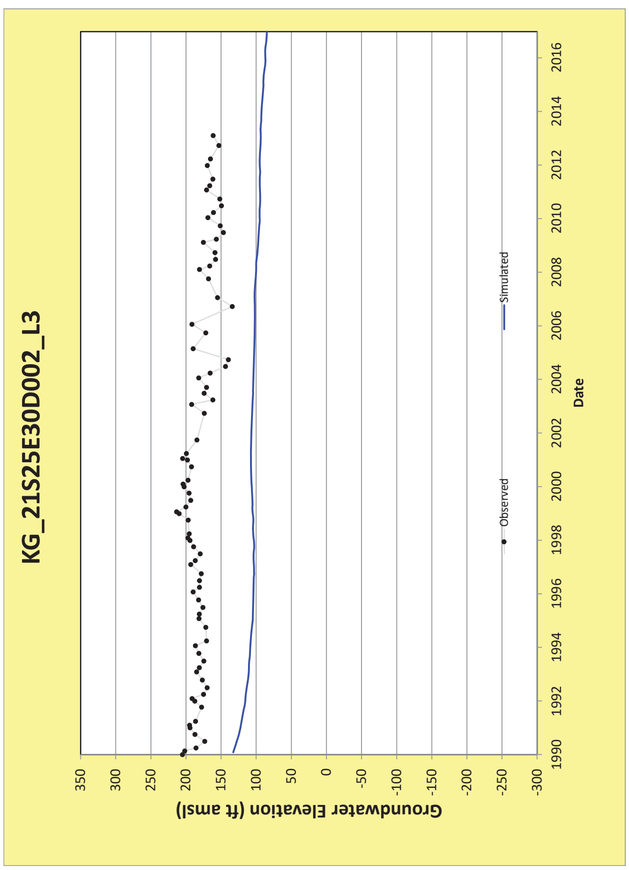
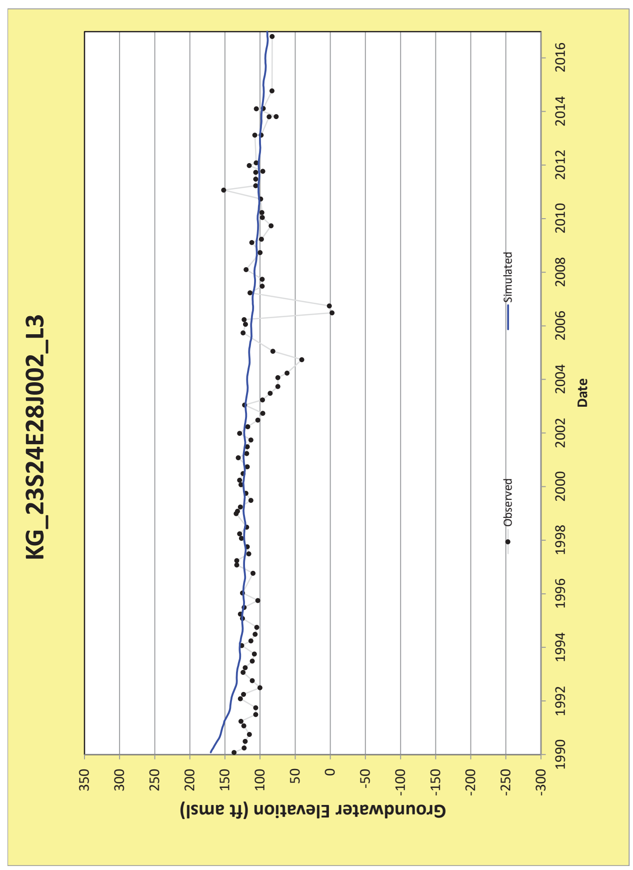
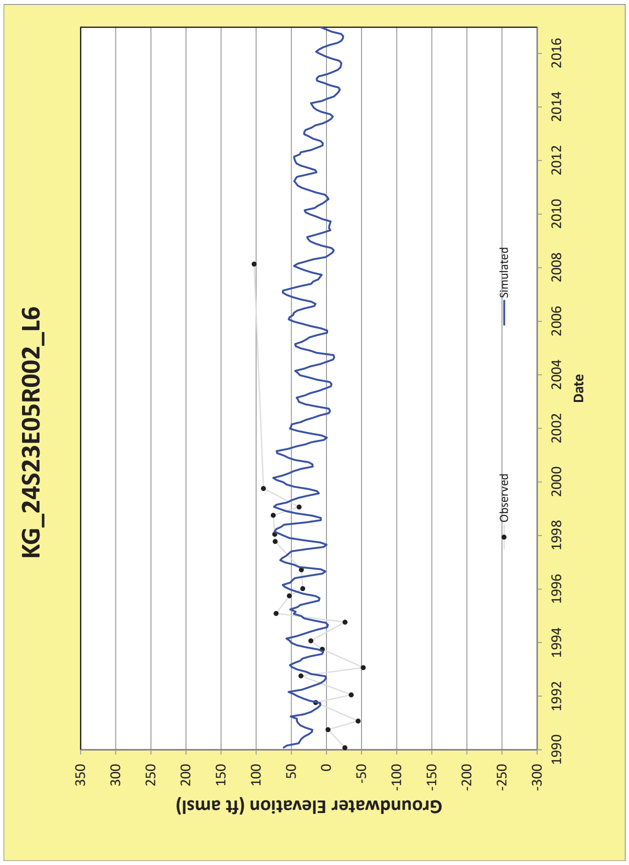
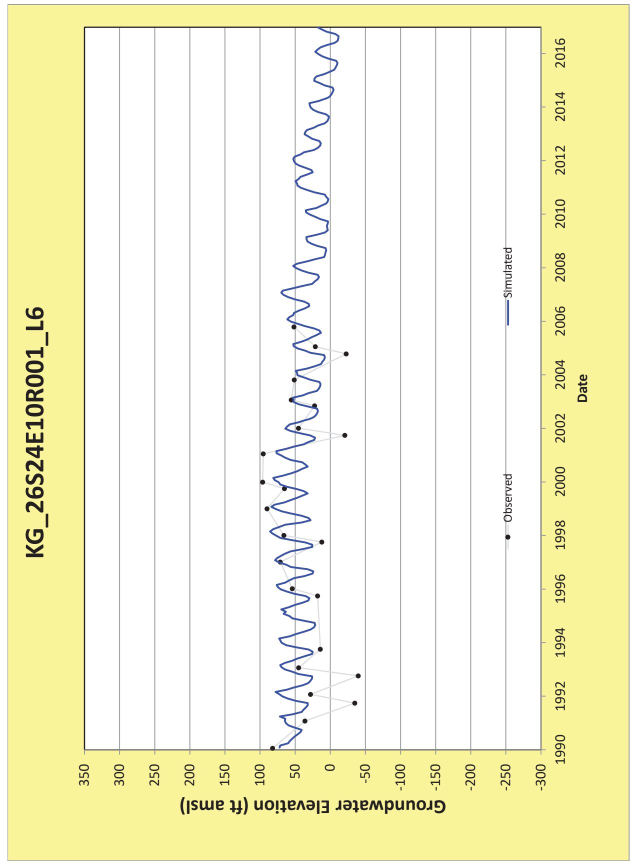
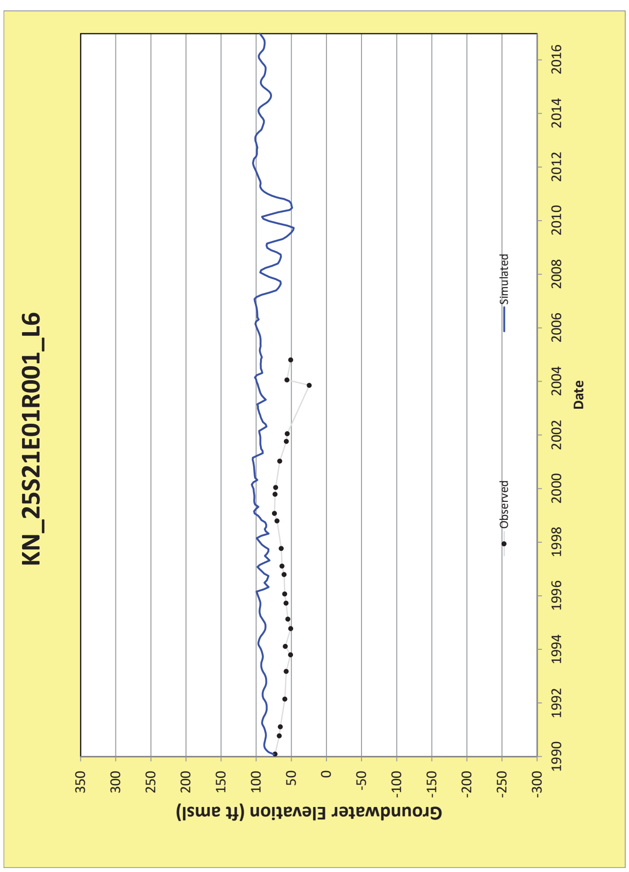
Date
Observed
Simulated


KG_21S25E30D002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_23S24E28J002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_24S23E05R002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KG_26S24E10R001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KN_25S21E01R001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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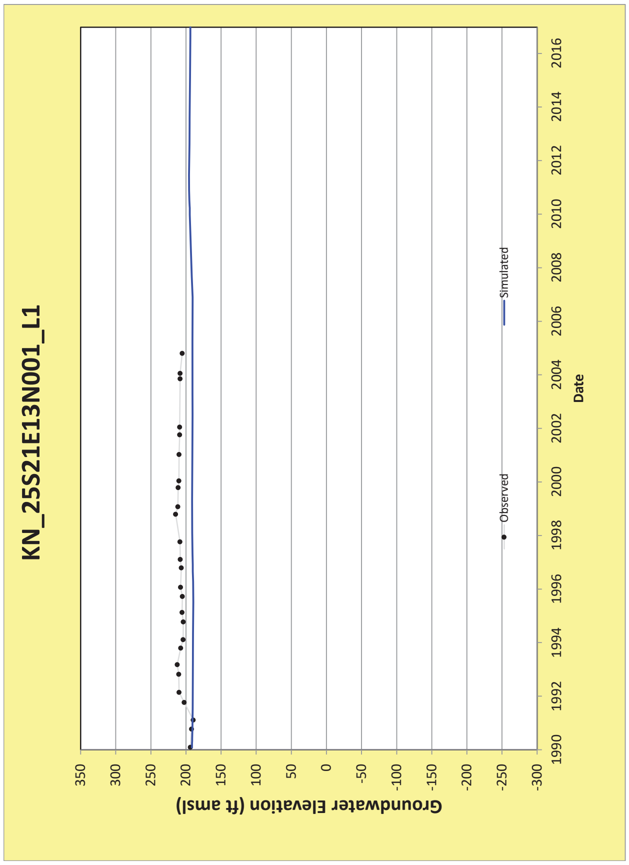
KN_25S21E13N001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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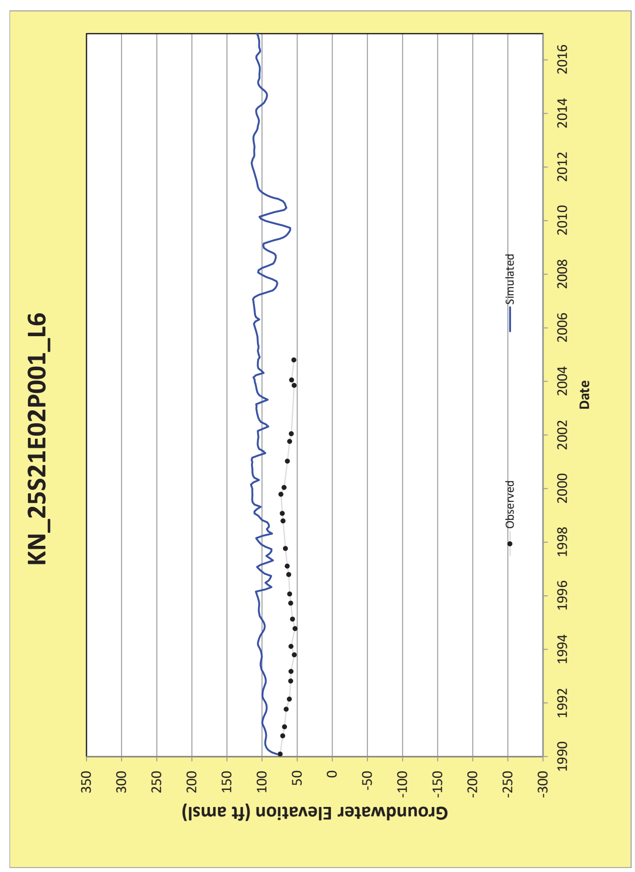
KN_25S21E02P001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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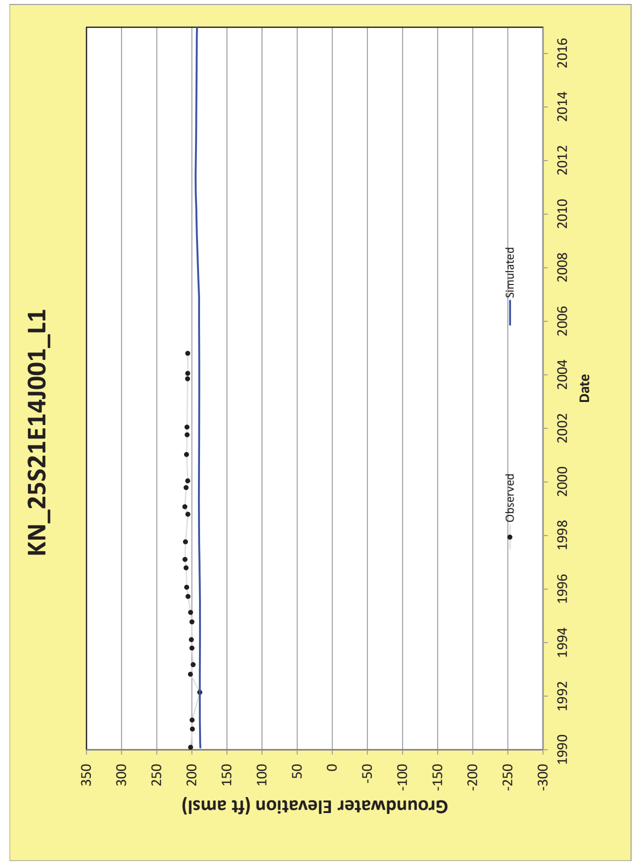
KN_25S21E14J001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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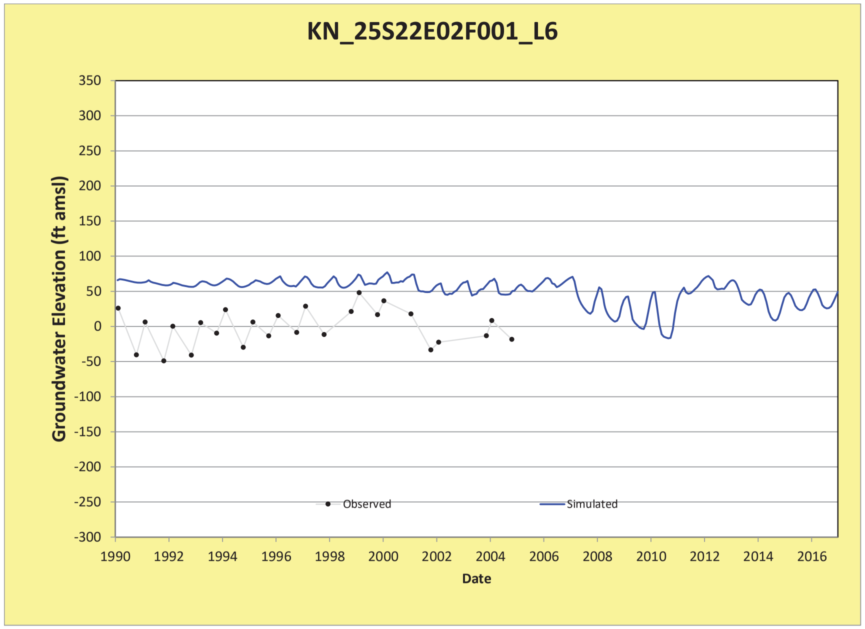
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Groundwater Elevation (ft amsl)
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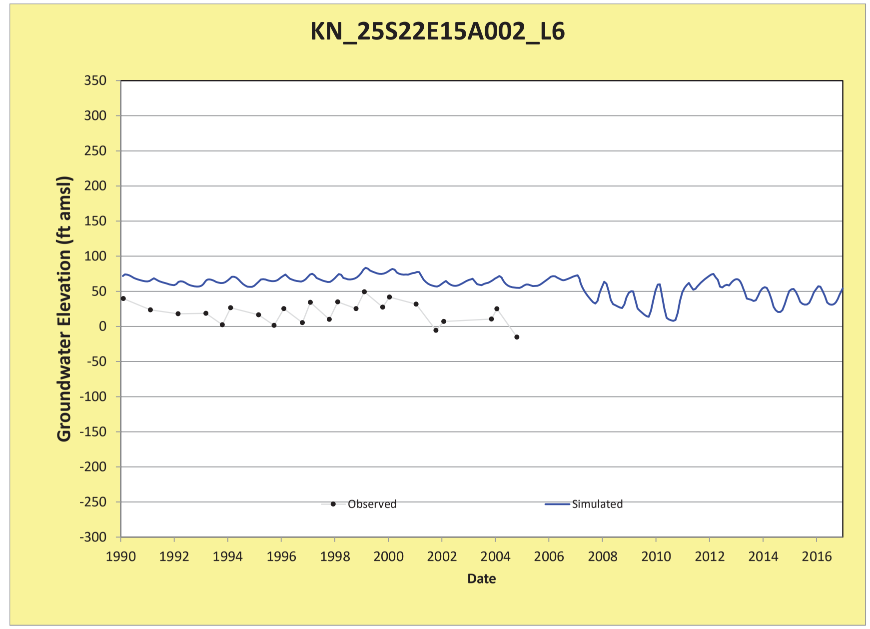
KN_25S22E15A002_L6
Groundwater Elevation (ft amsl)
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Observed
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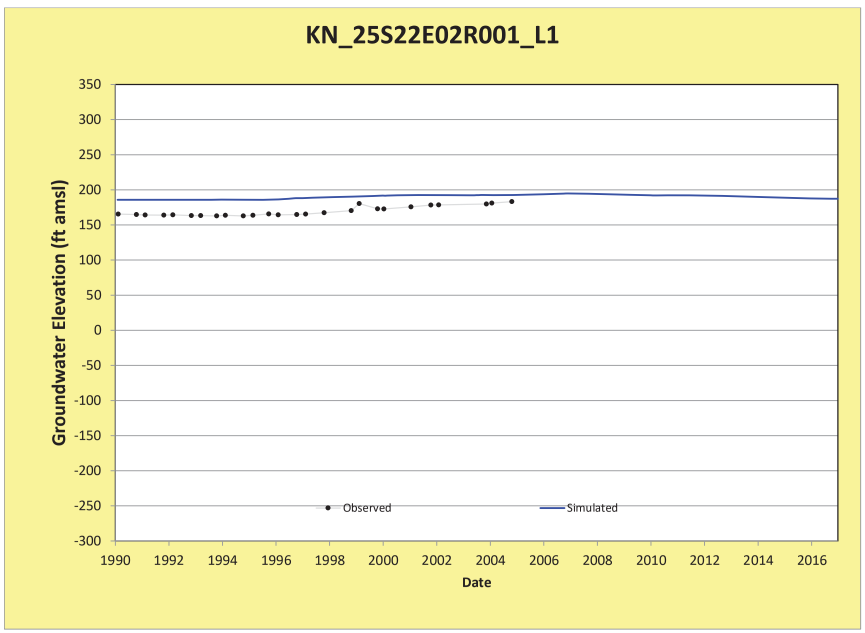
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Groundwater Elevation (ft amsl)
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Date
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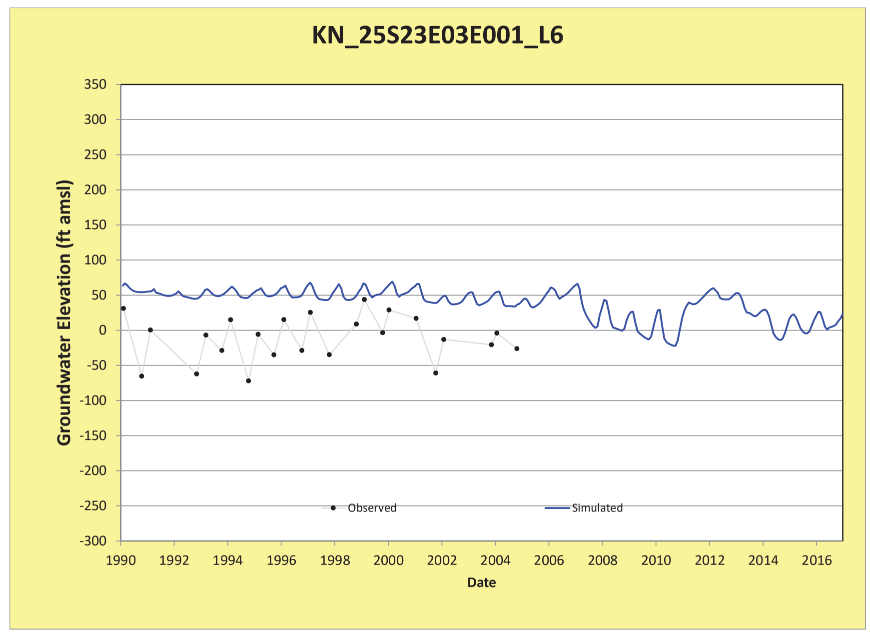
Simulated


KN_25S23E03E001_L6
Groundwater Elevation (ft amsl)
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Date
Observed
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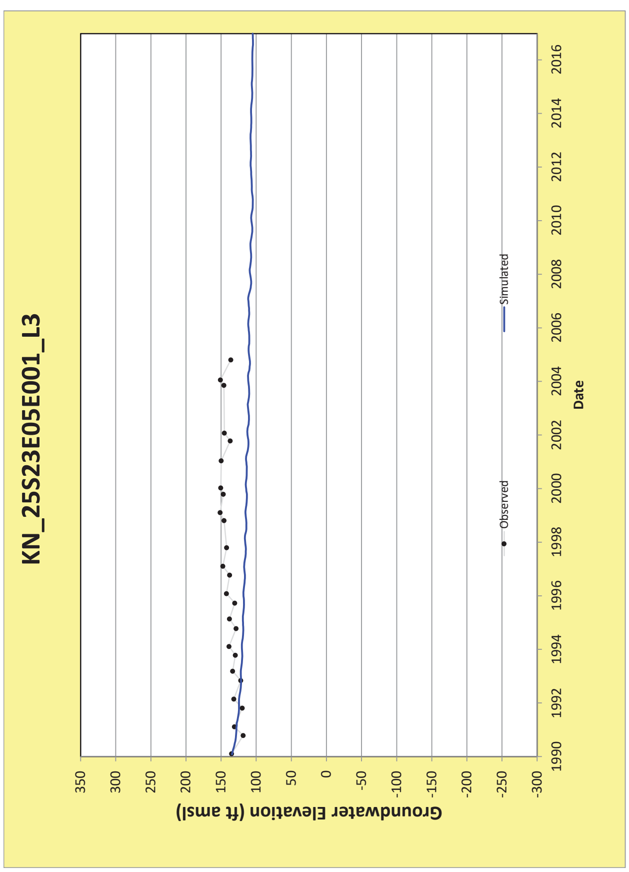
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Groundwater Elevation (ft amsl)
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Observed
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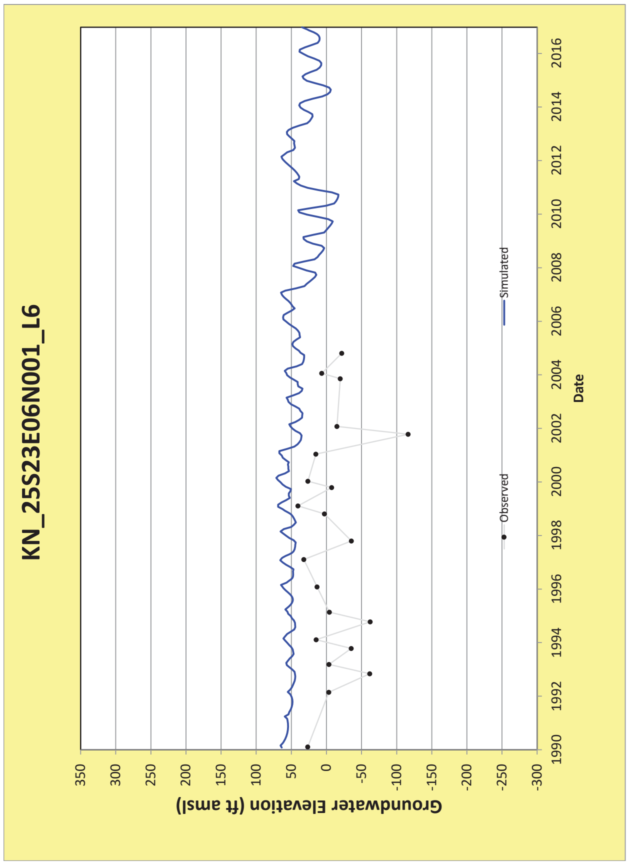
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Groundwater Elevation (ft amsl)
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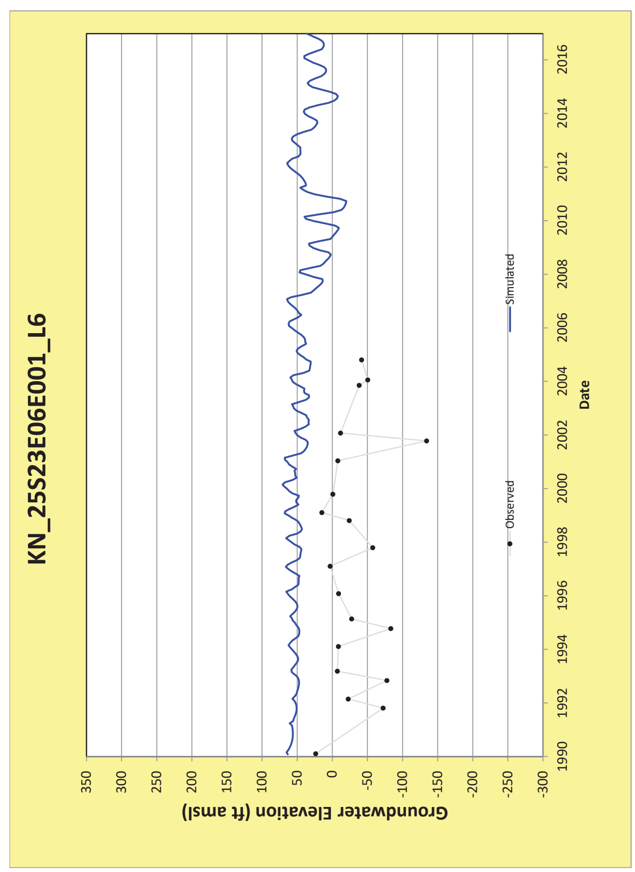
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Groundwater Elevation (ft amsl)
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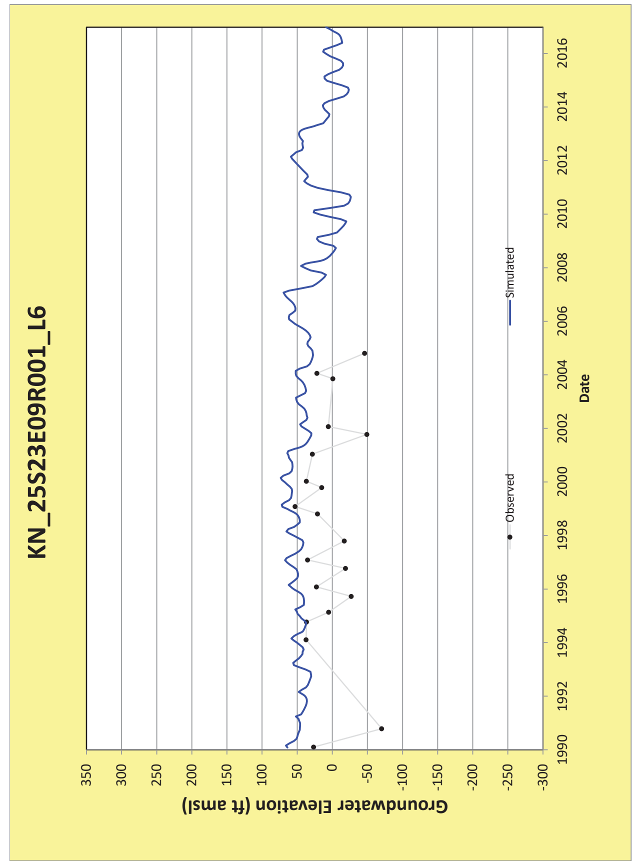
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Groundwater Elevation (ft amsl)
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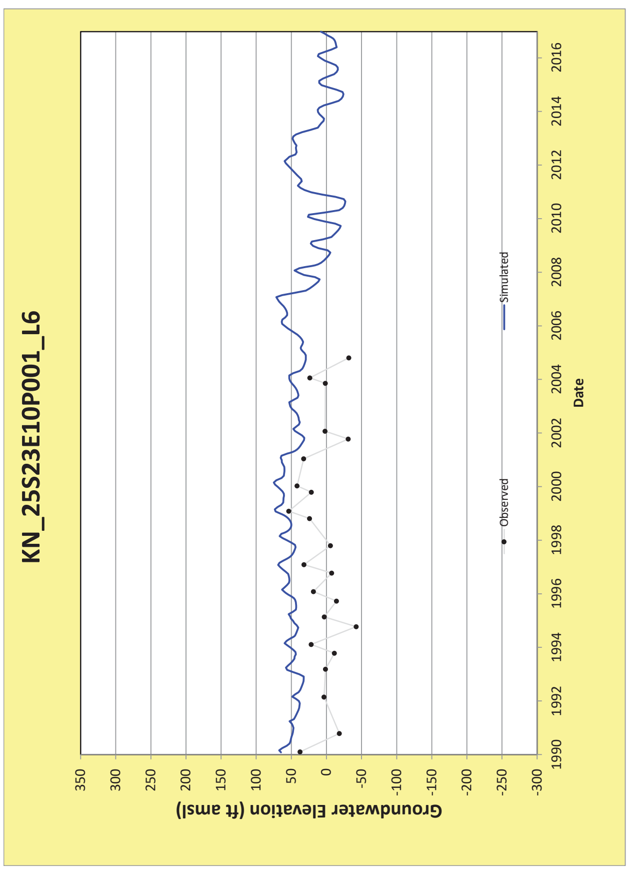
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Groundwater Elevation (ft amsl)
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Observed
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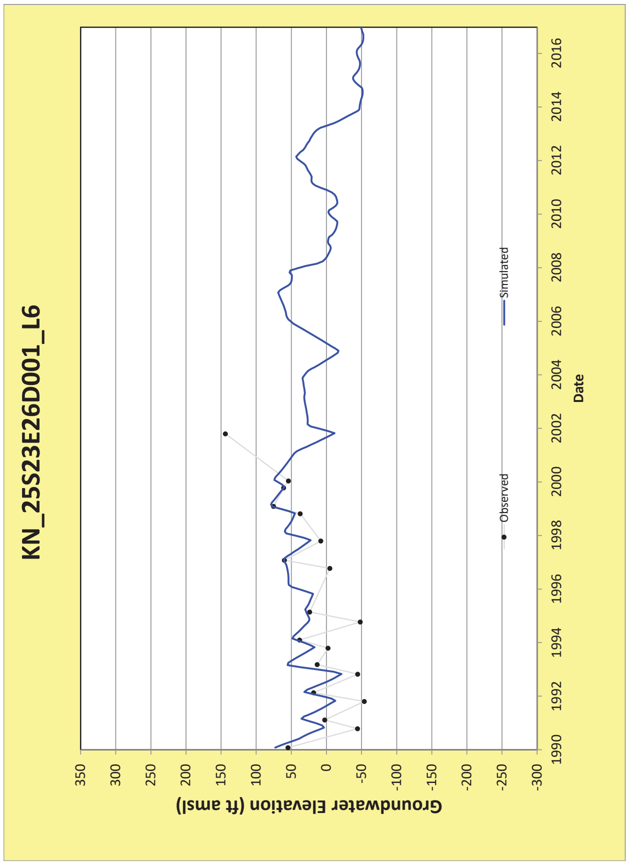
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Groundwater Elevation (ft amsl)
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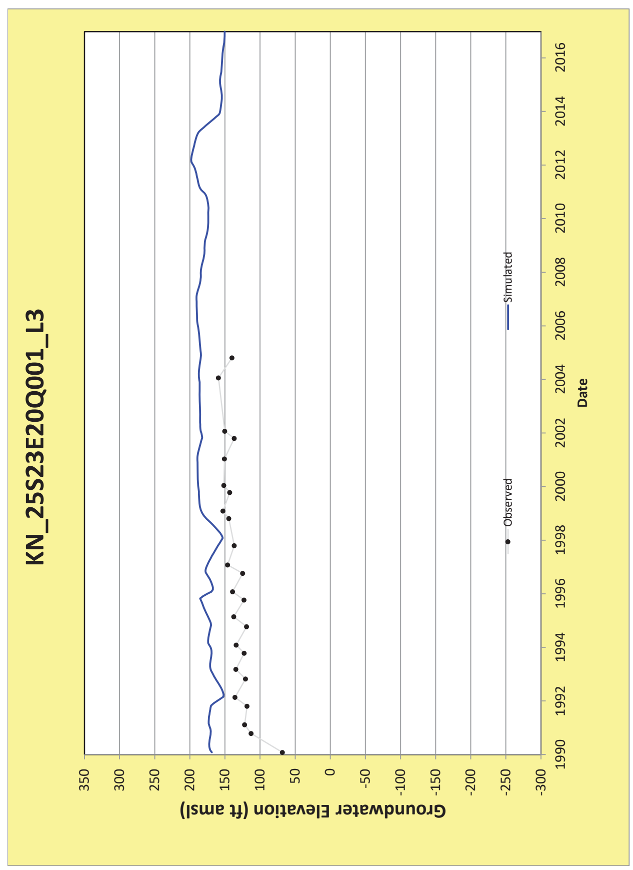
Date
Observed
Simulated


KN_25S23E20Q001_L3
Groundwater Elevation (ft amsl)
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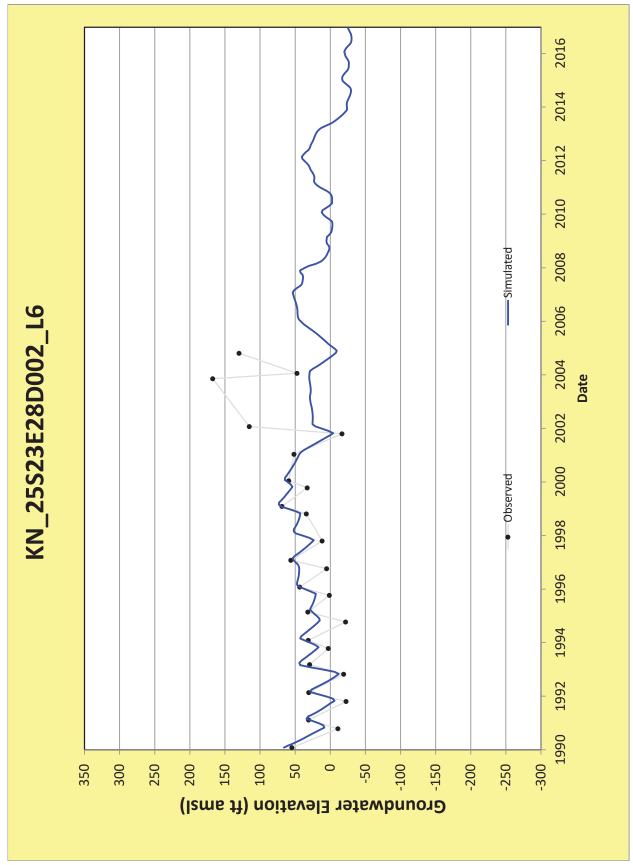
Date
Observed
Simulated


KN_25S23E28D002_L6
Groundwater Elevation (ft amsl)
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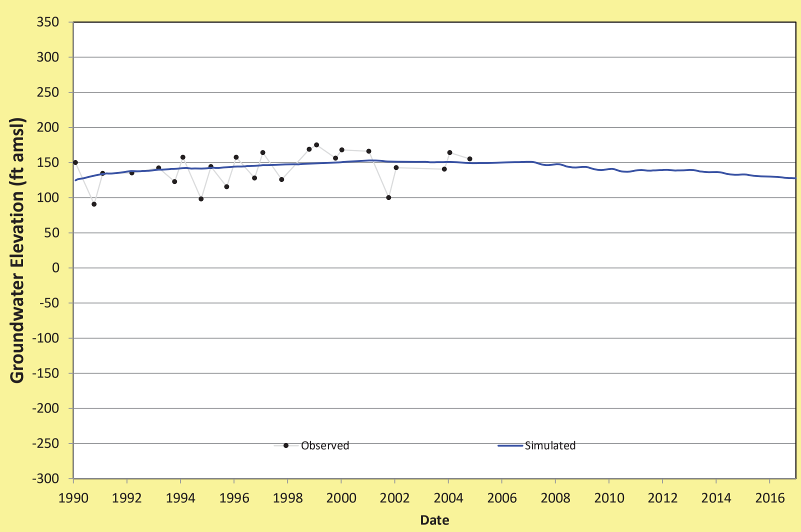
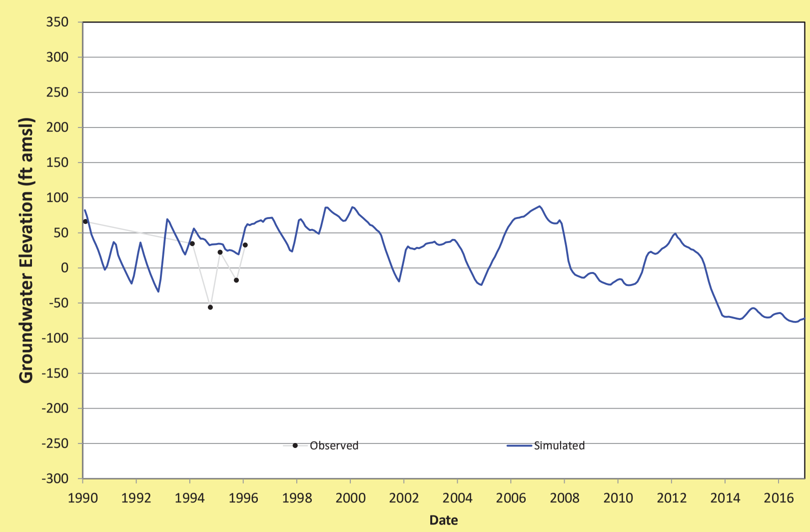
Date
Observed
Simulated

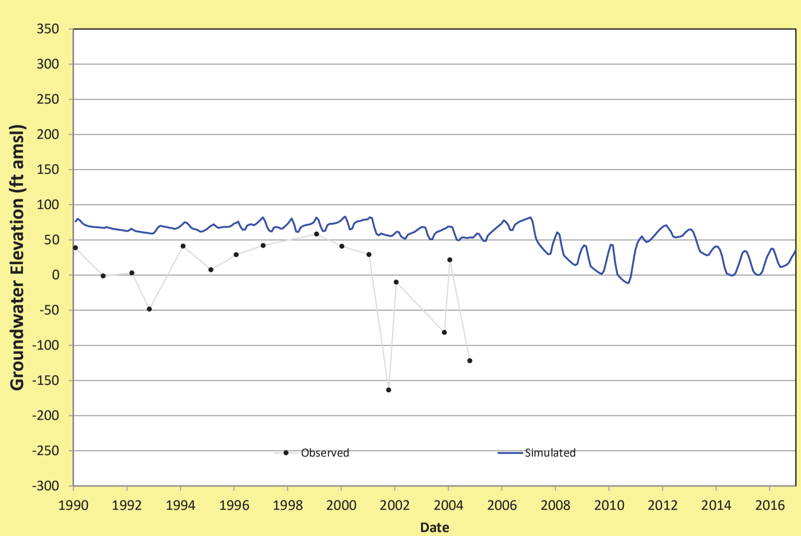
KN_25S24E04R001_L3



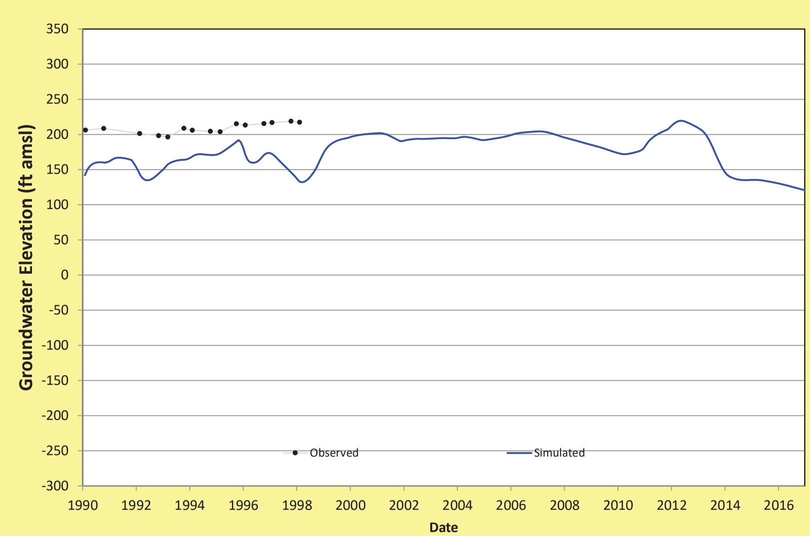
KN_25S24E19P001_L6

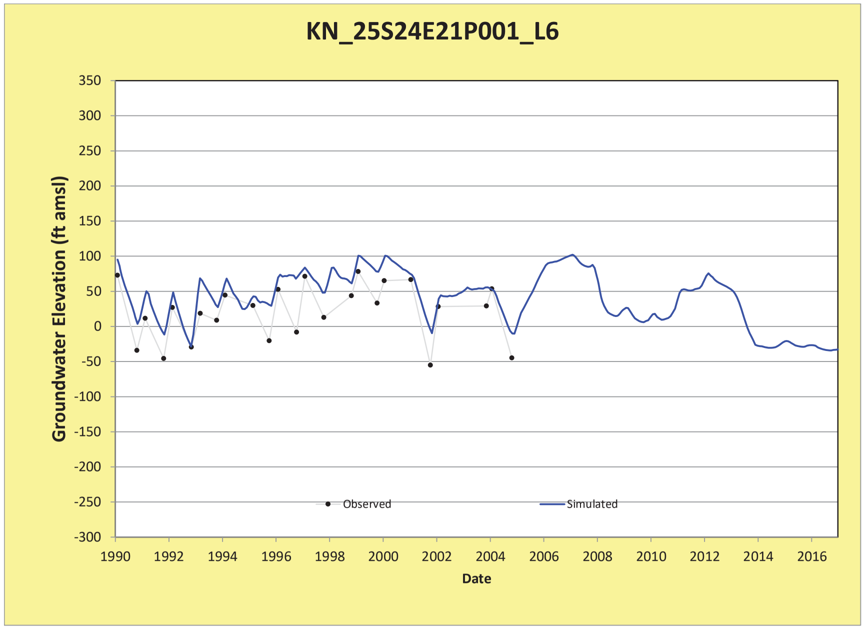


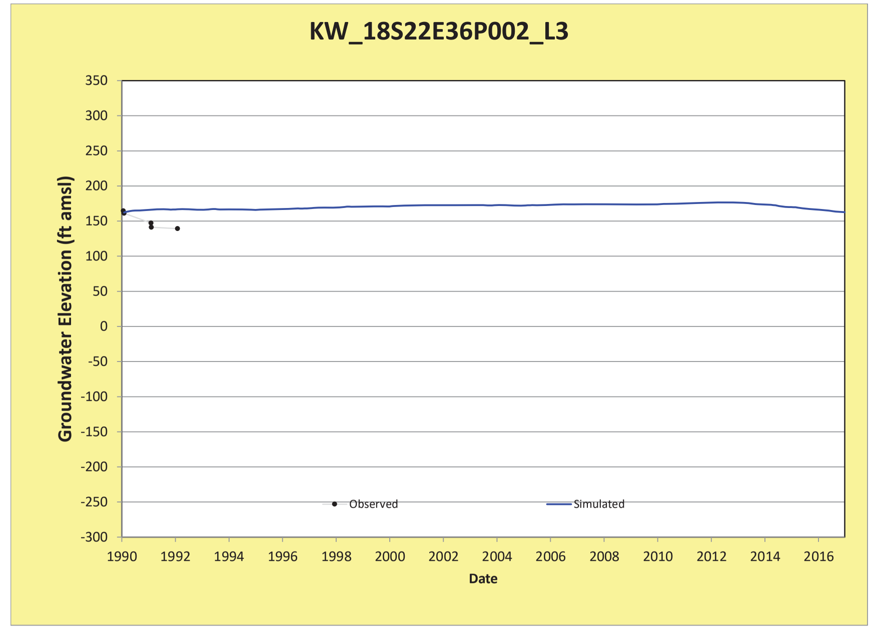
KN_25S24E06D002_L6

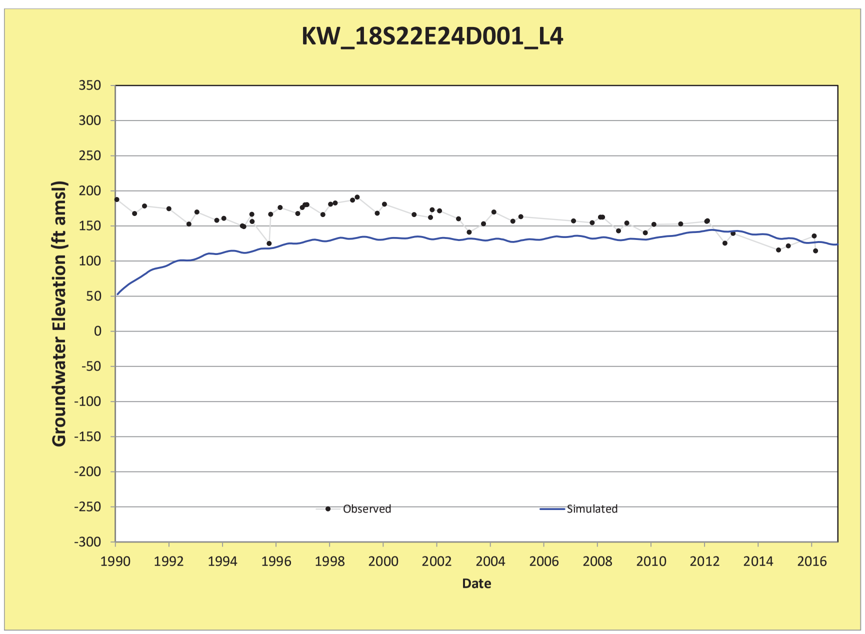


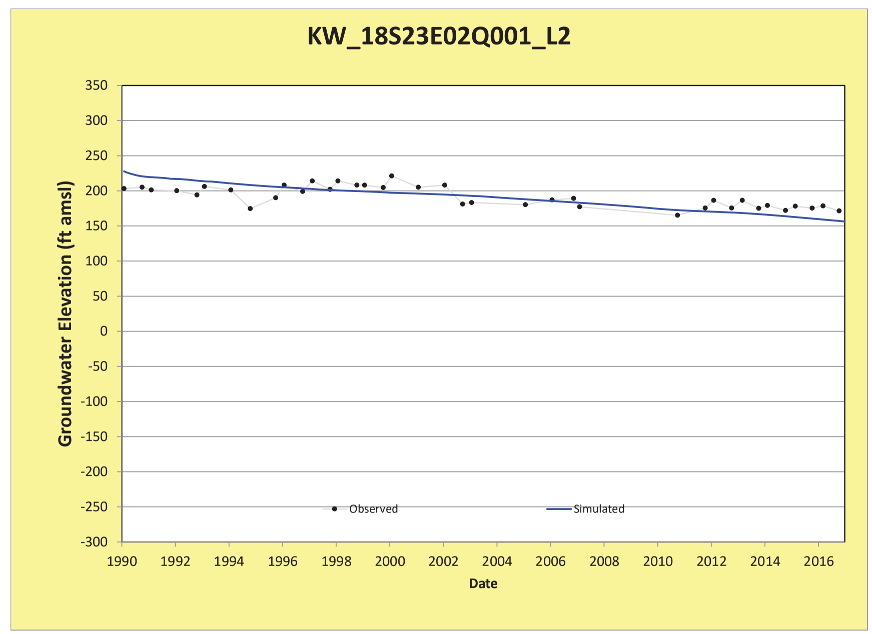
KN_25S24E19R002_L2

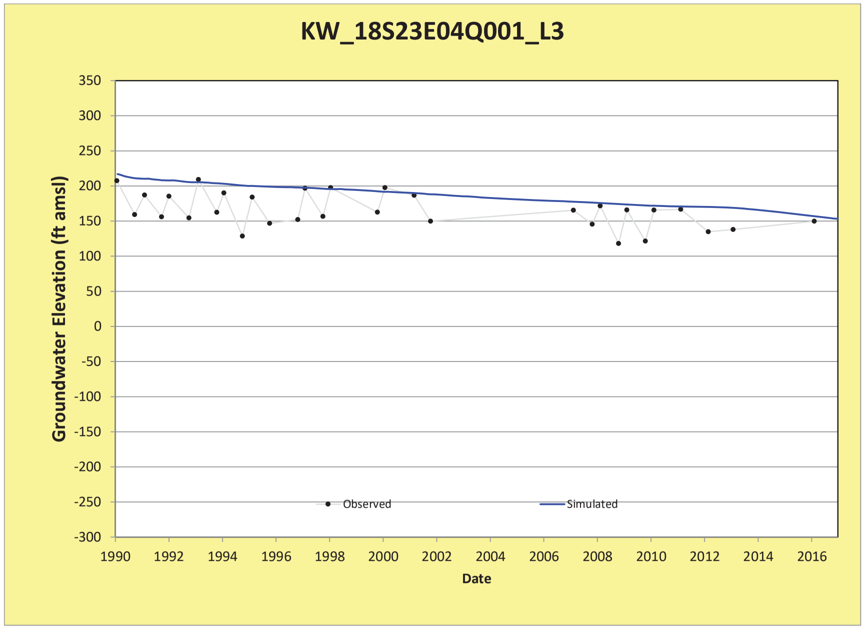


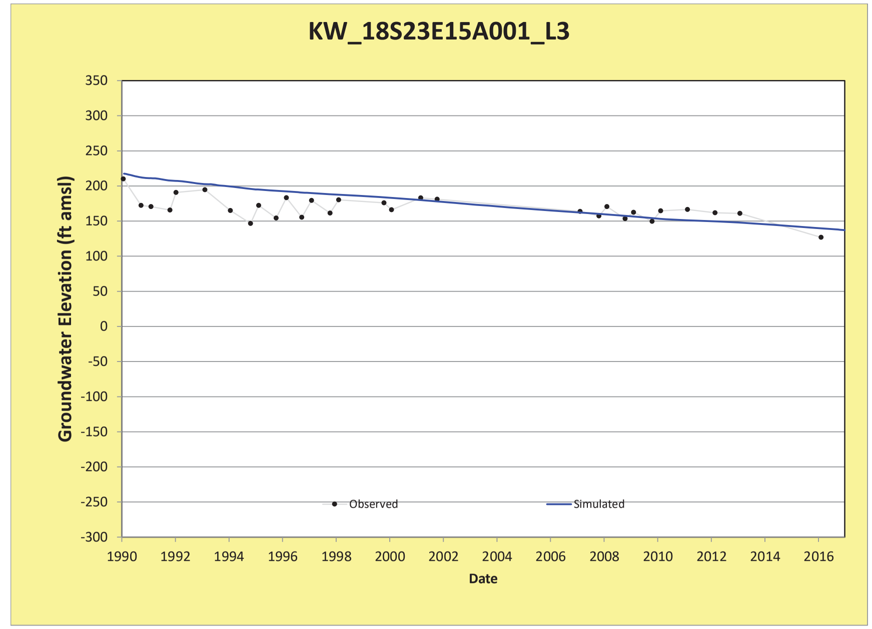

KN_25S24E21P001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

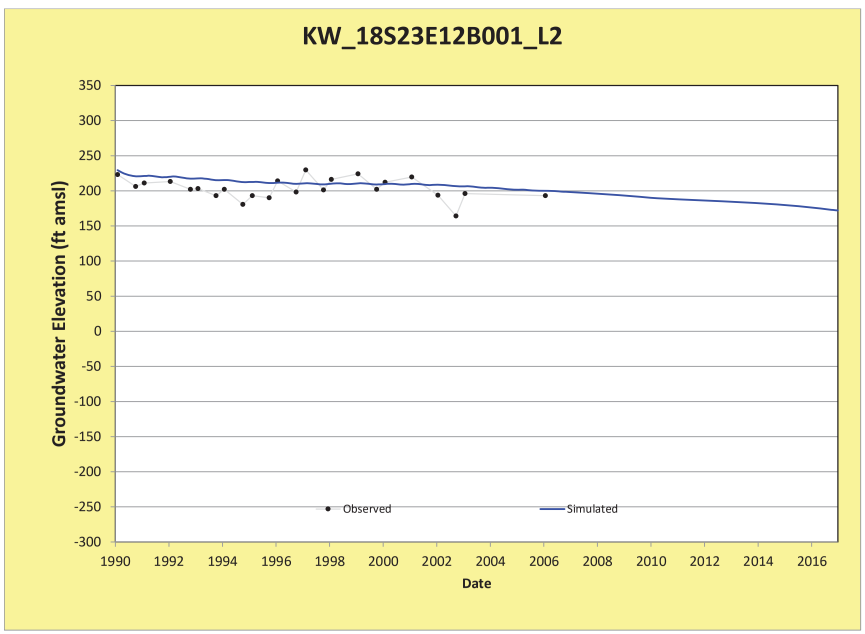

KW_18S22E36P002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

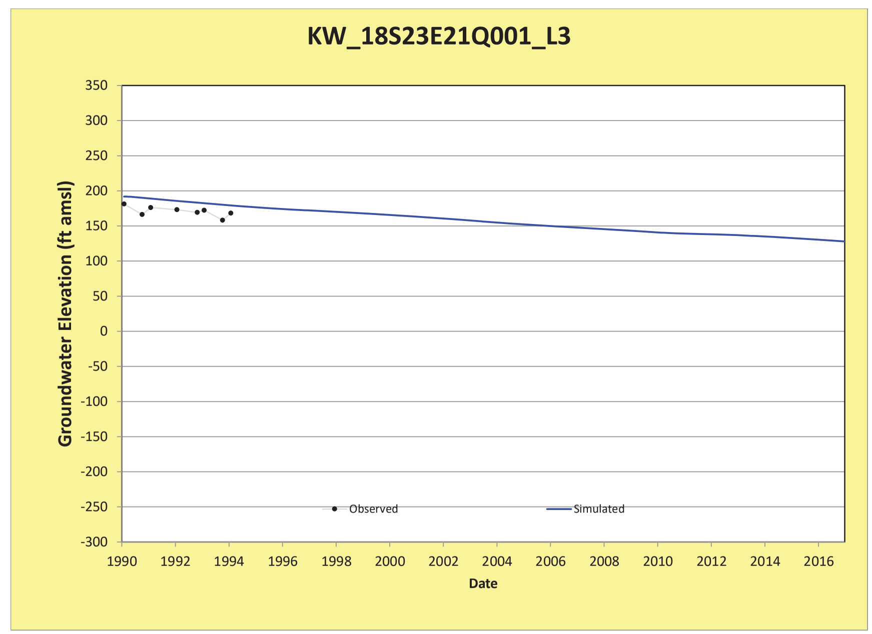

KW_18S22E24D001_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

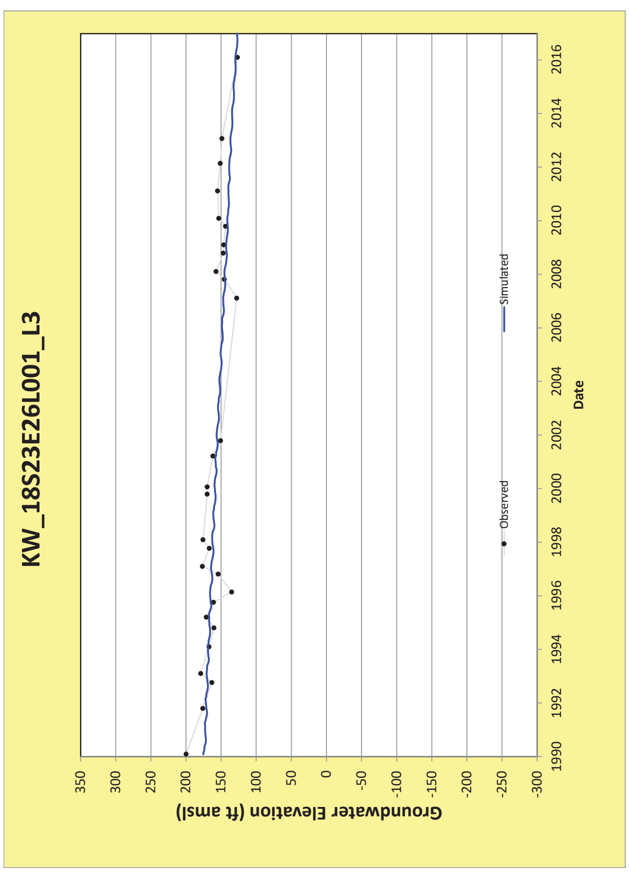

KW_18S23E02Q001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E04Q001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E15A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E12B001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E21Q001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E26L001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
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50
0
-50
-100
-150
-200
-250
-300
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1992
1994
1996
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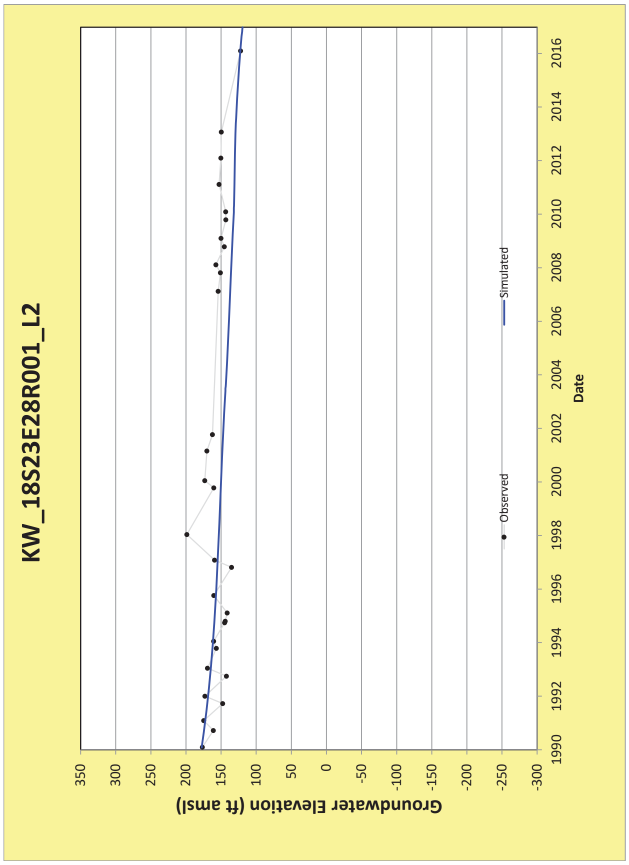
2014
2016
Date
Observed
Simulated


KW_18S23E28R001_L2
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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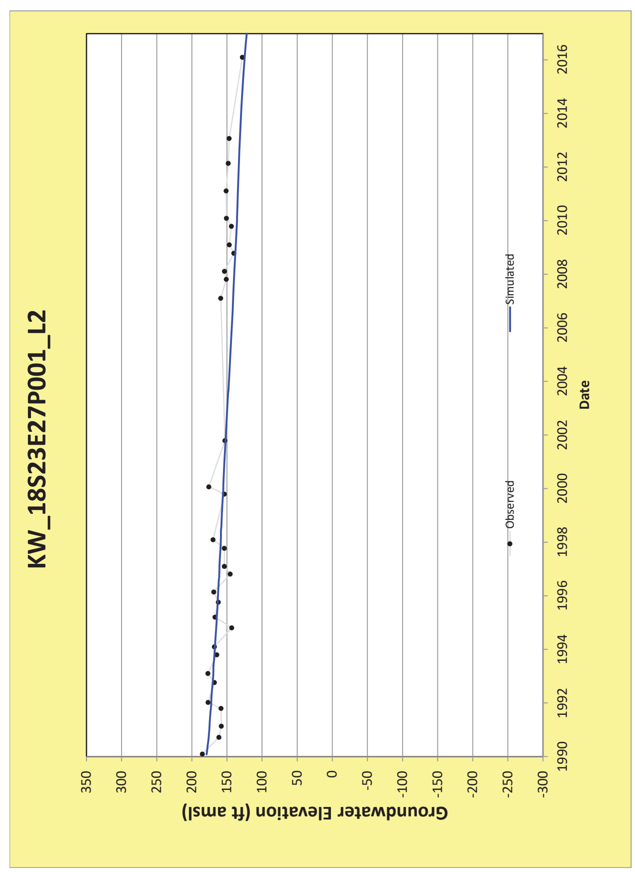
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


KW_18S23E27P001_L2
Groundwater Elevation (ft amsl)
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300
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200
150
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50
0
-50
-100
-150
-200
-250
-300
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1994
1996
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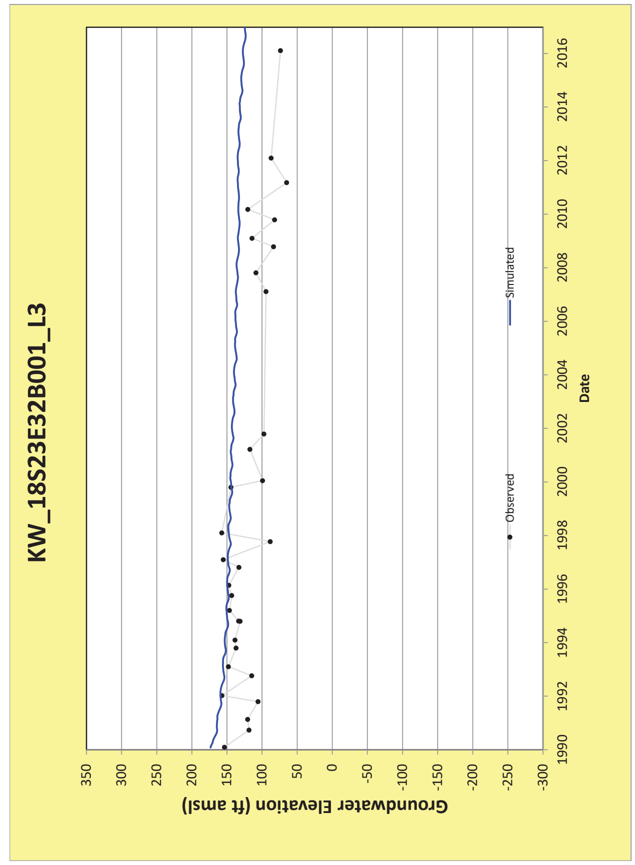
2008
2010
2012
2014
2016
Date
Observed
Simulated


KW_18S23E32B001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
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1998
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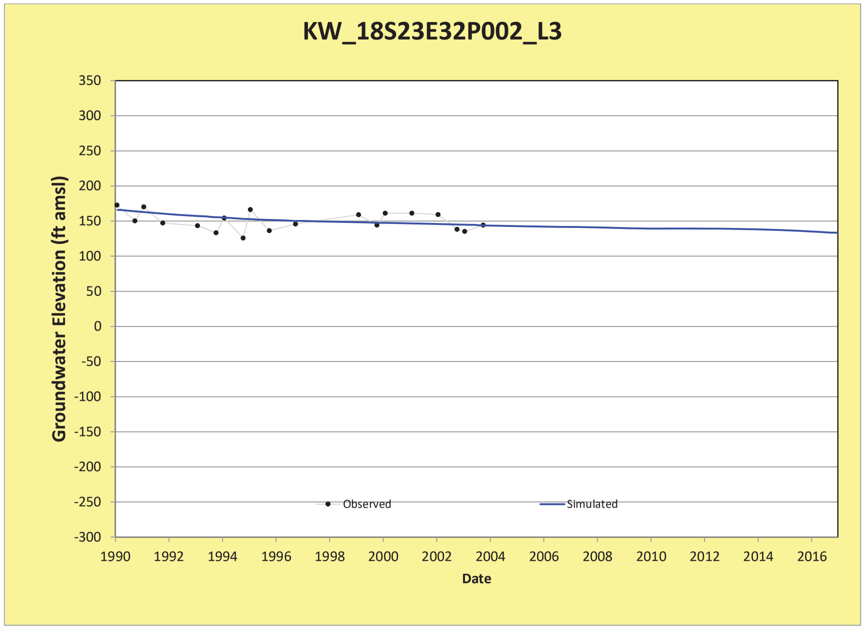
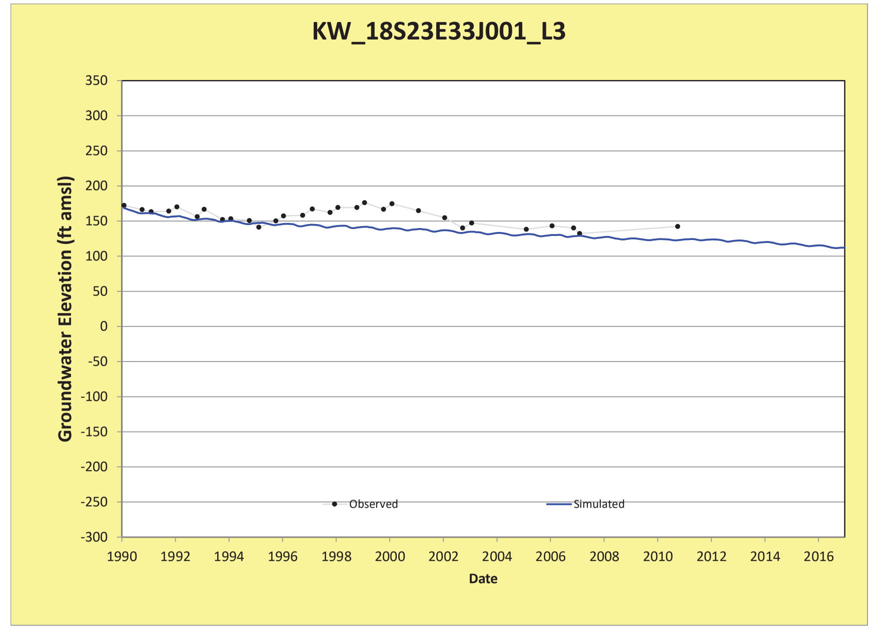
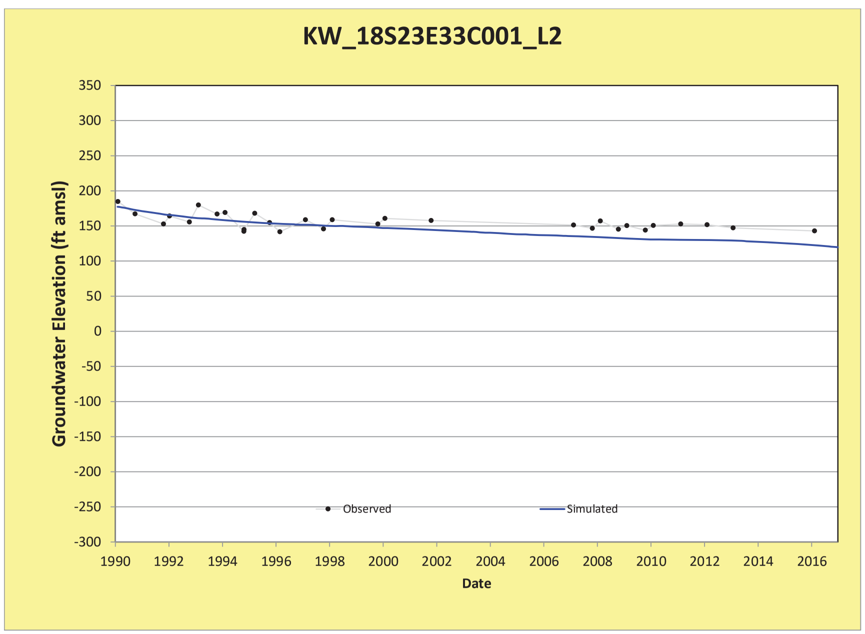
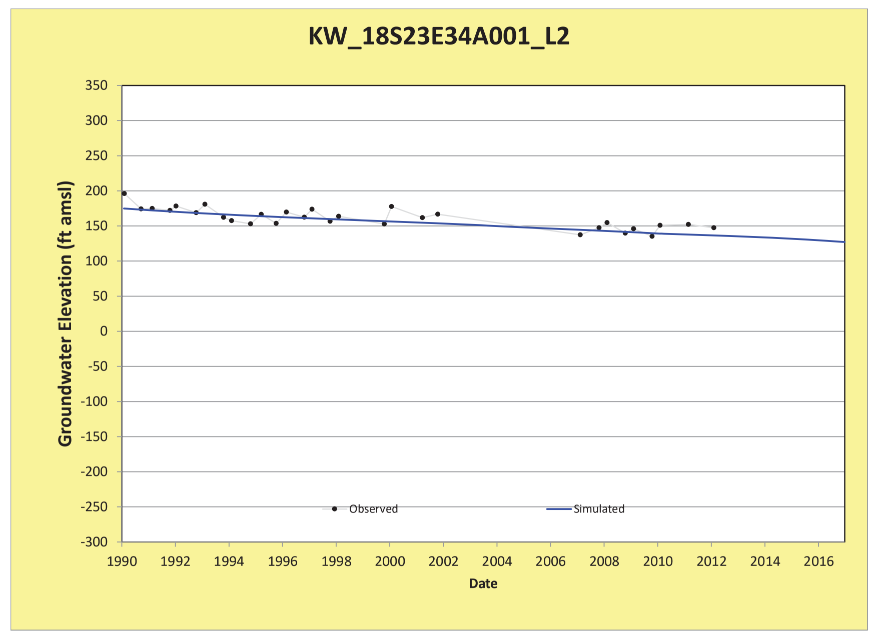
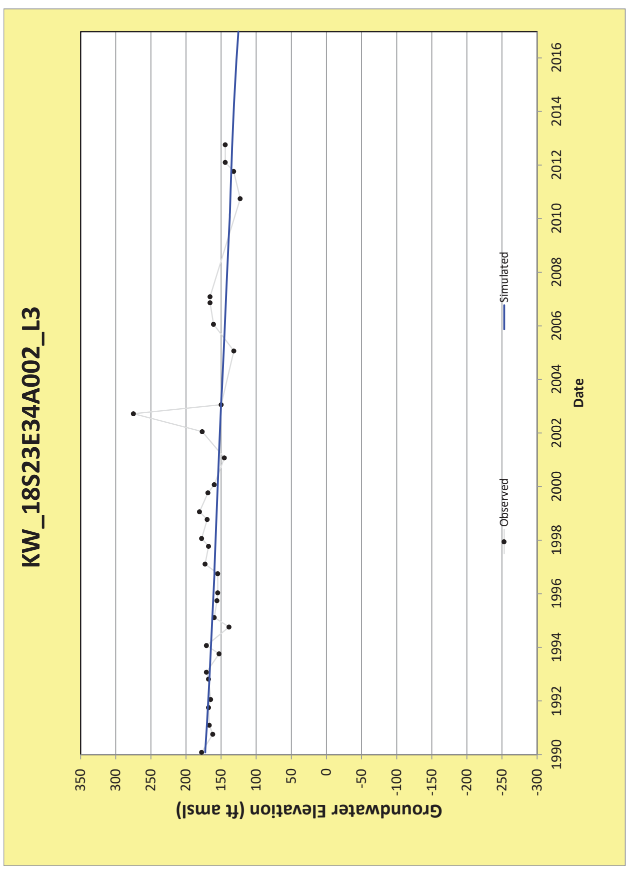
2008
2010
2012
2014
2016
Date
Observed
Simulated


KW_18S23E32P002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E33J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E33C001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E34A001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_18S23E34A002_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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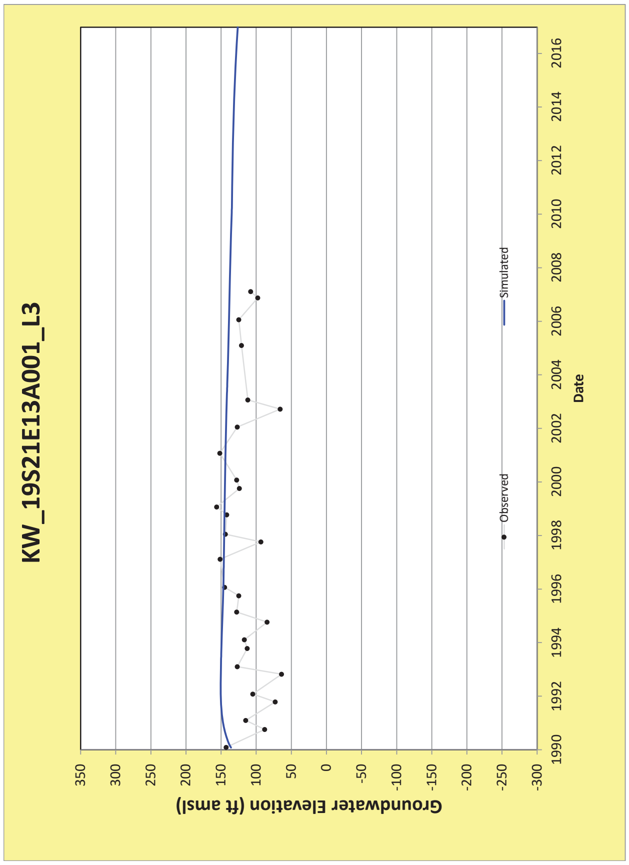
Date
Observed
Simulated


KW_19S21E13A001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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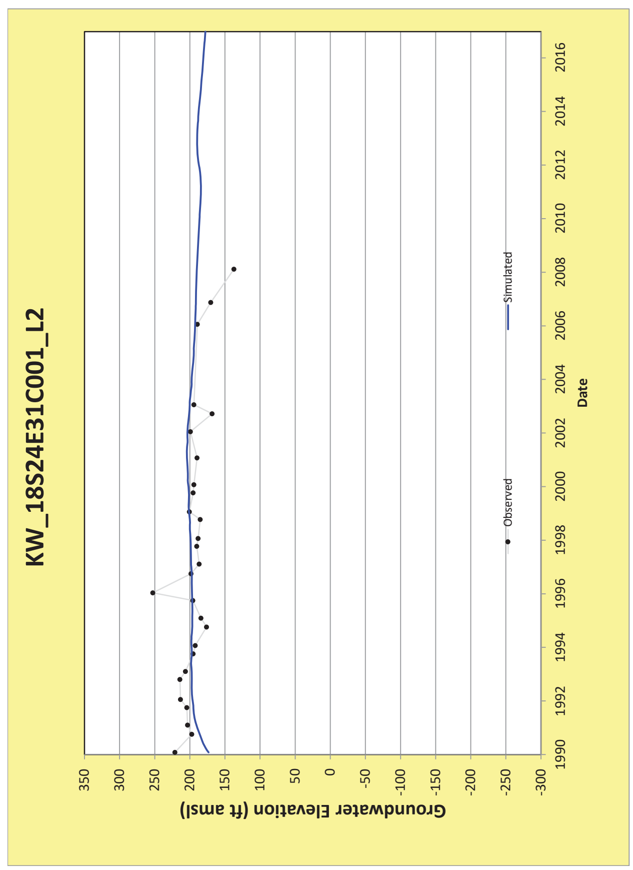
Date
Observed
Simulated


KW_18S24E31C001_L2
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
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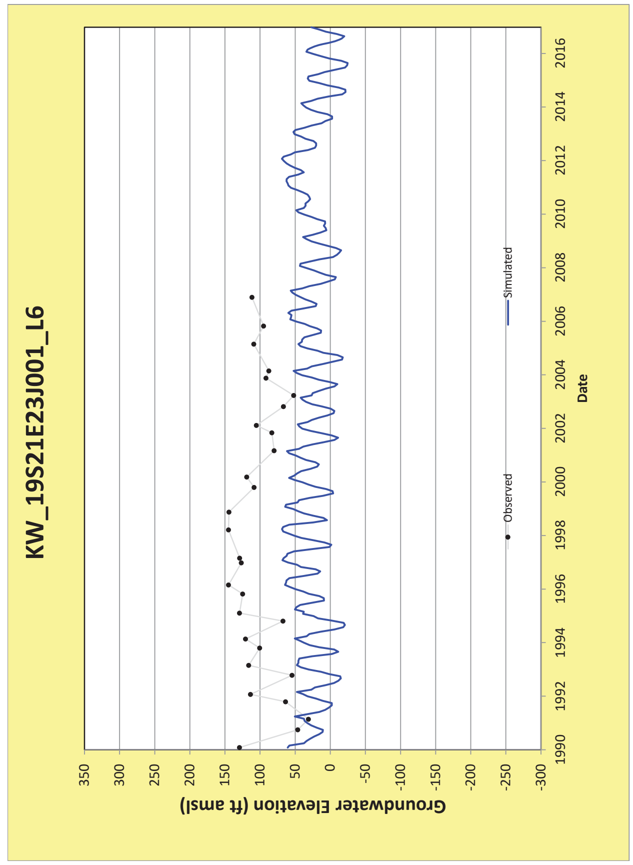
2016
Date
Observed
Simulated


KW_19S21E23J001_L6
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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1992
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2010
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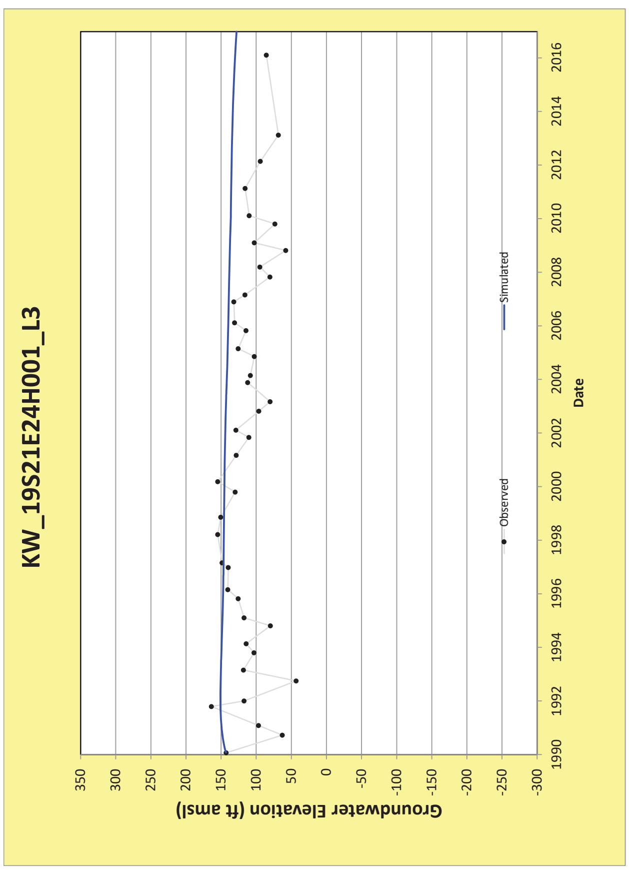
2016
Date
Observed
Simulated


KW_19S21E24H001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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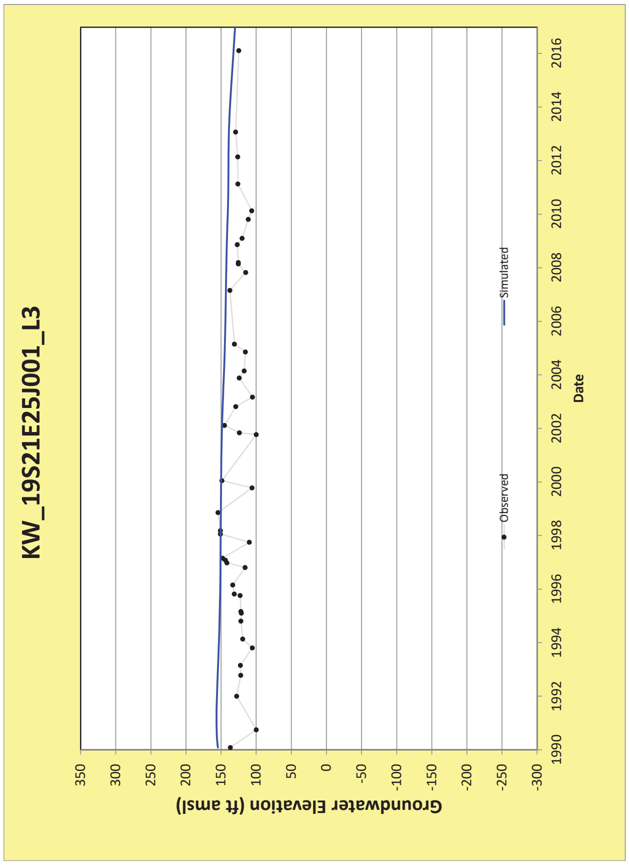
Date
Observed
Simulated


KW_19S21E25J001_L3
Groundwater Elevation (ft amsl)
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200
150
100
50
0
-50
-100
-150
-200
-250
-300
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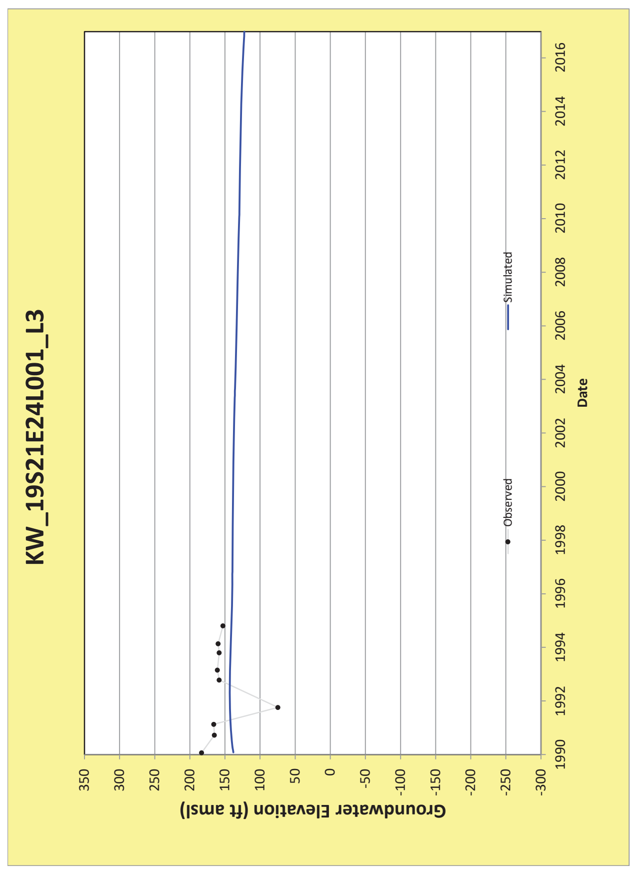
2016
Date
Observed
Simulated


KW_19S21E24L001_L3
Groundwater Elevation (ft amsl)
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300
250
200
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100
50
0
-50
-100
-150
-200
-250
-300
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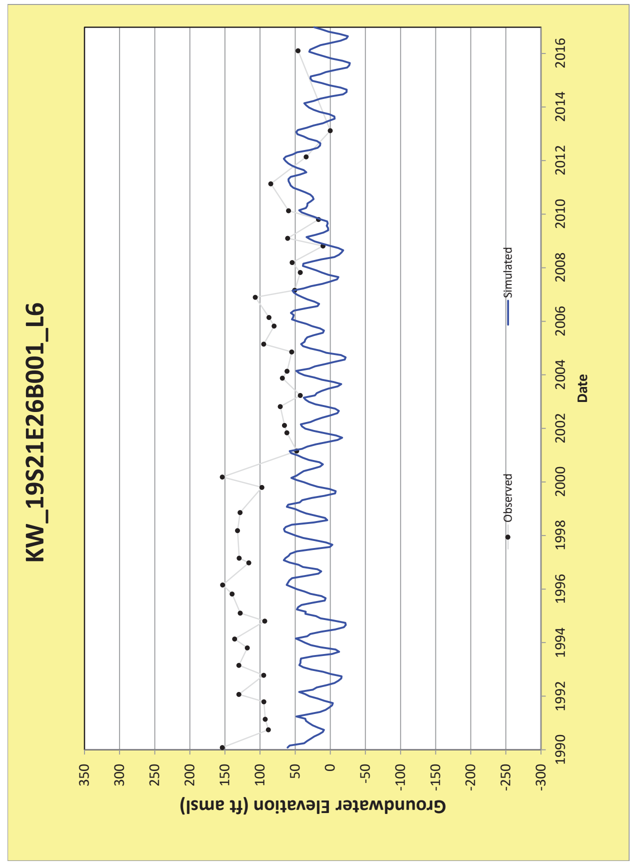
Date
Observed
Simulated


KW_19S21E26B001_L6
Groundwater Elevation (ft amsl)
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300
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200
150
100
50
0
-50
-100
-150
-200
-250
-300
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1992
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2010
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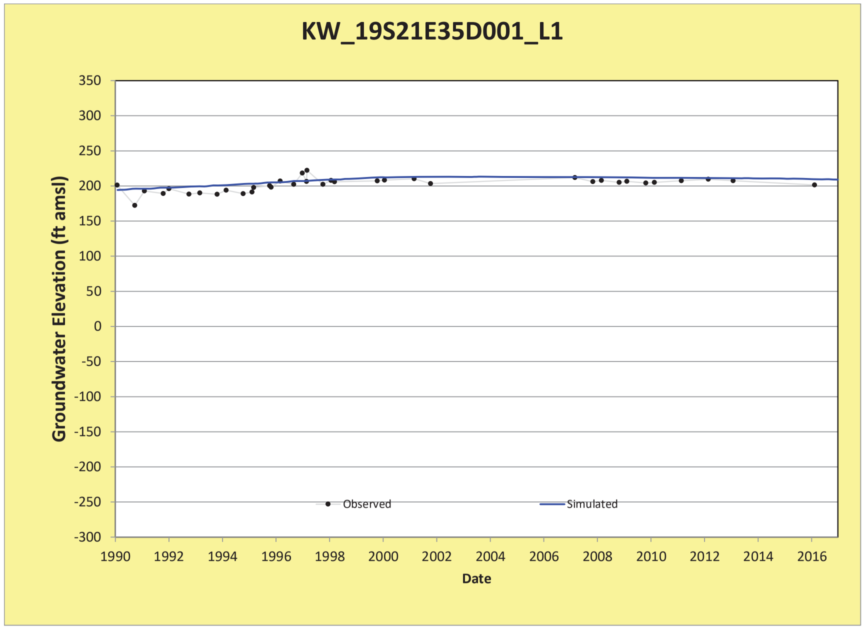
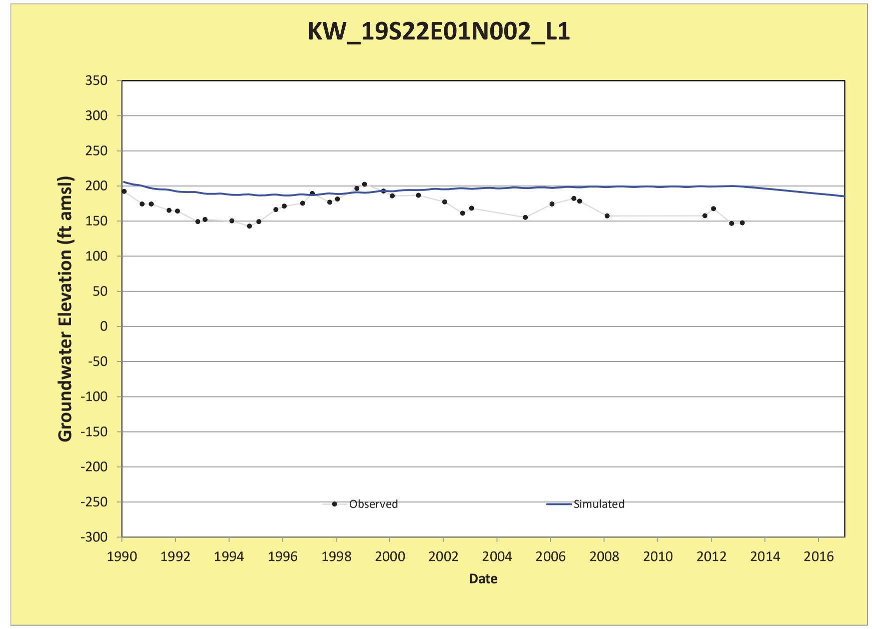
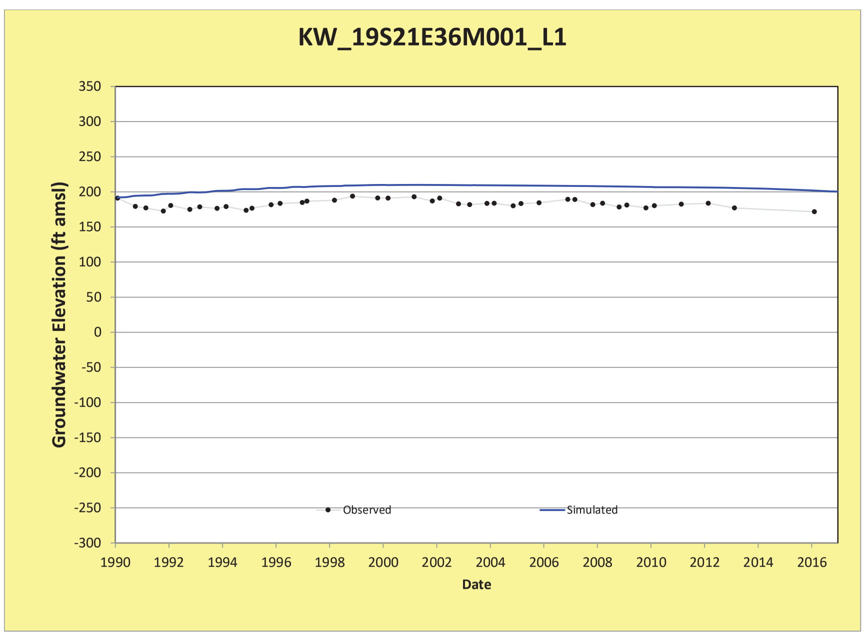
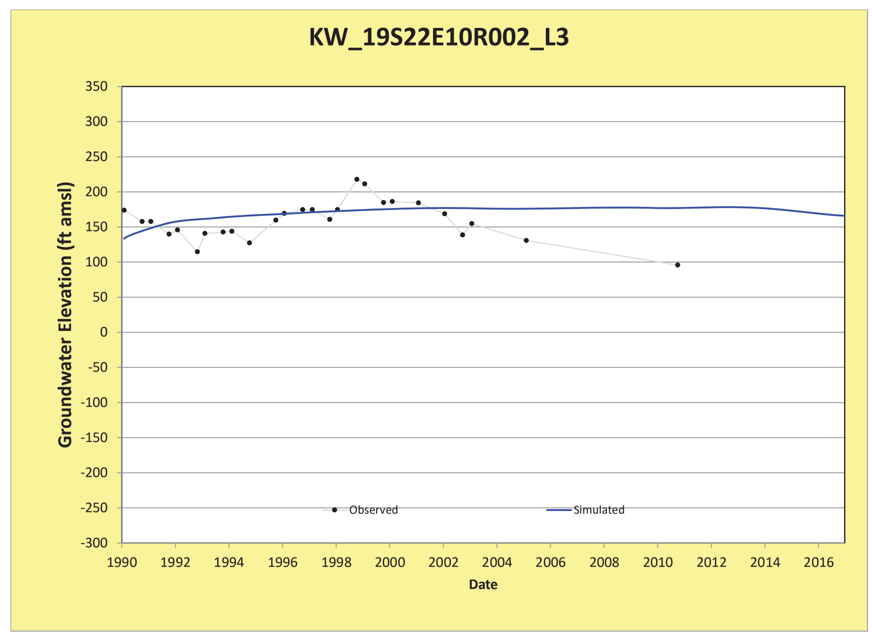
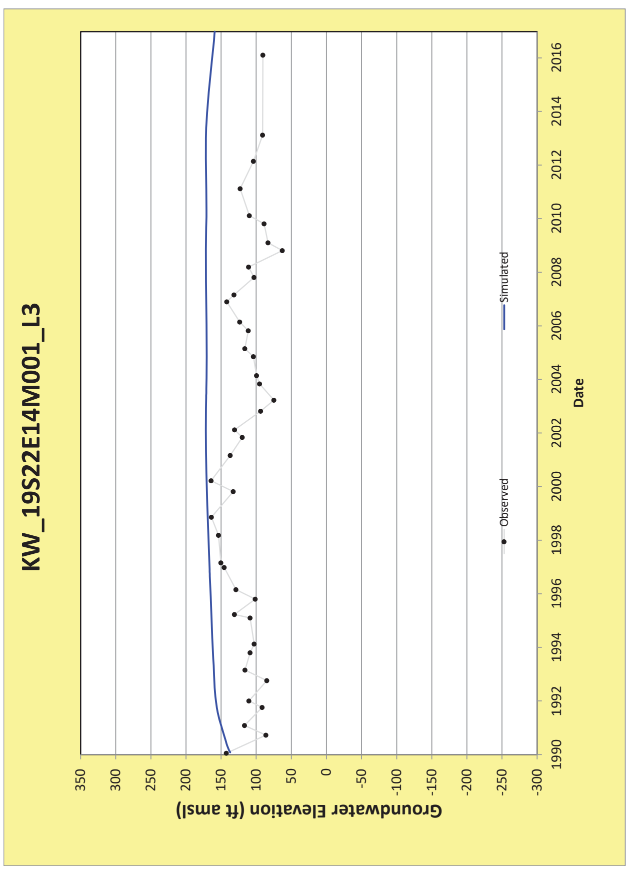
2016
Date
Observed
Simulated


KW_19S21E35D001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S22E01N002_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S21E36M001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S22E10R002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S22E14M001_L3
Groundwater Elevation (ft amsl)
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250
200
150
100
50
0
-50
-100
-150
-200
-250
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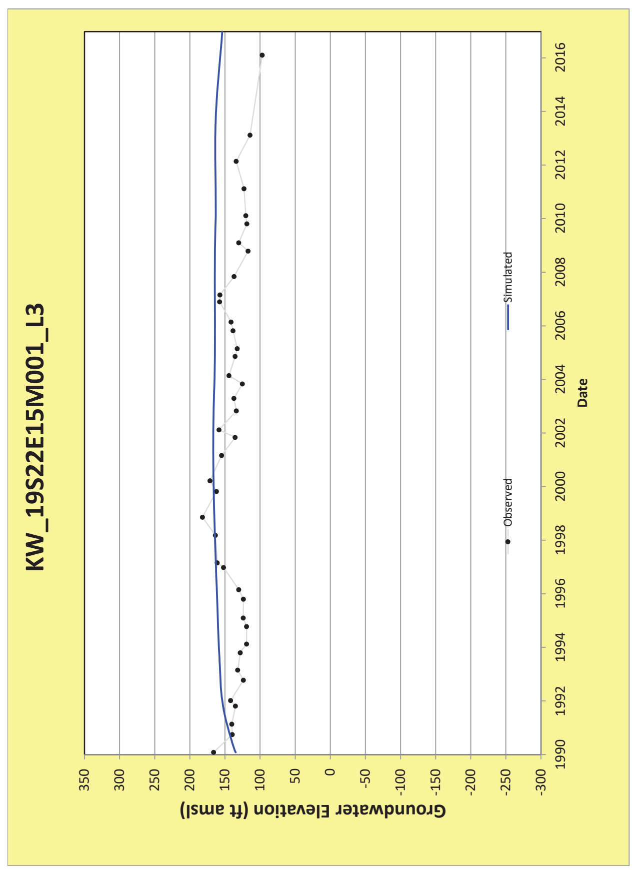
2016
Date
Observed
Simulated


KW_19S22E15M001_L3
Groundwater Elevation (ft amsl)
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200
150
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0
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-100
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-200
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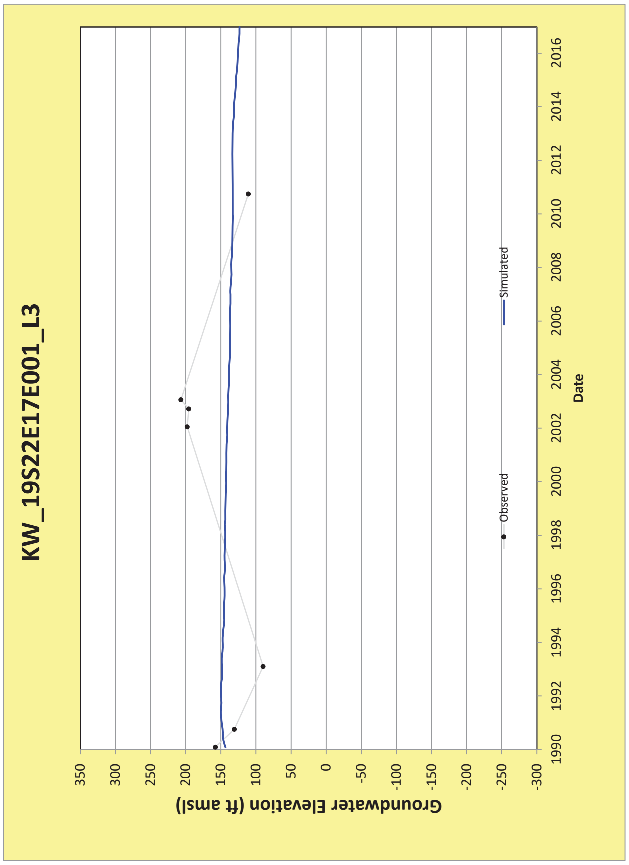
Date
Observed
Simulated


KW_19S22E17E001_L3
Groundwater Elevation (ft amsl)
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250
200
150
100
50
0
-50
-100
-150
-200
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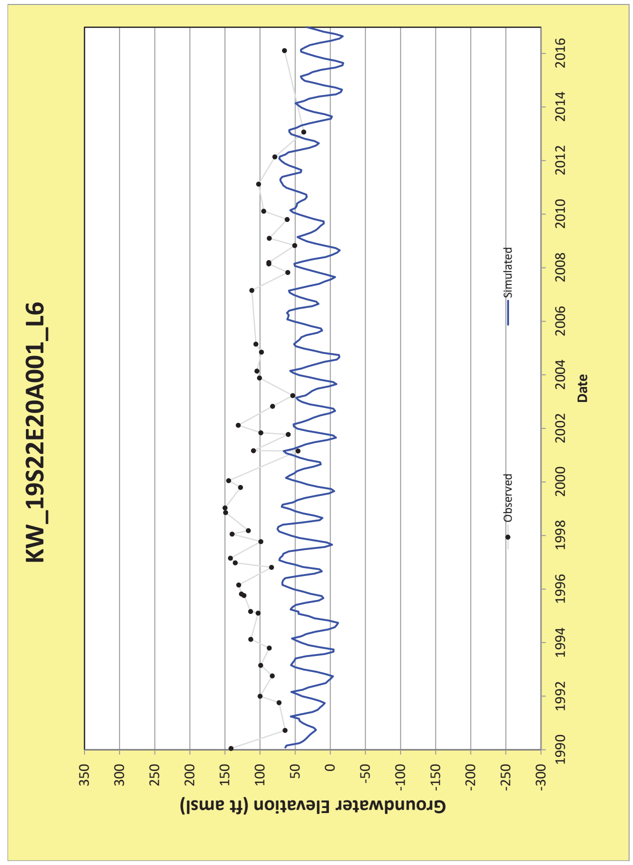
Date
Observed
Simulated


KW_19S22E20A001_L6
Groundwater Elevation (ft amsl)
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200
150
100
50
0
-50
-100
-150
-200
-250
-300
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2000
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2010
2012
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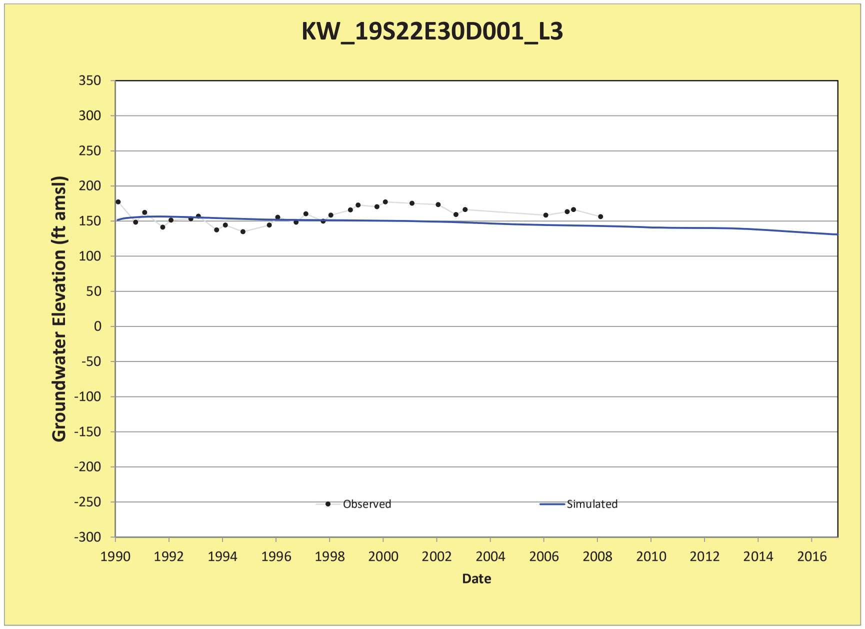
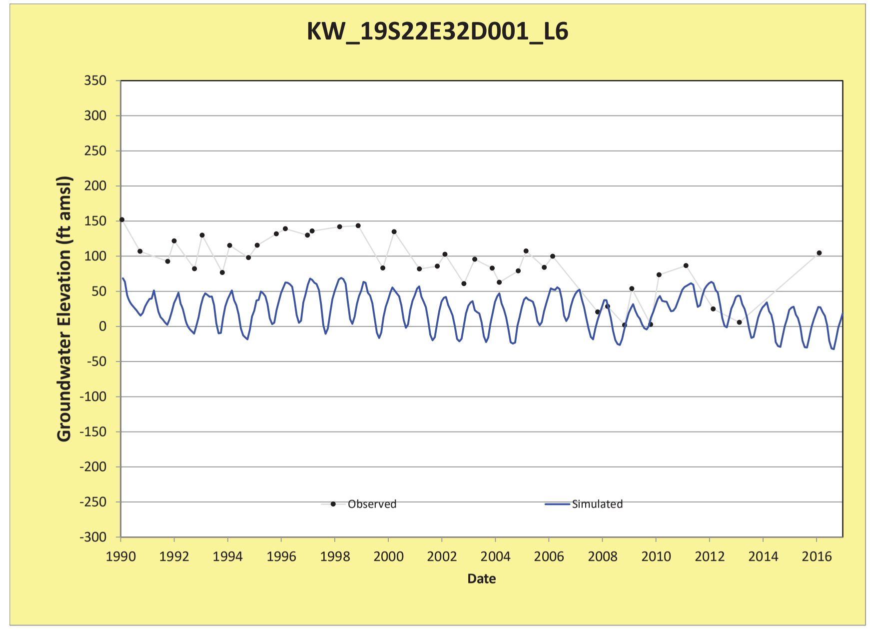
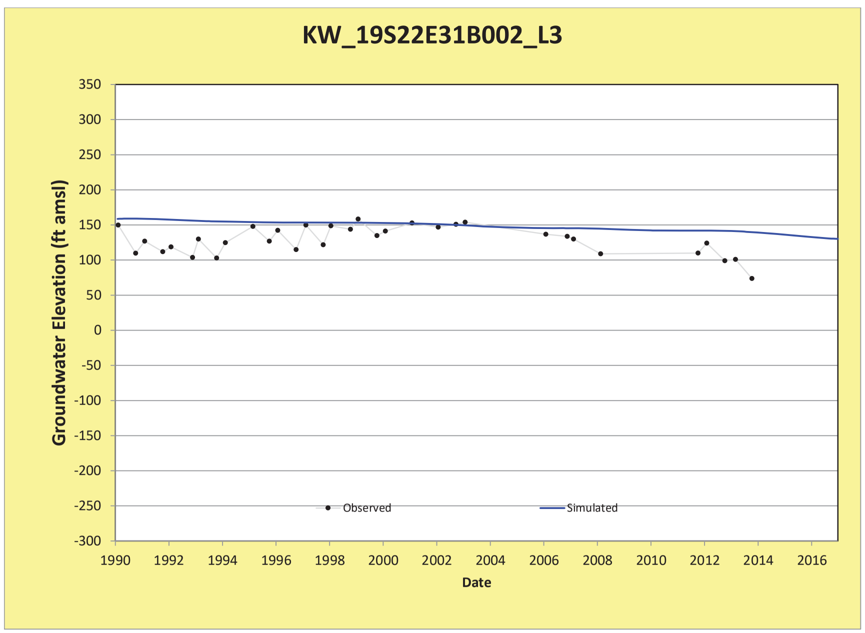
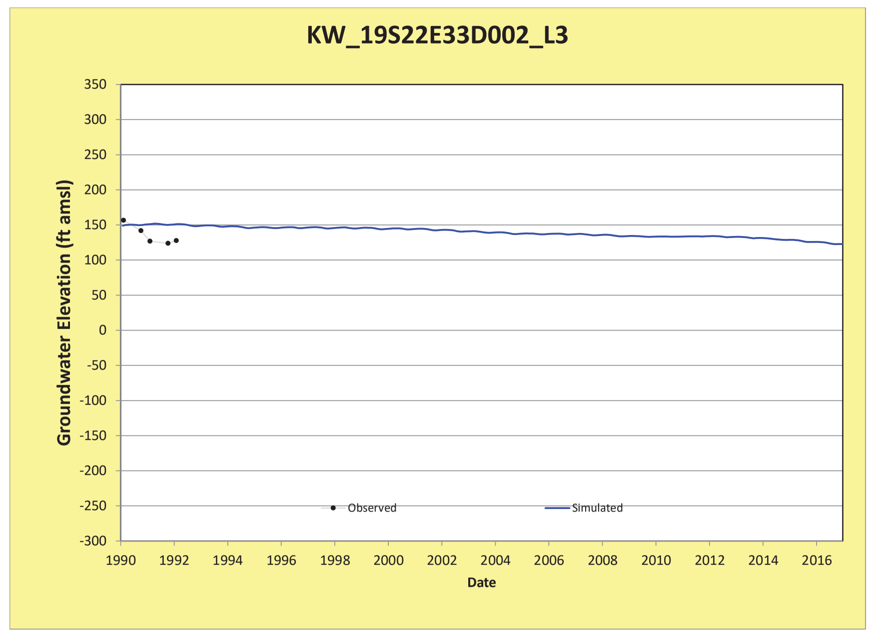
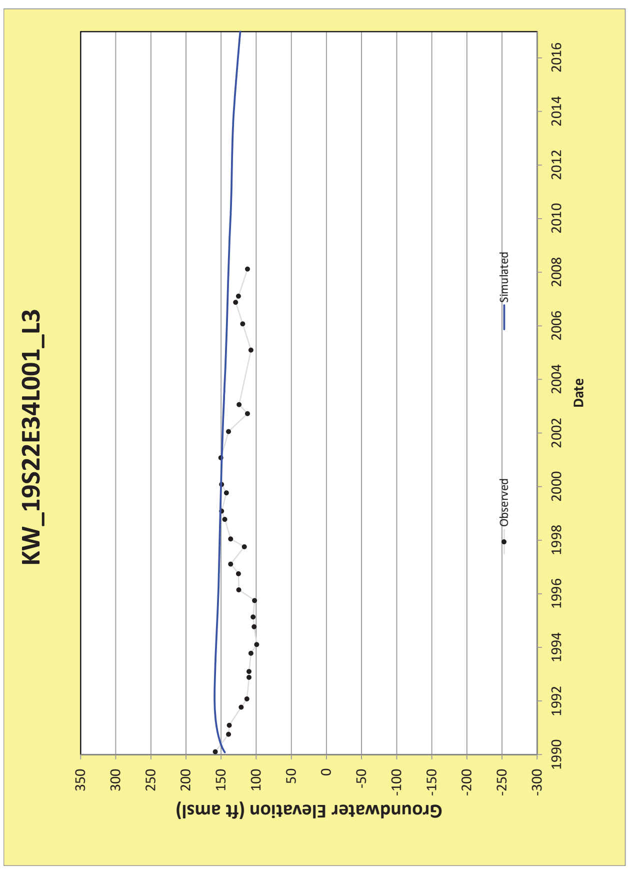
2016
Date
Observed
Simulated

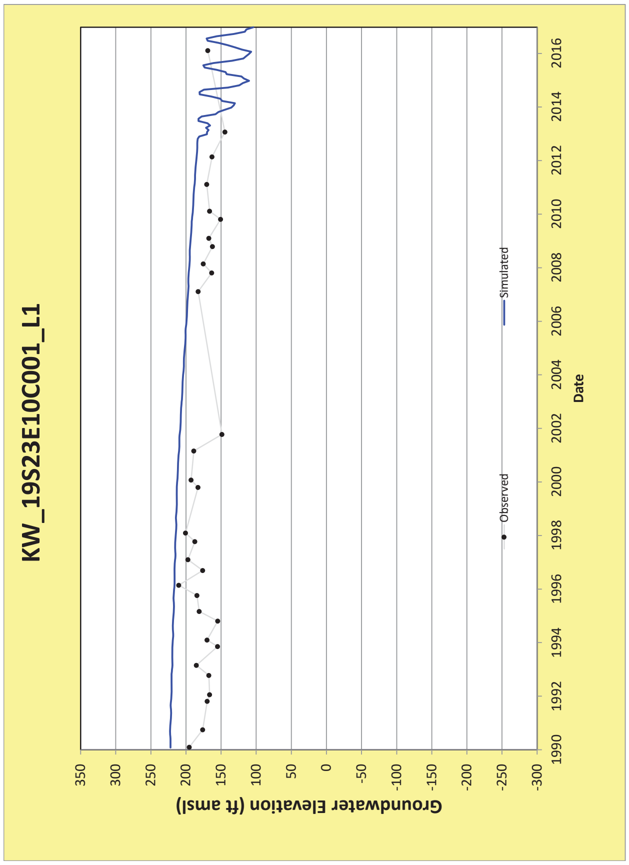

KW_19S22E30D001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

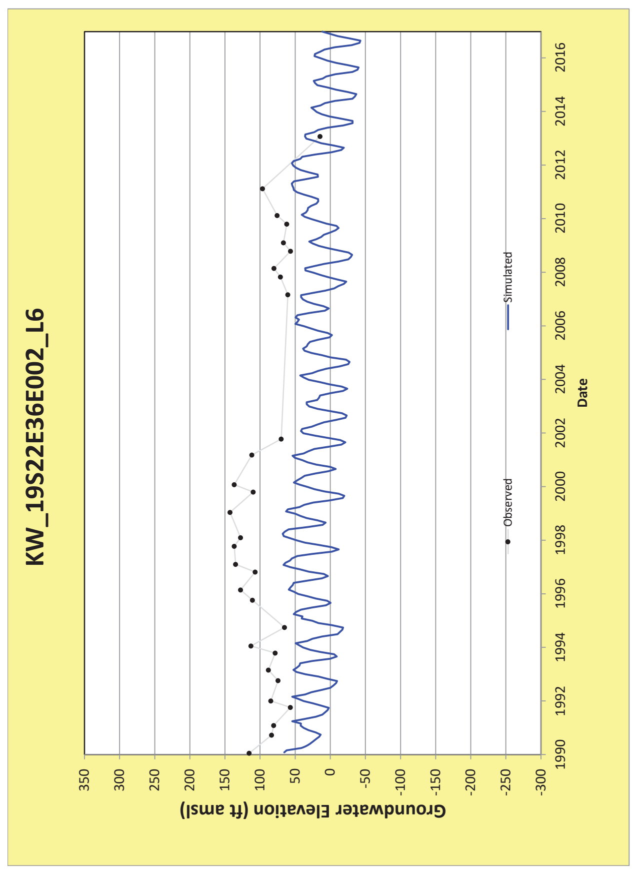

KW_19S22E32D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

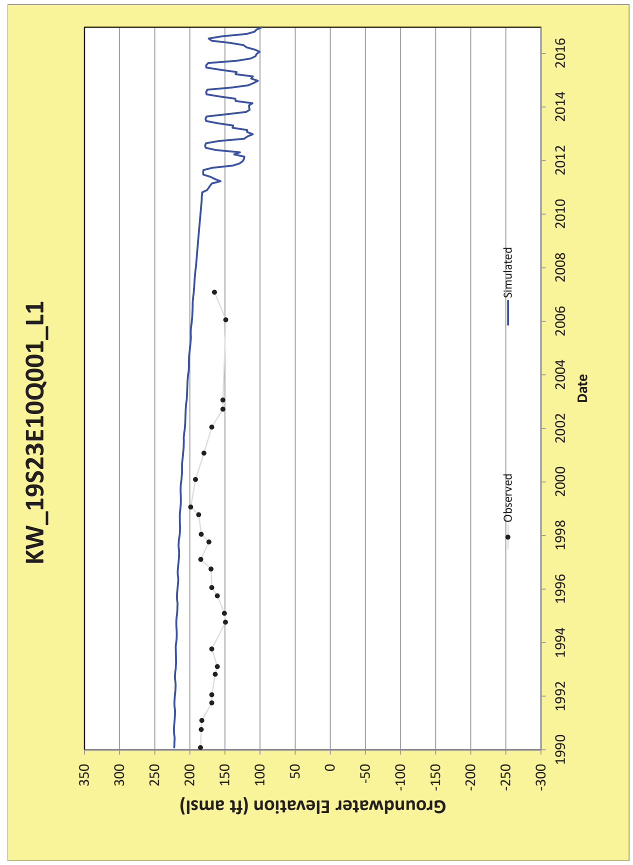

KW_19S22E31B002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

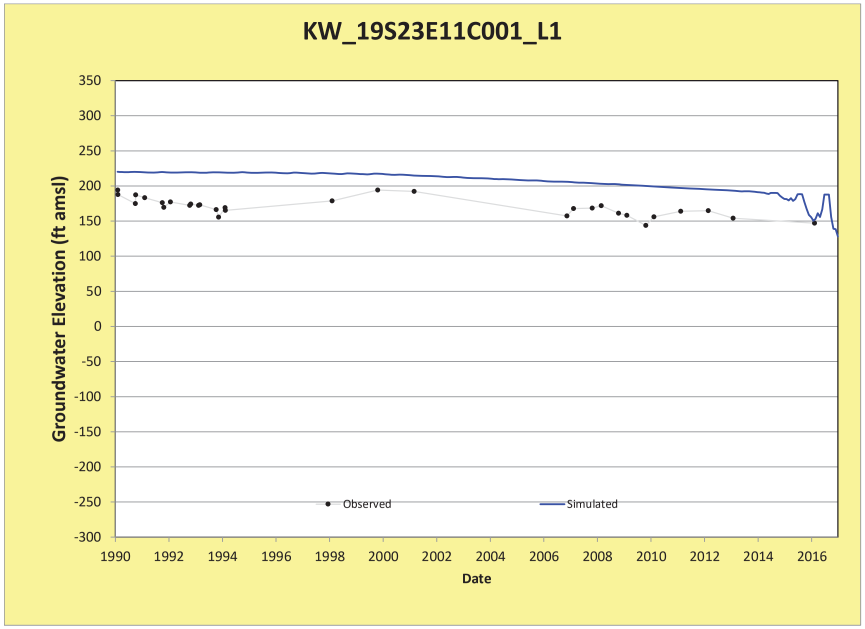

KW_19S22E33D002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

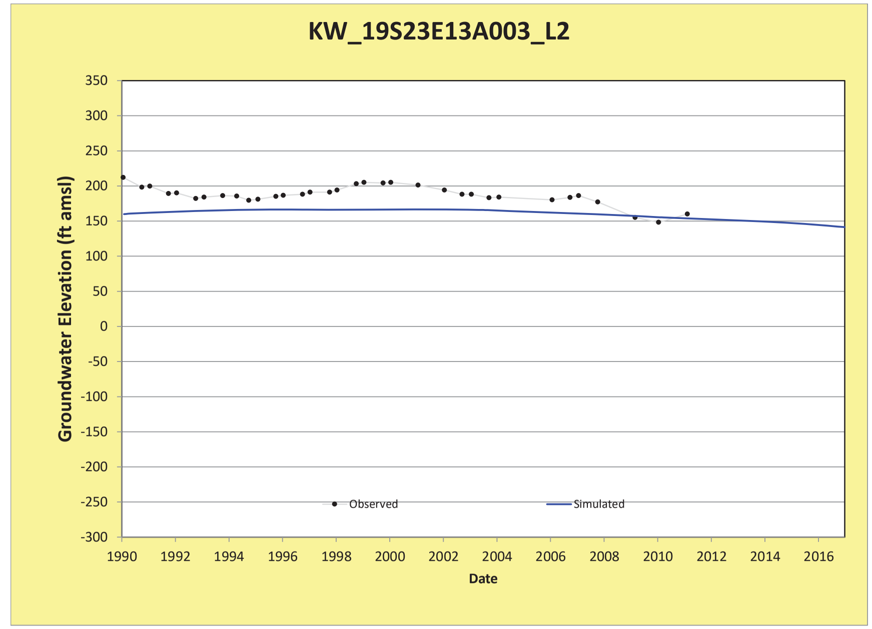

KW_19S22E34L001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

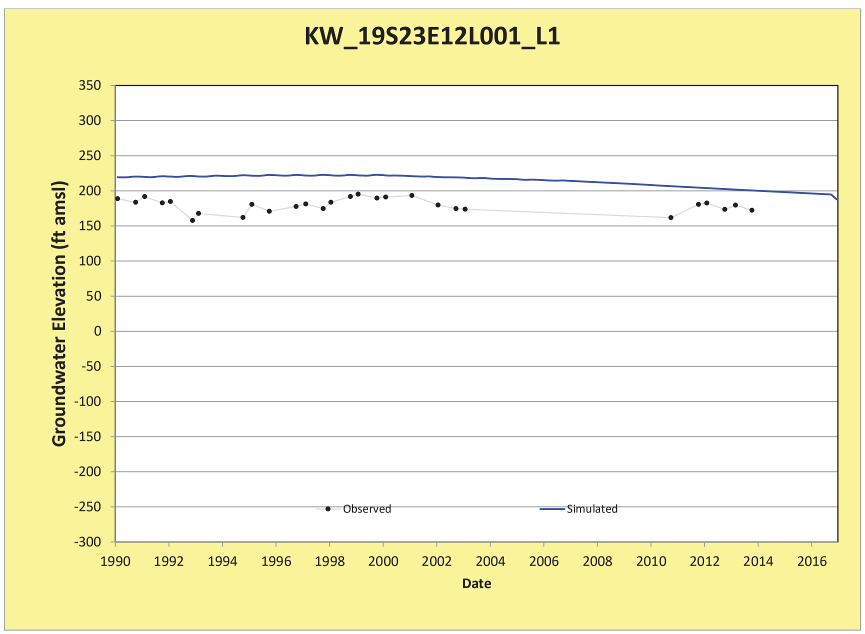

KW_19S23E10C001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

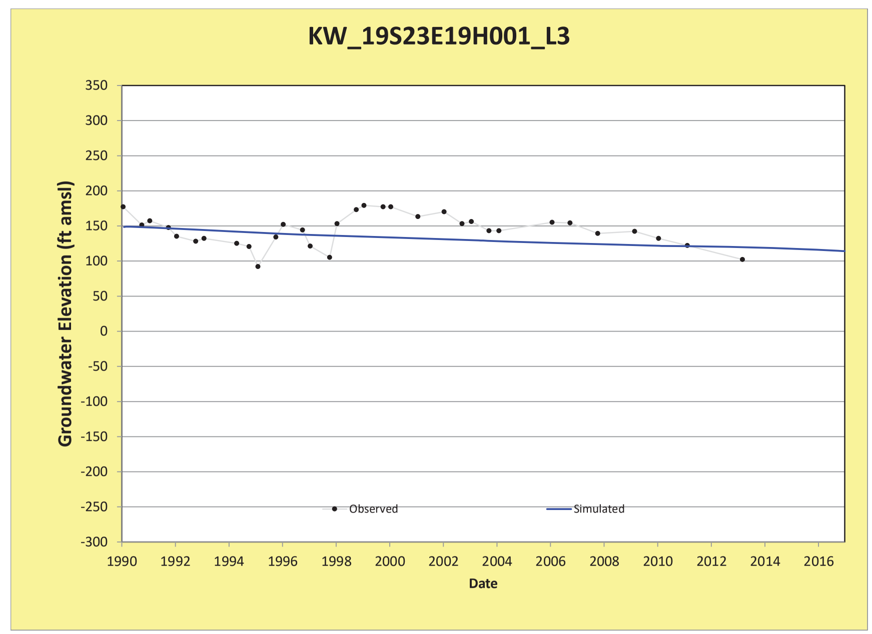

KW_19S22E36E002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

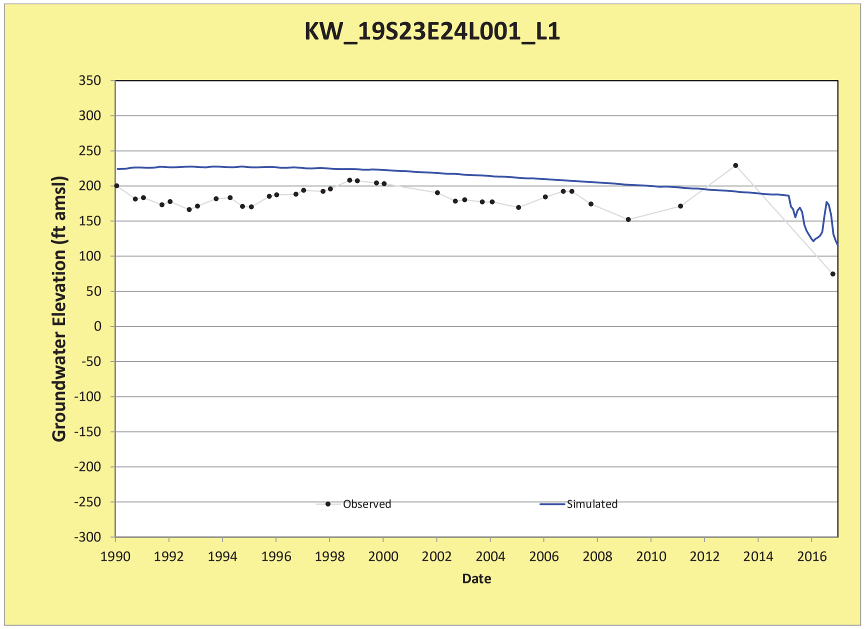

KW_19S23E10Q001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

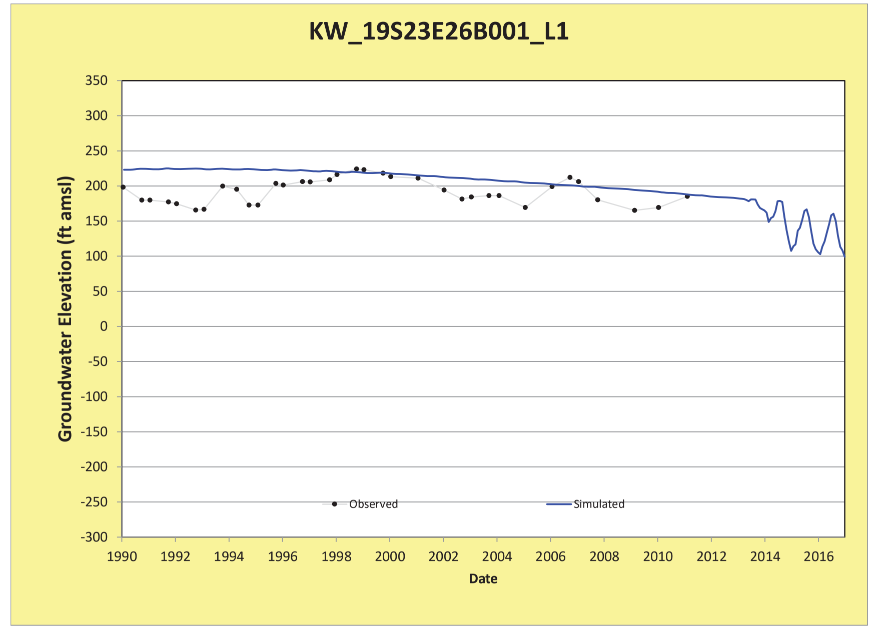

KW_19S23E11C001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

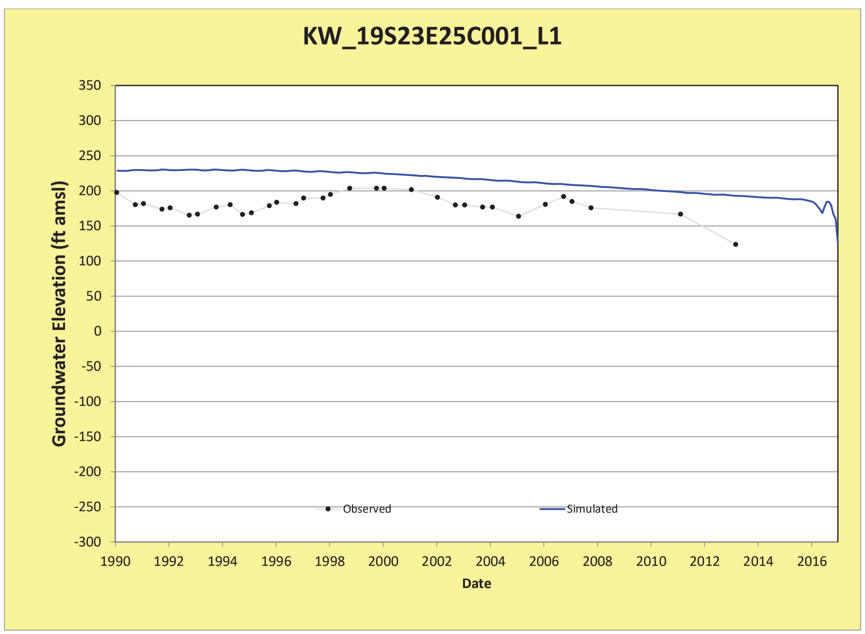

KW_19S23E13A003_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

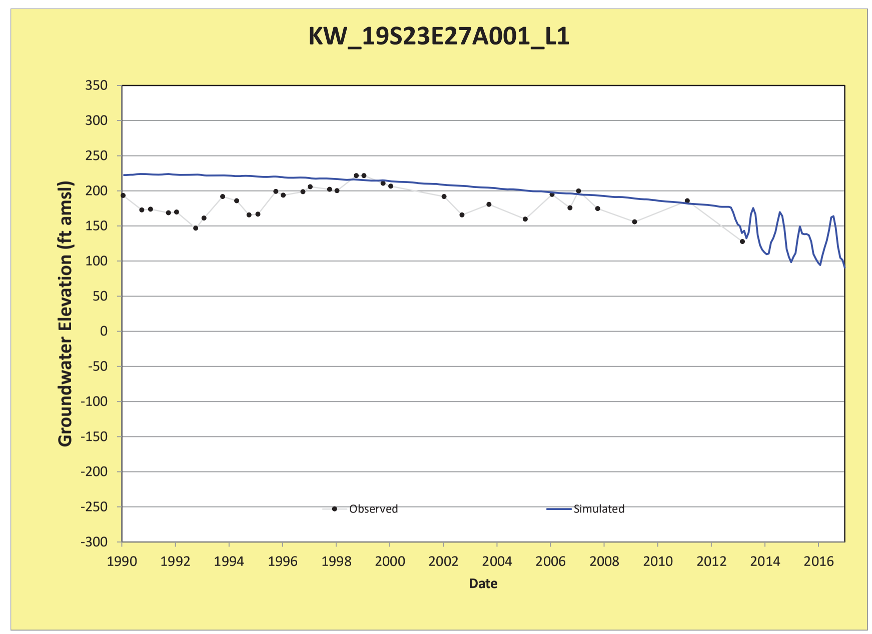

KW_19S23E12L001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

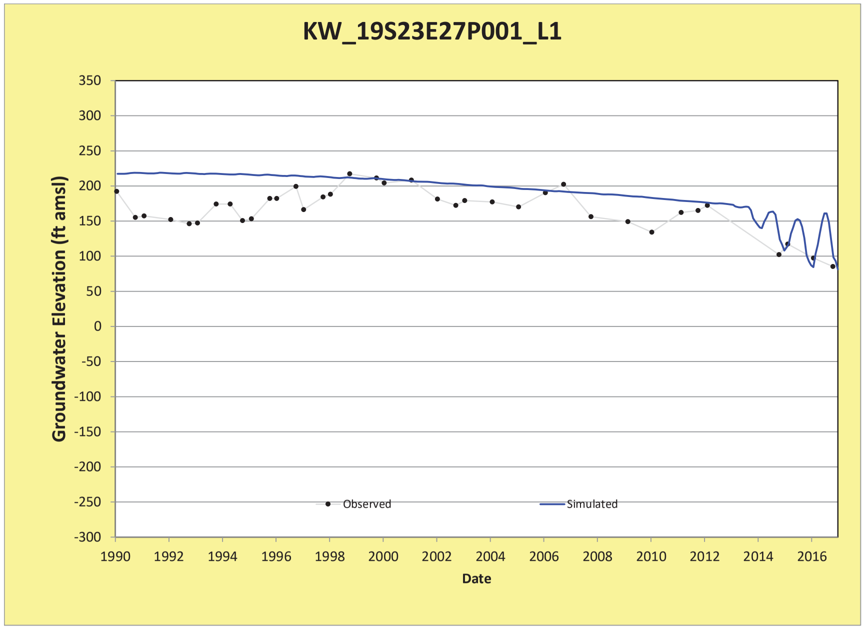

KW_19S23E19H001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S23E24L001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S23E26B001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S23E25C001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S23E27A001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S23E27P001_L1
Groundwater Elevation (ft amsl)
350
300
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-50
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-150
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-250
-300
1990
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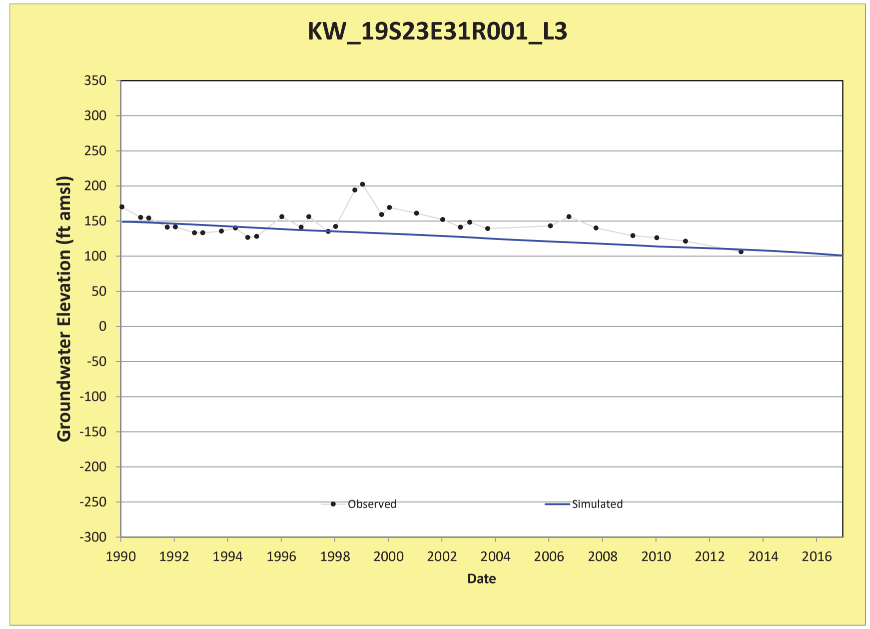
2016
Date
Observed
Simulated


KW_19S23E31R001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
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1998
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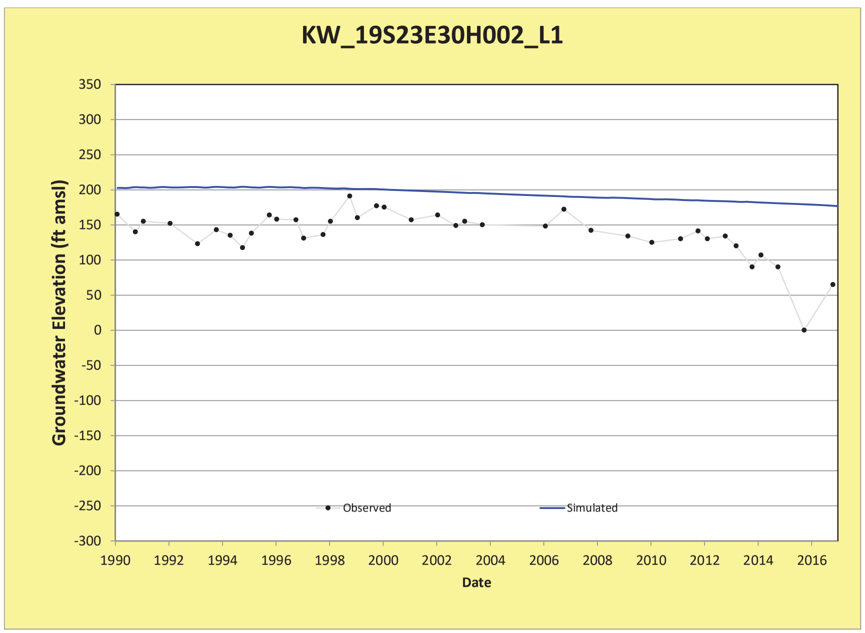
2012
2014
2016
Date
Observed
Simulated


KW_19S23E30H002_L1
Groundwater Elevation (ft amsl)
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300
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200
150
100
50
0
-50
-100
-150
-200
-250
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1992
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1996
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2000
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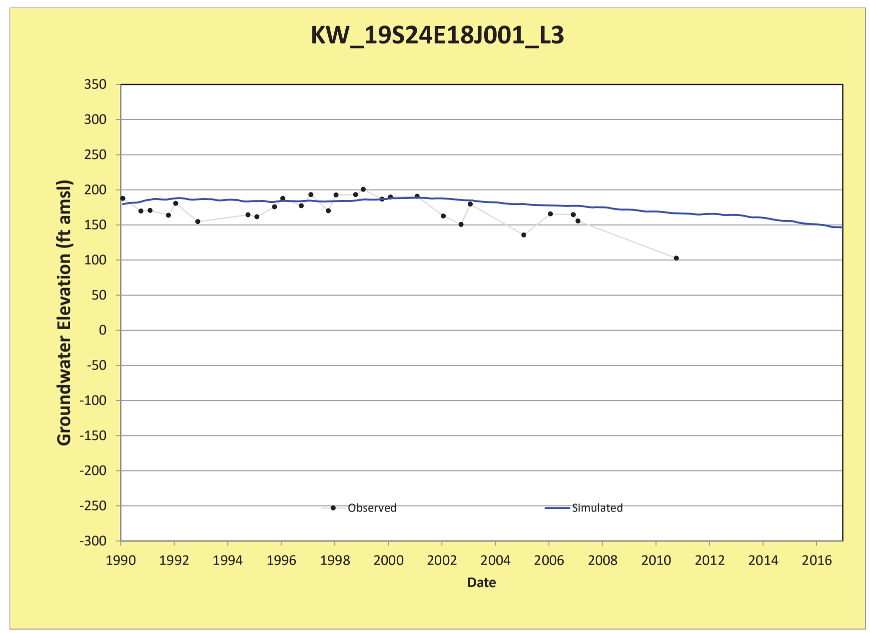
2010
2012
2014
2016
Date
Observed
Simulated


KW_19S24E18J001_L3
Groundwater Elevation (ft amsl)
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200
150
100
50
0
-50
-100
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-200
-250
-300
1990
1992
1994
1996
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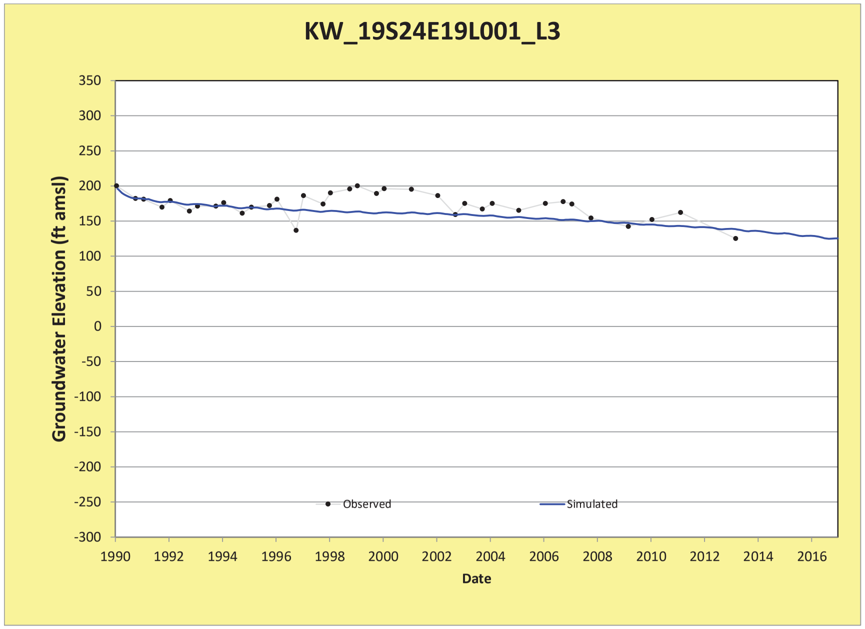
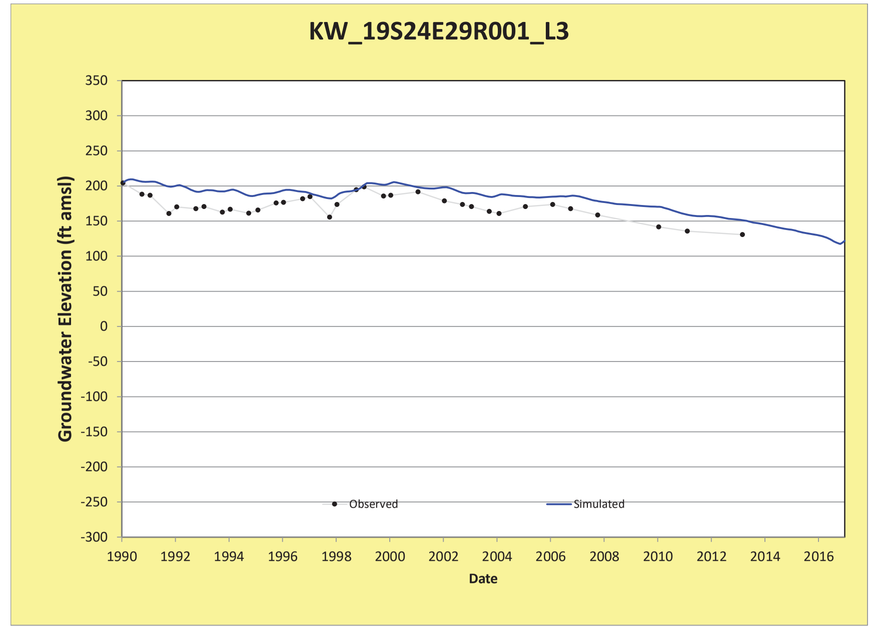
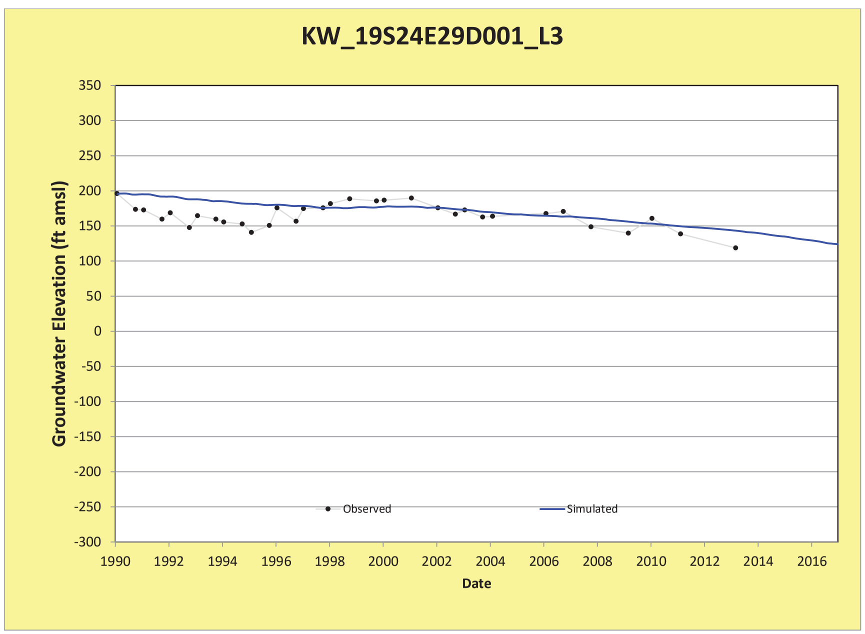
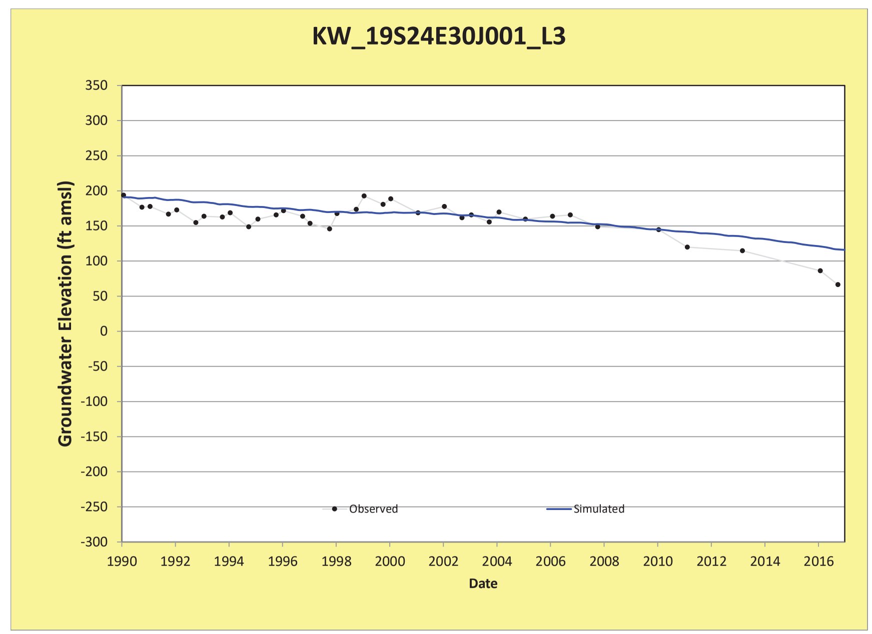
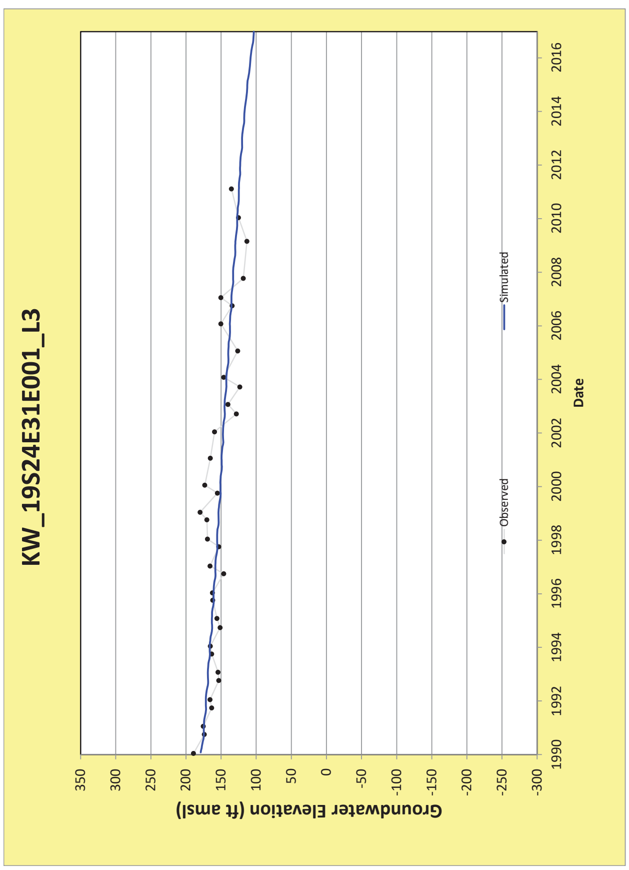
2016
Date
Observed
Simulated

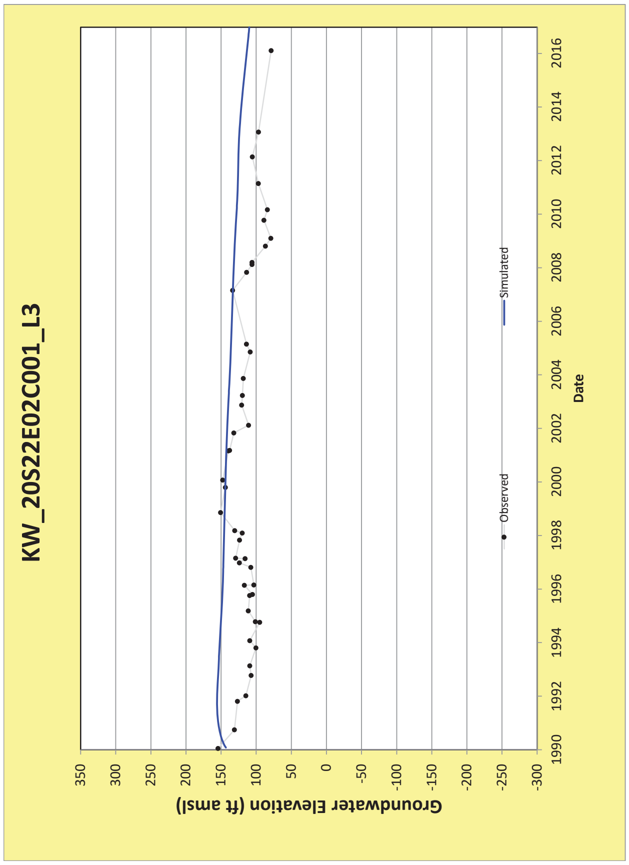

KW_19S24E19L001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S24E29R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S24E29D001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S24E30J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_19S24E31E001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S22E02C001_L3
Groundwater Elevation (ft amsl)
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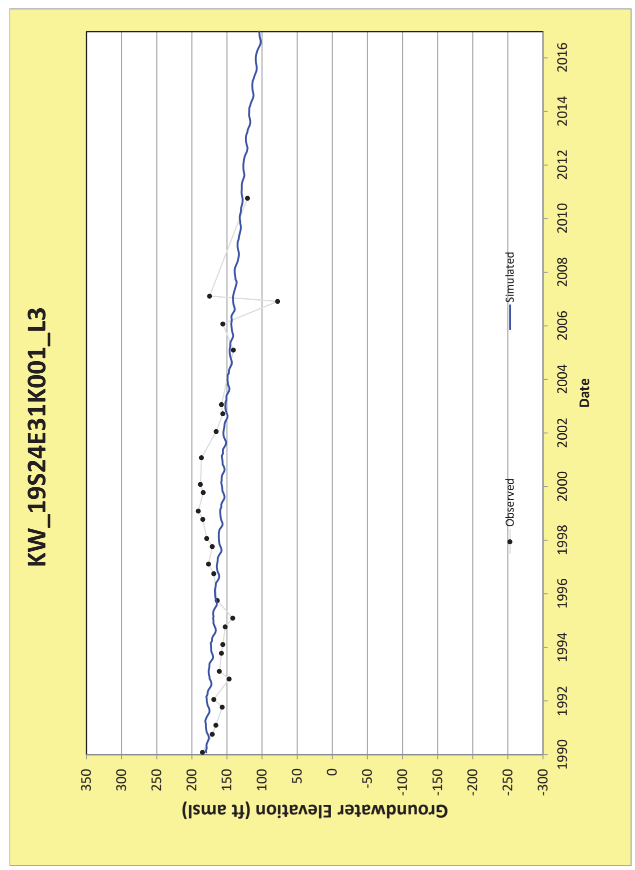
Observed
Simulated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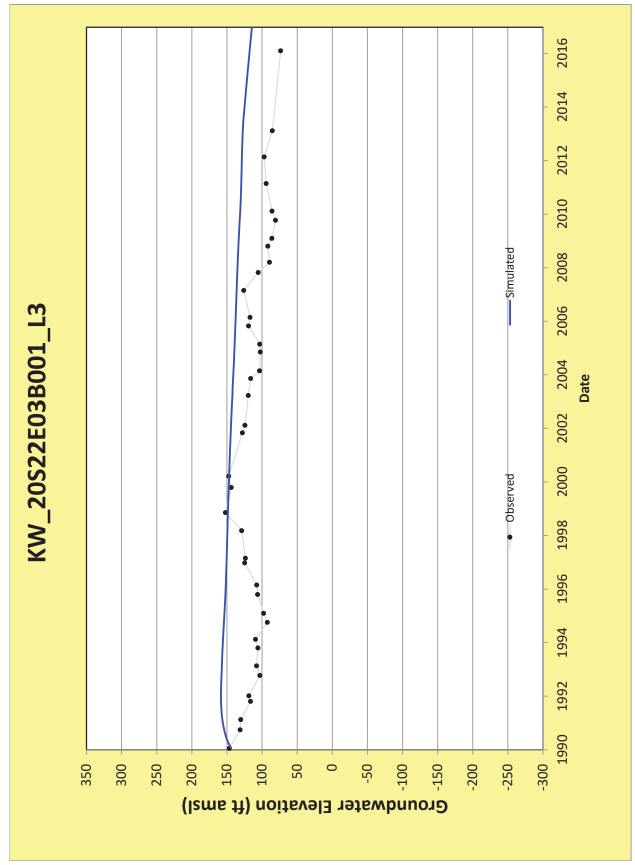
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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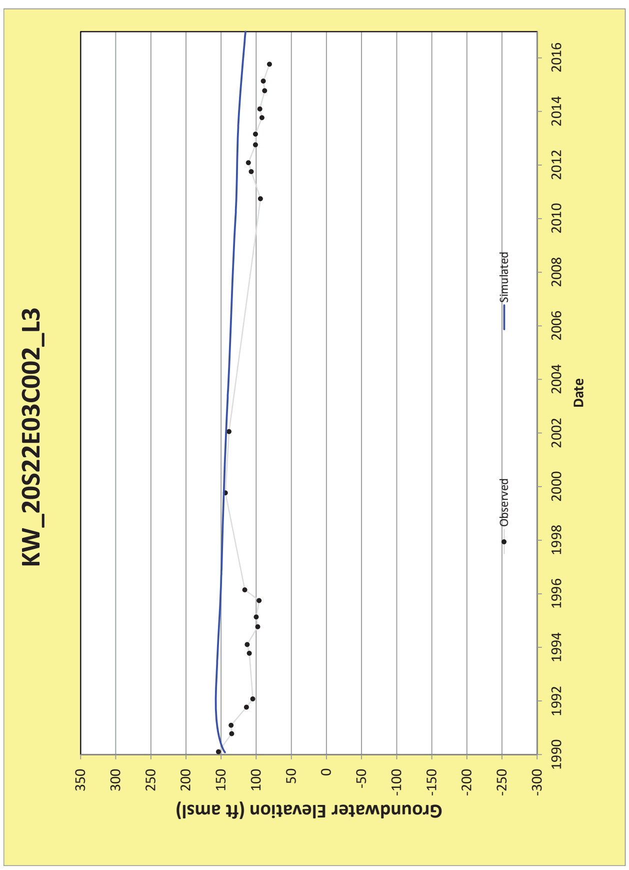
Observed
Simulated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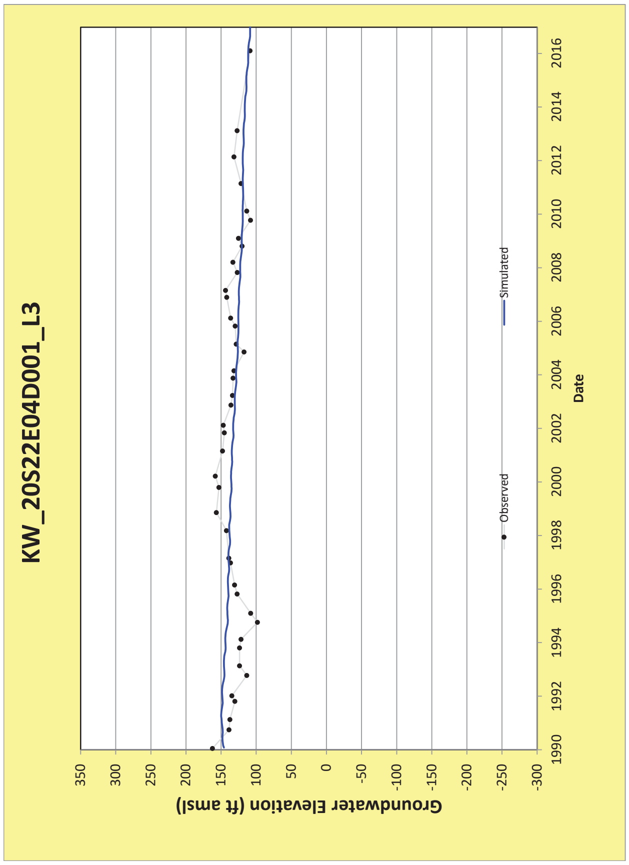
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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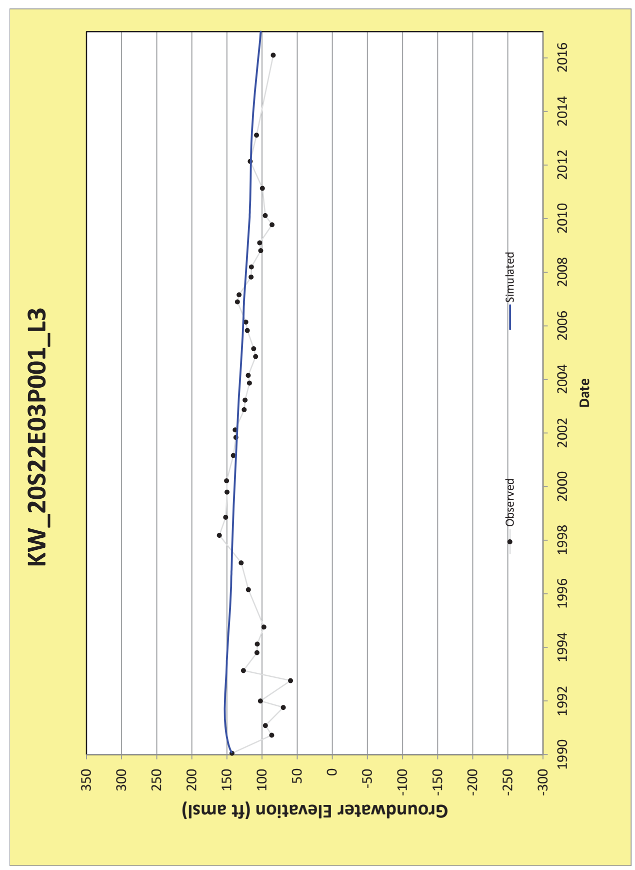
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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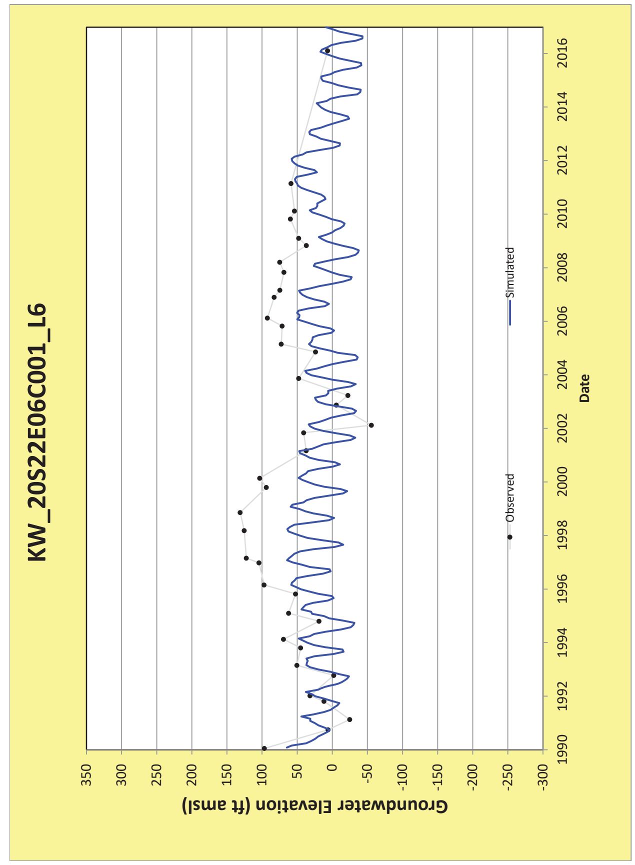
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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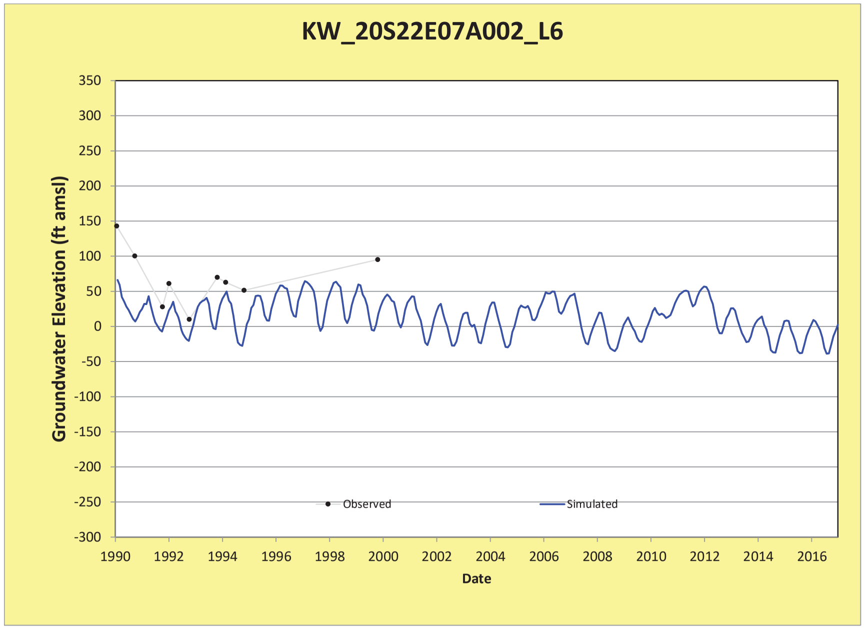
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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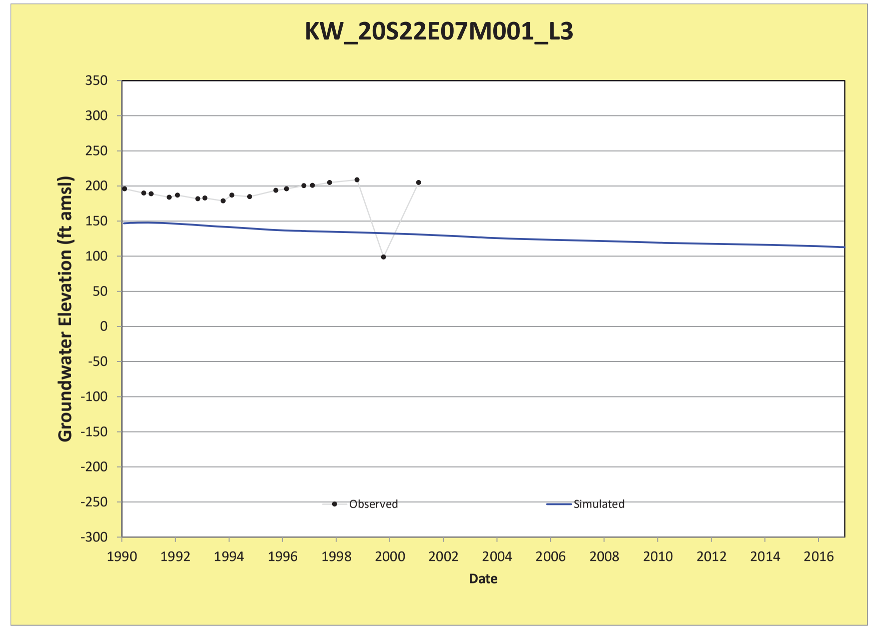
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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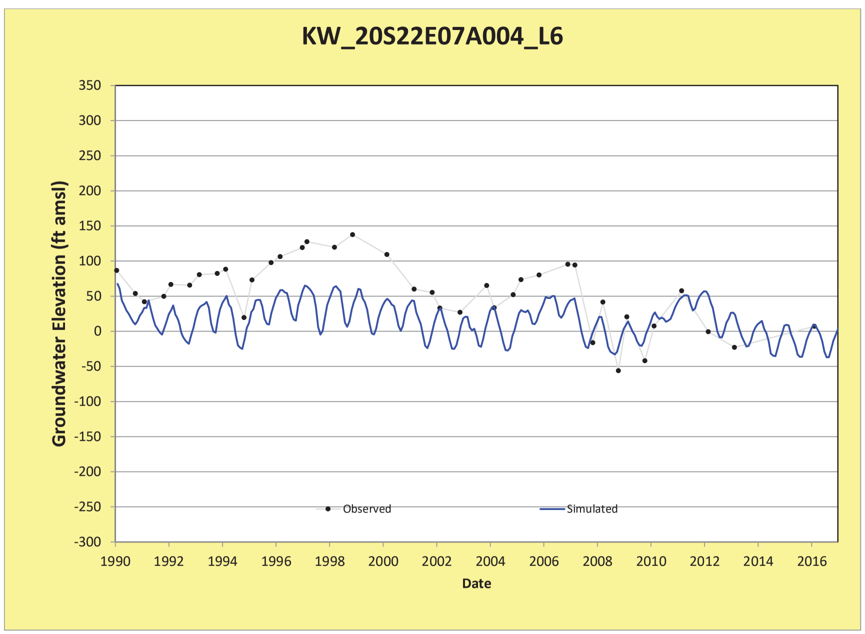
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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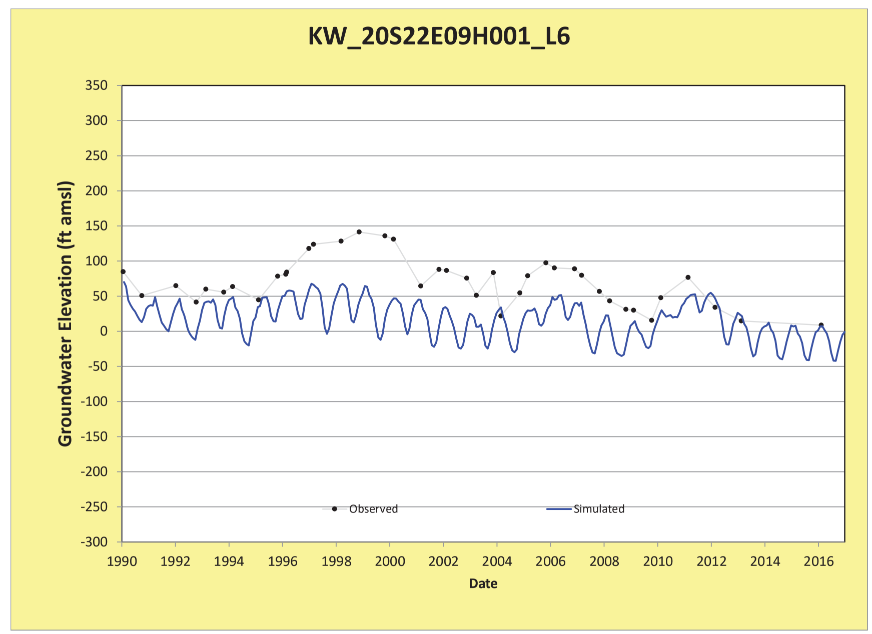
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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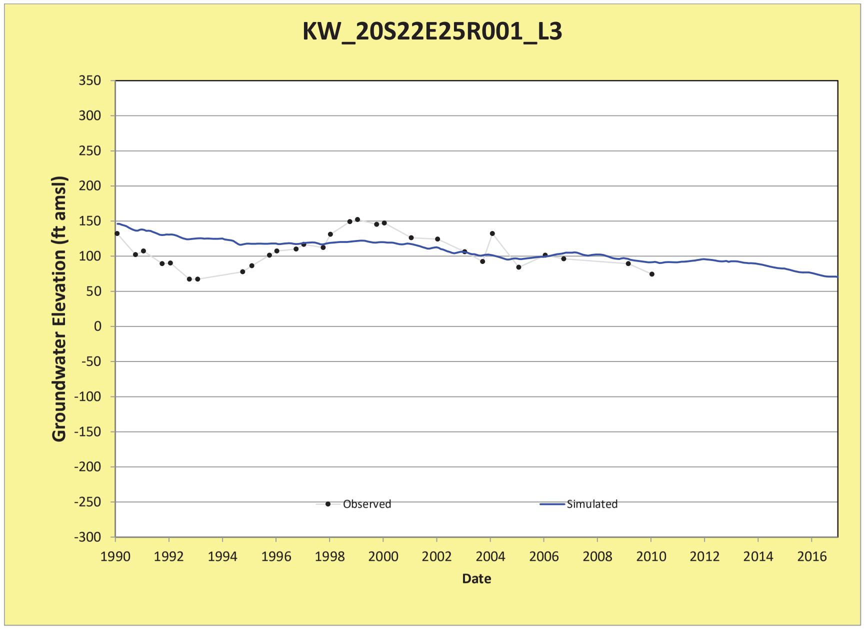
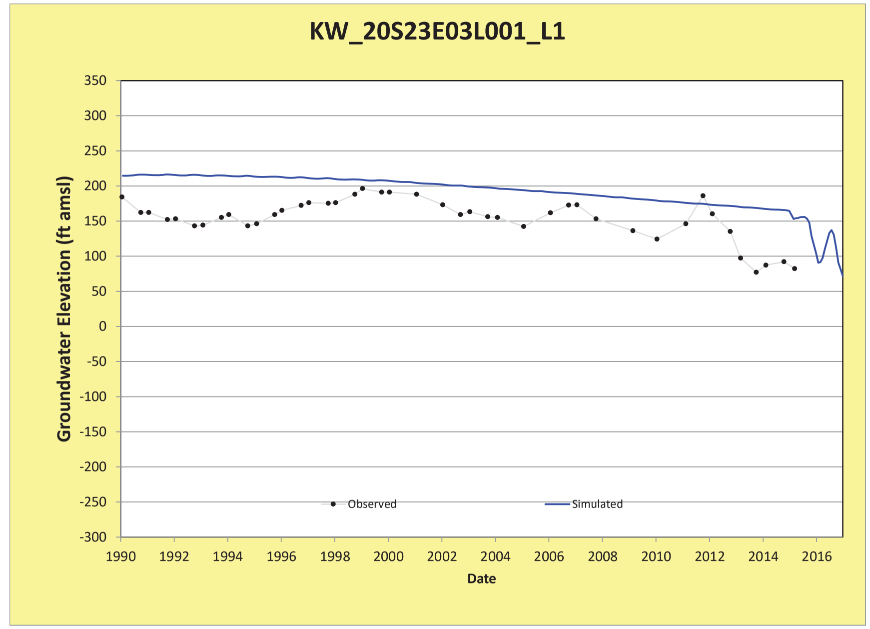
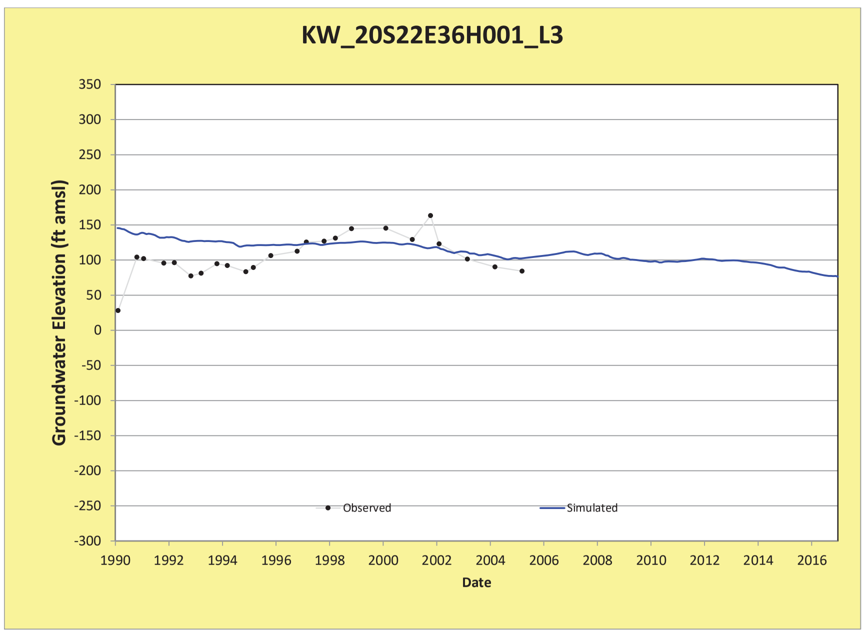
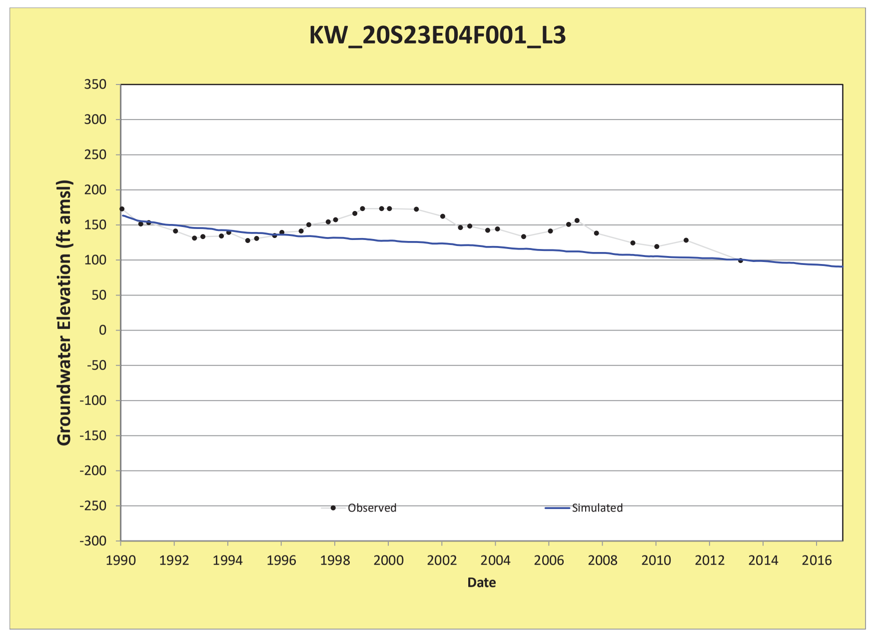
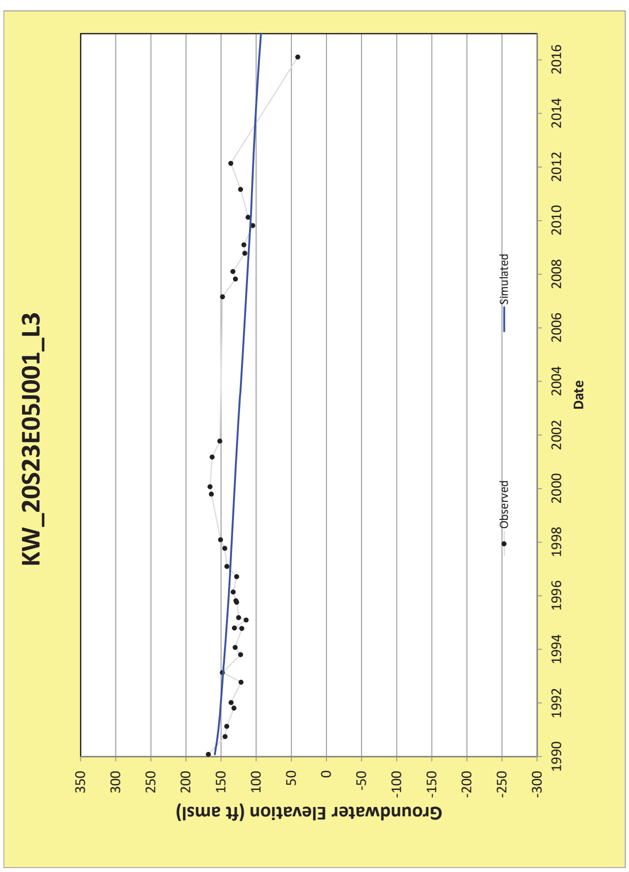
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S22E25R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S23E03L001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S22E36H001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S23E04F001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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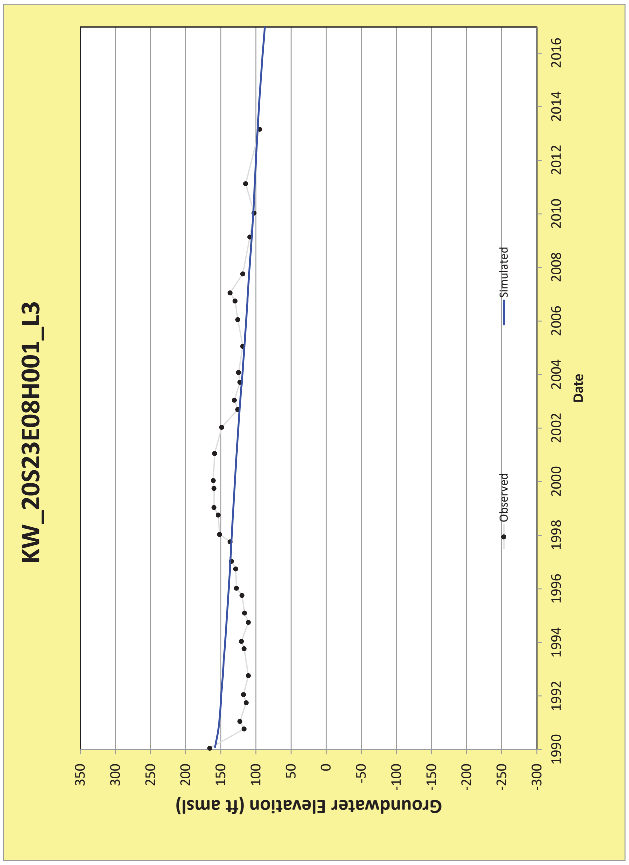
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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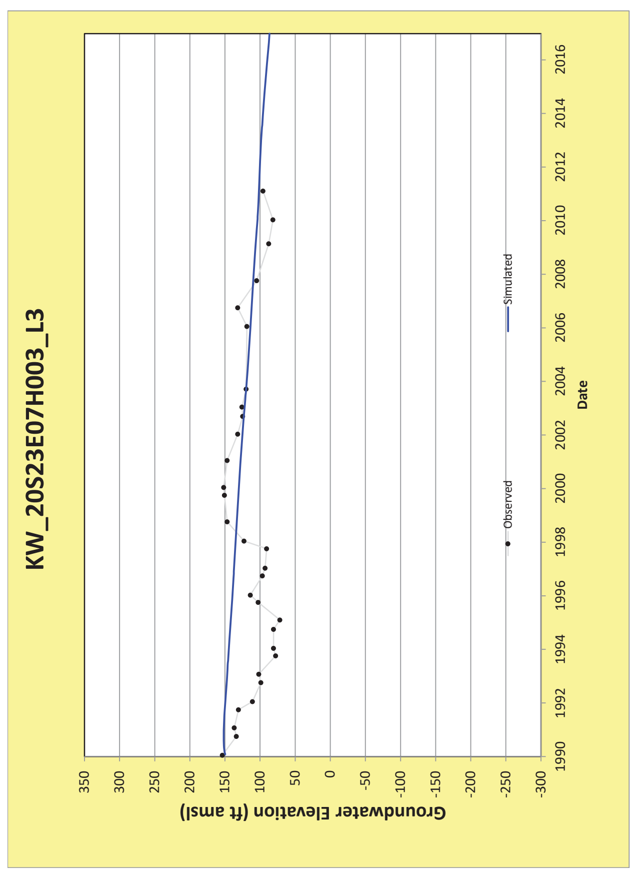
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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Observed
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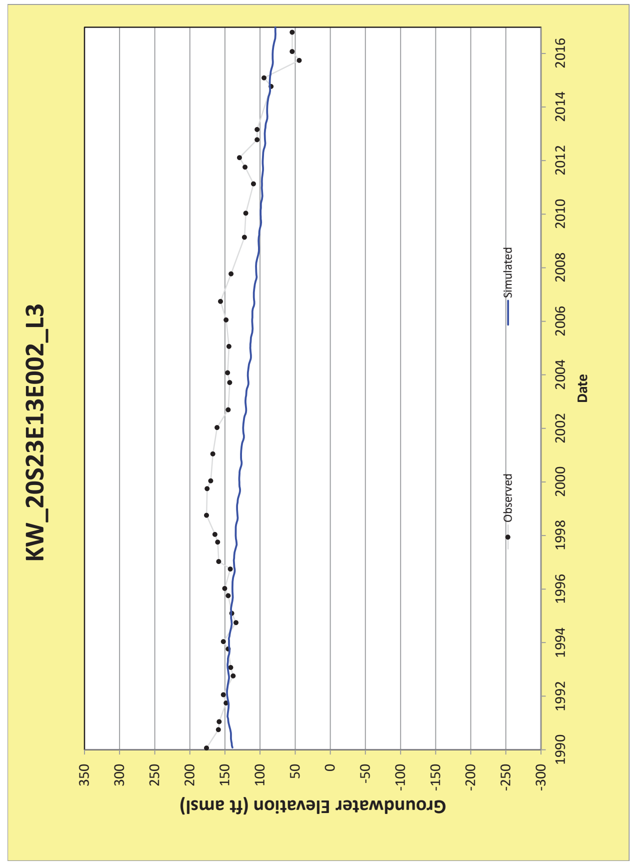
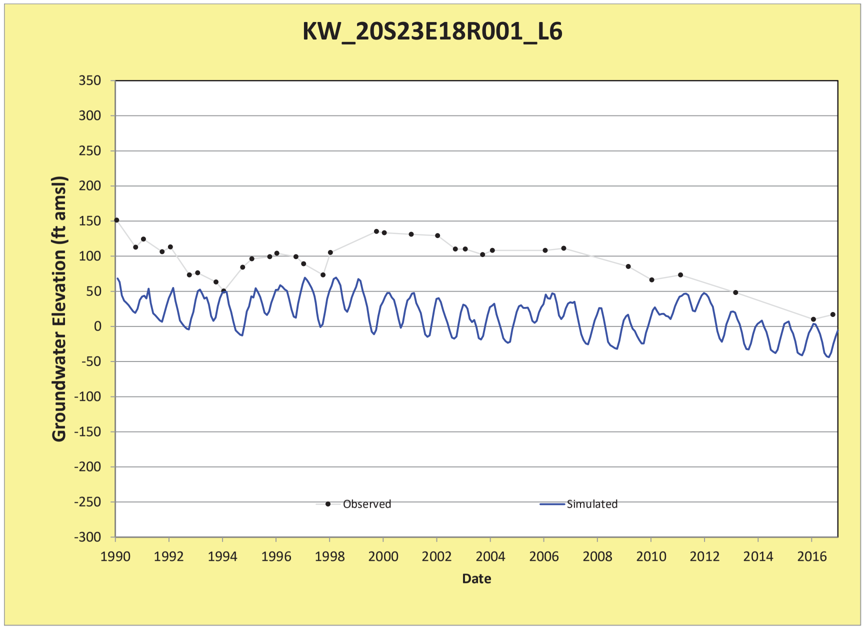
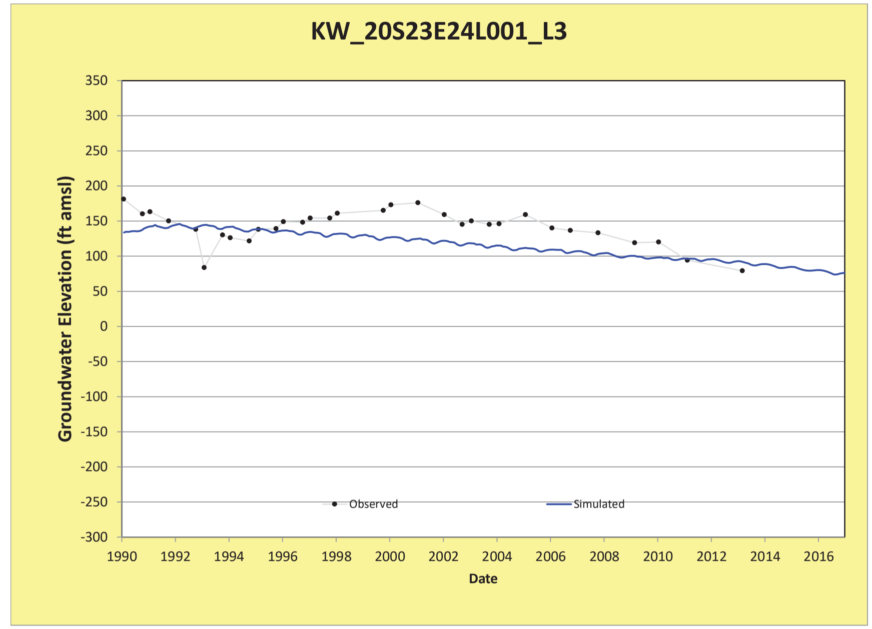

KW_20S23E13E002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S23E18R001_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


KW_20S23E24L001_L3
Groundwater Elevation (ft amsl)
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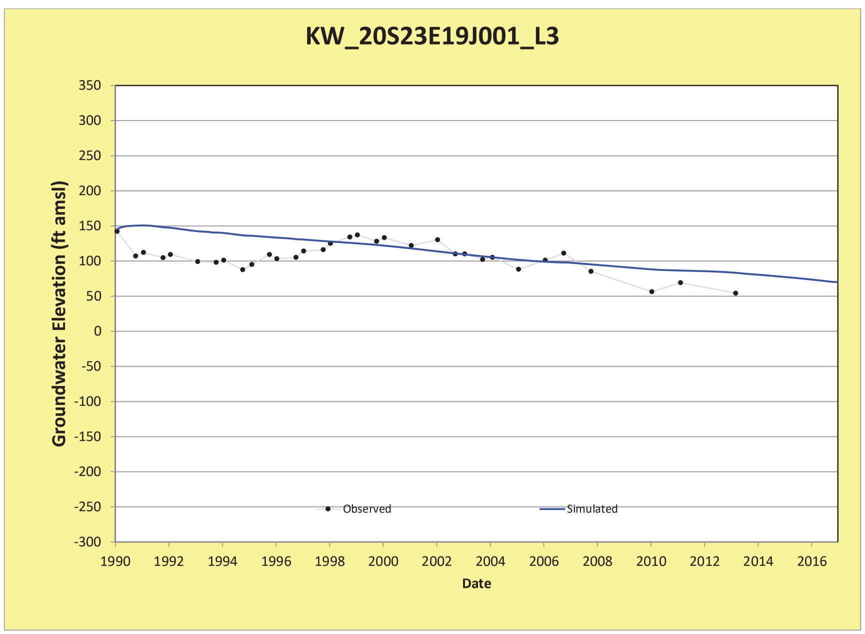
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


KW_20S23E19J001_L3
Groundwater Elevation (ft amsl)
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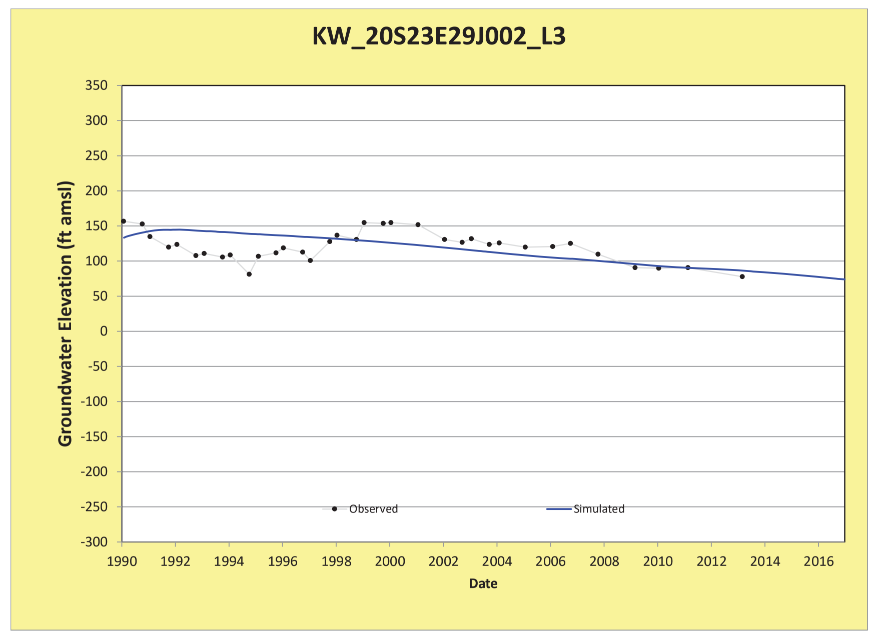
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


KW_20S23E29J002_L3
Groundwater Elevation (ft amsl)
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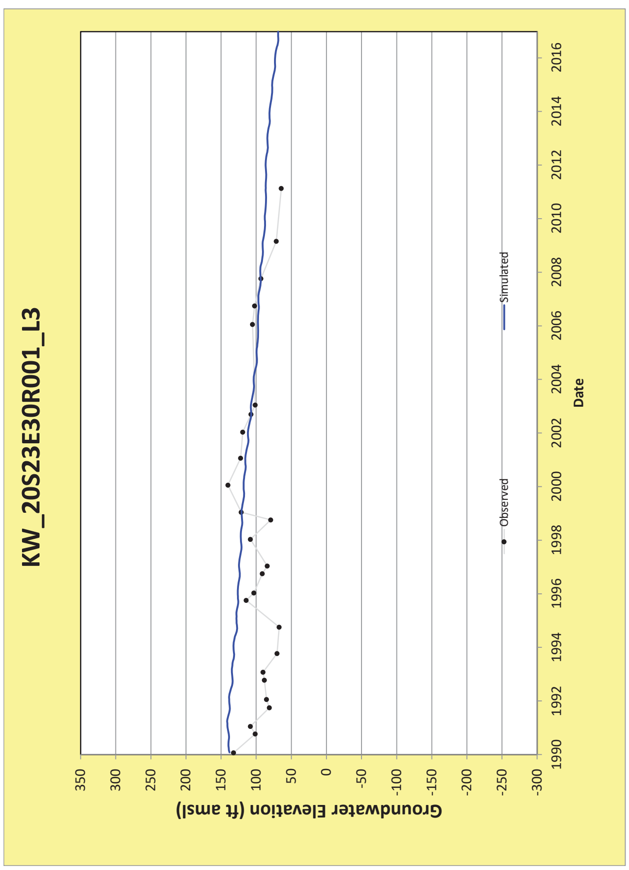
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated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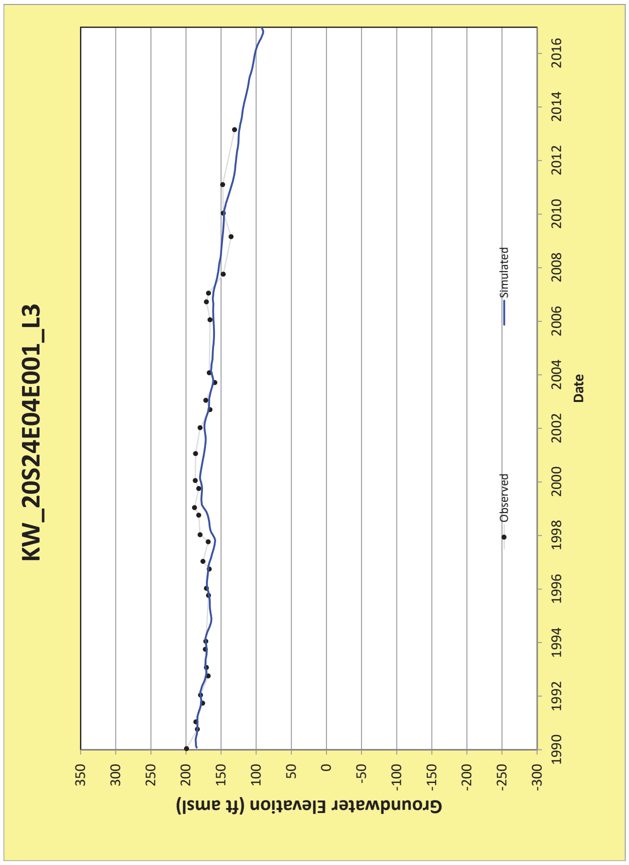
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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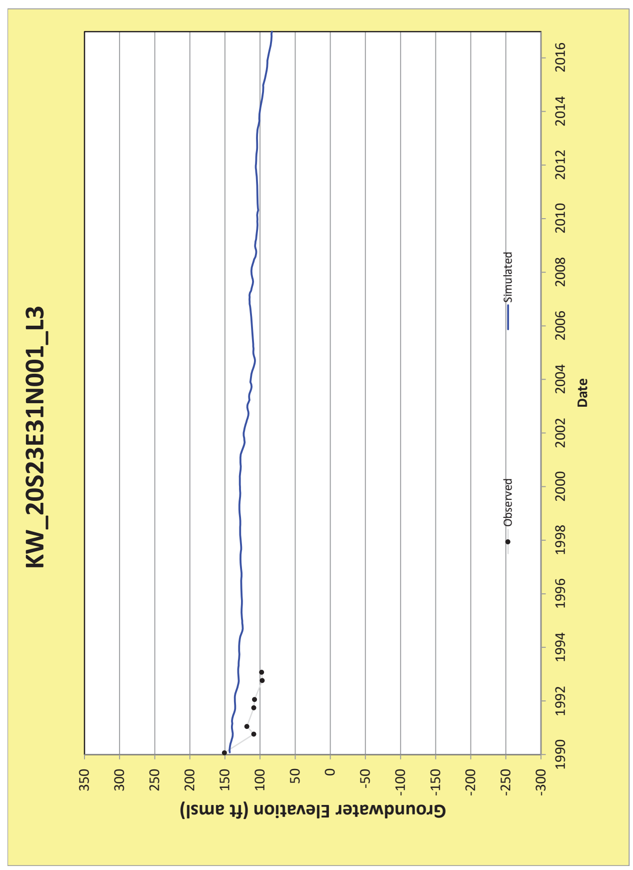
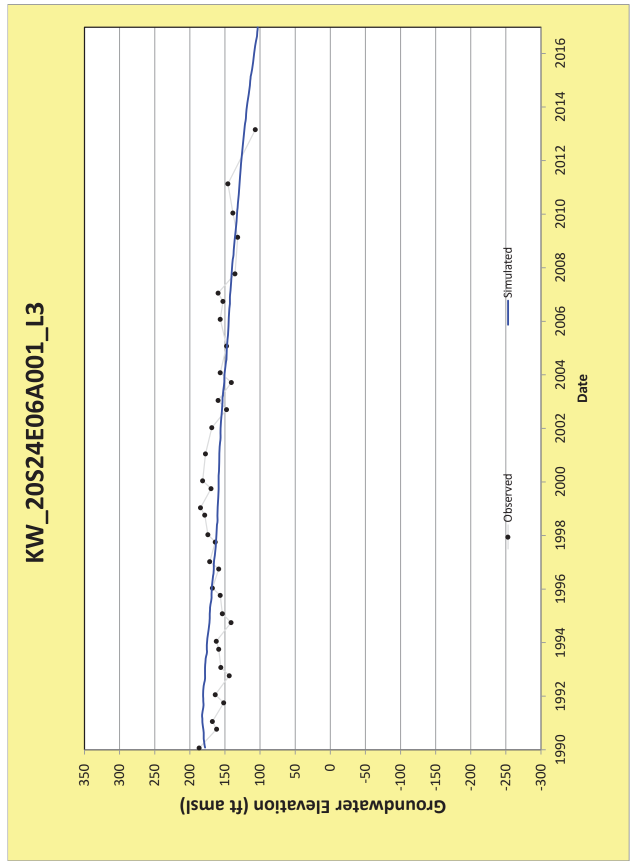
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_20S23E31N001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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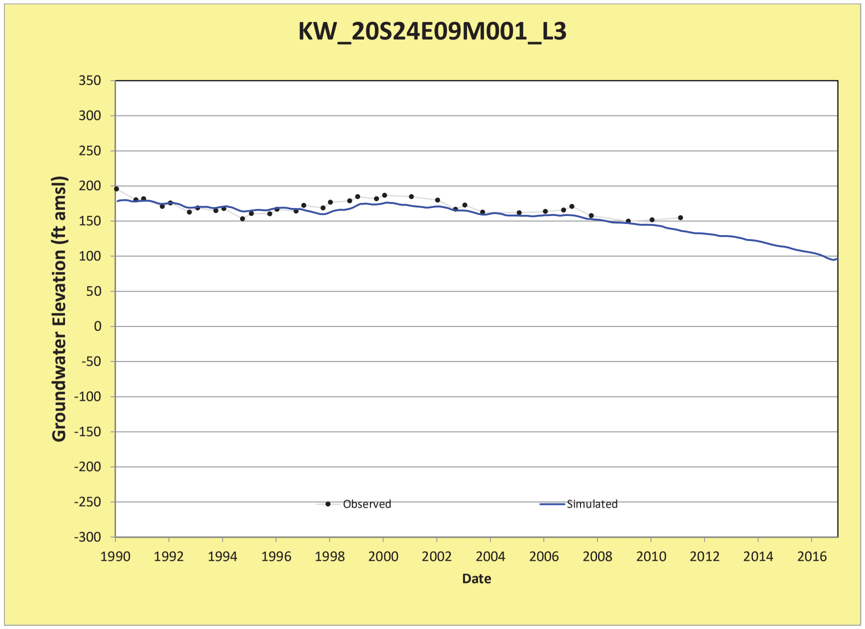
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
Date
Observed
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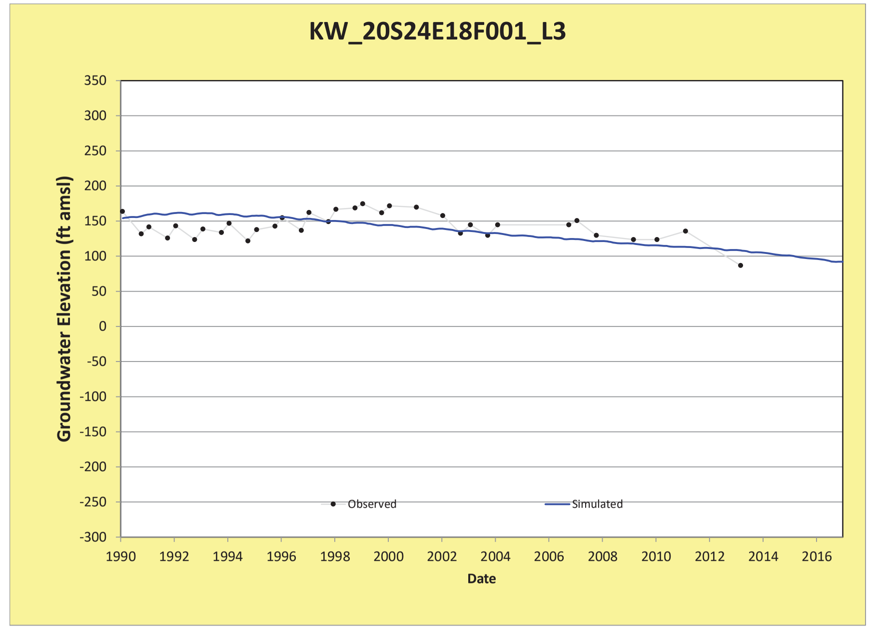
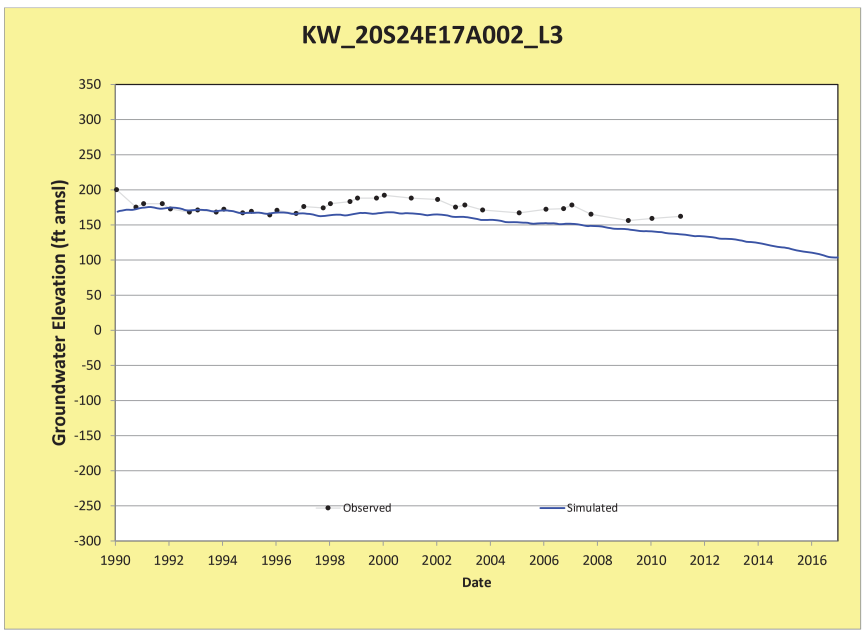

KW_20S24E18F001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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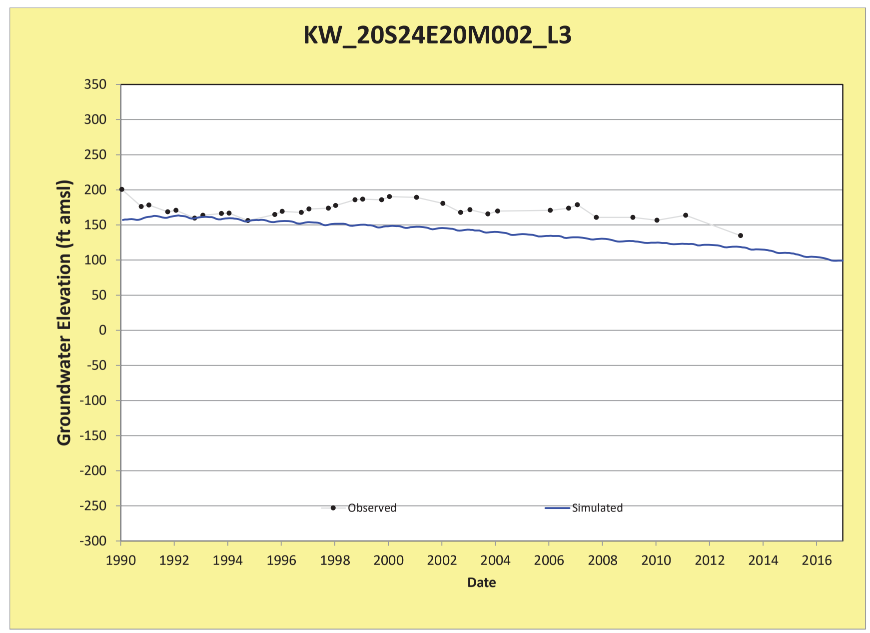
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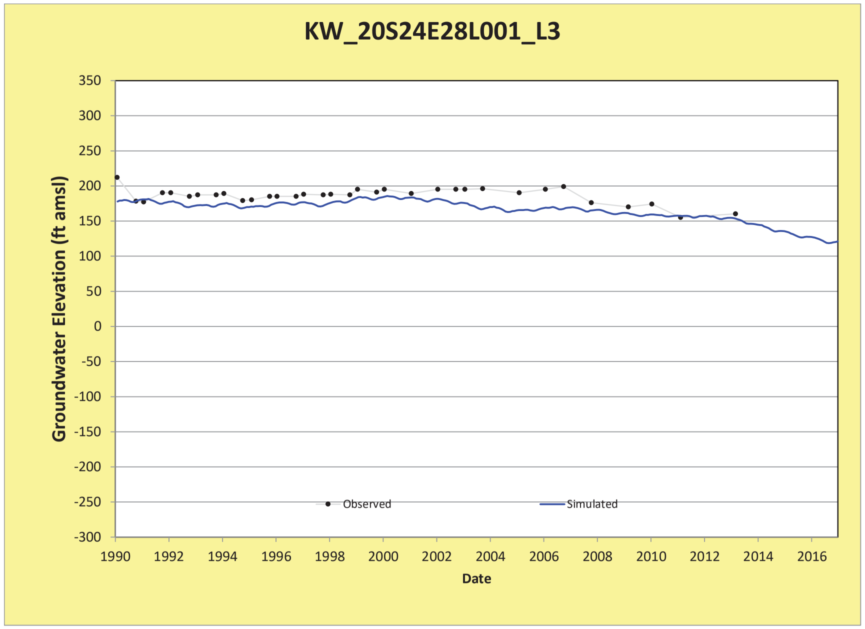
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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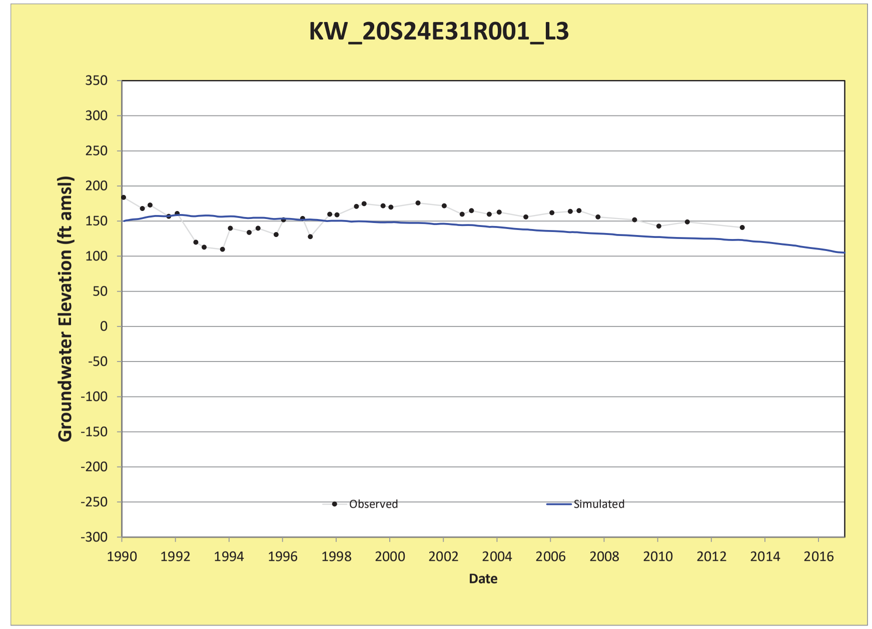
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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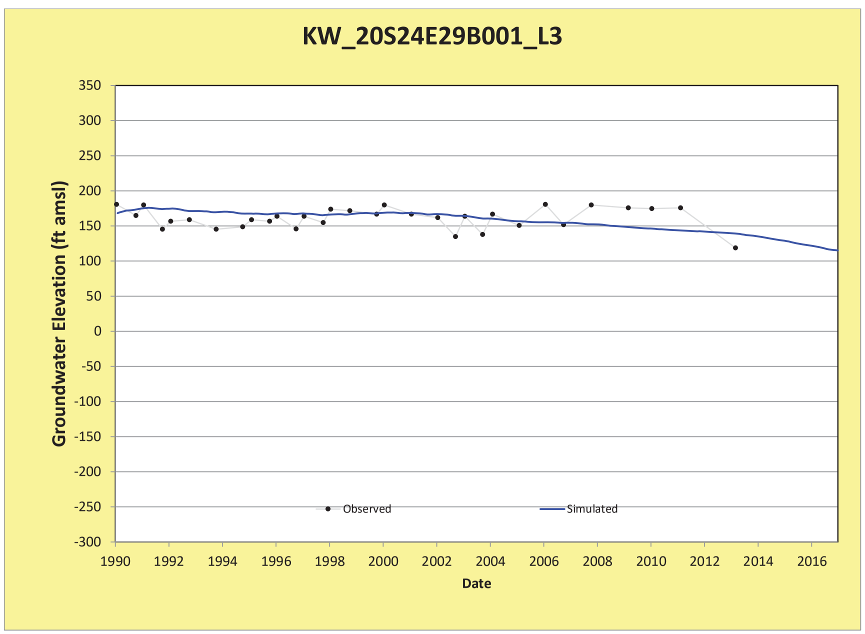
KW_20S24E29B001_L3
Groundwater Elevation (ft amsl)
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Date
Observed
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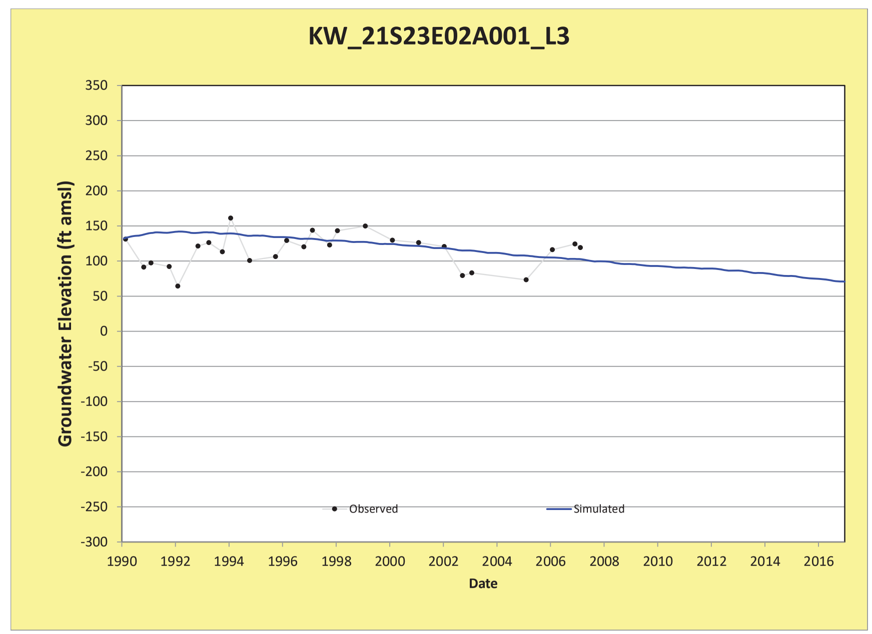
KW_21S23E02A001_L3
Groundwater Elevation (ft amsl)
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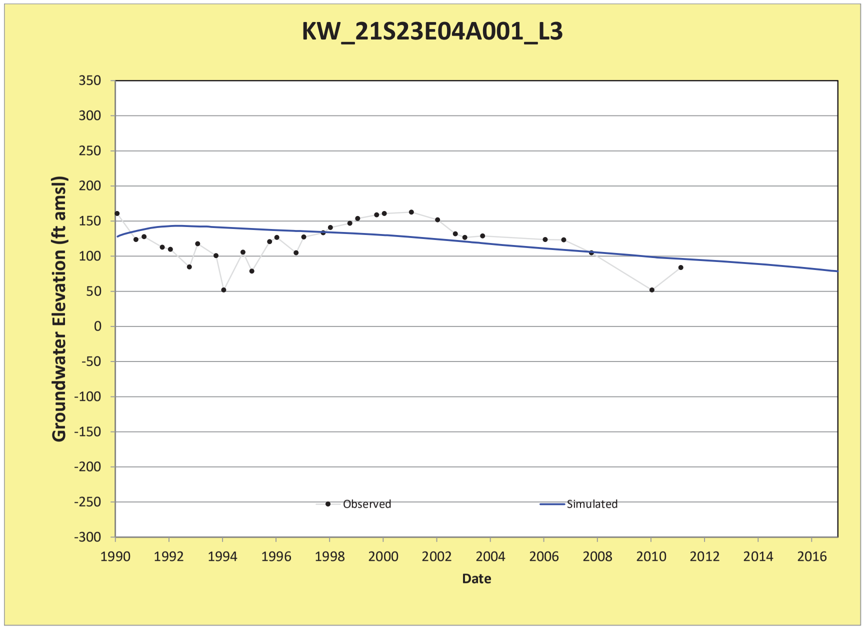
KW_21S23E04A001_L3
Groundwater Elevation (ft amsl)
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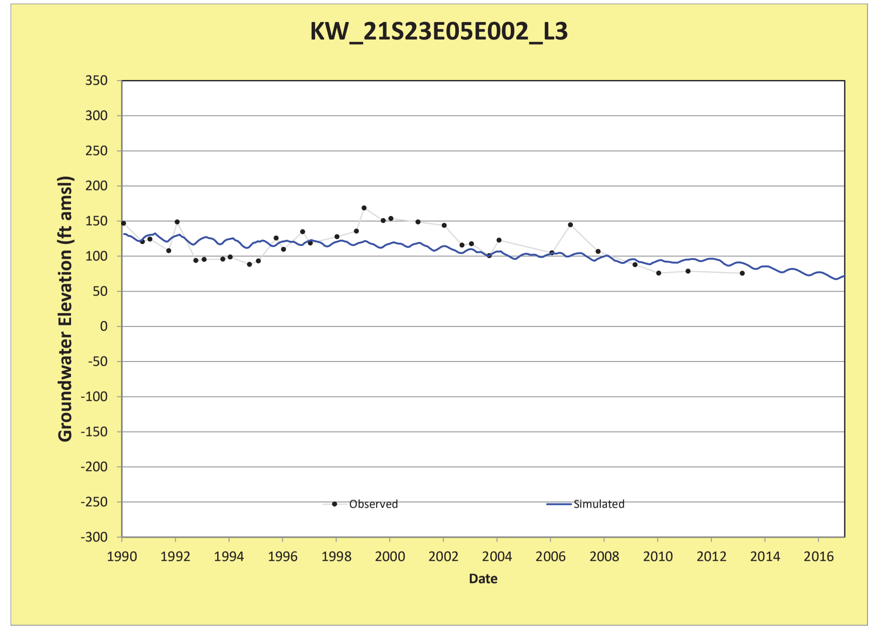
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Groundwater Elevation (ft amsl)
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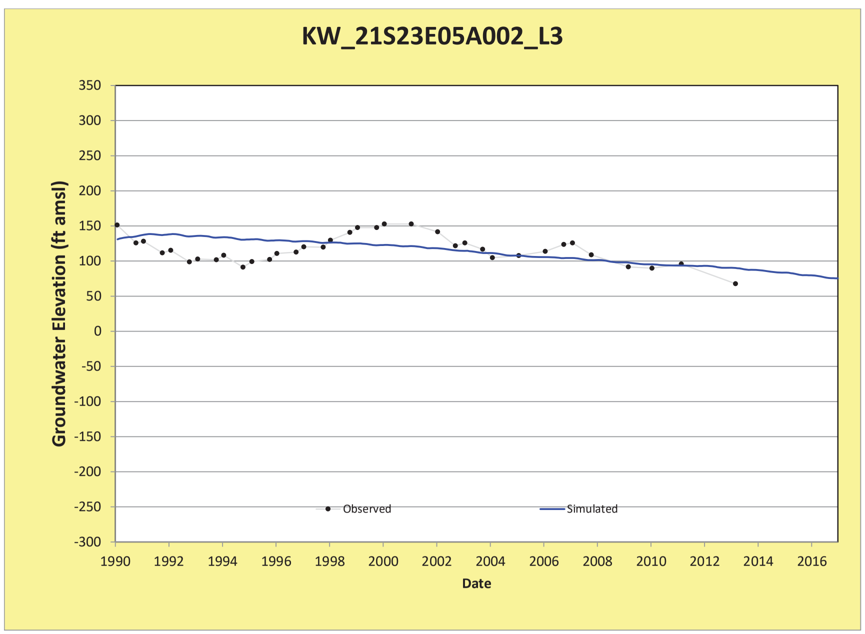
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Groundwater Elevation (ft amsl)
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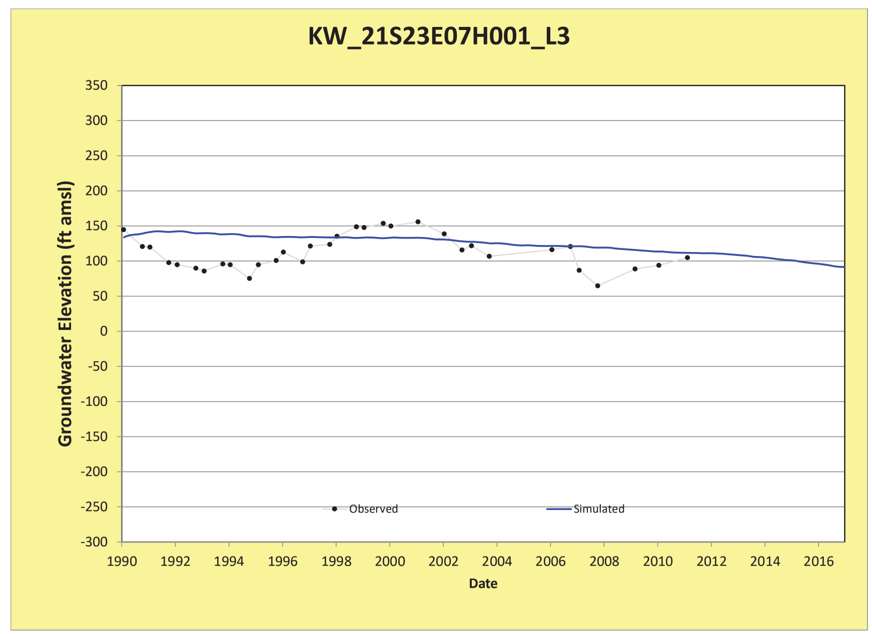
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Groundwater Elevation (ft amsl)
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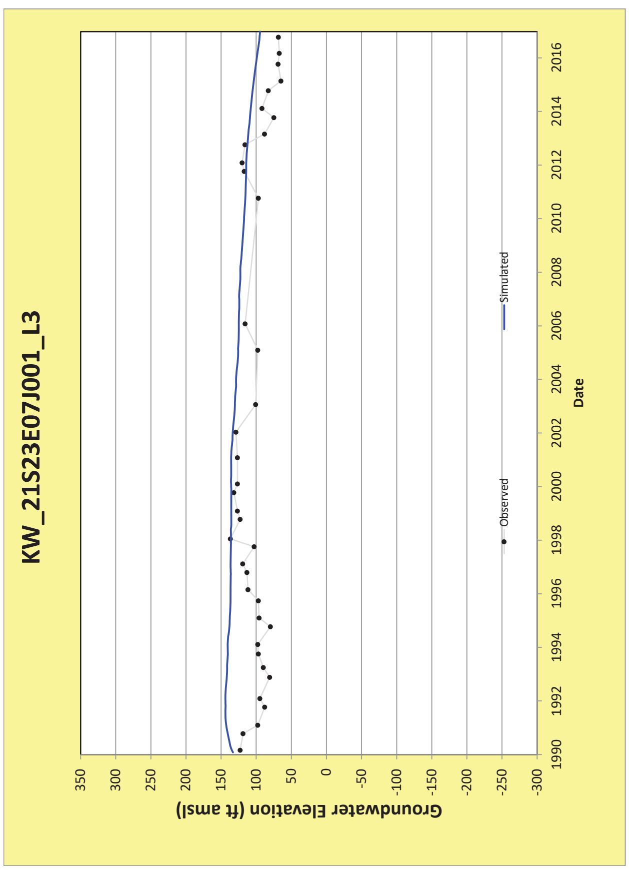
Simulated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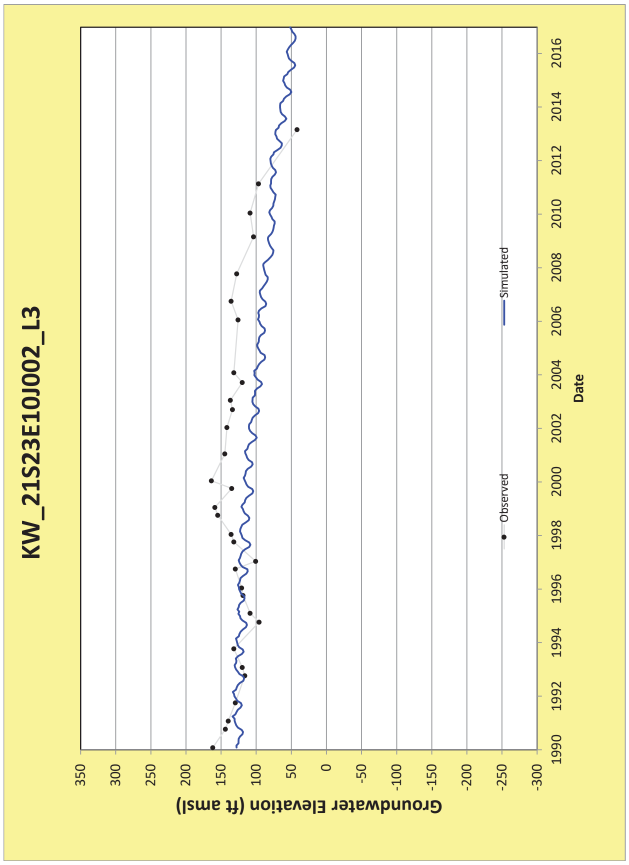
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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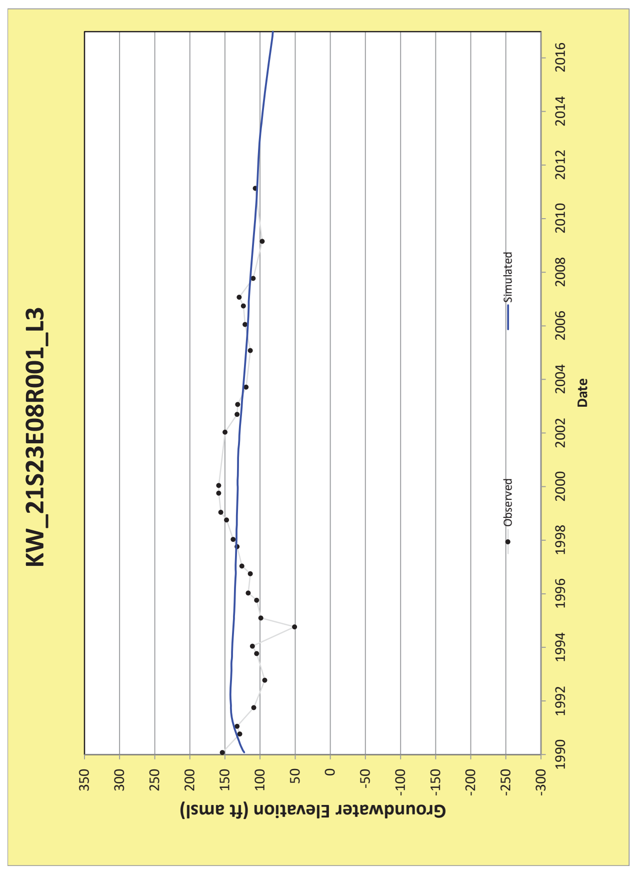
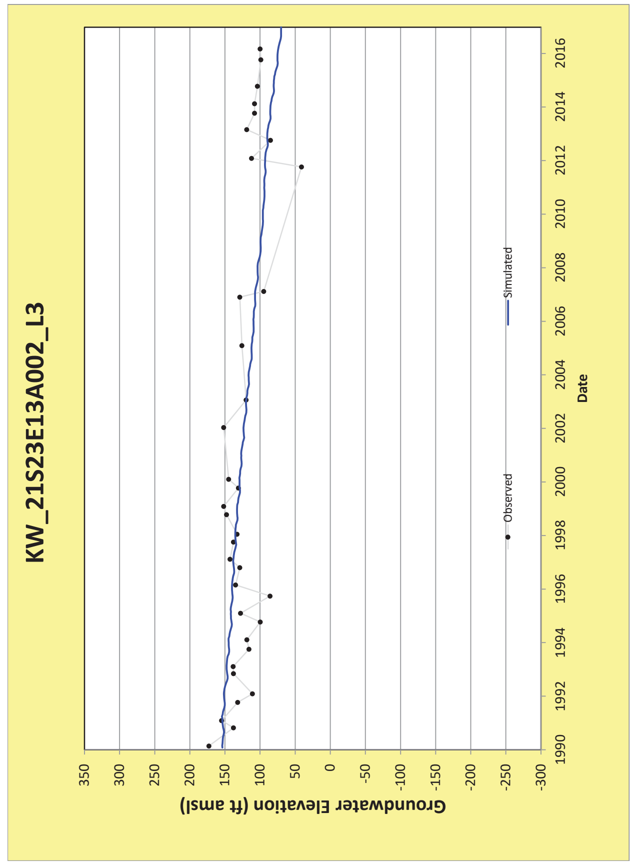
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_21S23E08R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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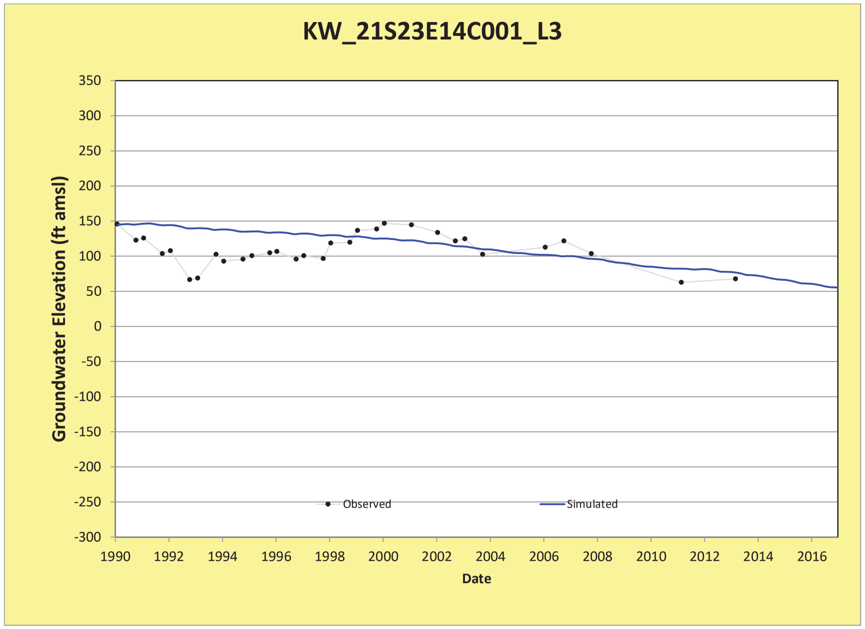
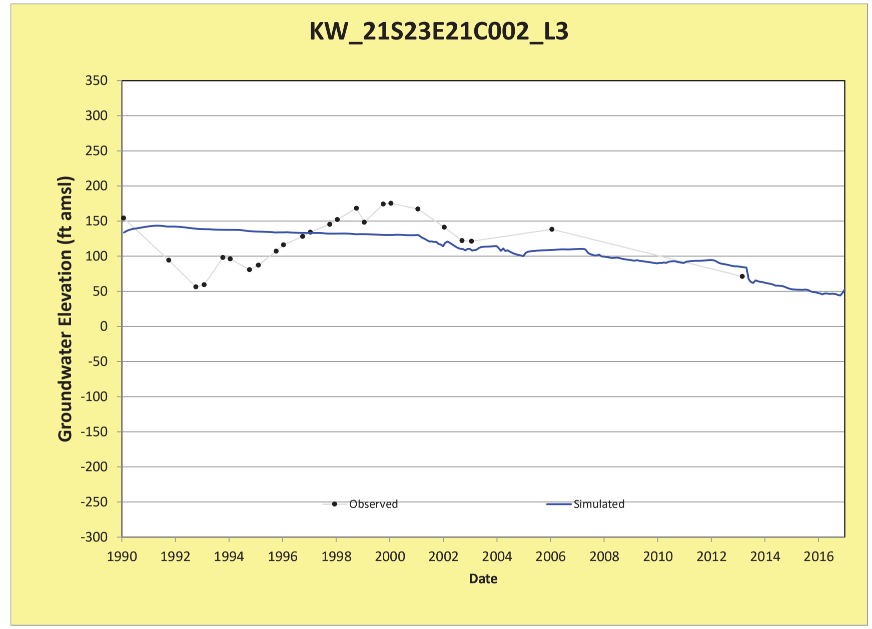
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_21S23E14C001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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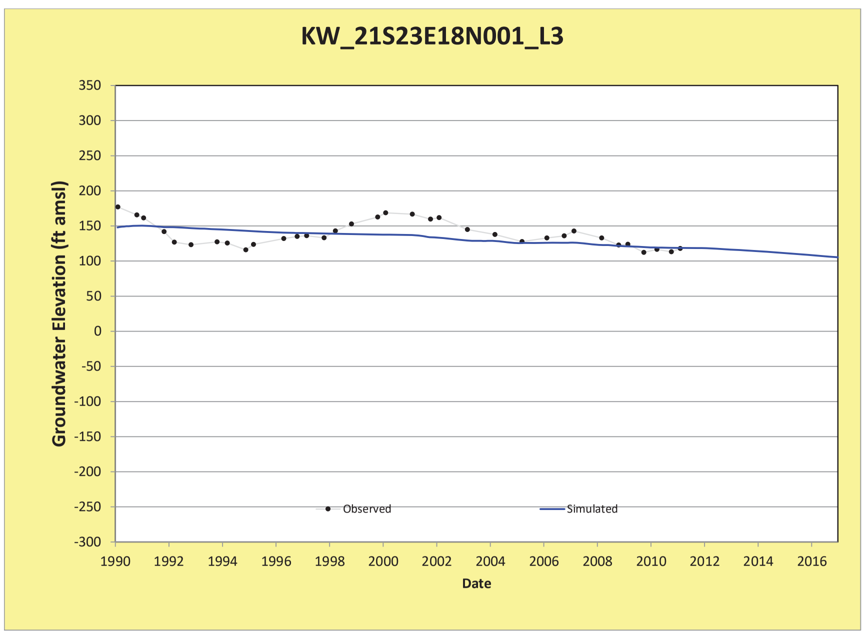
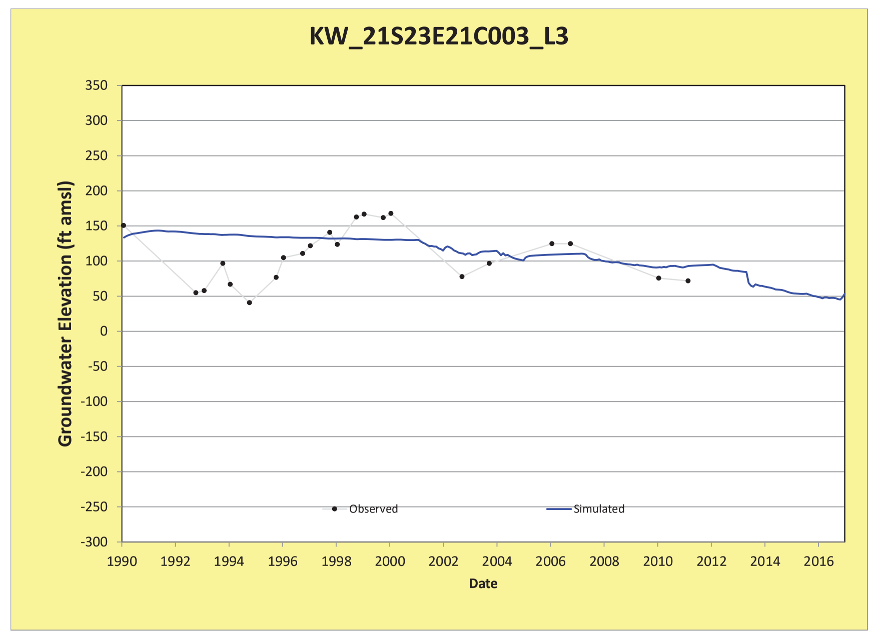
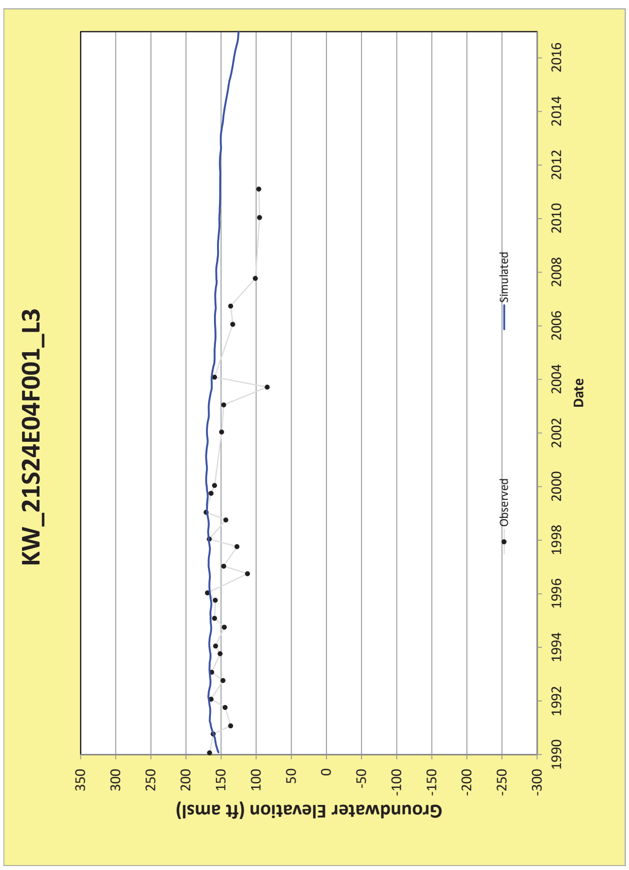
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_21S23E18N001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_21S23E21C003_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


KW_21S24E04F001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
350
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200
150
100
50
0
-50
-100
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-200
-250
-300
1990
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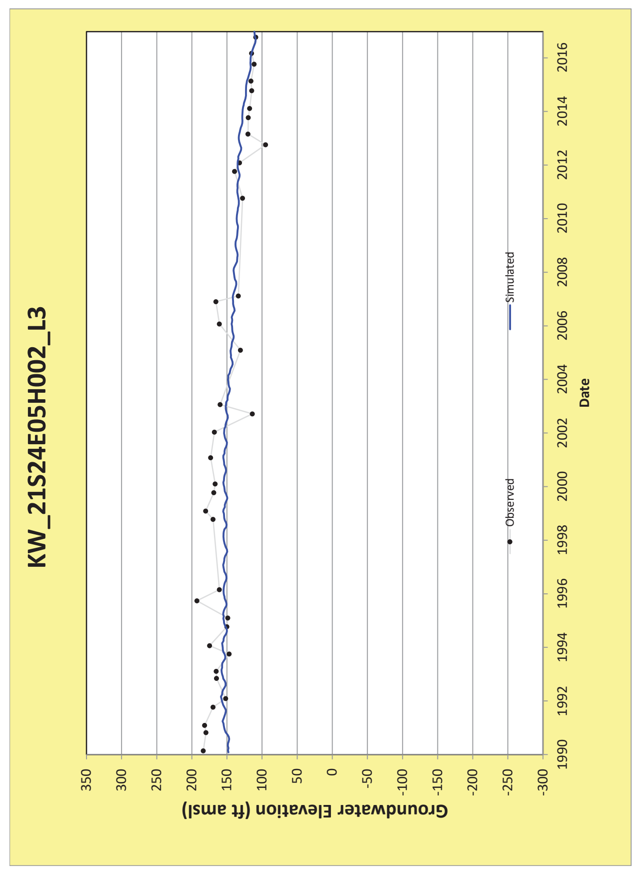
KW_21S24E05H002_L3
Groundwater Elevation (ft amsl)
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Observed
Simulated
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200
150
100
50
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-50
-100
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-300
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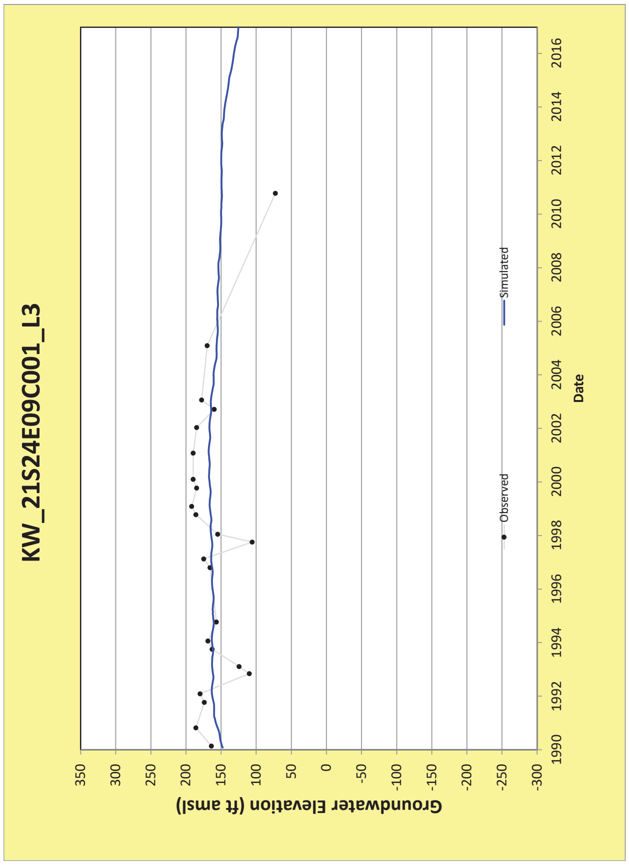
KW_21S24E09C001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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300
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200
150
100
50
0
-50
-100
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-200
-250
-300
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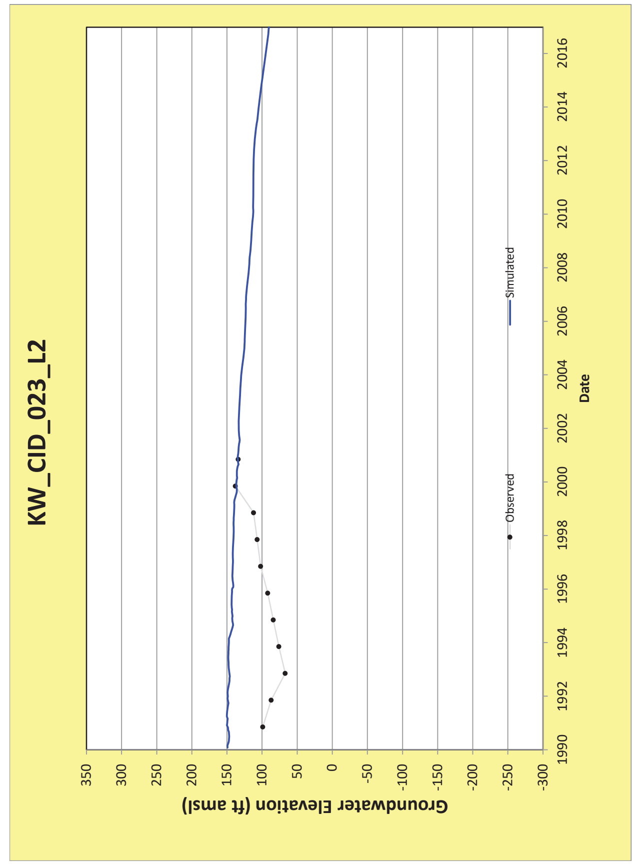
KW_CID_023_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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100
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0
-50
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-300
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2014
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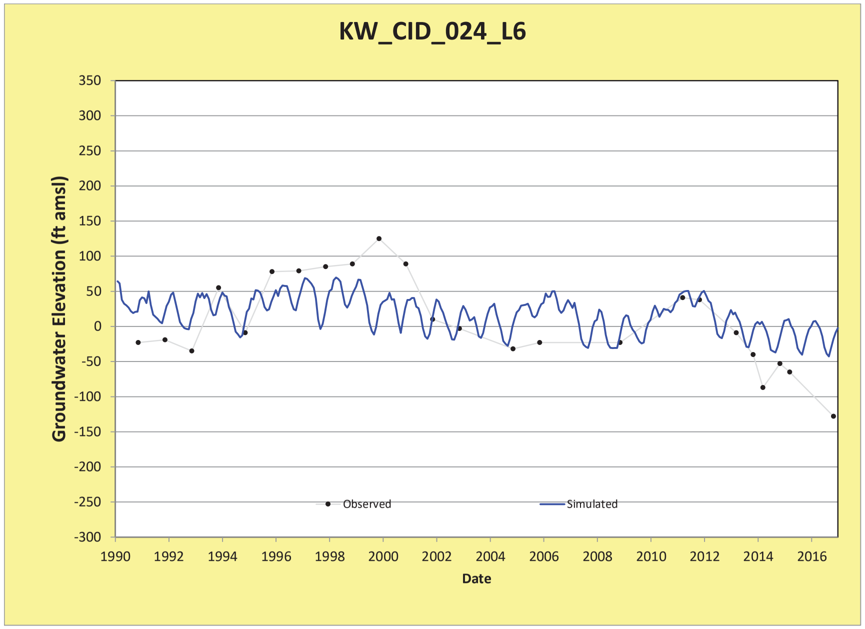
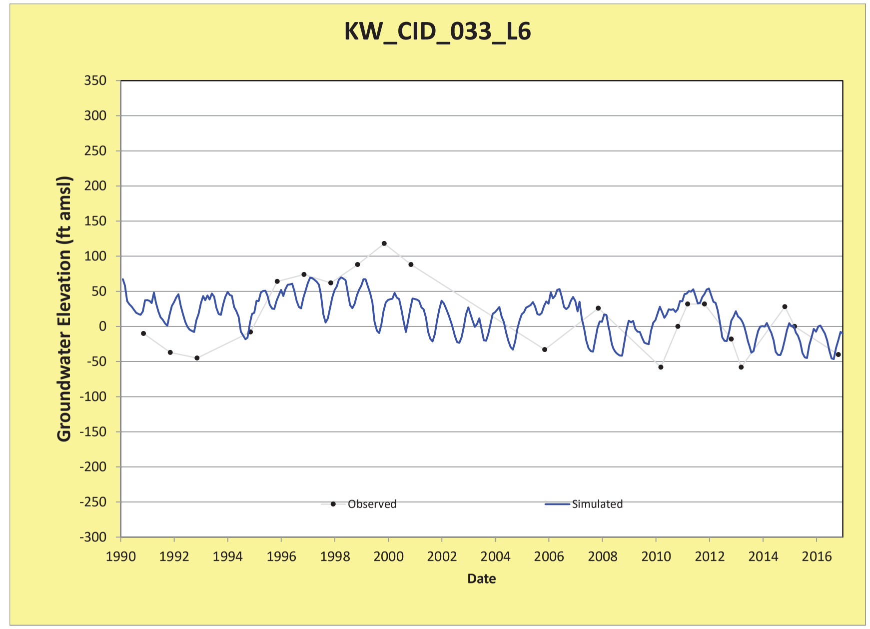
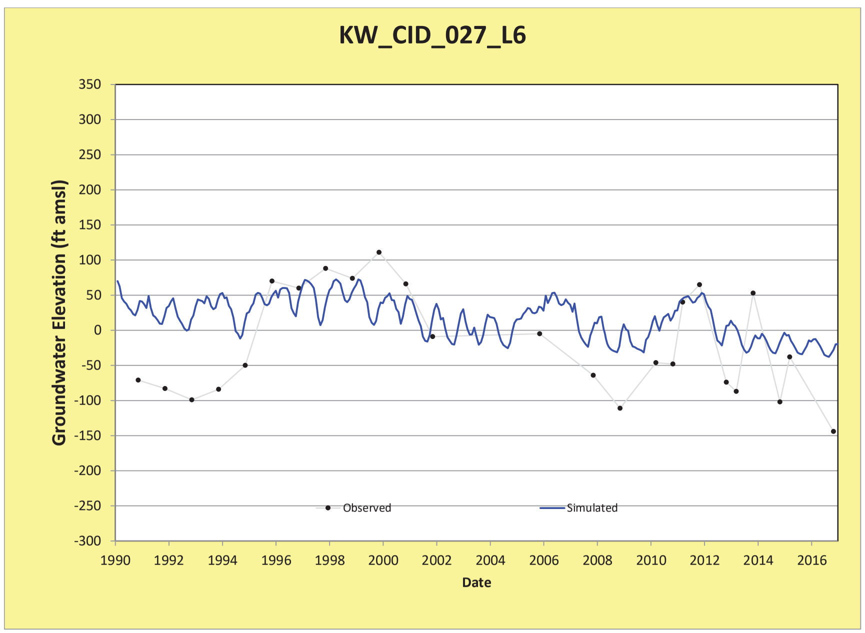
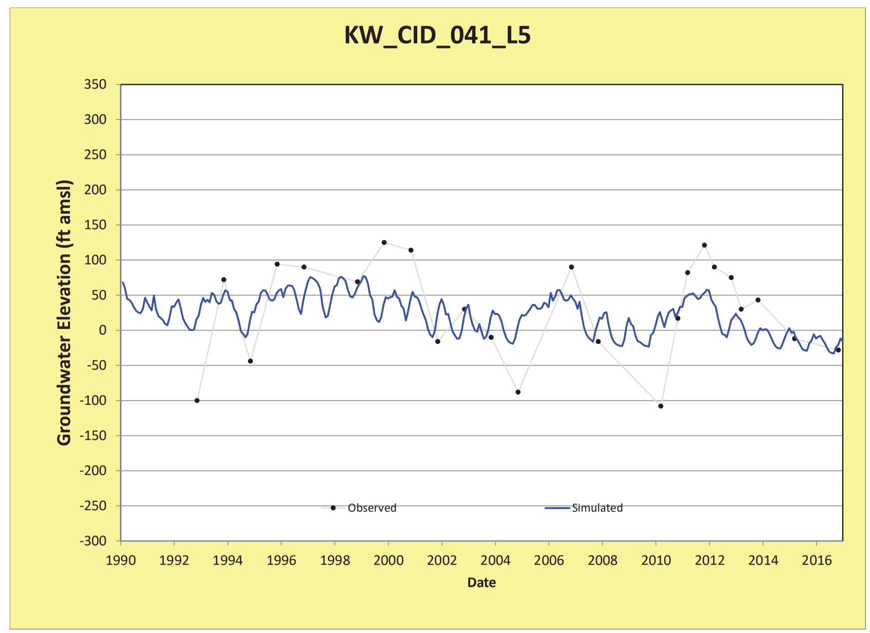
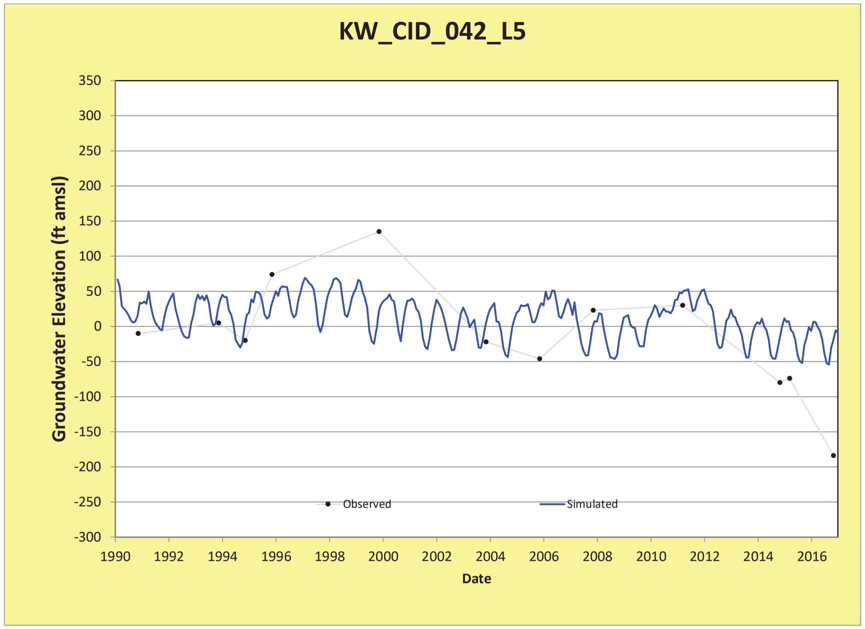
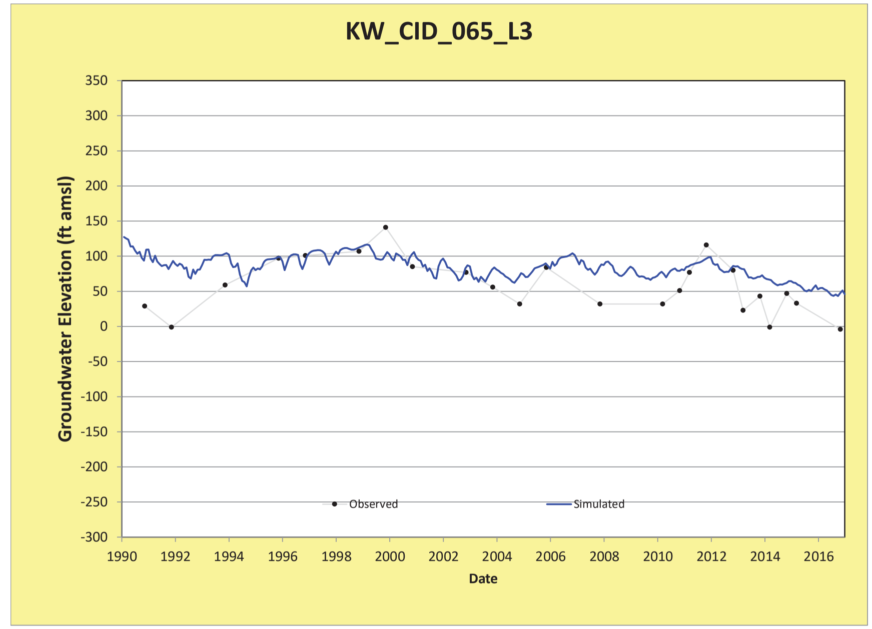

KW_CID_024_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

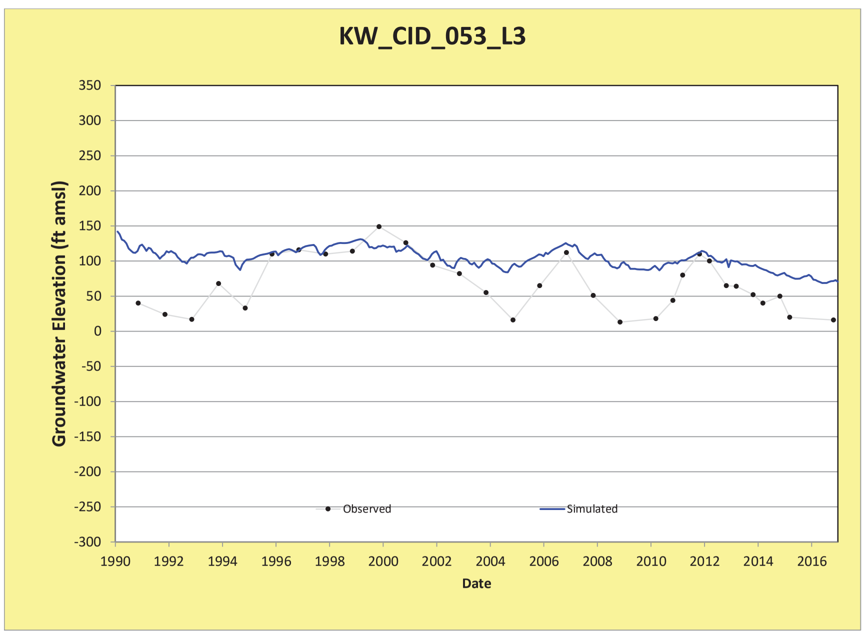

KW_CID_033_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

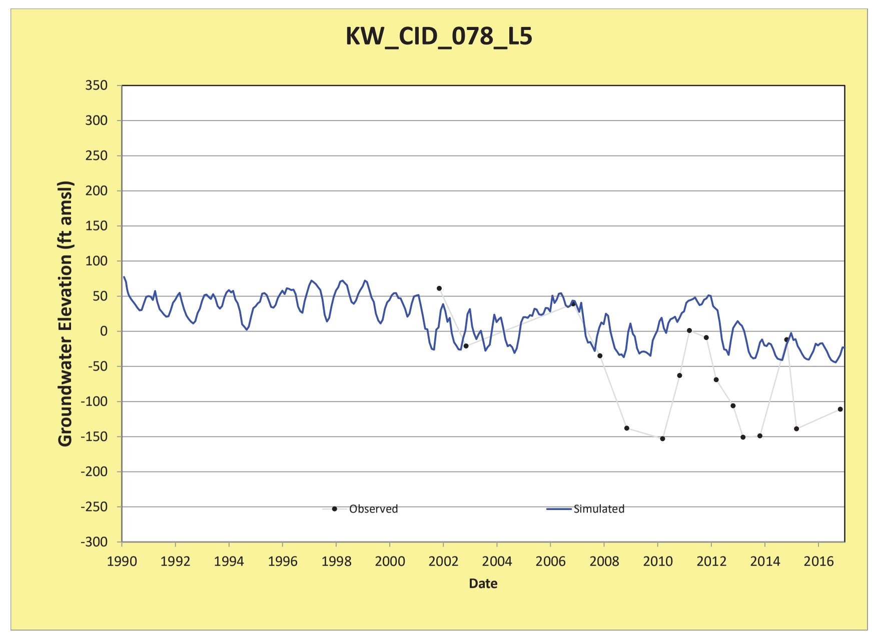

KW_CID_027_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

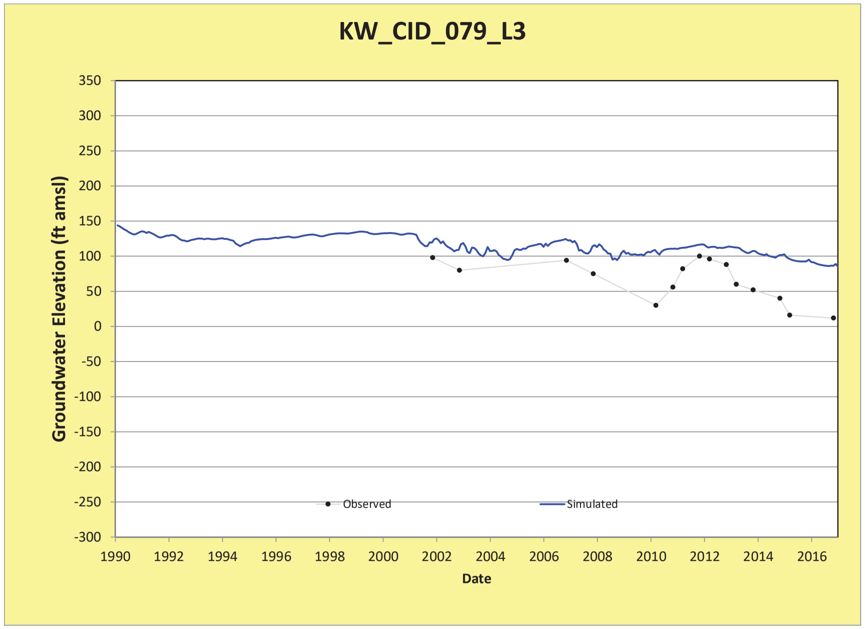

KW_CID_041_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

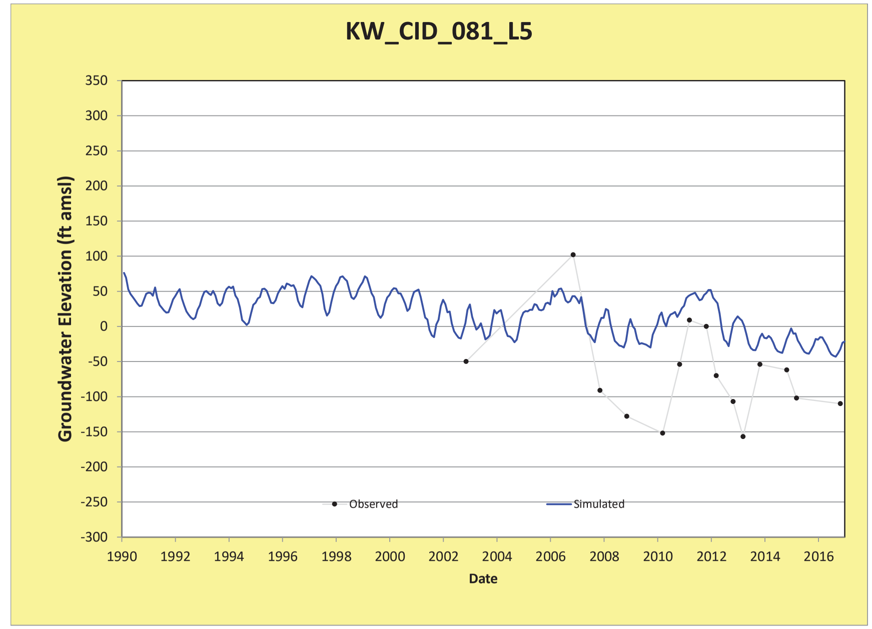

KW_CID_042_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

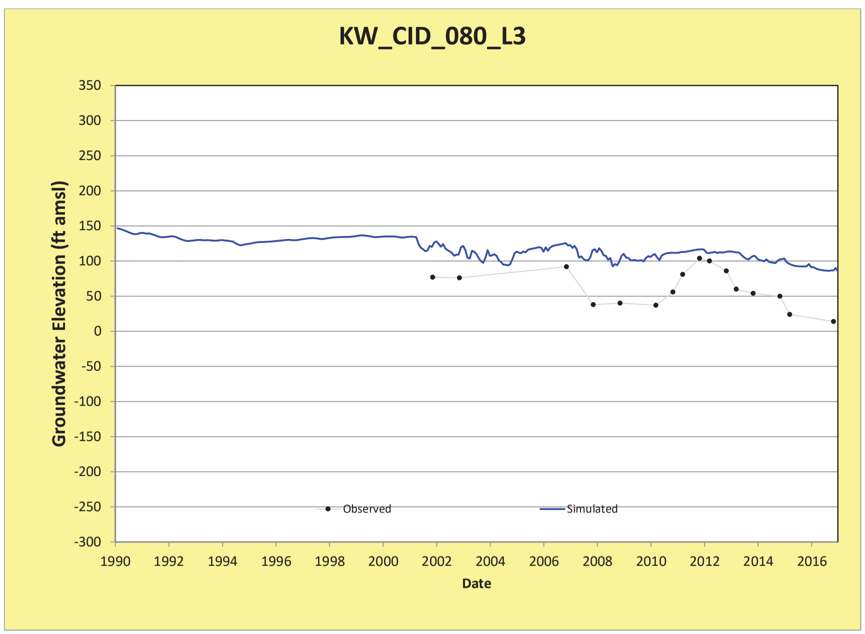

KW_CID_065_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

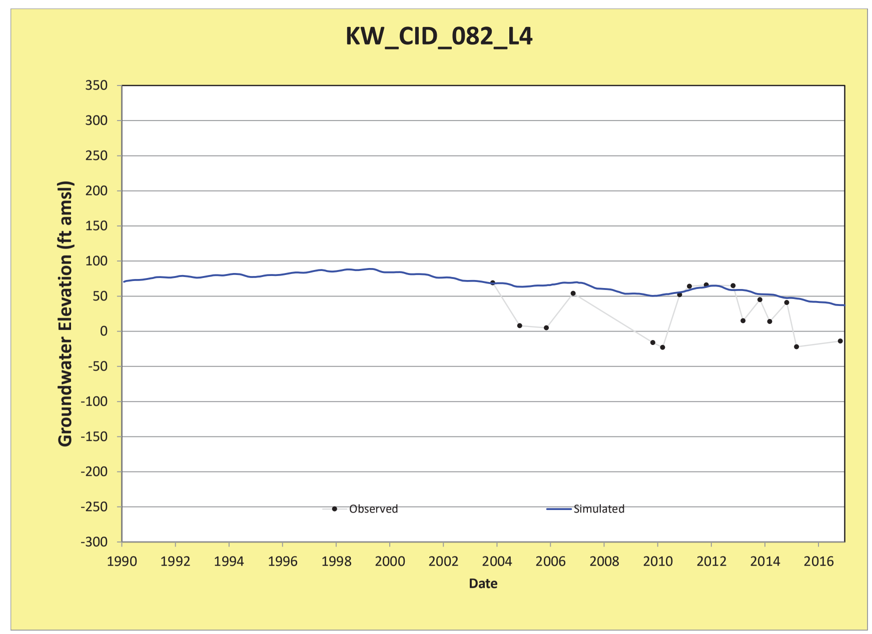

KW_CID_053_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

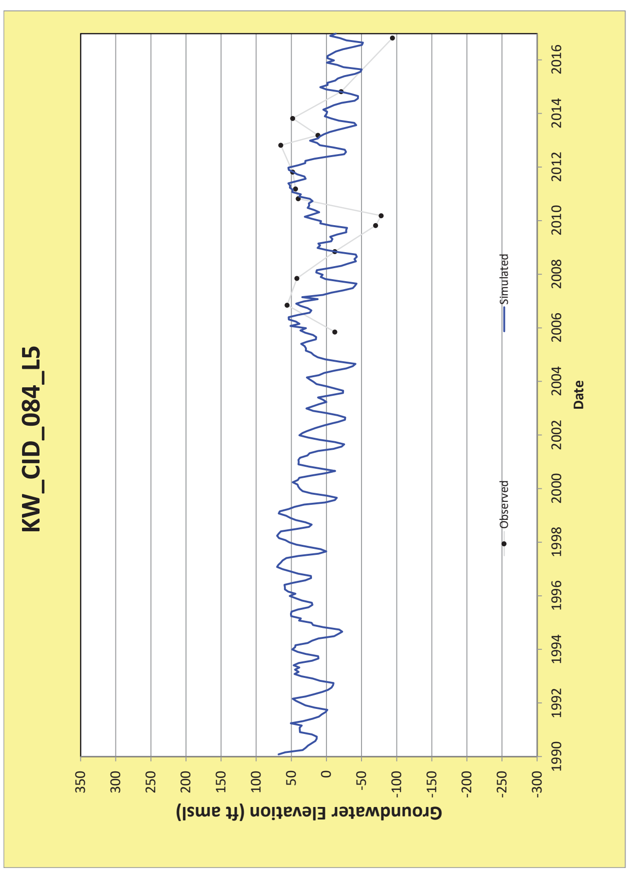

KW_CID_078_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

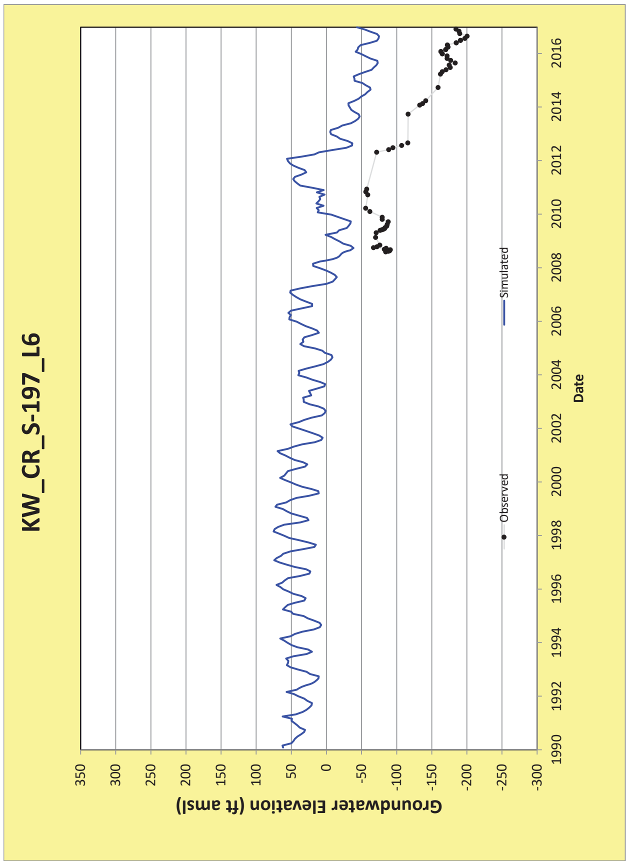

KW_CID_079_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

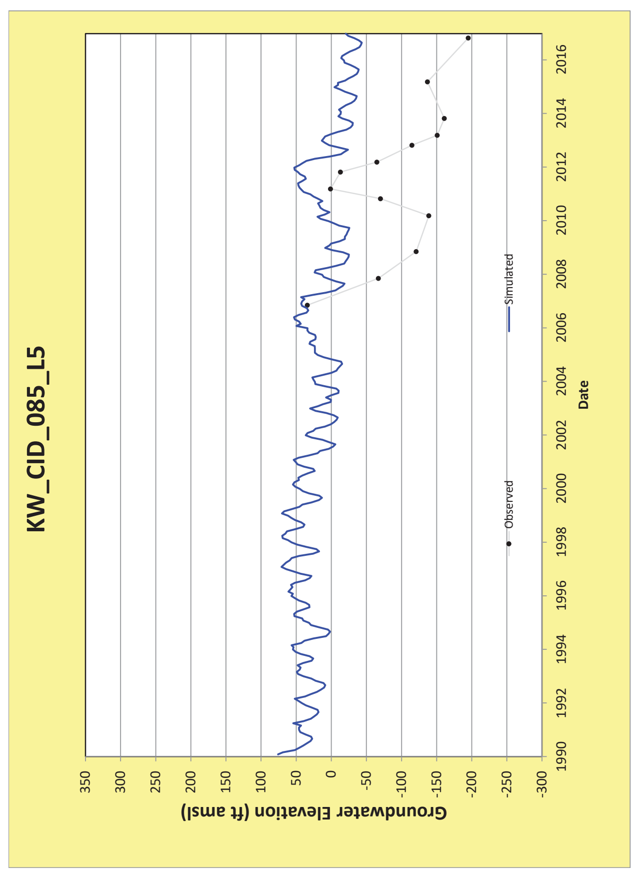

KW_CID_081_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

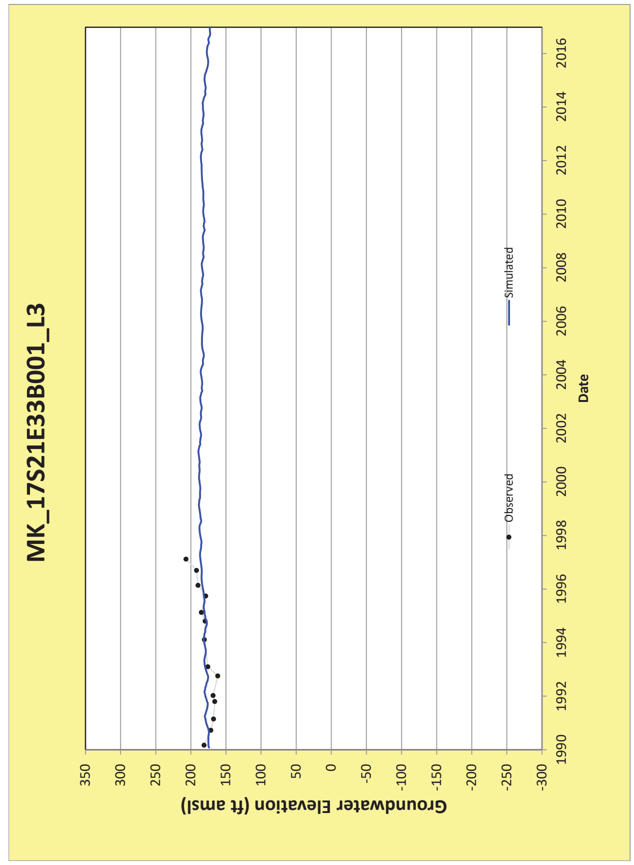

KW_CID_080_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

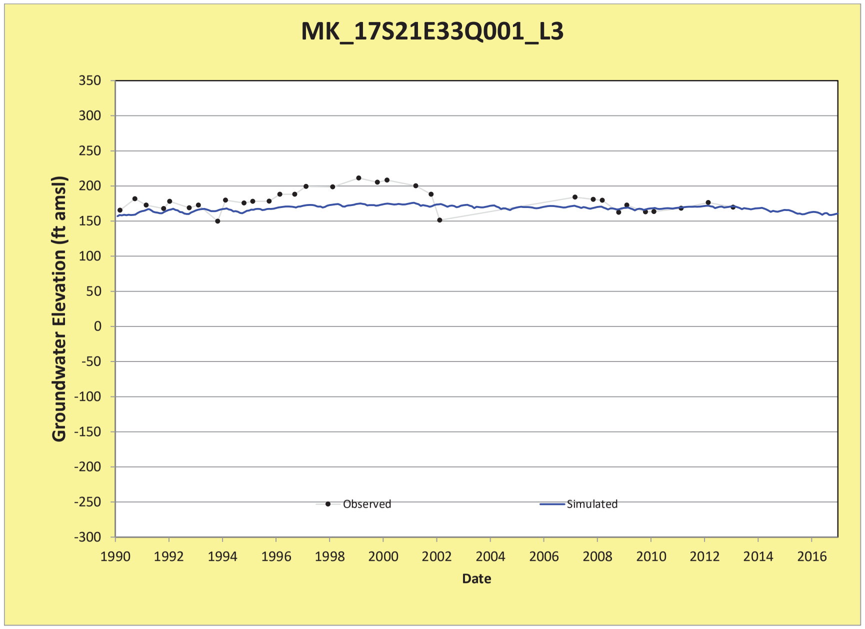

KW_CID_082_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

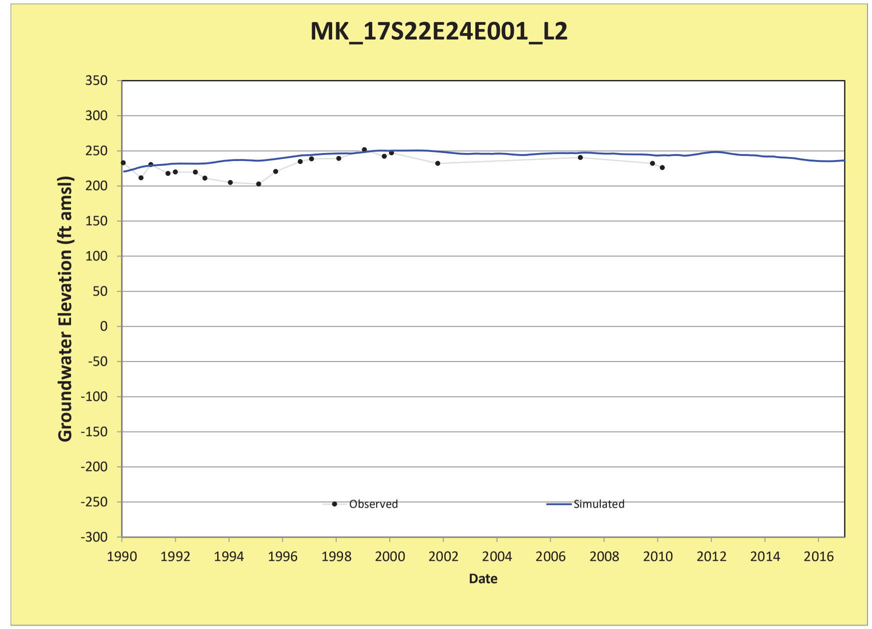

KW_CID_084_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

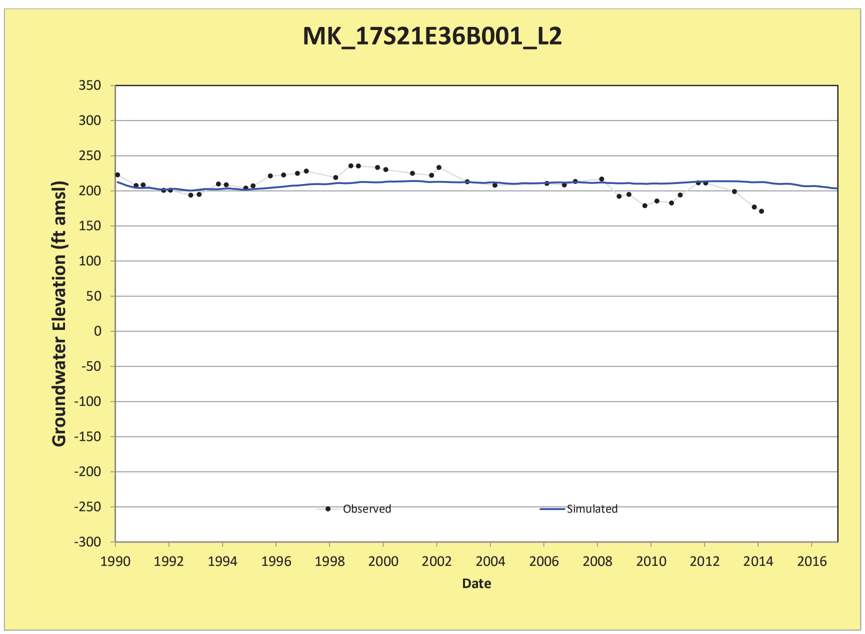

KW_CR_S-197_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

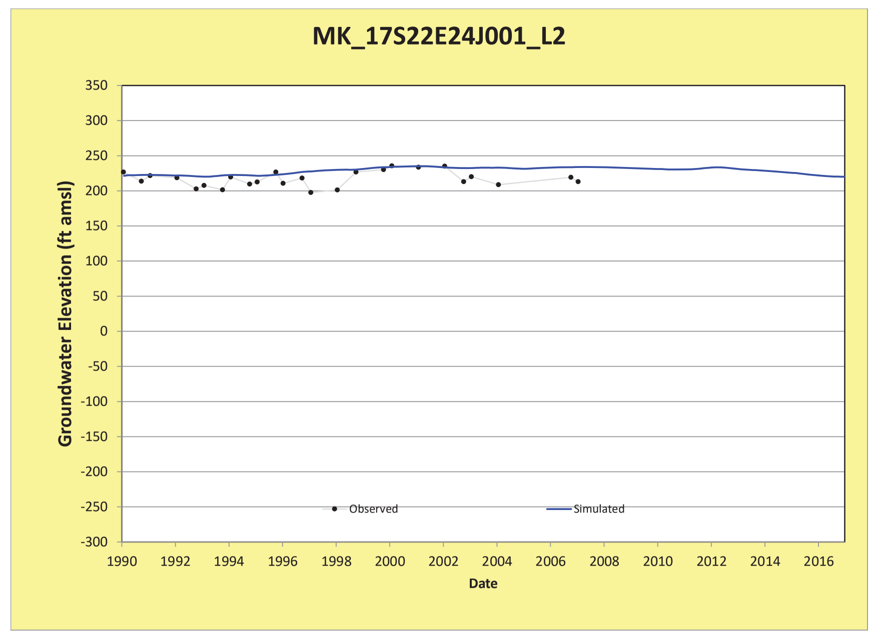

KW_CID_085_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

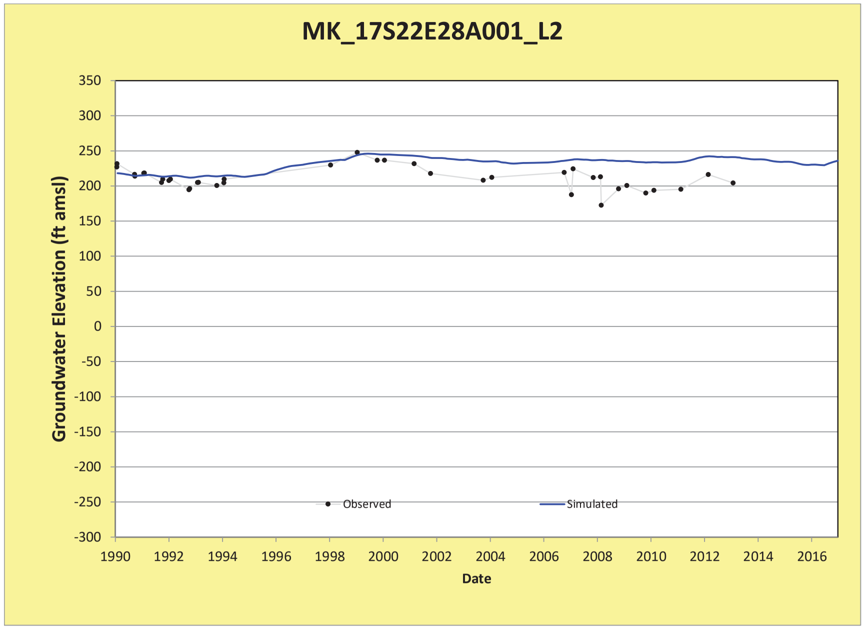

MK_17S21E33B001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_17S21E33Q001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_17S22E24E001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_17S21E36B001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_17S22E24J001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_17S22E28A001_L2
Groundwater Elevation (ft amsl)
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-100
-150
-200
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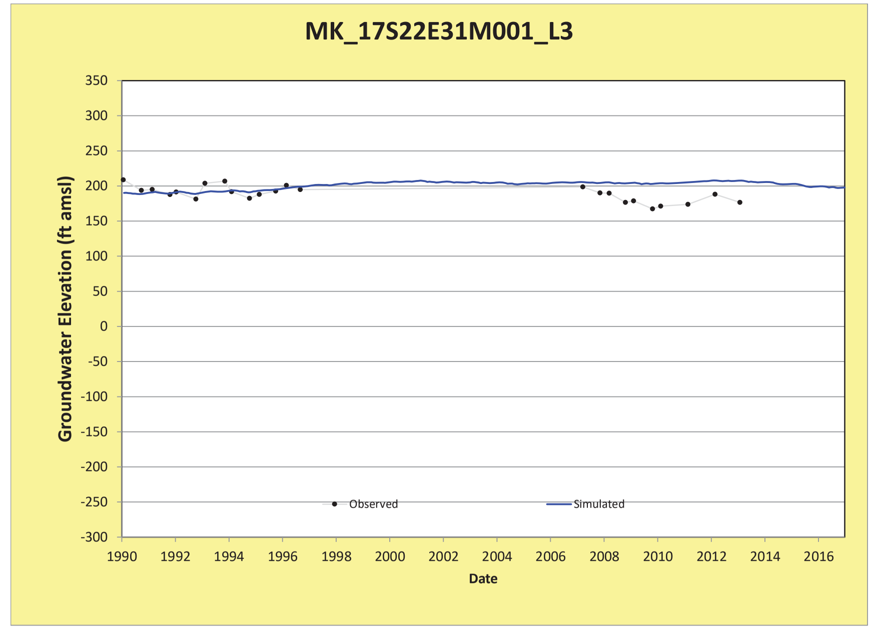
Date
Observed
Simulated


MK_17S22E31M001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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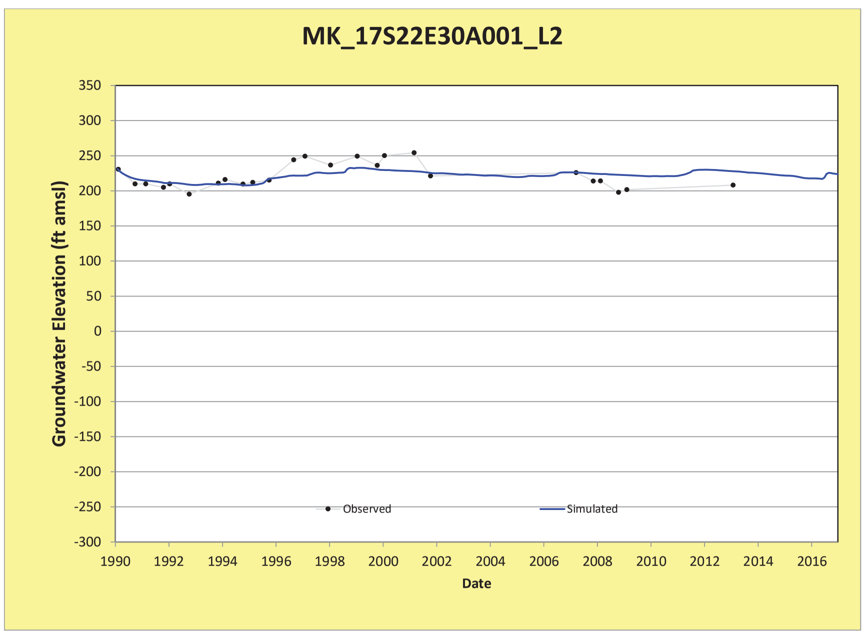
Date
Observed
Simulated


MK_17S22E30A001_L2
Groundwater Elevation (ft amsl)
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150
100
50
0
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-100
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-200
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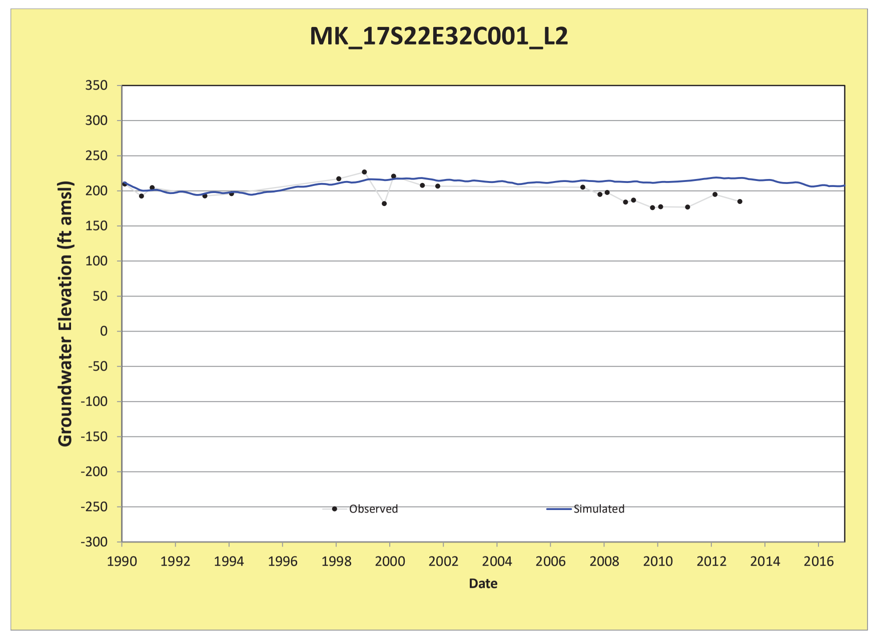
Date
Observed
Simulated


MK_17S22E32C001_L2
Groundwater Elevation (ft amsl)
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200
150
100
50
0
-50
-100
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-200
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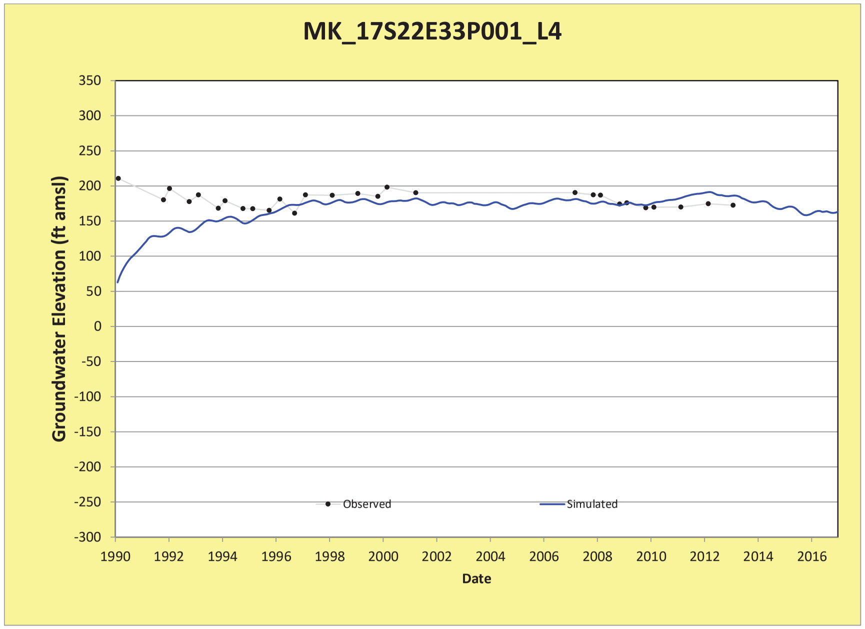
Date
Observed
Simulated


MK_17S22E33P001_L4
Groundwater Elevation (ft amsl)
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0
-50
-100
-150
-200
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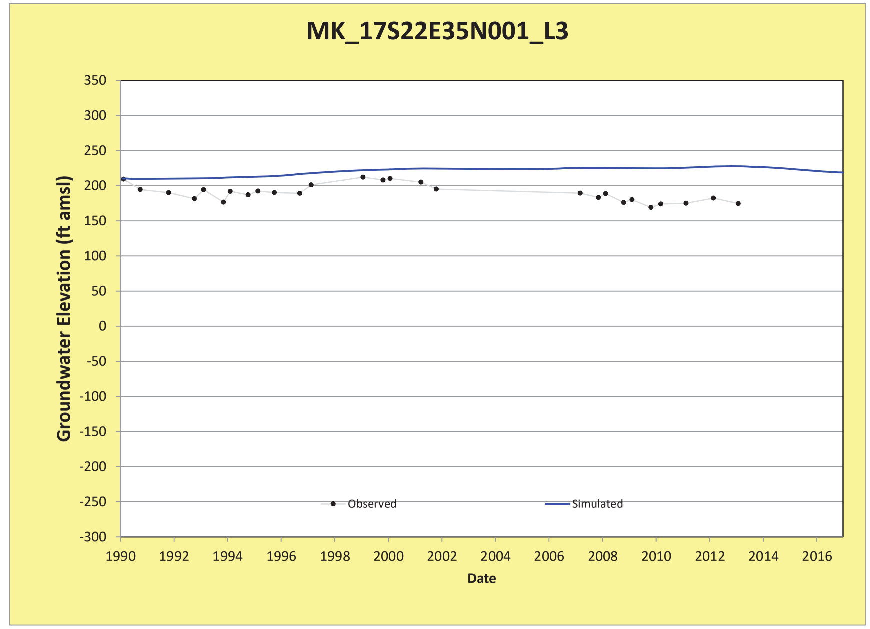
2016
Date
Observed
Simulated


MK_17S22E35N001_L3
Groundwater Elevation (ft amsl)
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200
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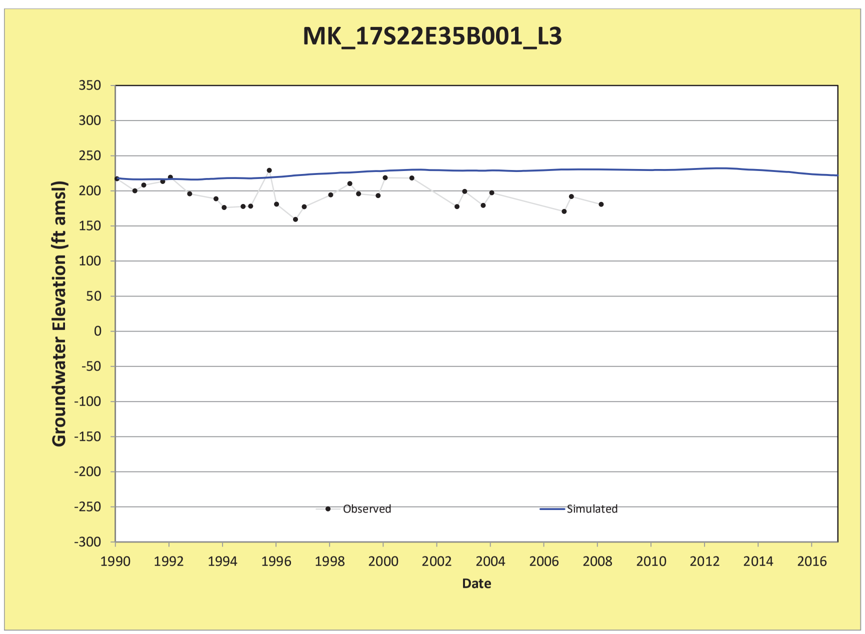
Date
Observed
Simulated


MK_17S22E35B001_L3
Groundwater Elevation (ft amsl)
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0
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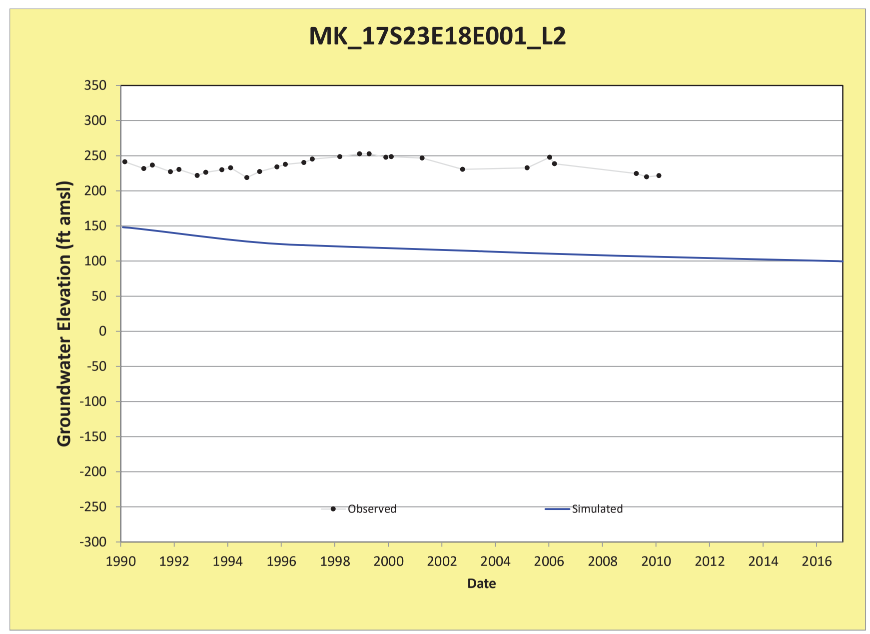
Date
Observed
Simulated


MK_17S23E18E001_L2
Groundwater Elevation (ft amsl)
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200
150
100
50
0
-50
-100
-150
-200
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-300
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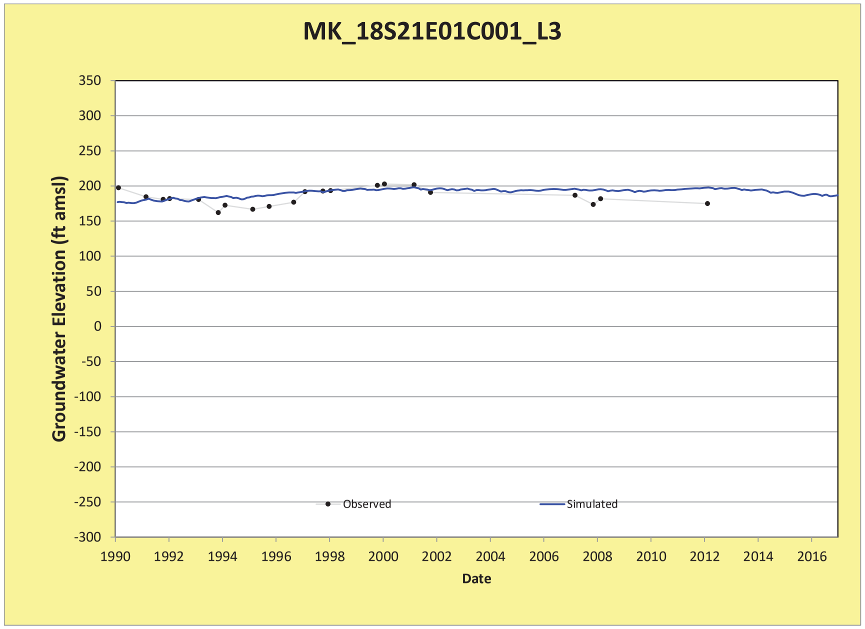
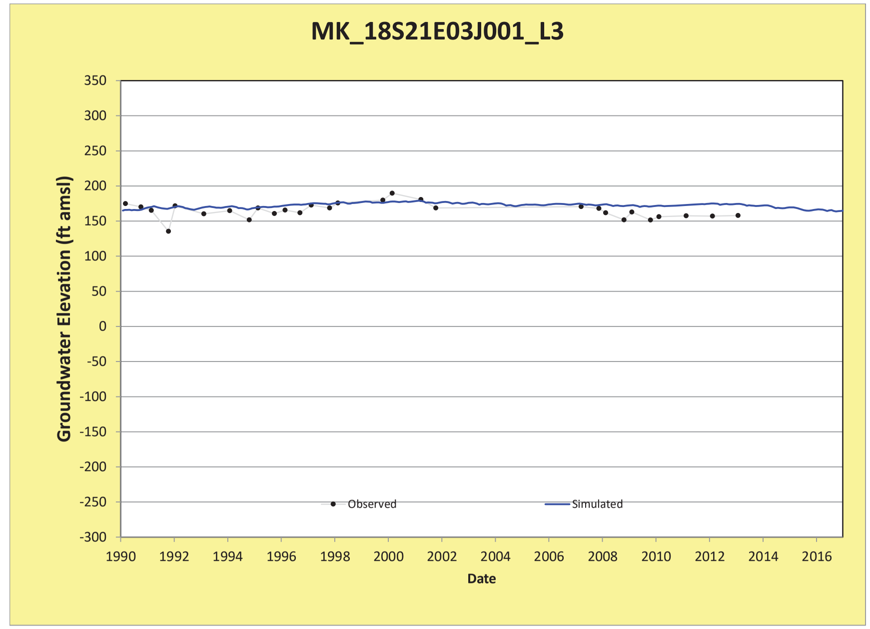
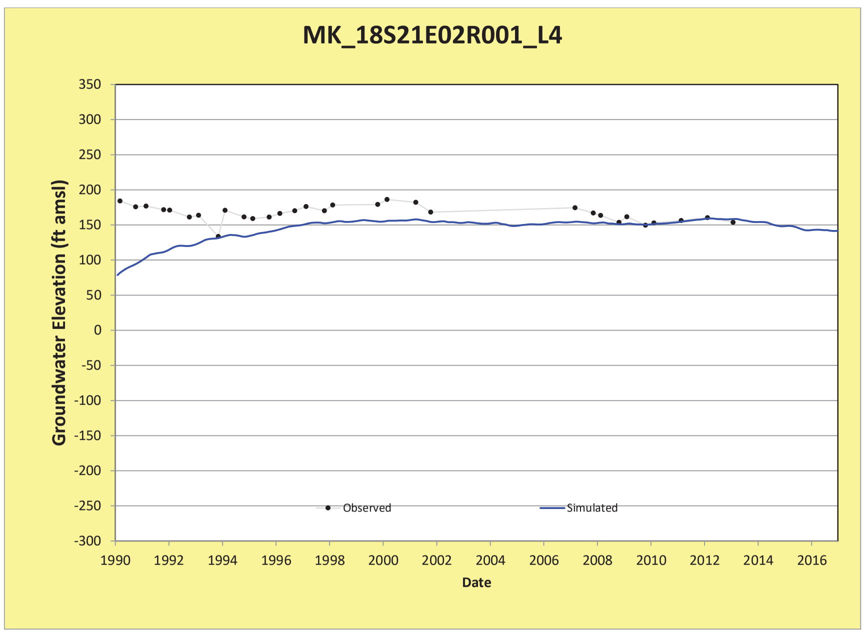
Date
Observed
Simulated



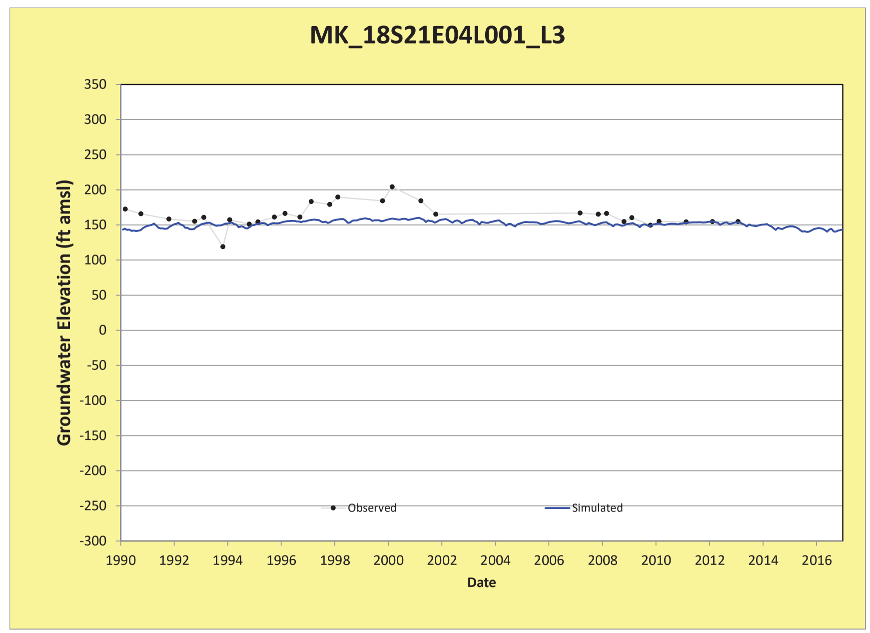
MK_18S21E01C001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated



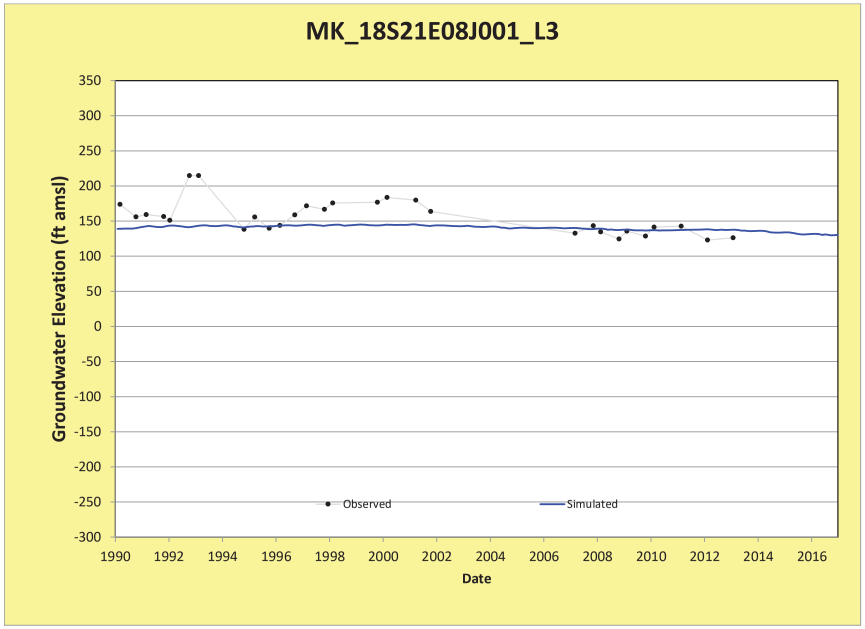
MK_18S21E03J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated



MK_18S21E02R001_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated



MK_18S21E04L001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_18S21E08J001_L3
Groundwater Elevation (ft amsl)
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-150
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1990
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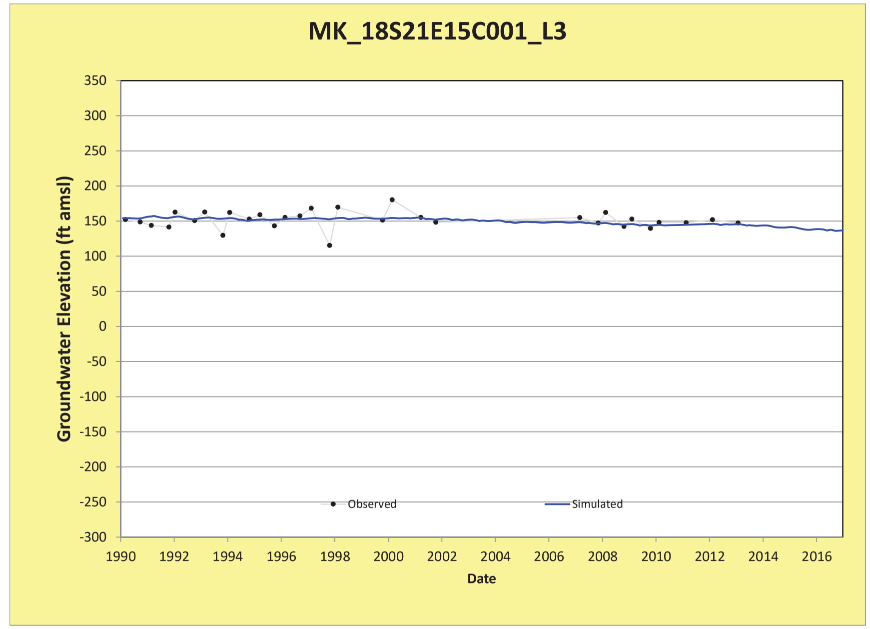
Date
Observed
Simulated


MK_18S21E15C001_L3
Groundwater Elevation (ft amsl)
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50
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-50
-100
-150
-200
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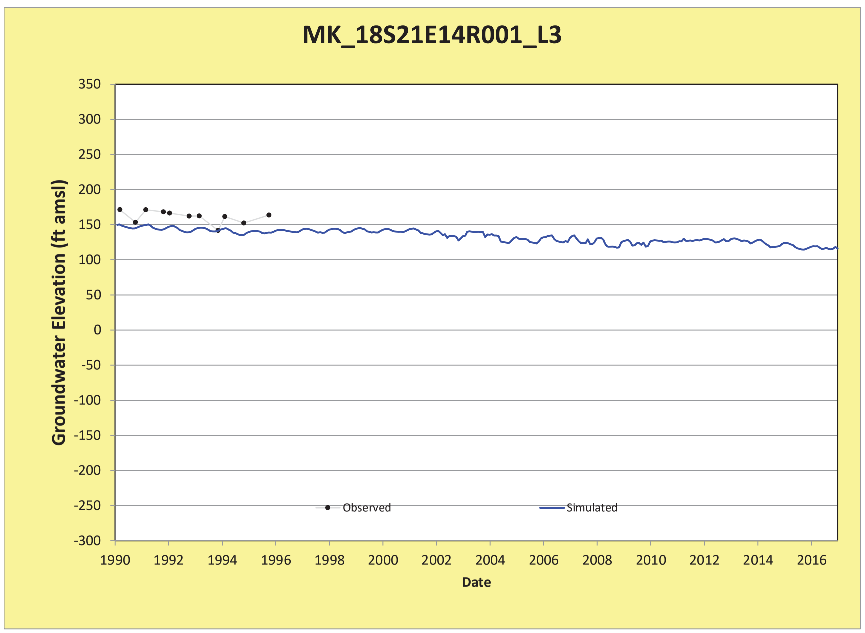
Date
Observed
Simulated


MK_18S21E14R001_L3
Groundwater Elevation (ft amsl)
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-50
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-150
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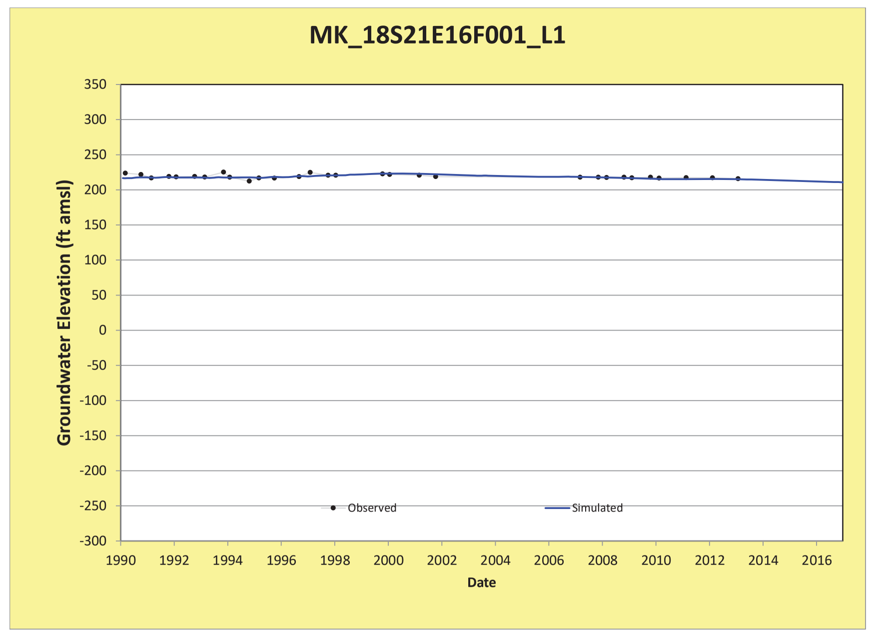
Date
Observed
Simulated


MK_18S21E16F001_L1
Groundwater Elevation (ft amsl)
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50
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-50
-100
-150
-200
-250
-300
1990
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2010
2012
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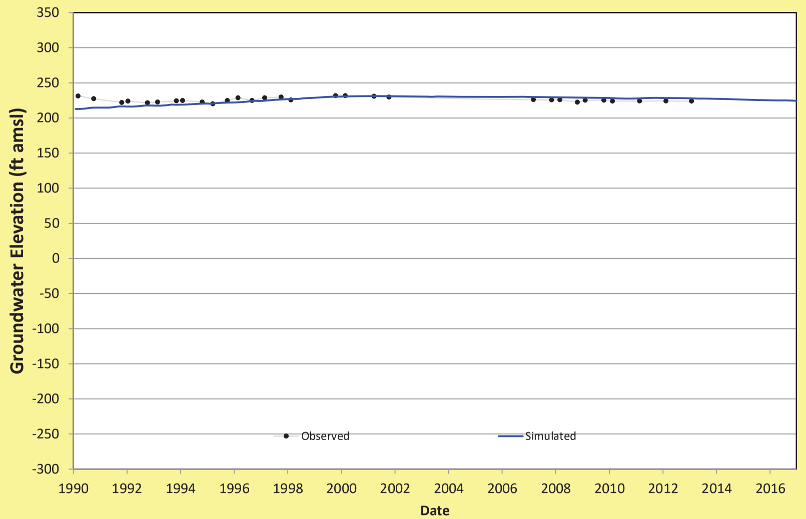
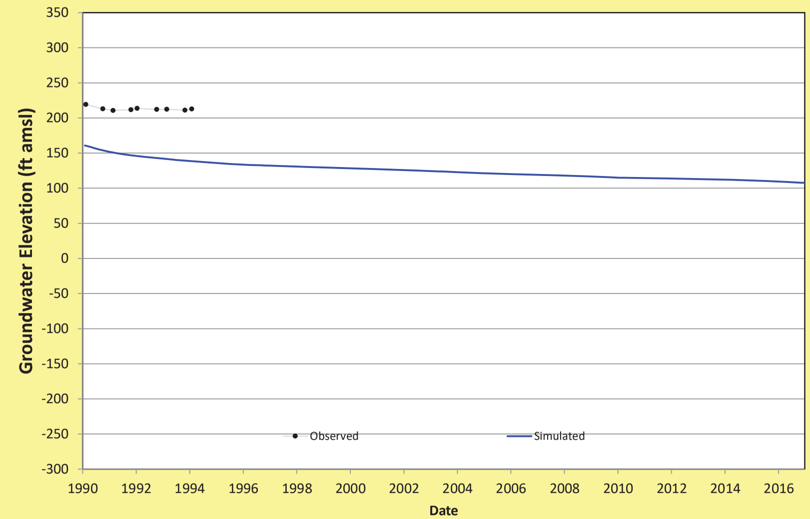
2016
Date
Observed
Simulated

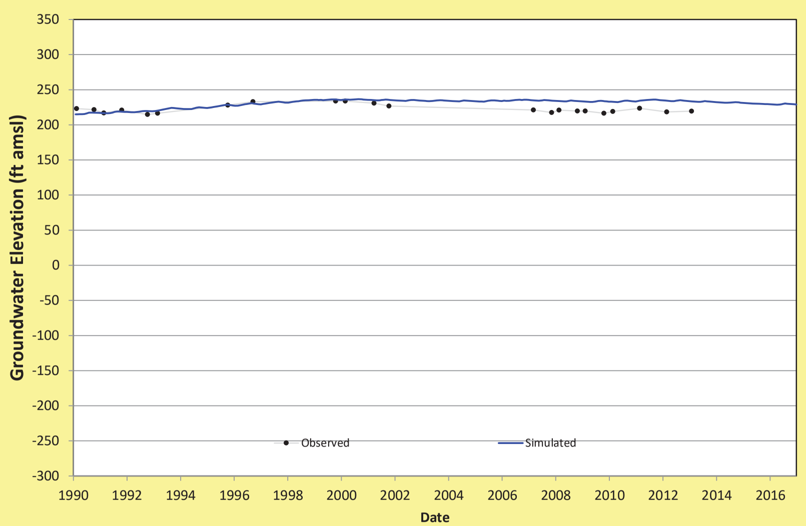
MK_18S21E17F001_L1



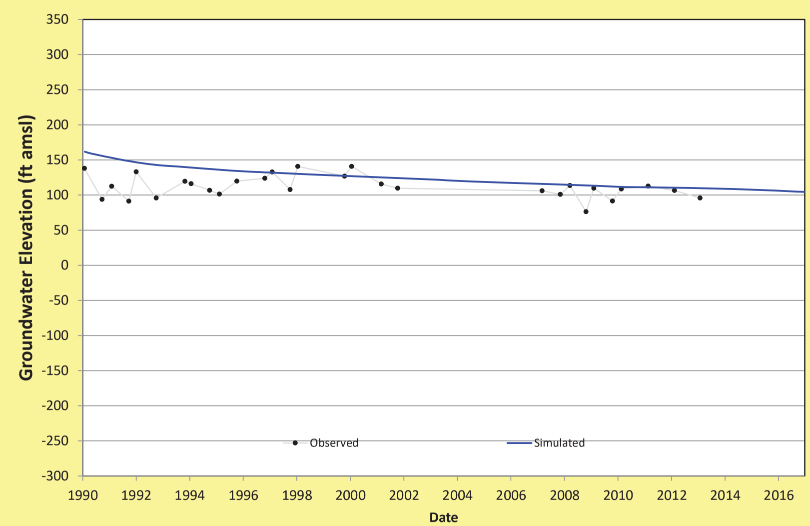
MK_18S21E29R001_L2

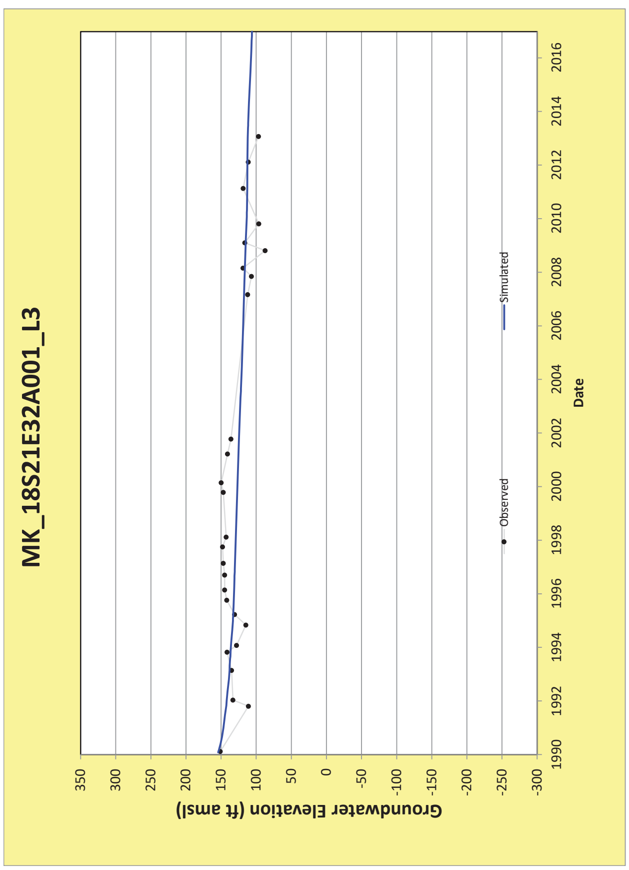


MK_18S21E20Q001_L1



MK_18S21E31B001_L3




MK_18S21E32A001_L3
Groundwater Elevation (ft amsl)
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-150
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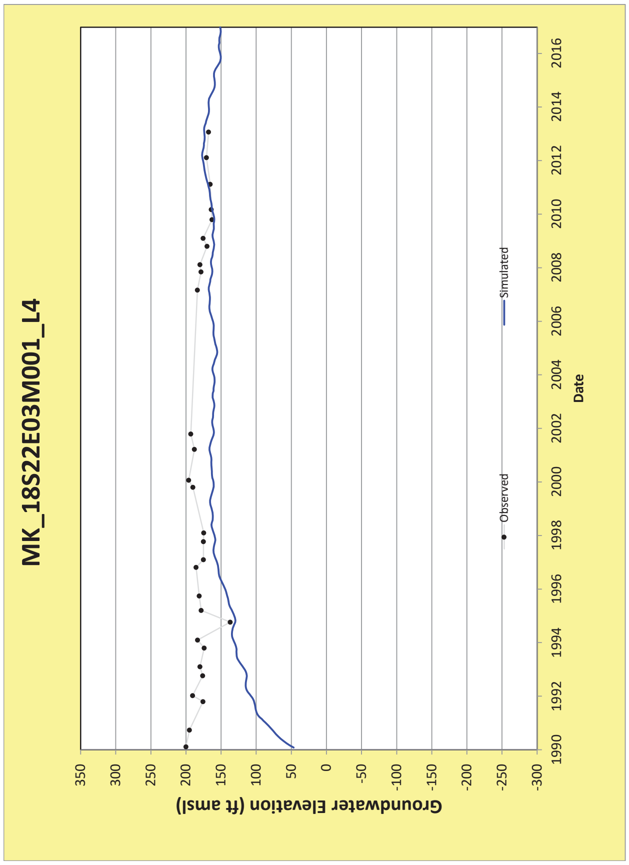
2016
Date
Observed
Simulated


MK_18S22E03M001_L4
Groundwater Elevation (ft amsl)
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200
150
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50
0
-50
-100
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-250
-300
1990
1992
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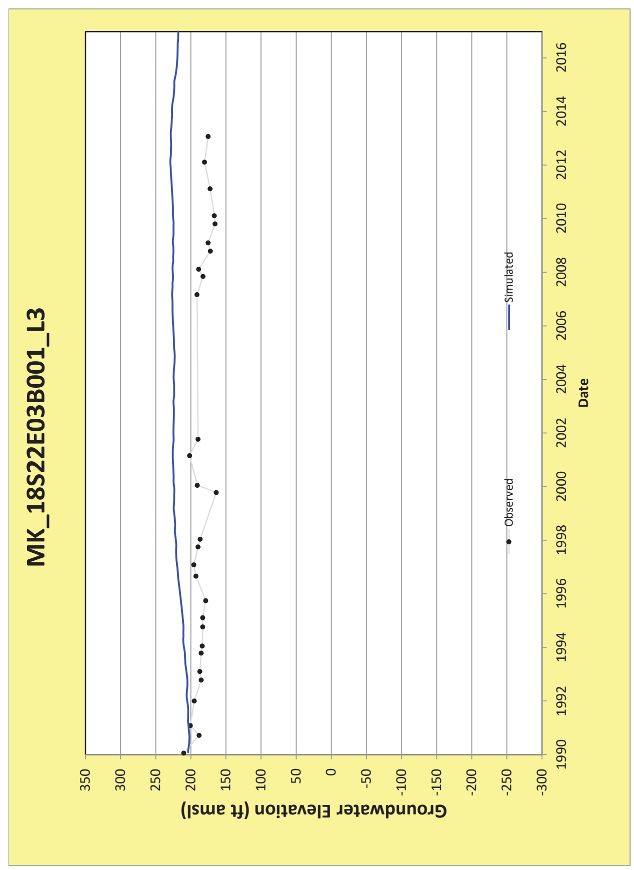
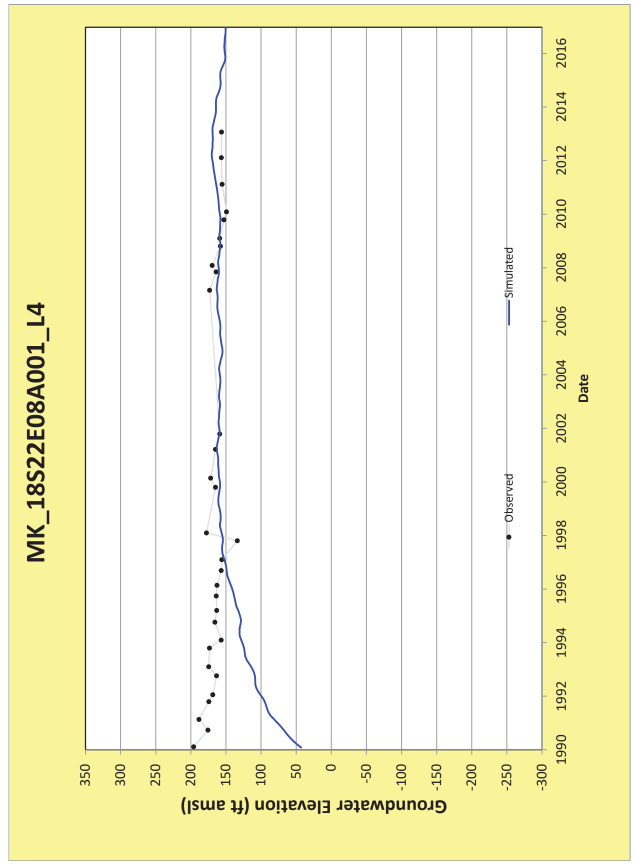
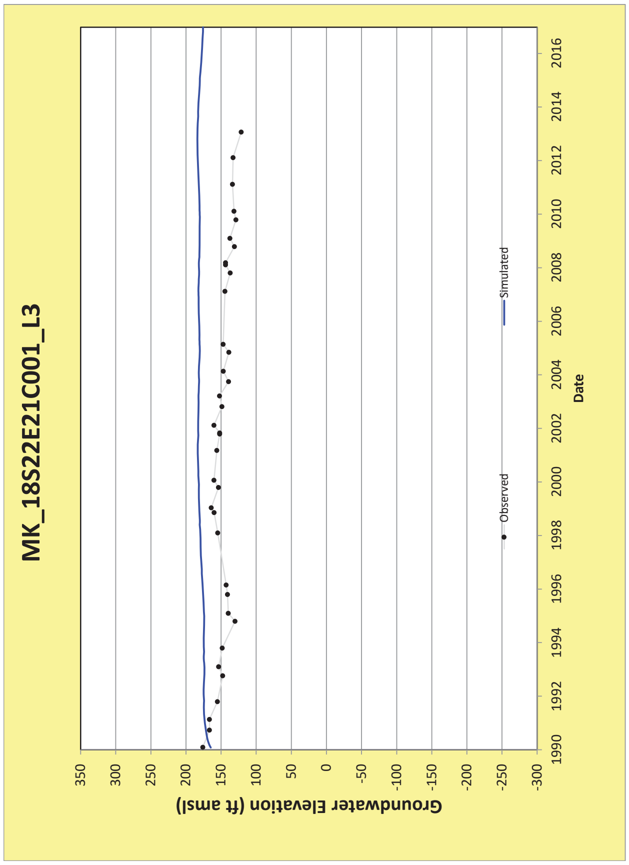
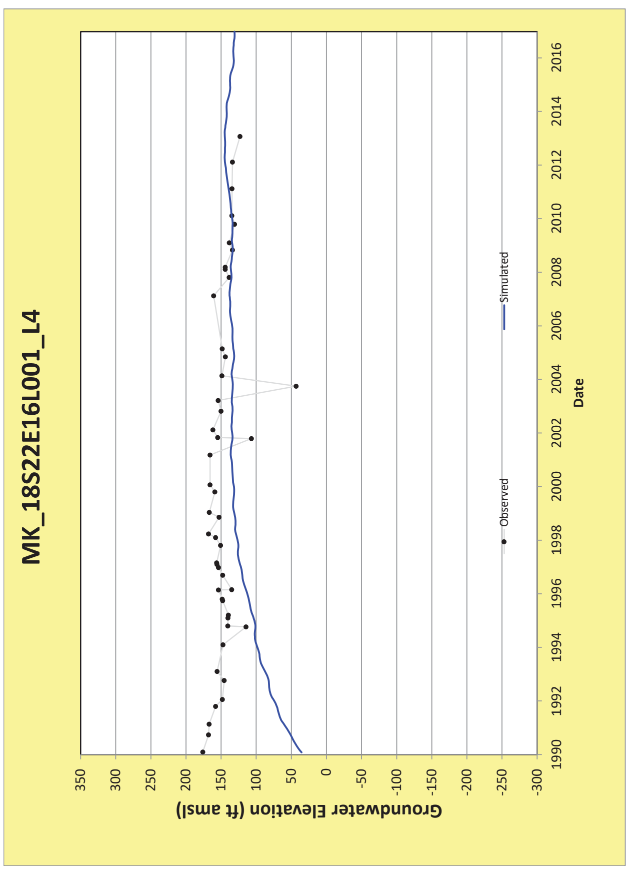
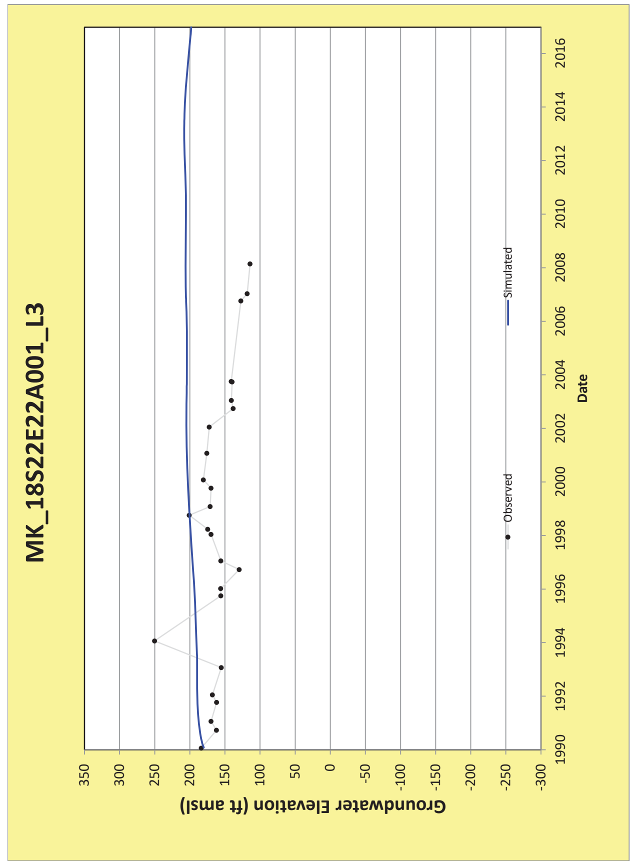
2012
2014
2016
Date
Observed
Simulated

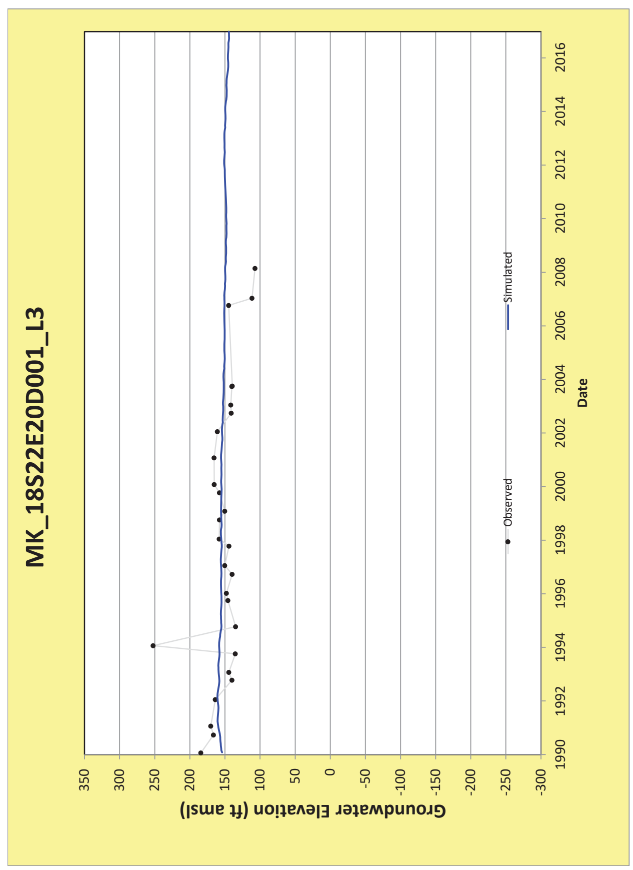

MK_18S22E03B001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


MK_18S22E08A001_L4
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated

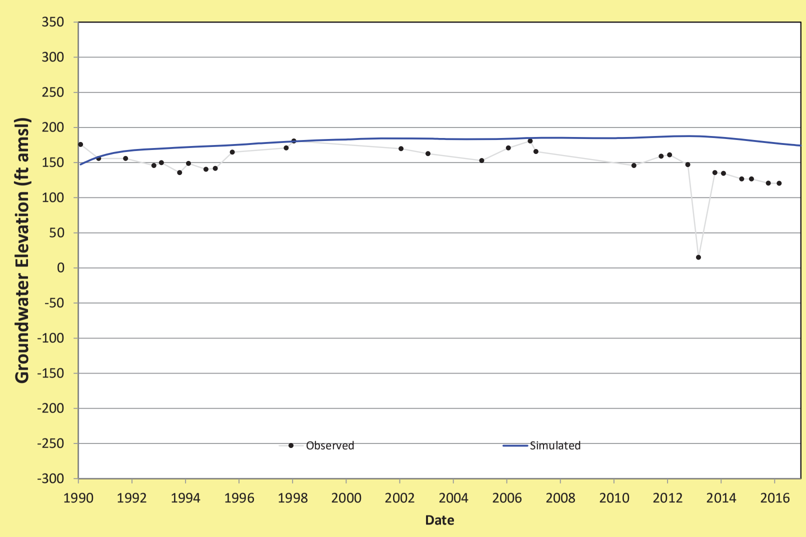

MK_18S22E21C001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_18S22E16L001_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

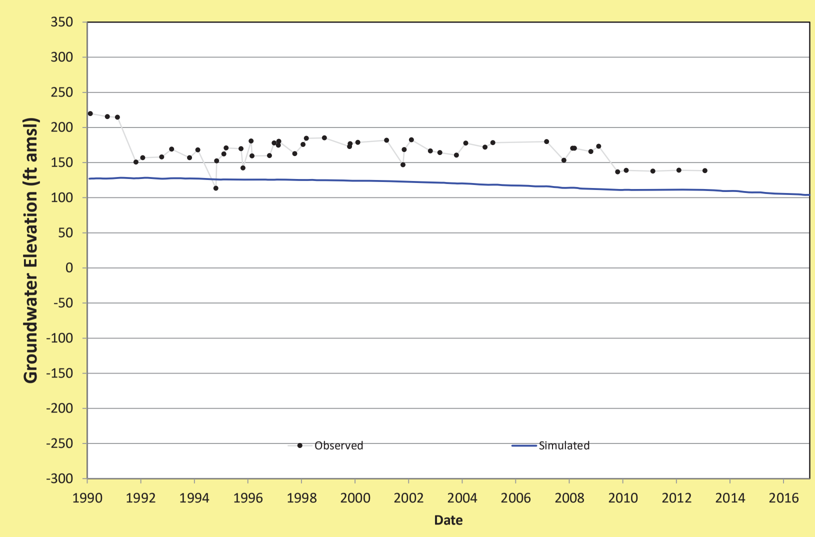

MK_18S22E22A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


MK_18S22E20D001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

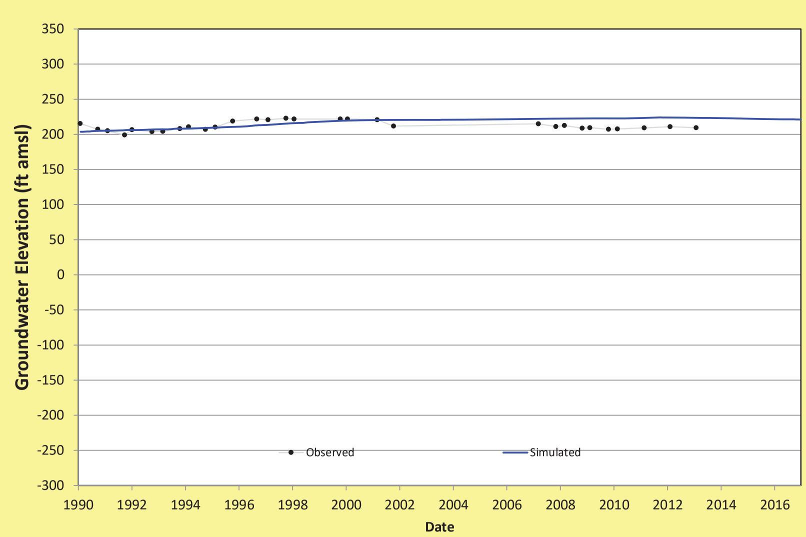
MK_18S22E34R001_L3



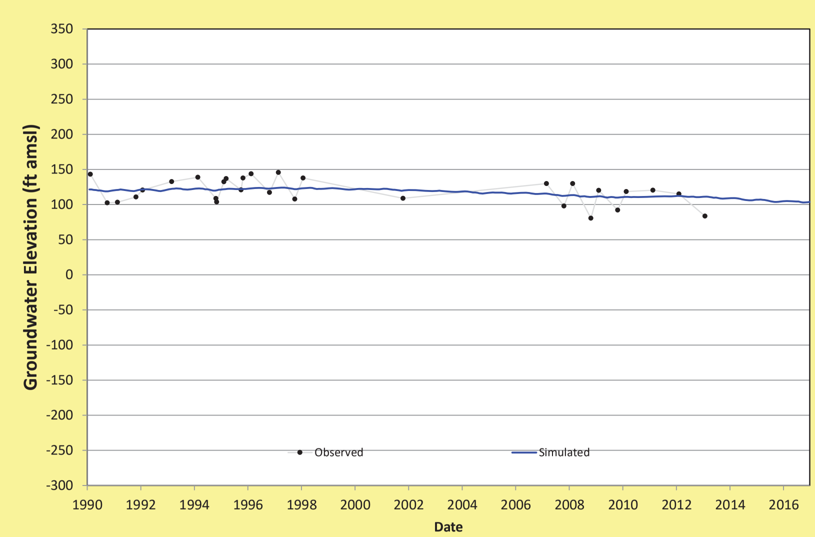
MK_19S21E03B001_L3

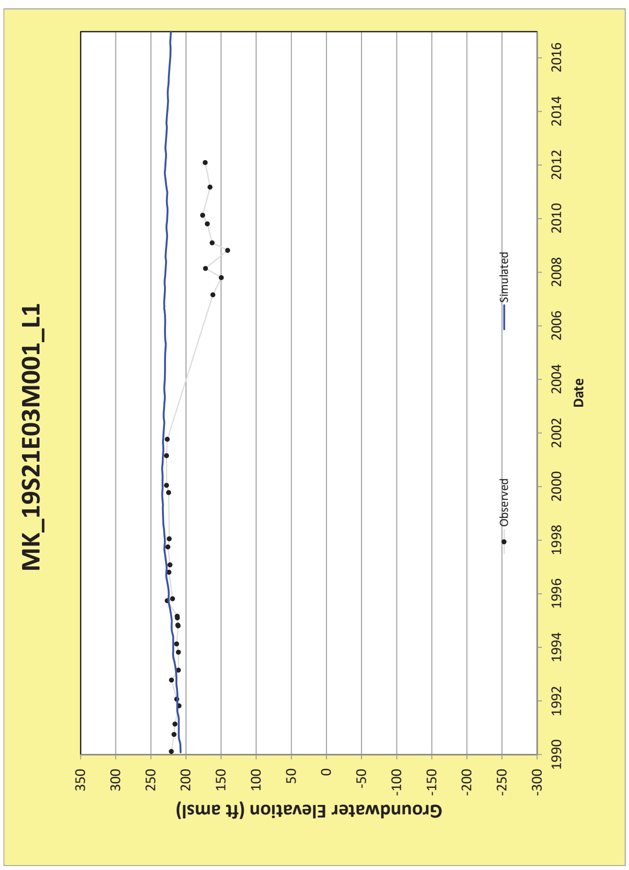


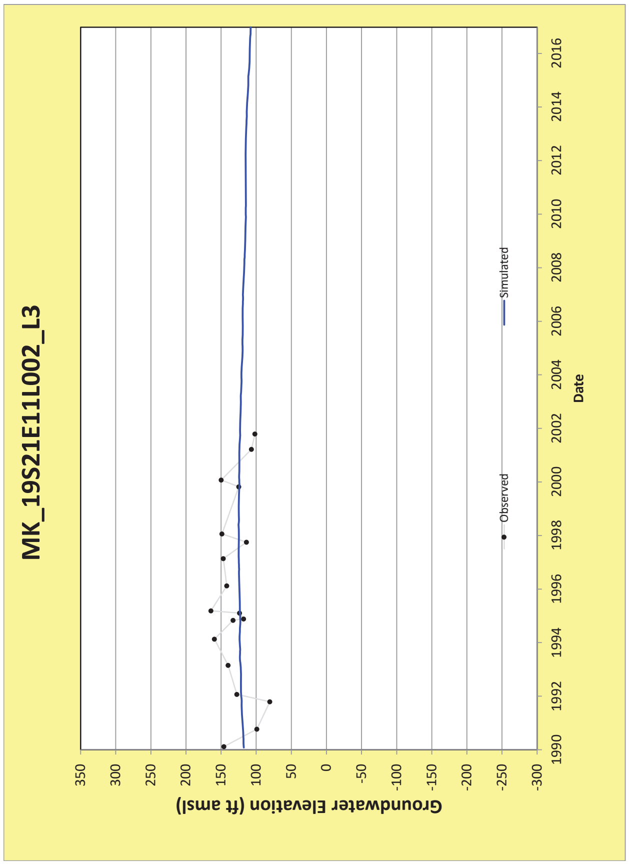
MK_19S20E12A001_L1

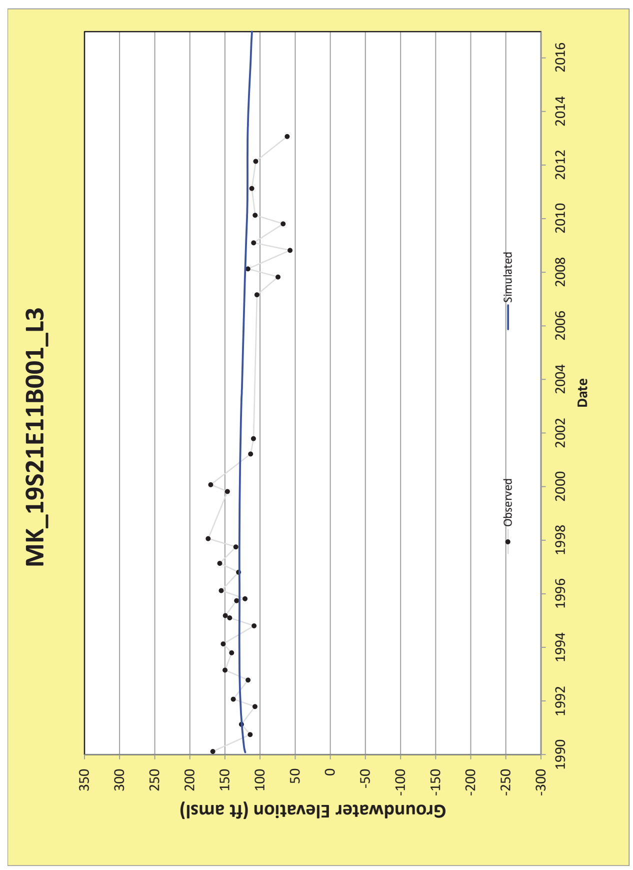


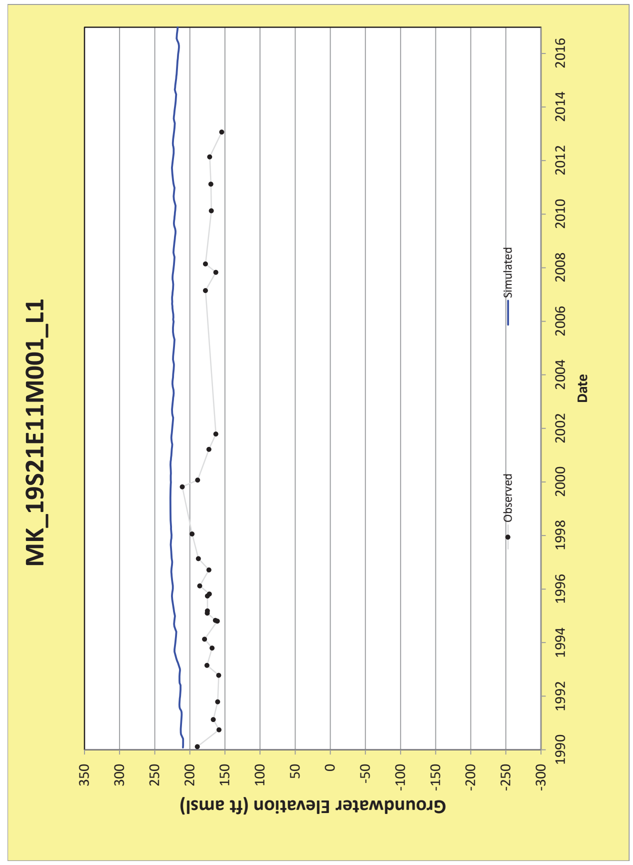
MK_19S21E03J001_L3

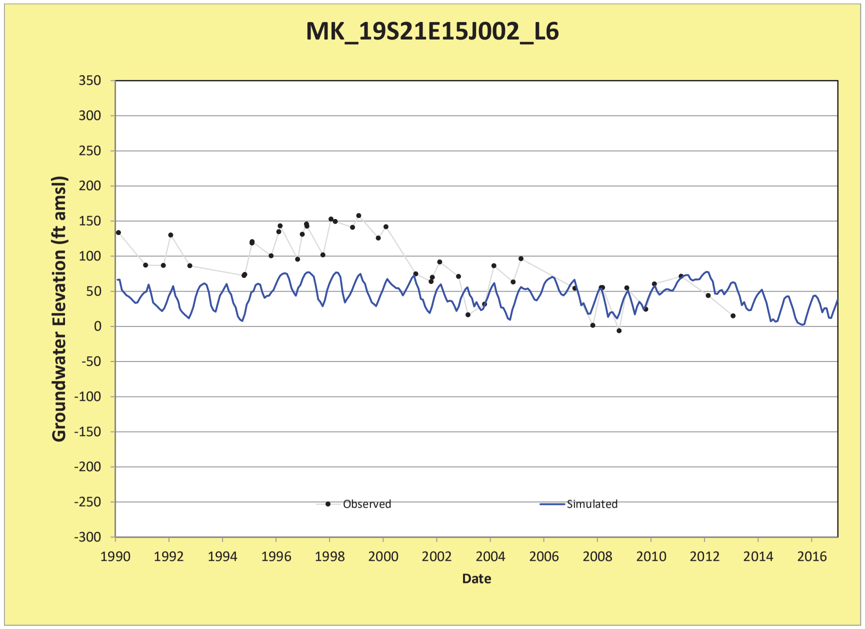


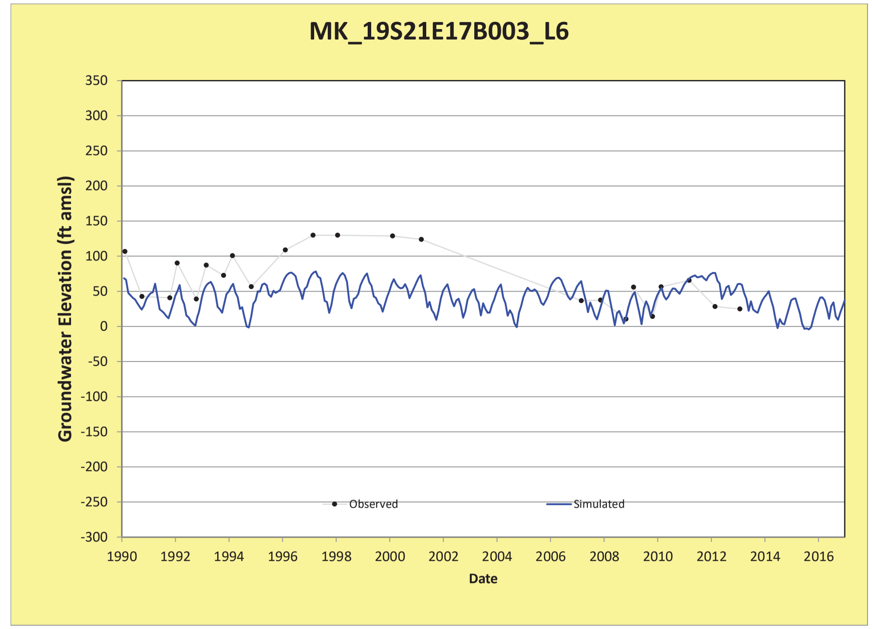

MK_19S21E03M001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

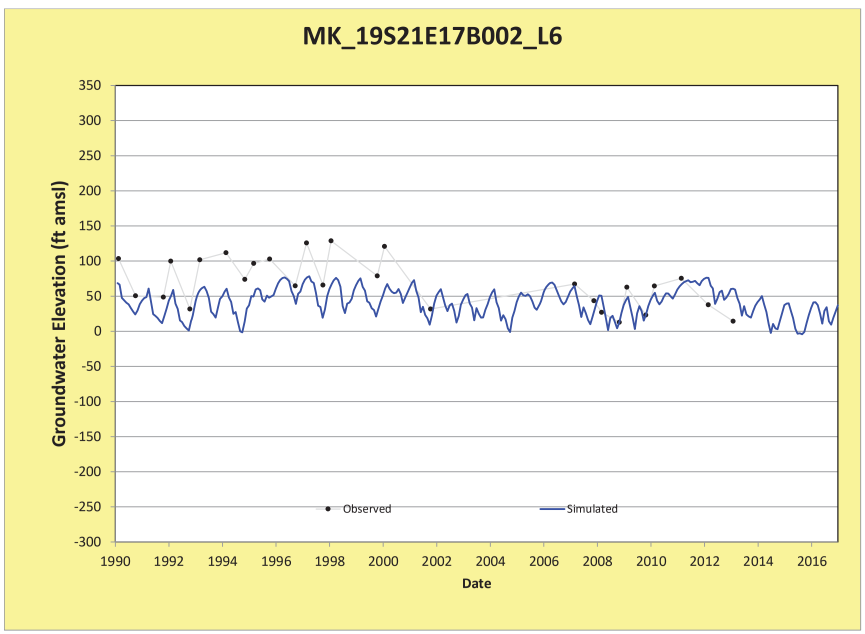

MK_19S21E11L002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

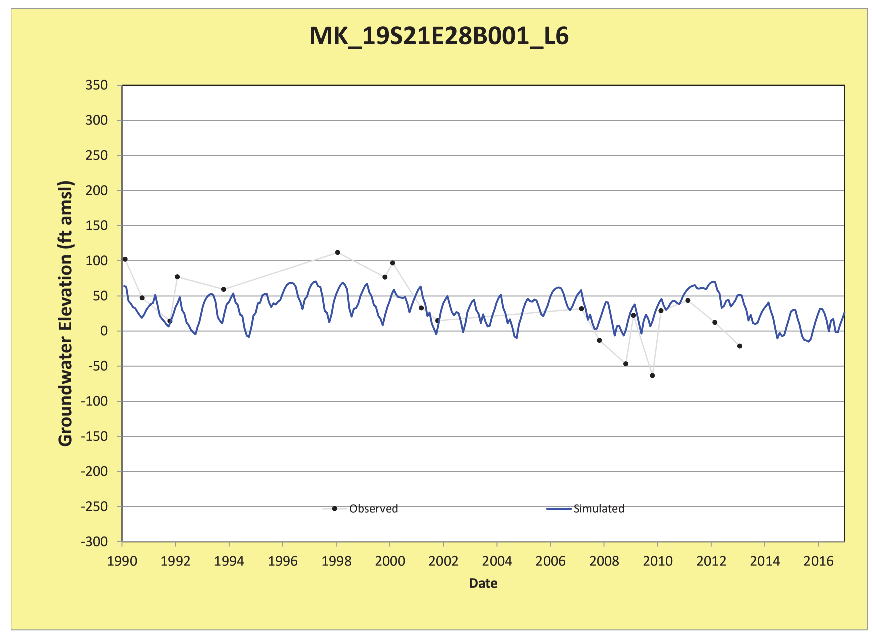

MK_19S21E11B001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

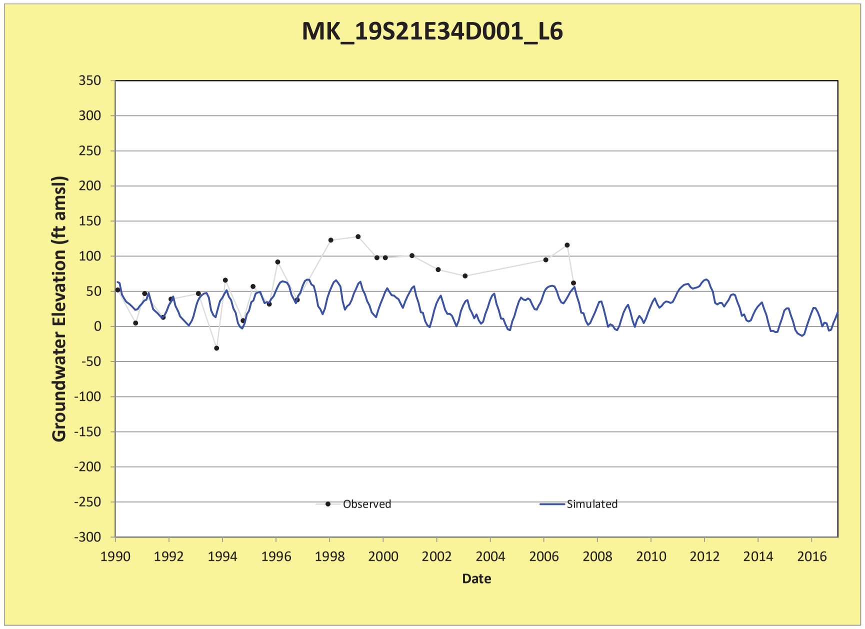

MK_19S21E11M001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

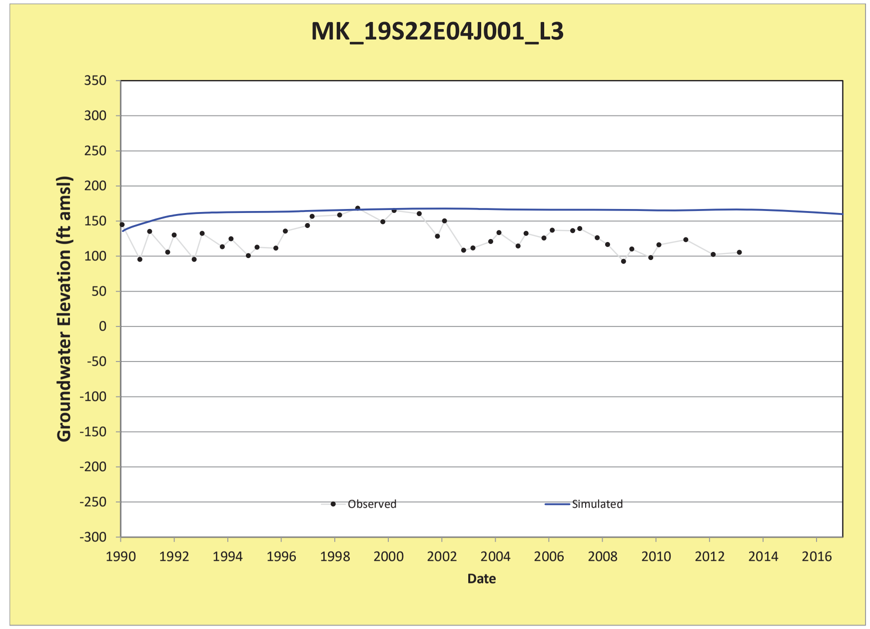

MK_19S21E15J002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

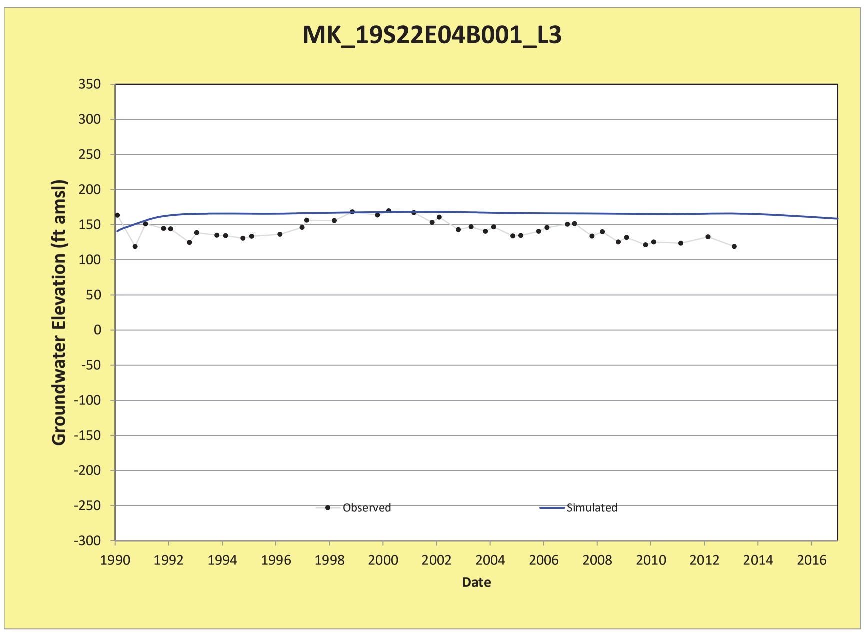

MK_19S21E17B003_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

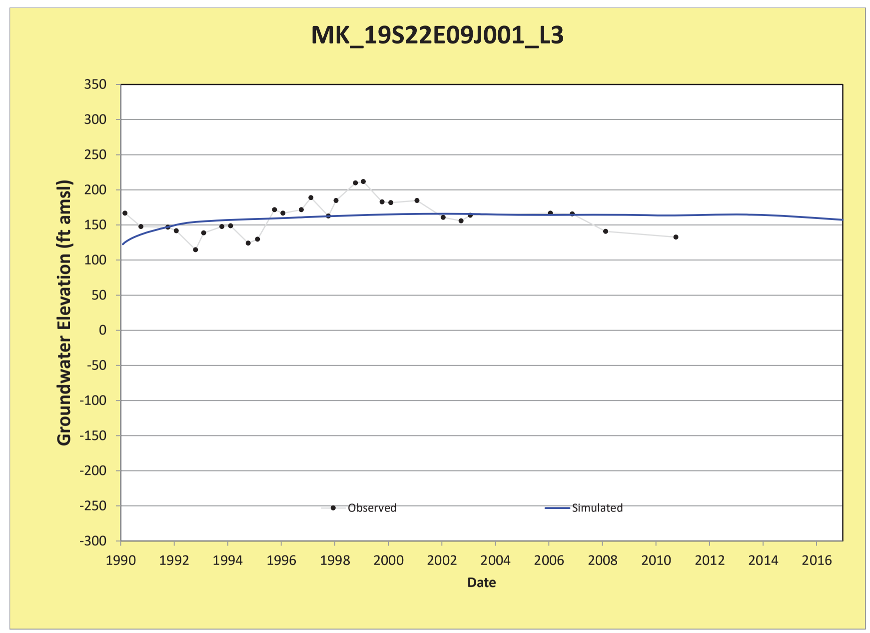

MK_19S21E17B002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

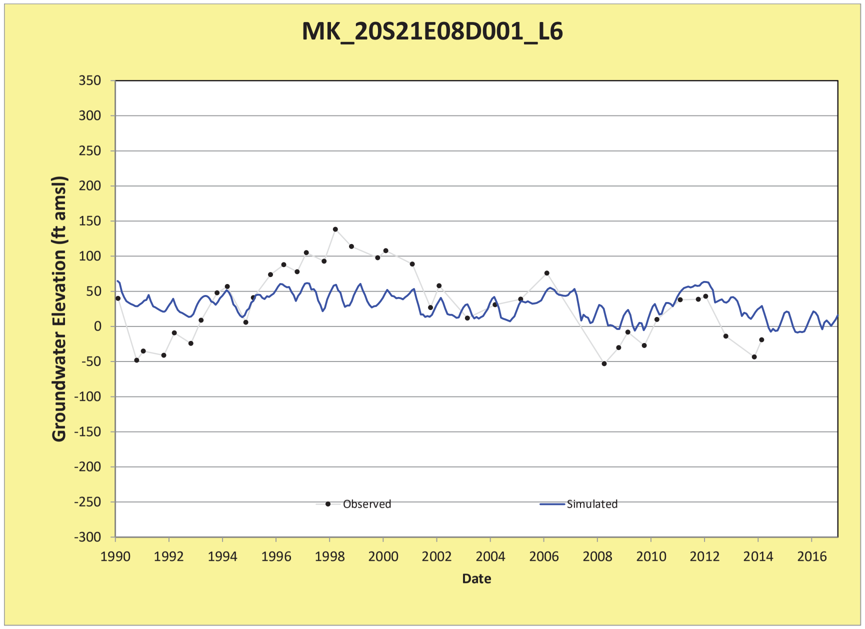

MK_19S21E28B001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

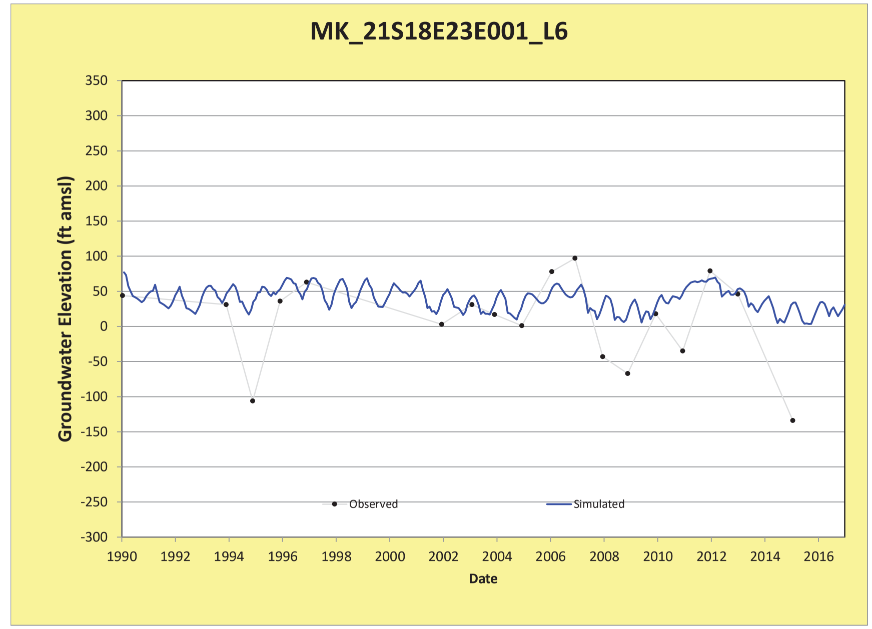

MK_19S21E34D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

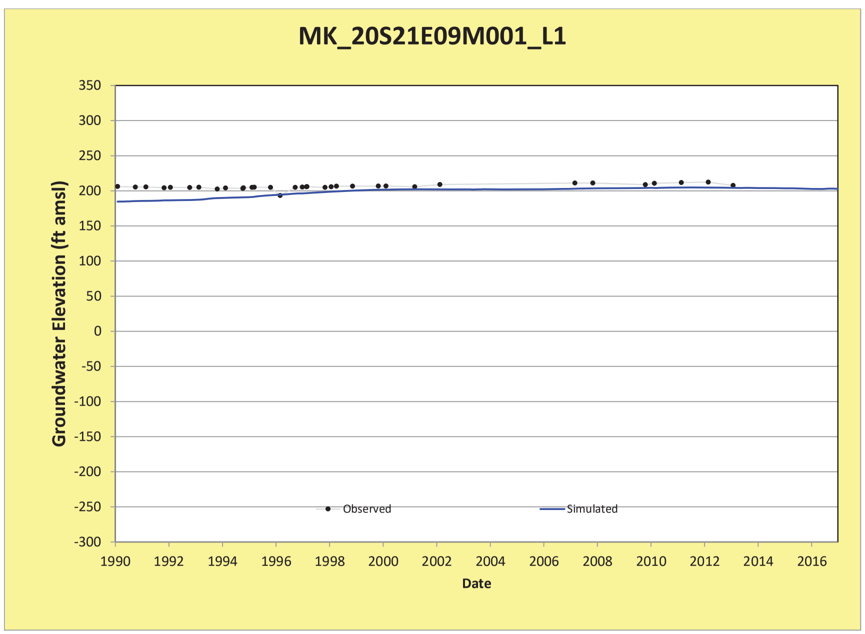

MK_19S22E04J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

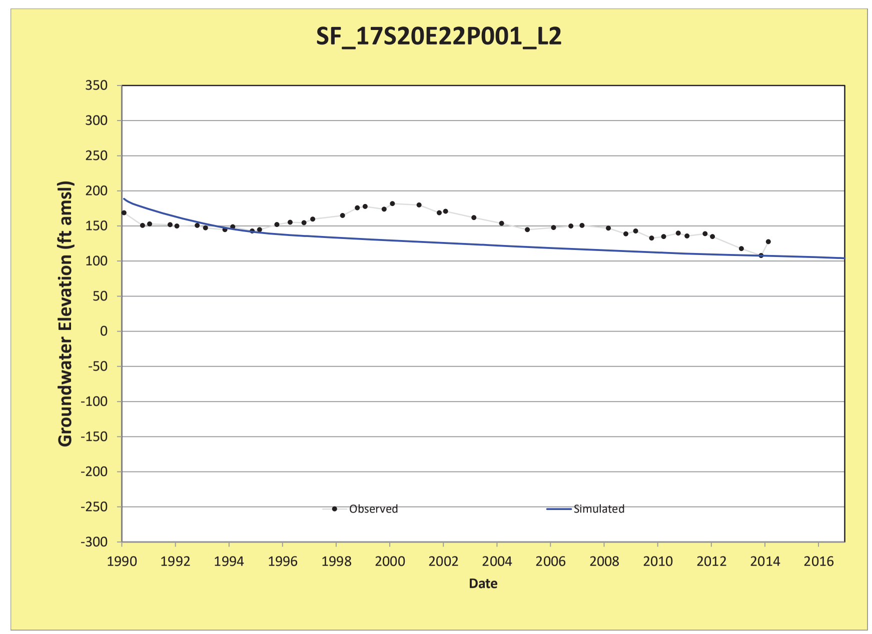

MK_19S22E04B001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

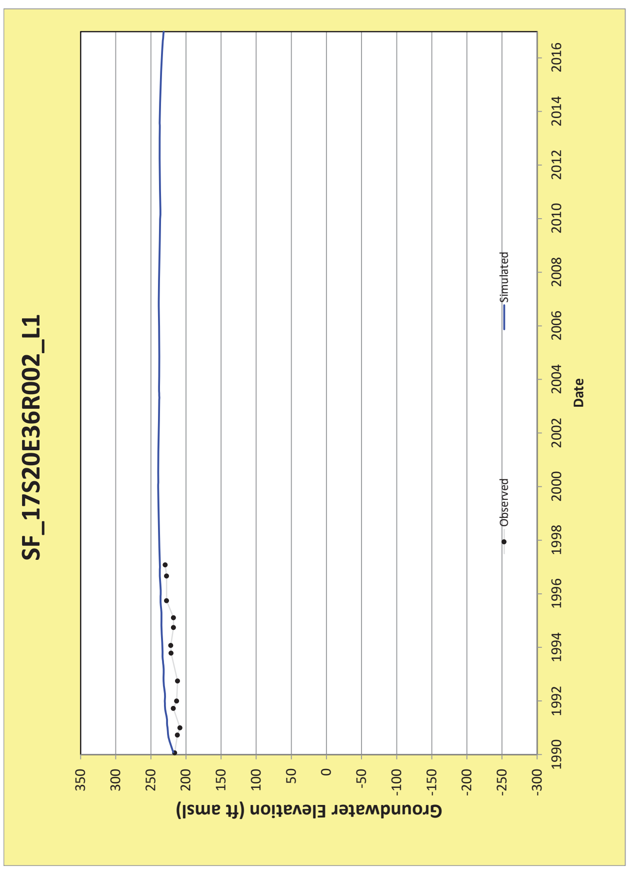

MK_19S22E09J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

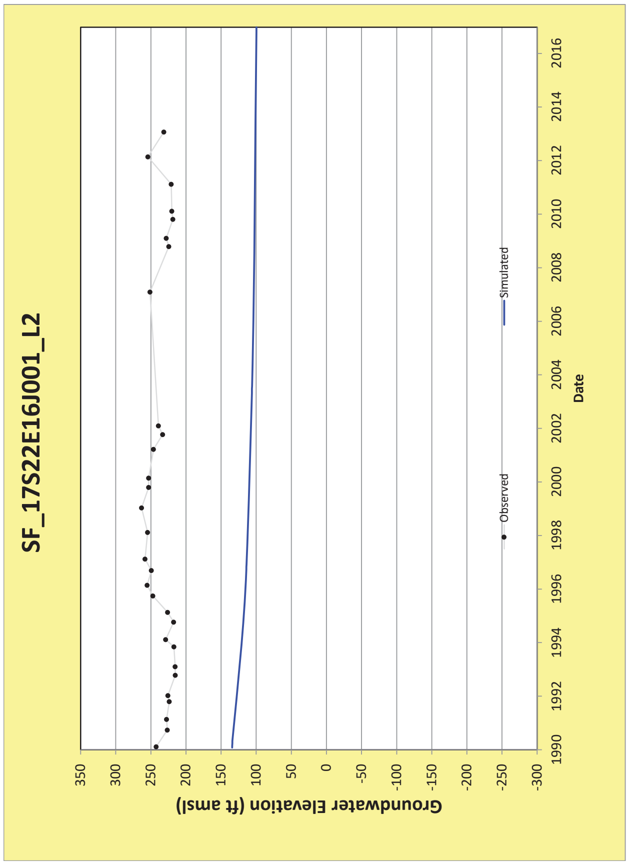

MK_20S21E08D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

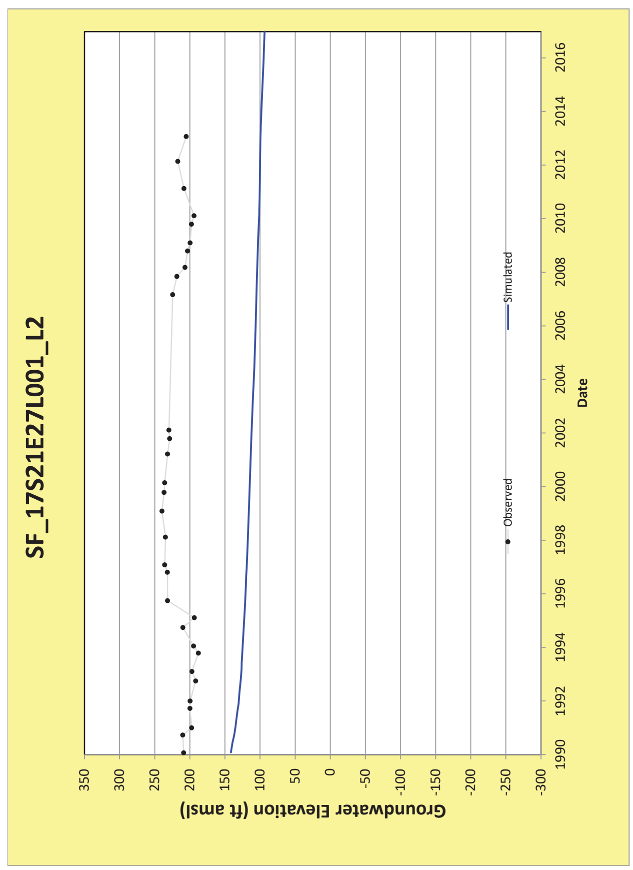

MK_21S18E23E001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

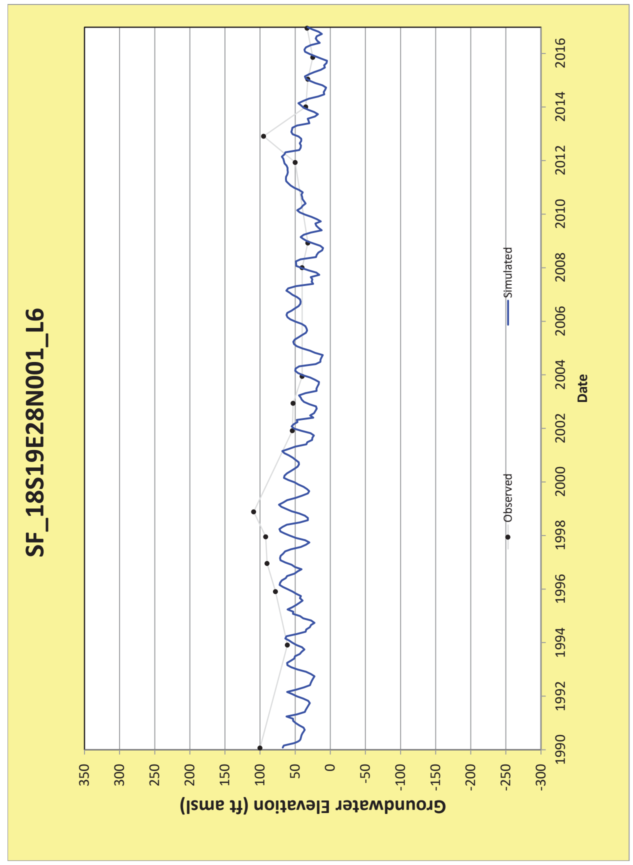

MK_20S21E09M001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

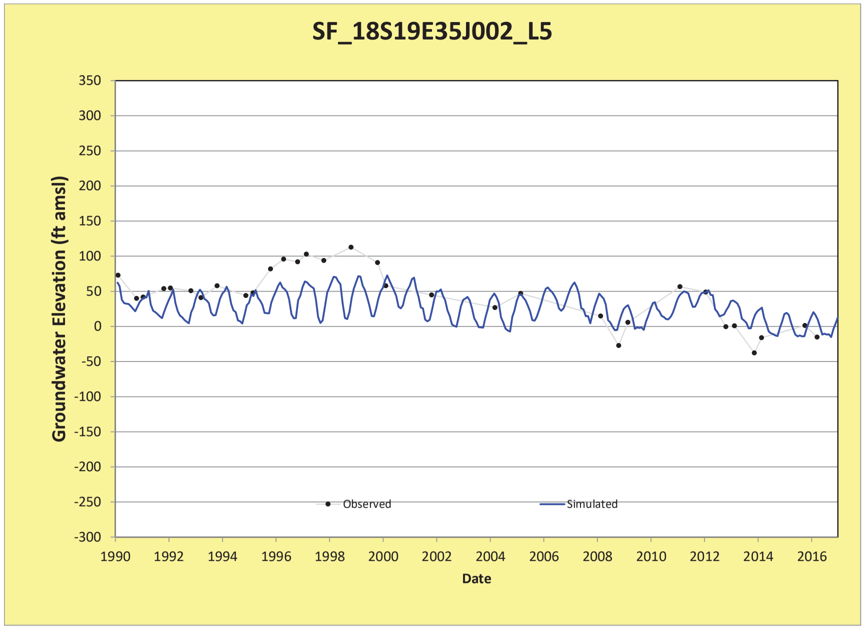

SF_17S20E22P001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

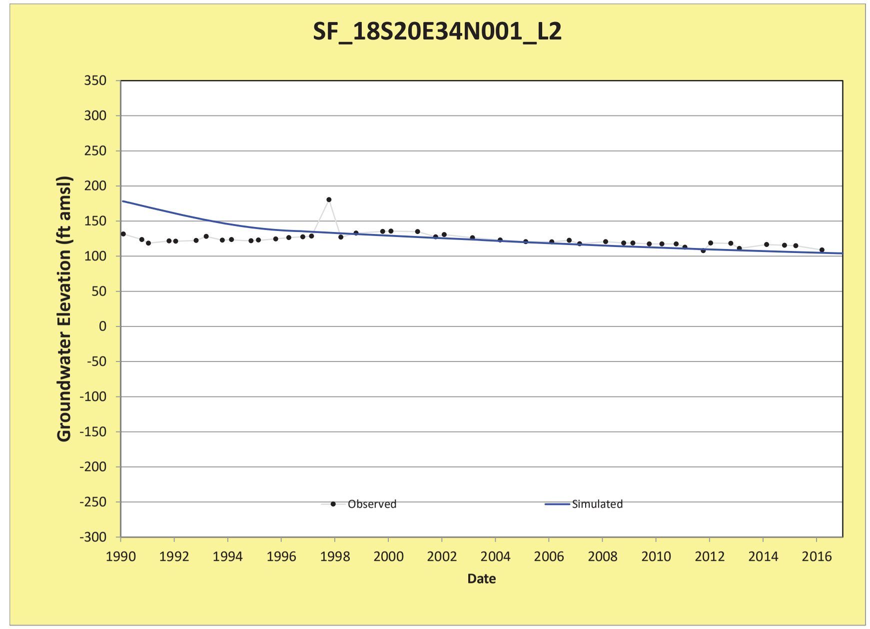

SF_17S20E36R002_L1
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated

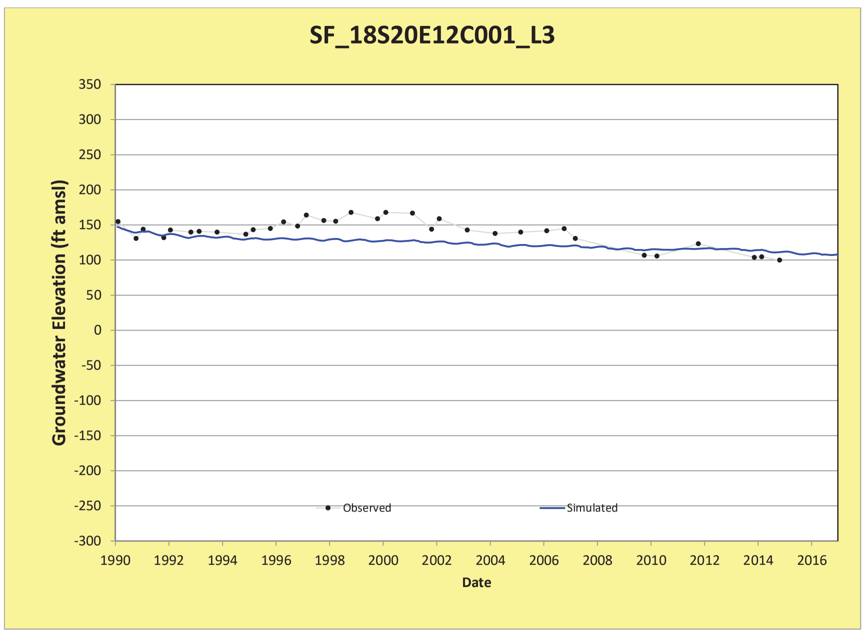

SF_17S22E16J001_L2
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated

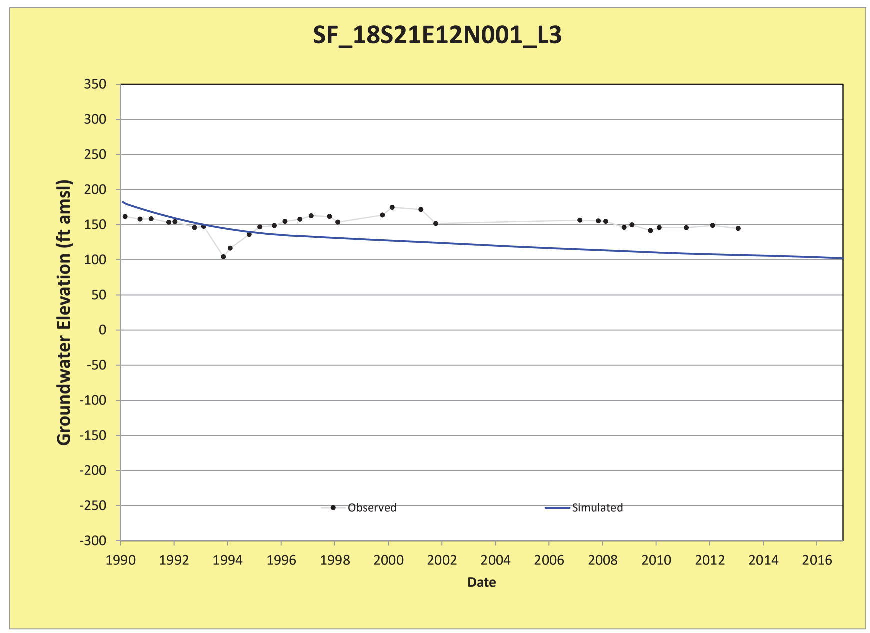

SF_17S21E27L001_L2
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_18S19E28N001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_18S19E35J002_L5
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_18S20E34N001_L2
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_18S20E12C001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_18S21E12N001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
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2006
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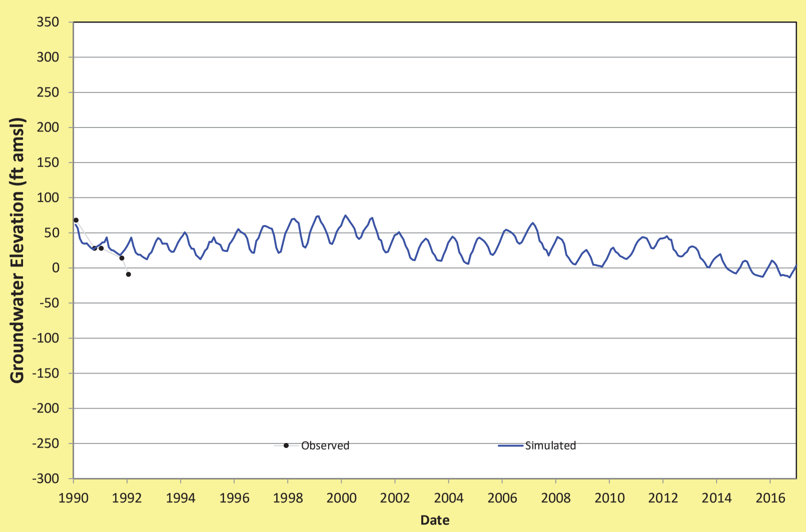
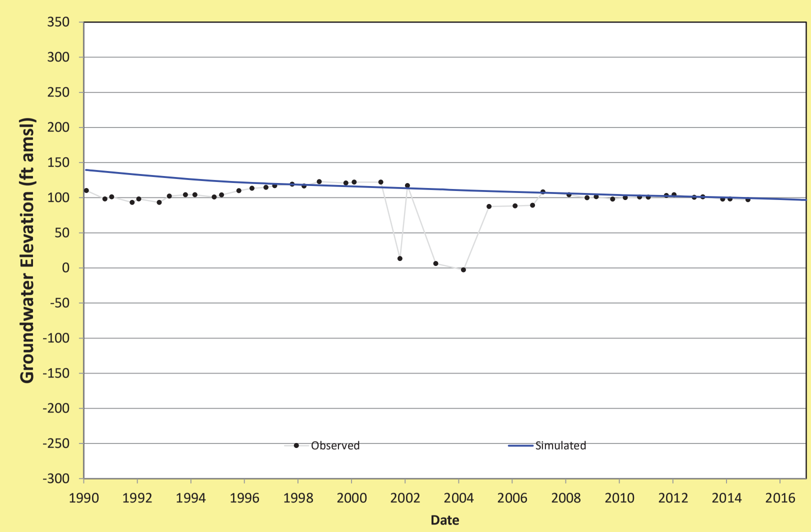
2010
2012
2014
2016
Date
Observed
Simulated

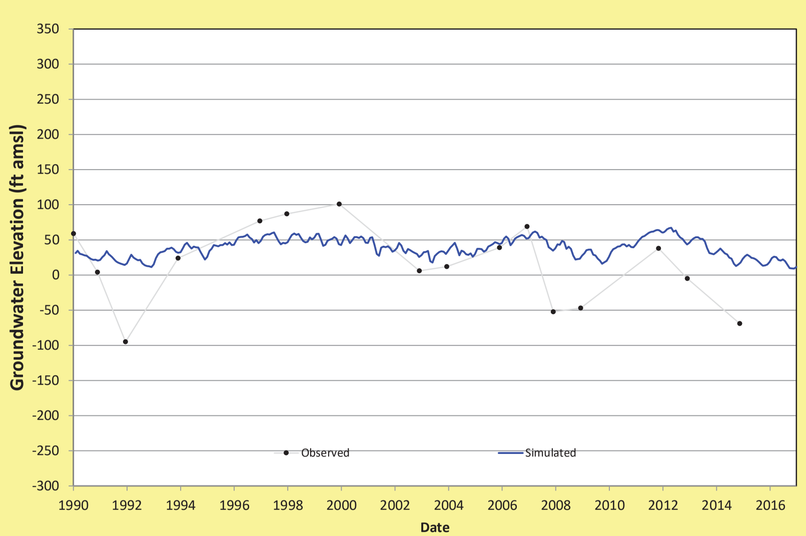
SF_19S19E03H002_L6



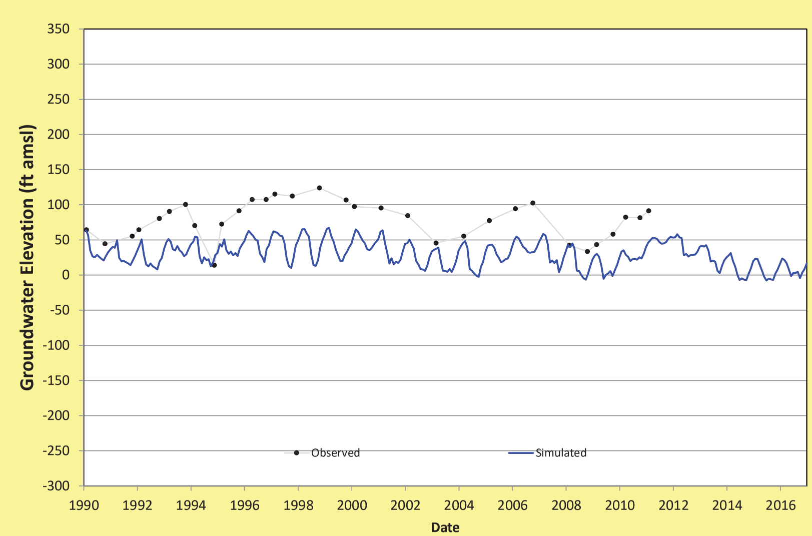
SF_19S20E06L001_L3

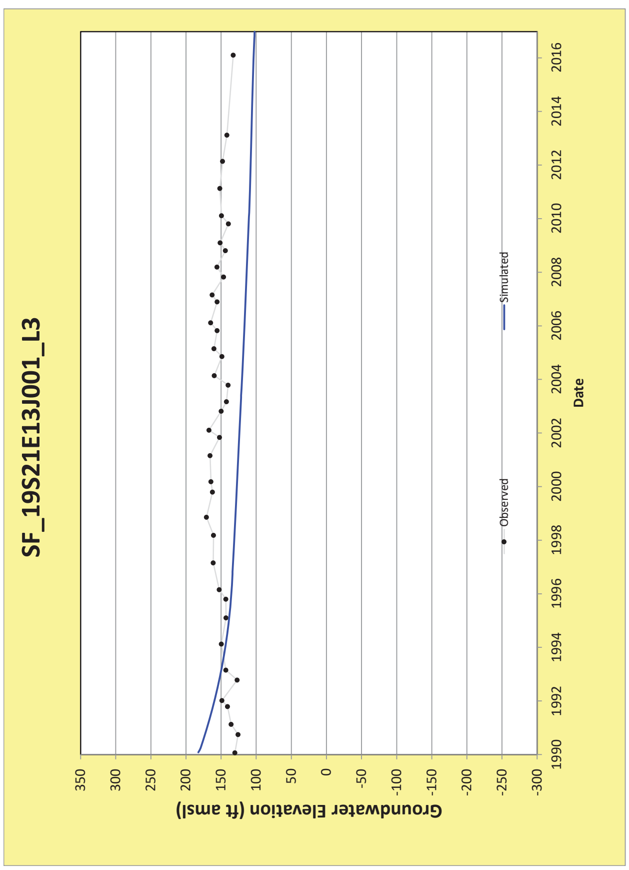


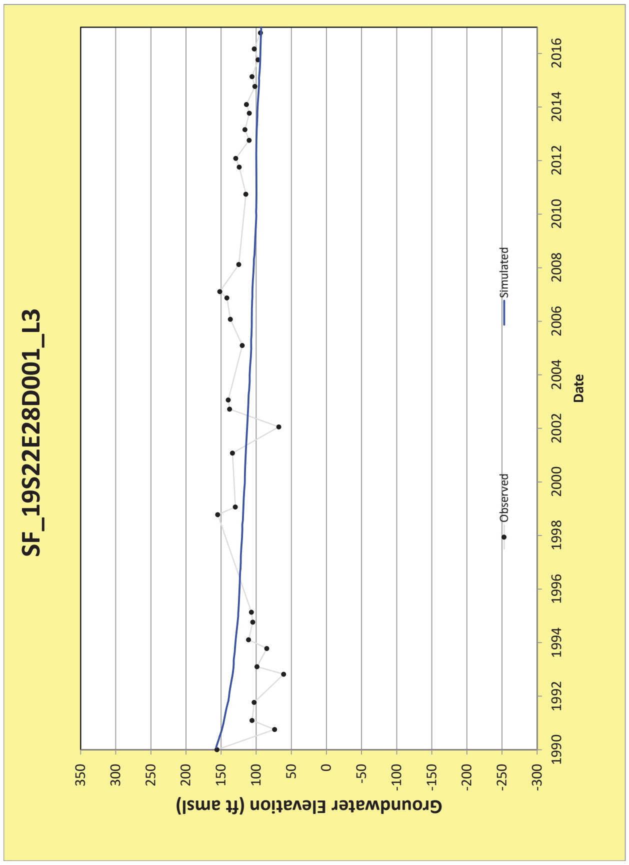
SF_19S19E27M001_L6

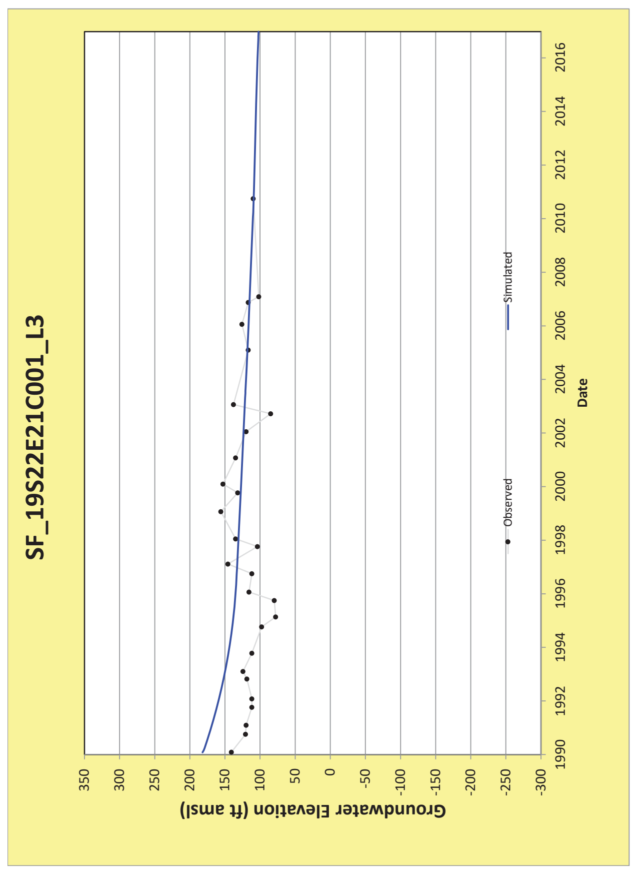


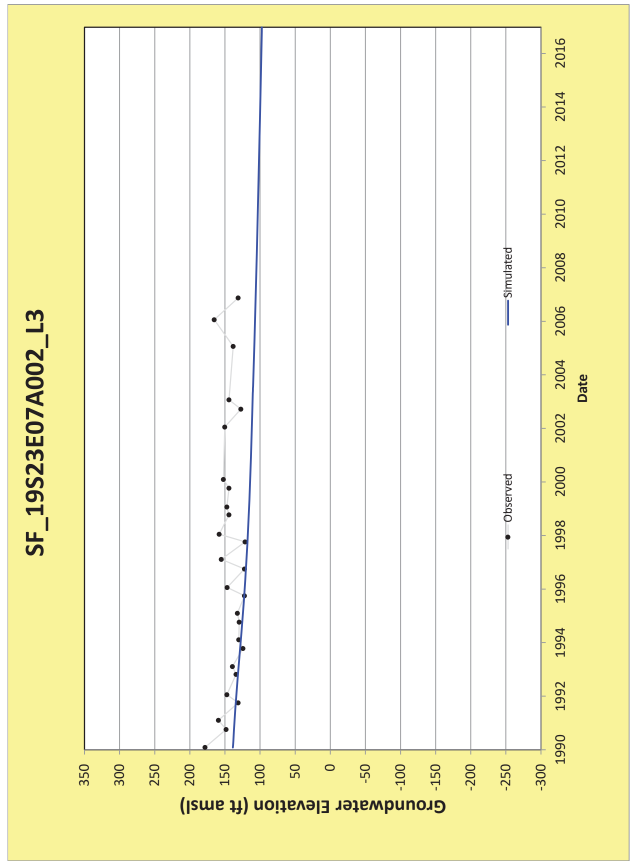
SF_19S20E07F001_L6

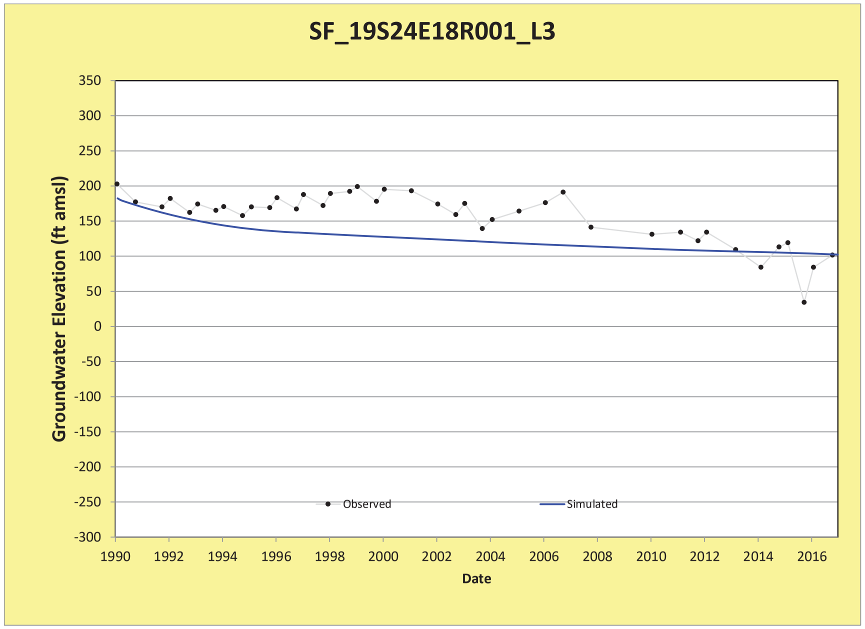



SF_19S21E13J001_L3
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated

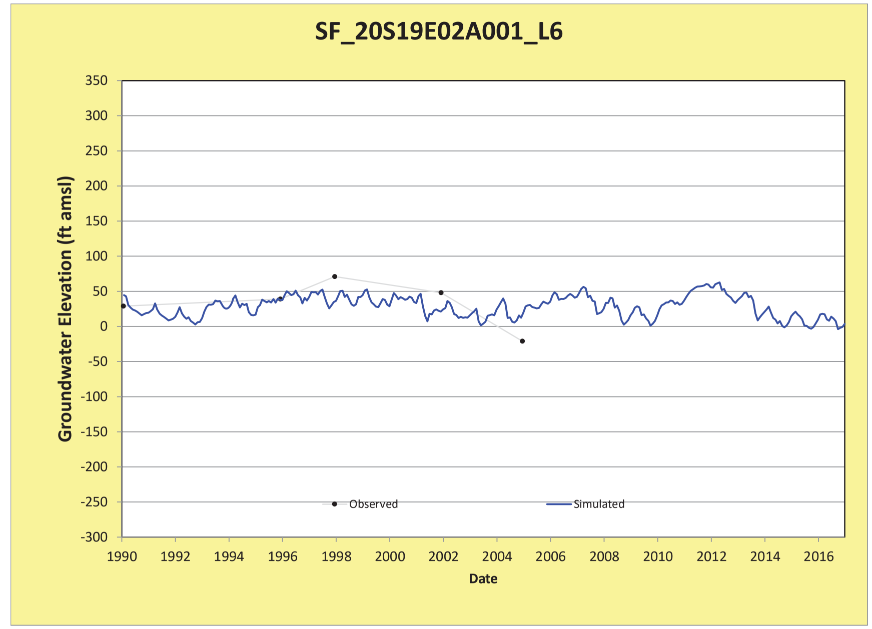

SF_19S22E28D001_L3
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SF_19S22E21C001_L3
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated

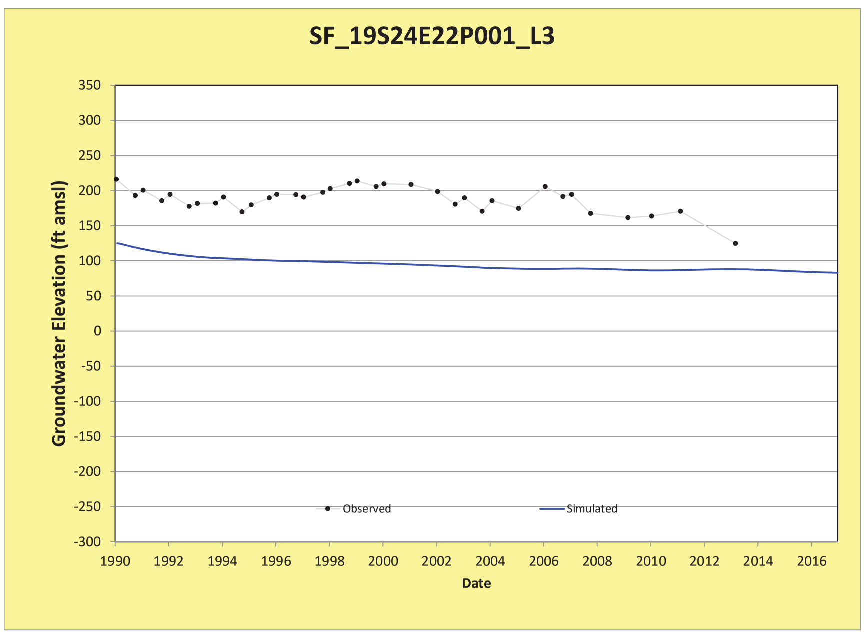

SF_19S23E07A002_L3
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated



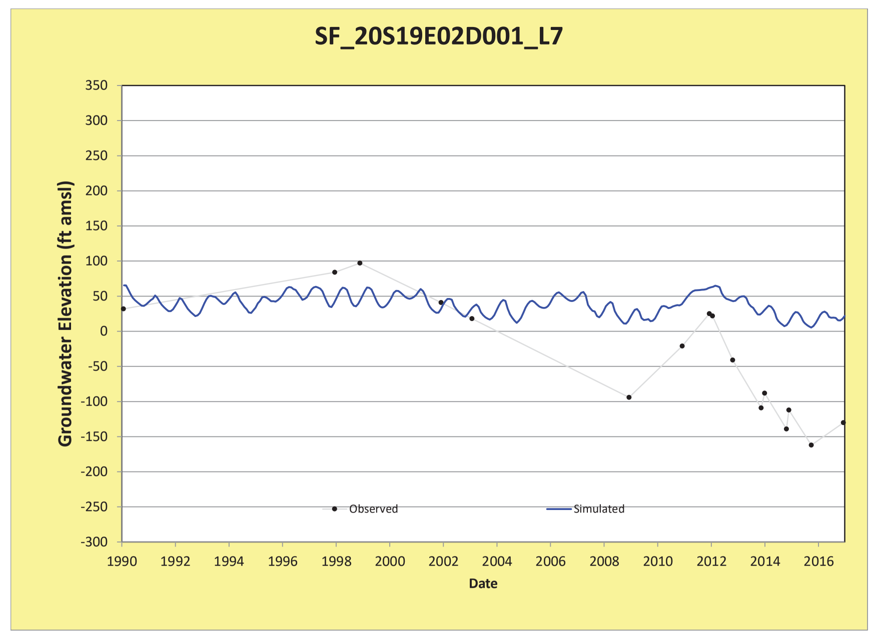
SF_19S24E18R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated



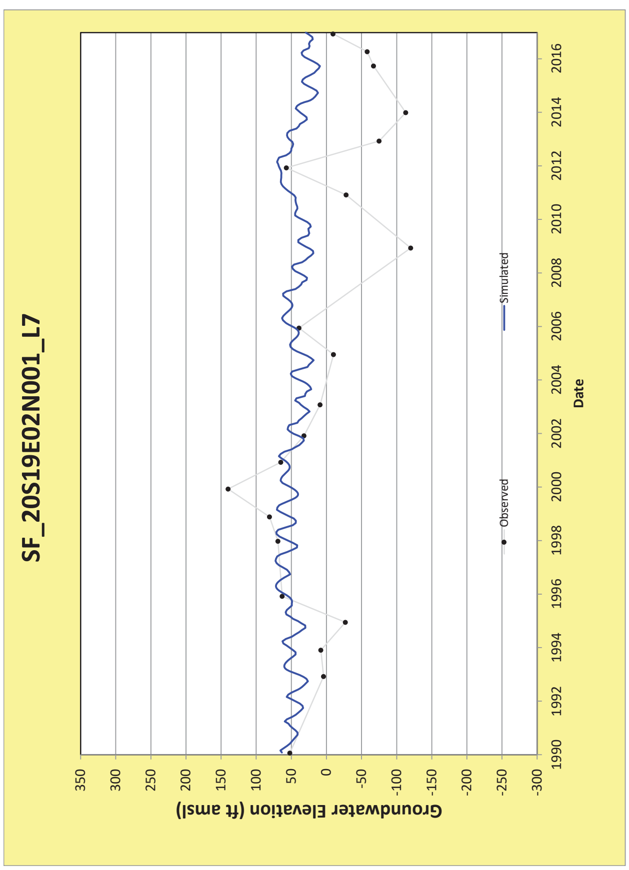
SF_20S19E02A001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

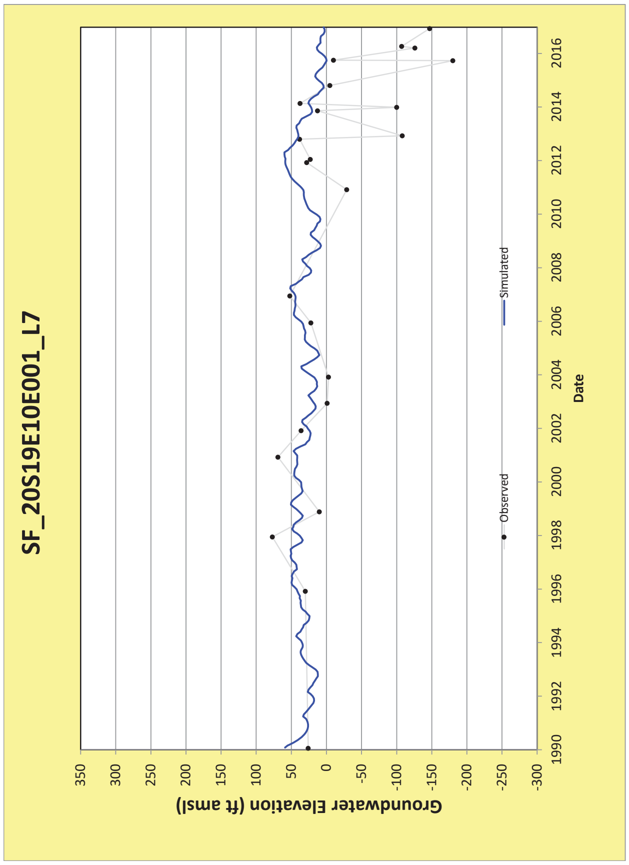


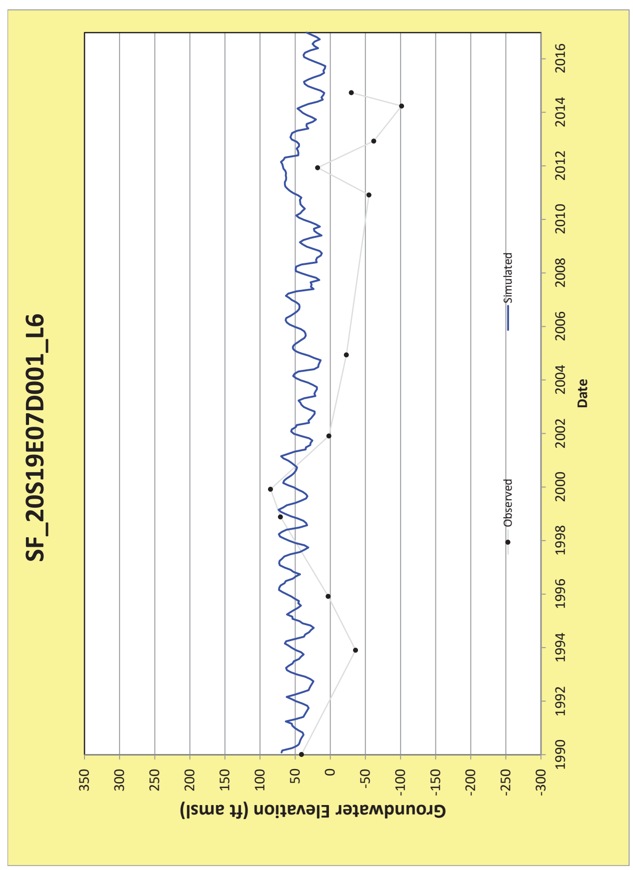
SF_19S24E22P001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

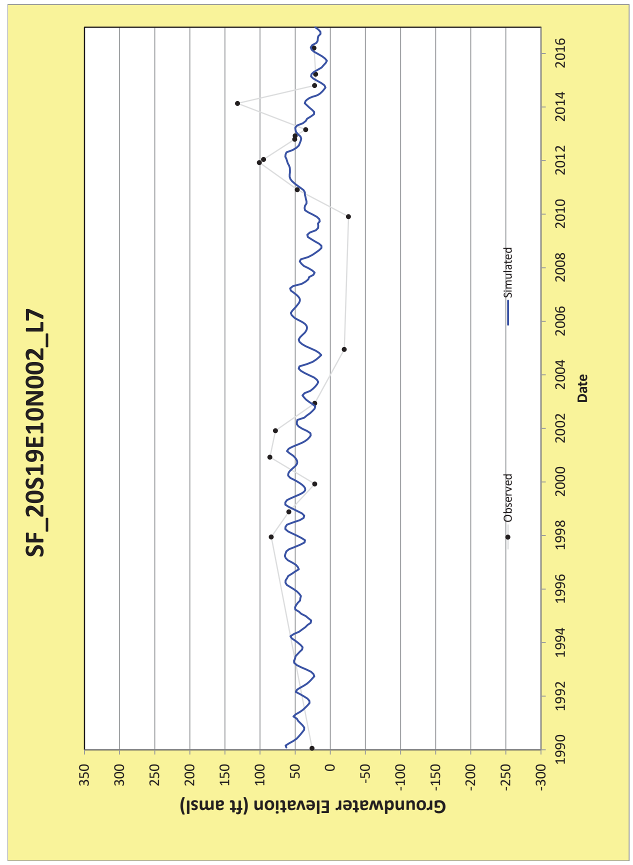


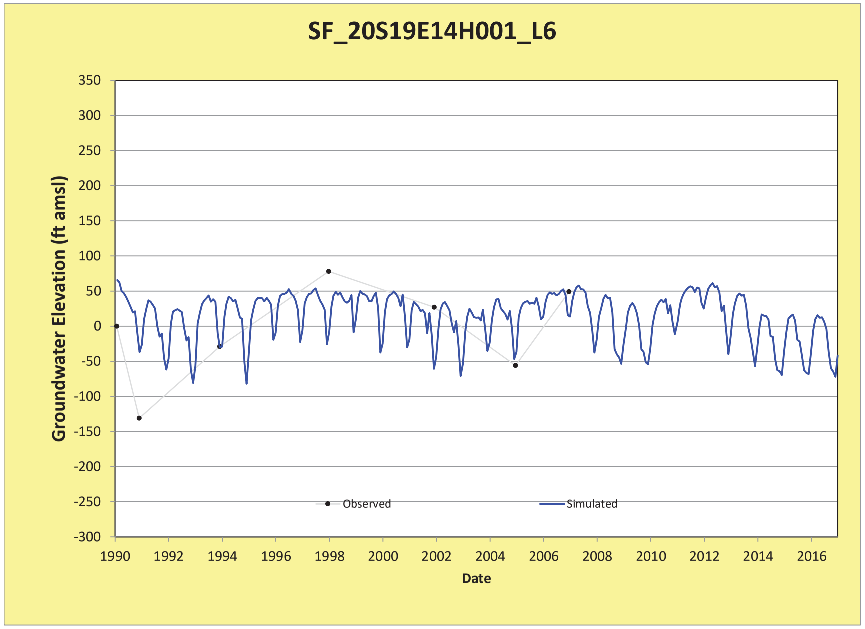
SF_20S19E02D001_L7
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

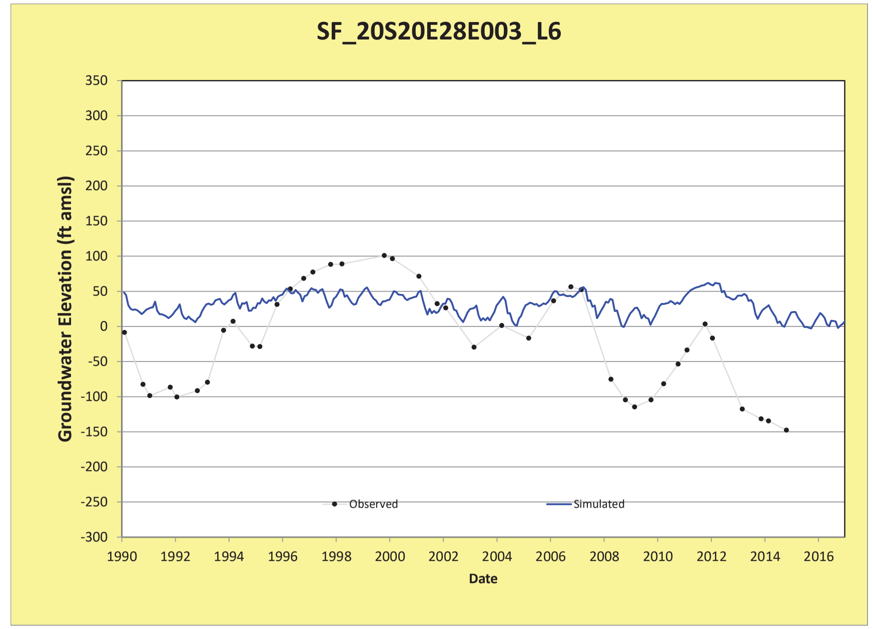

SF_20S19E02N001_L7
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

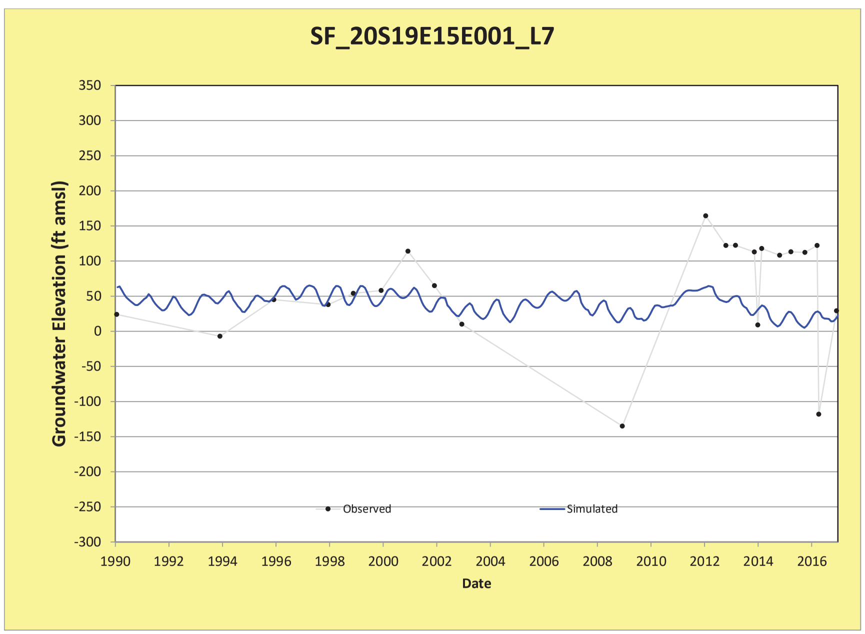

SF_20S19E10E001_L7
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

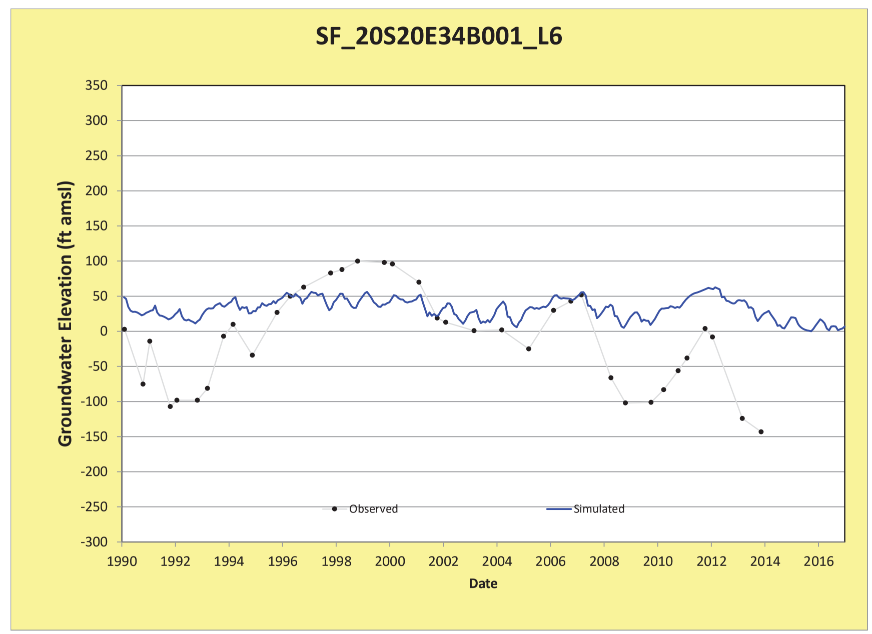

SF_20S19E07D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

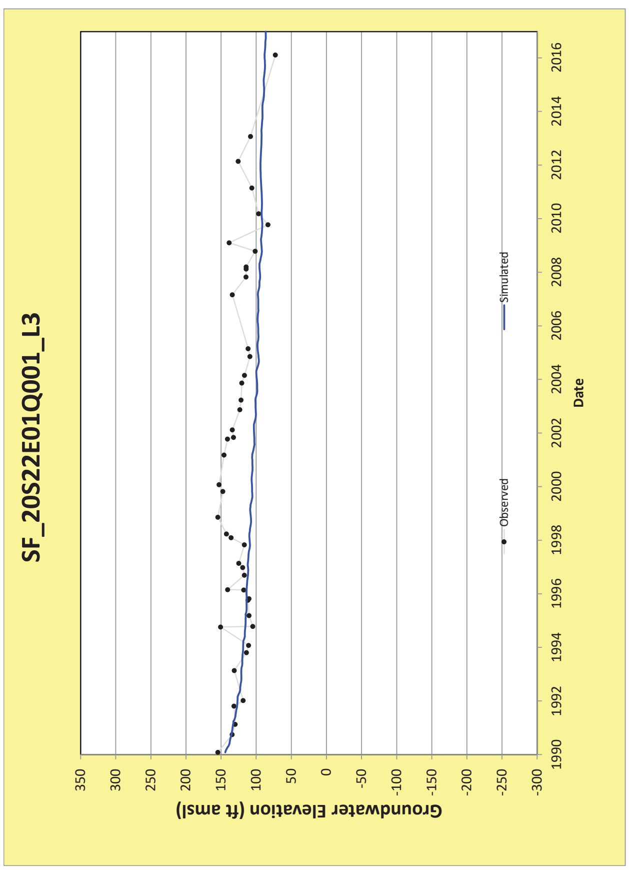

SF_20S19E10N002_L7
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

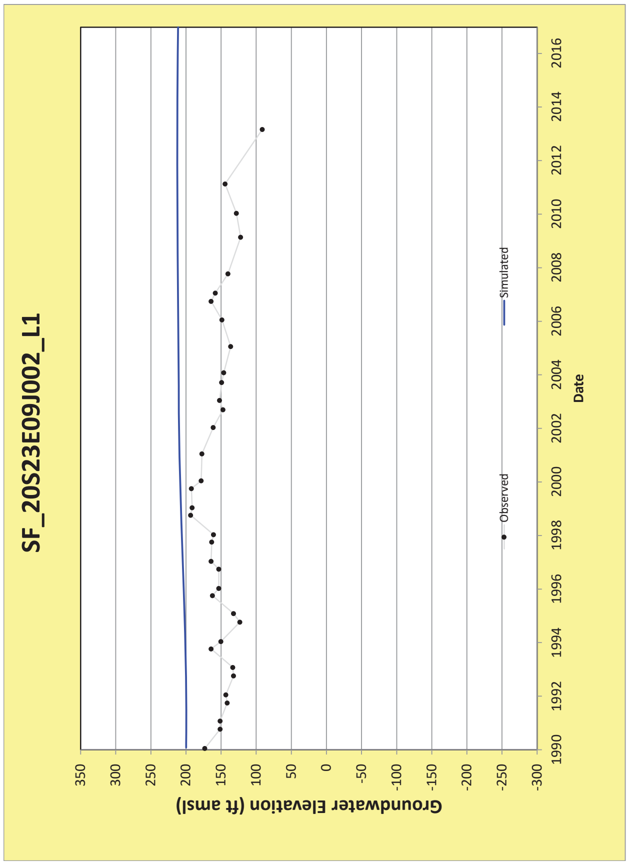

SF_20S19E14H001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


SF_20S20E28E003_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


SF_20S19E15E001_L7
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


SF_20S20E34B001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


SF_20S22E01Q001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_20S23E09J002_L1
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
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2004
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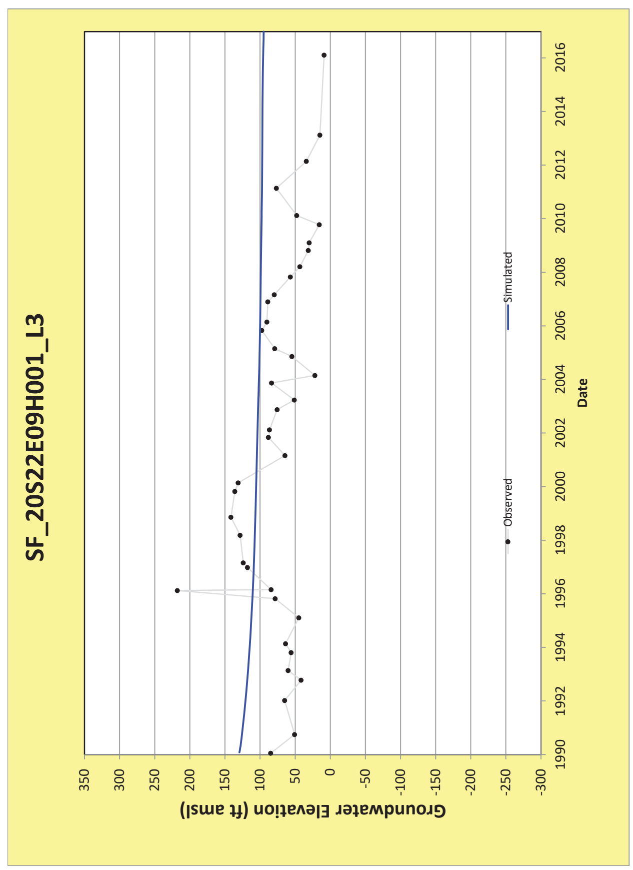
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_20S22E09H001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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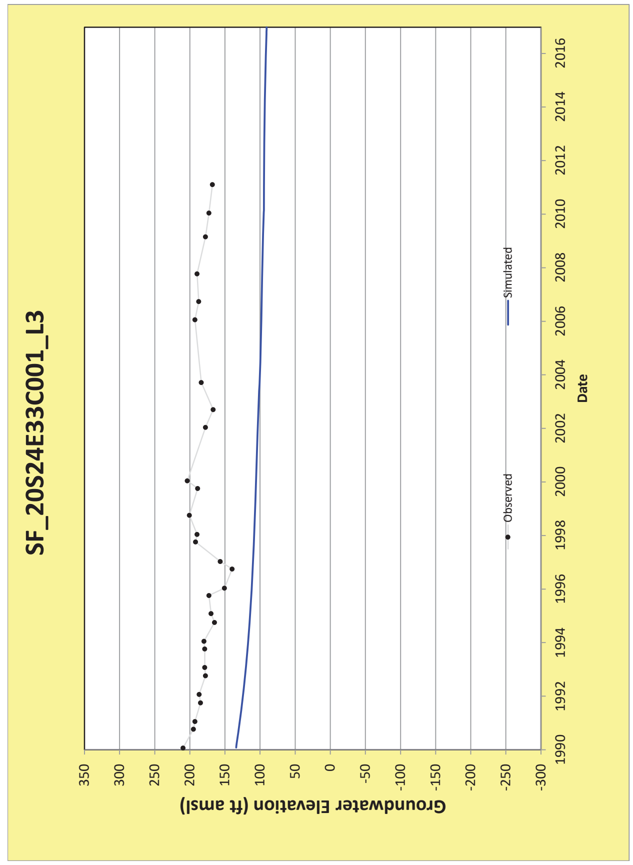
2010
2012
2014
2016
Date
Observed
Simulated


SF_20S24E33C001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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1992
1994
1996
1998
2000
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2004
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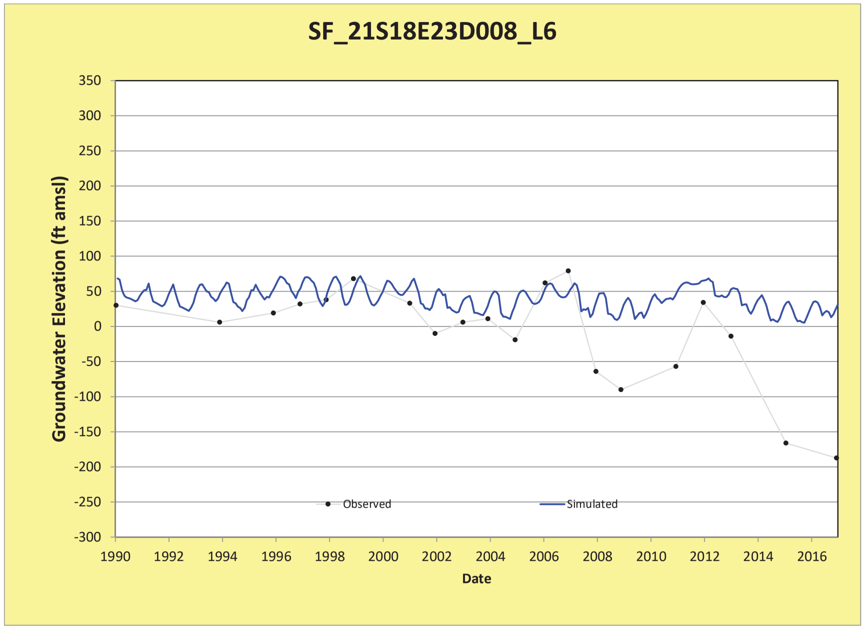
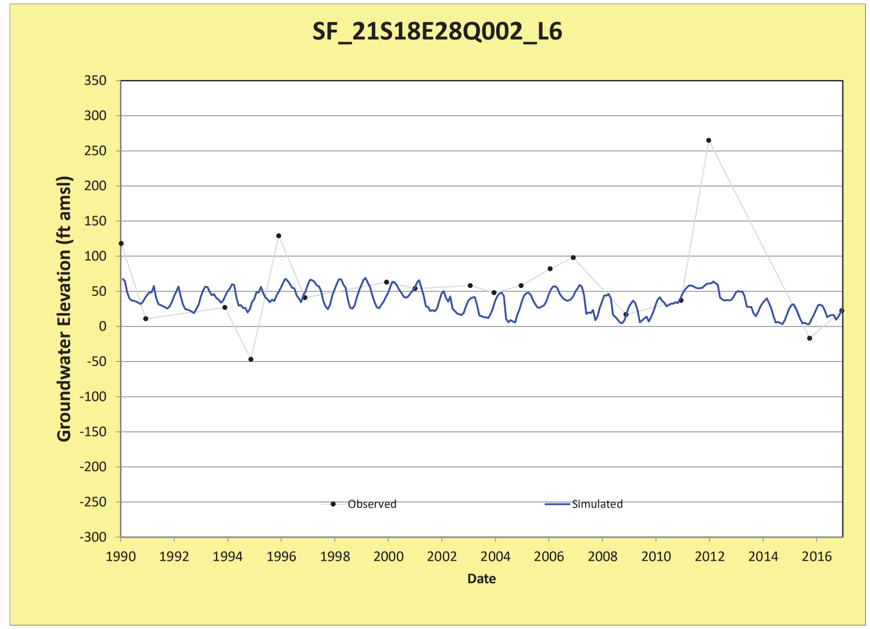
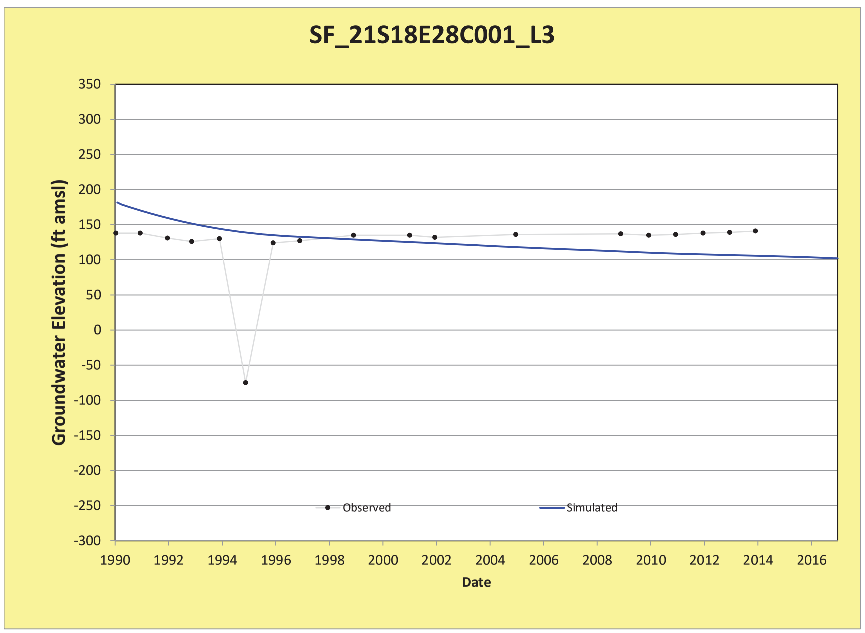
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_21S18E23D008_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_21S18E28Q002_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_21S18E28C001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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2006
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2010
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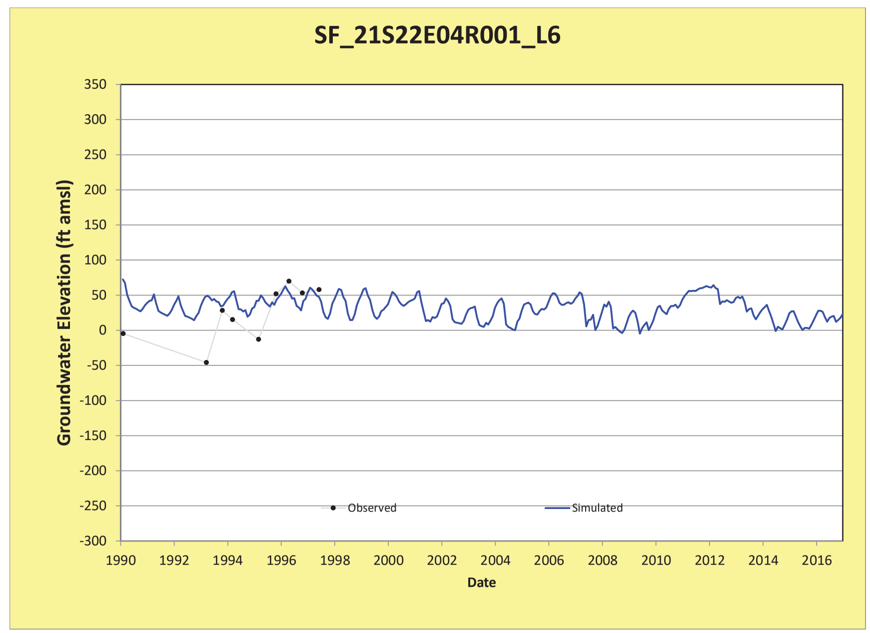
2014
2016
Date
Observed
Simulated


SF_21S22E04R001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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1992
1994
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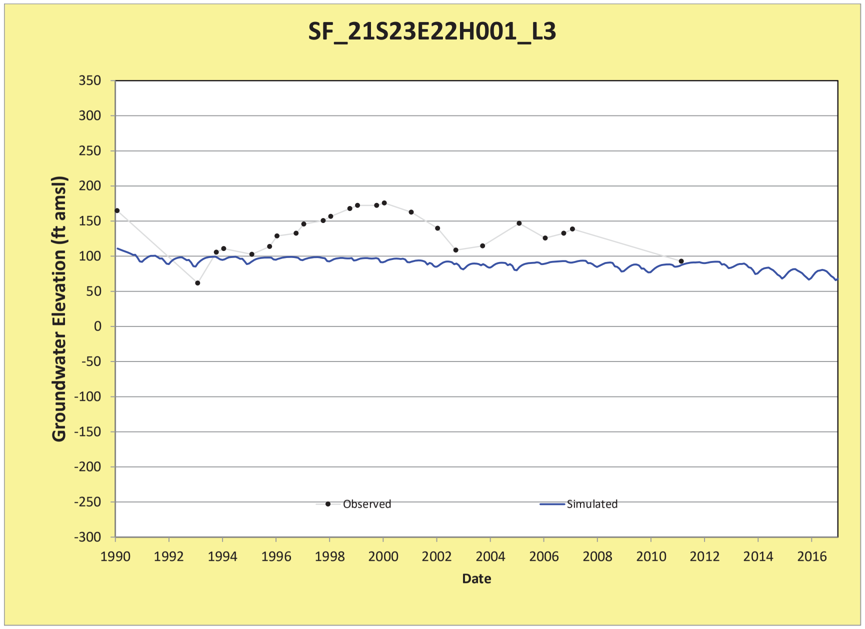
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_21S23E22H001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
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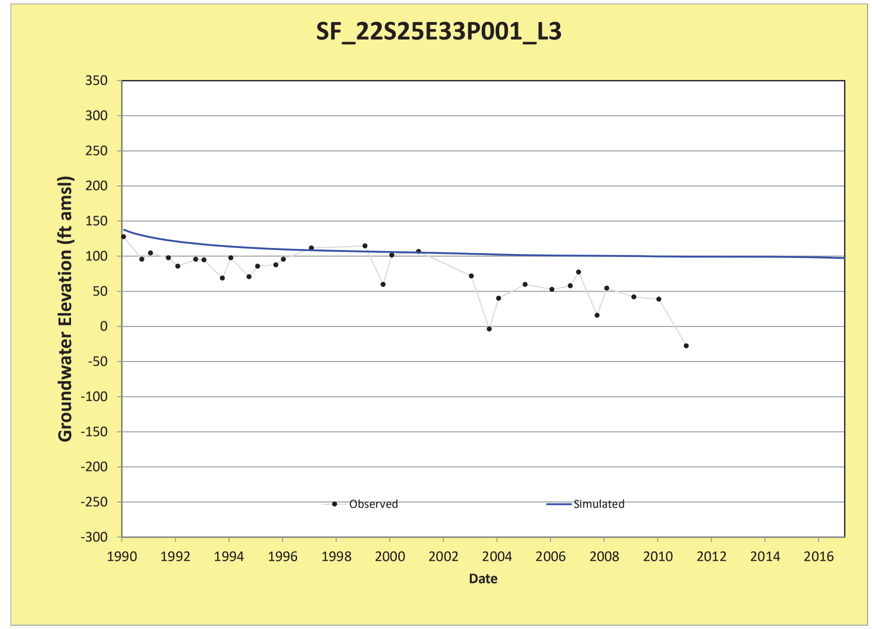
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_22S25E33P001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
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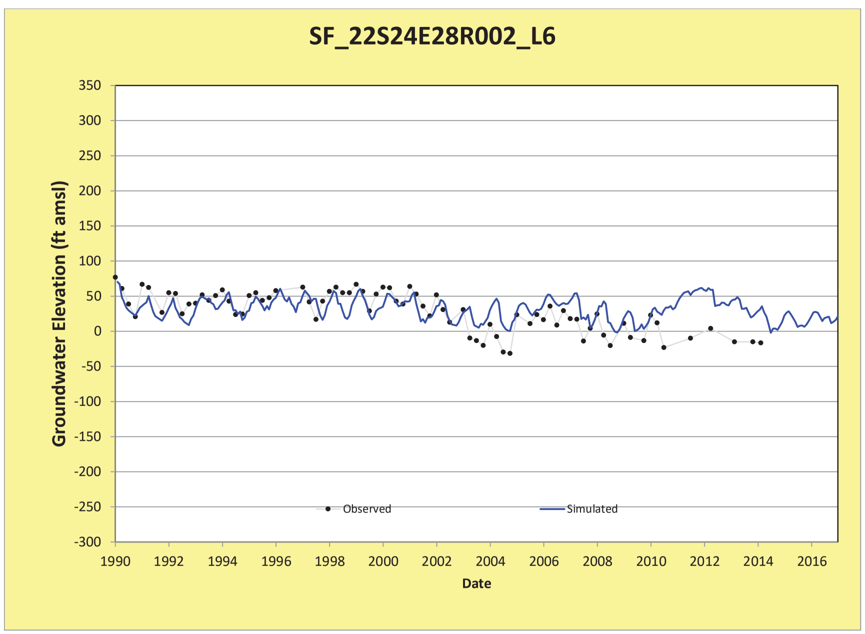
2012
2014
2016
Date
Observed
Simulated


SF_22S24E28R002_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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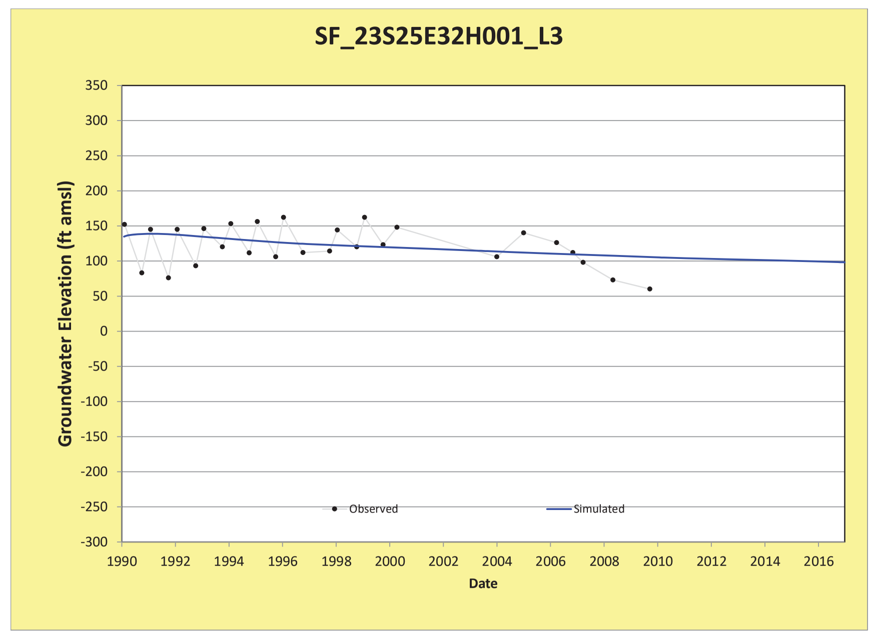
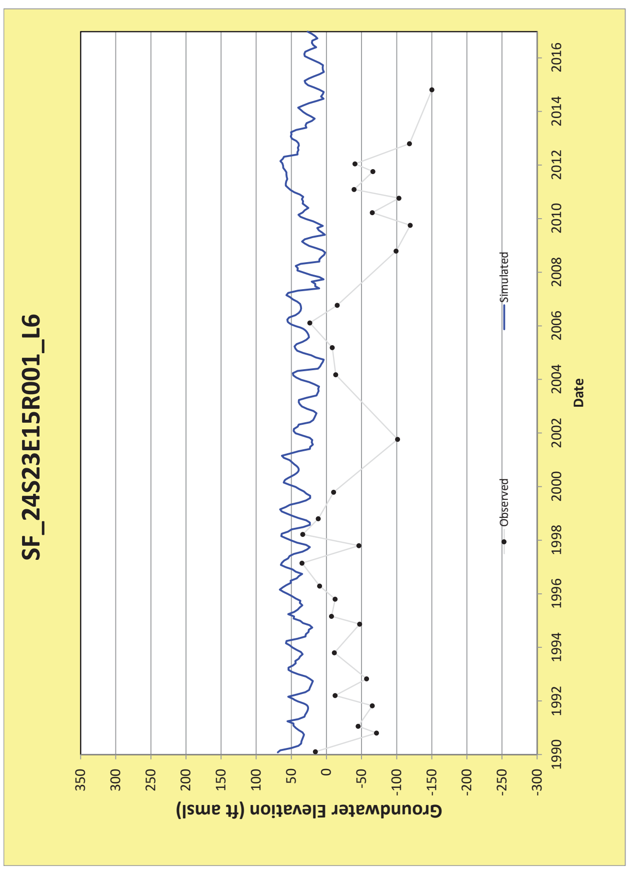
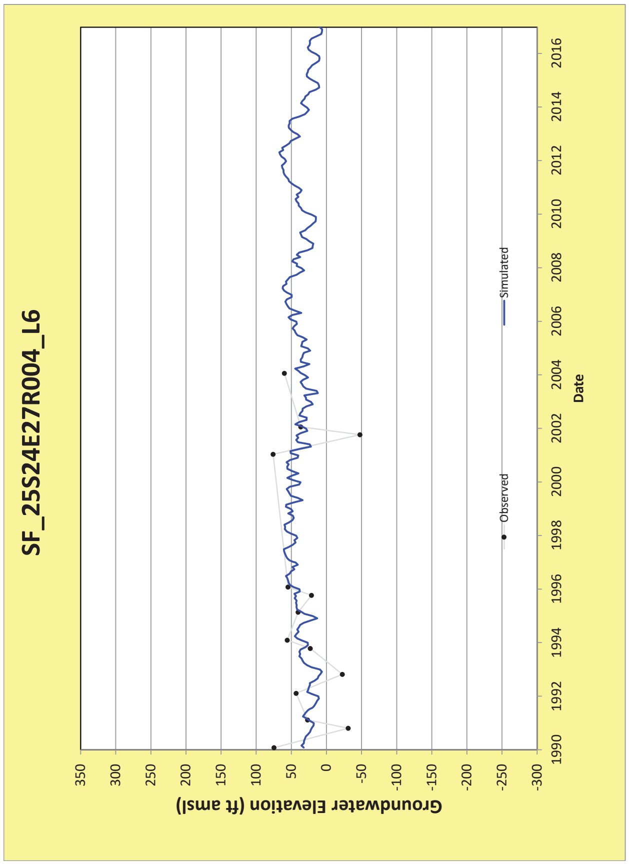
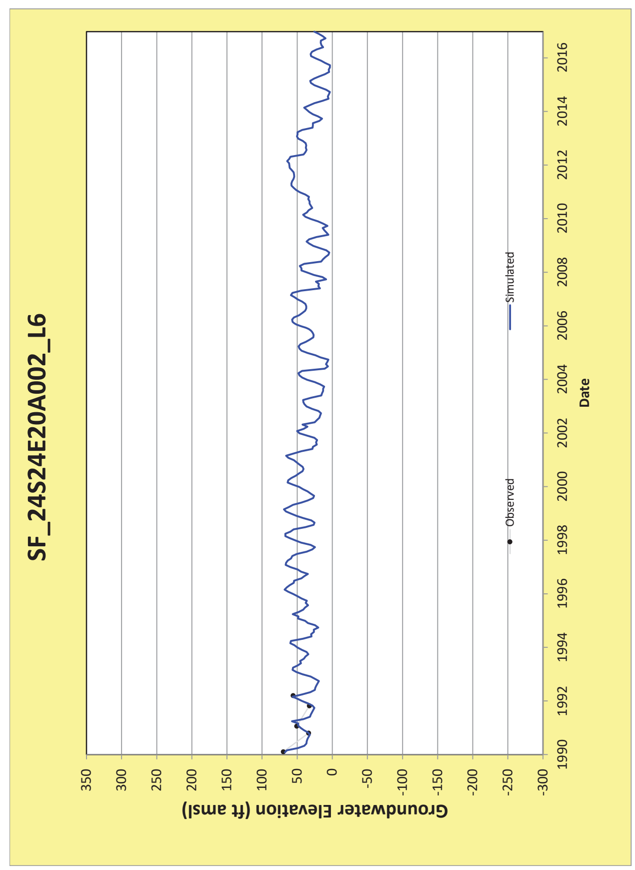
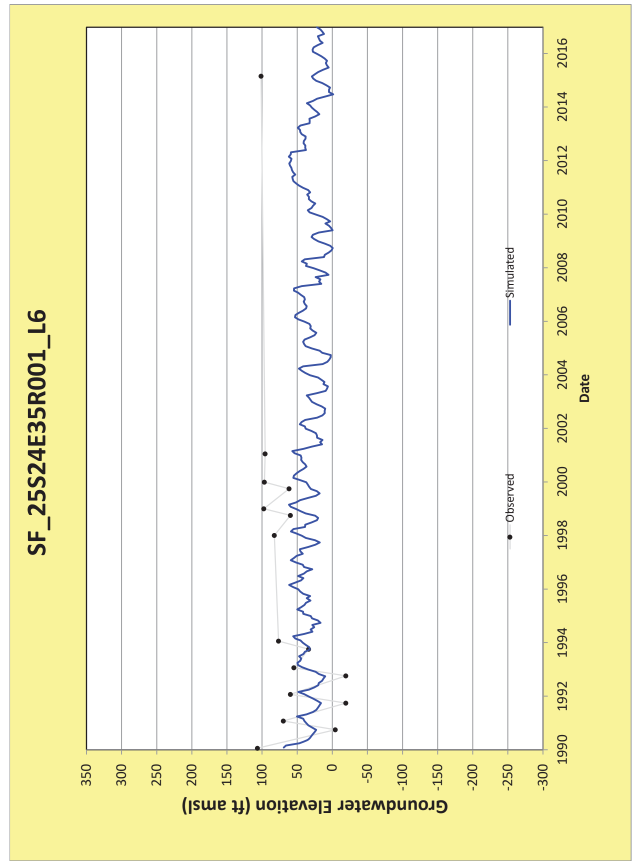
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated

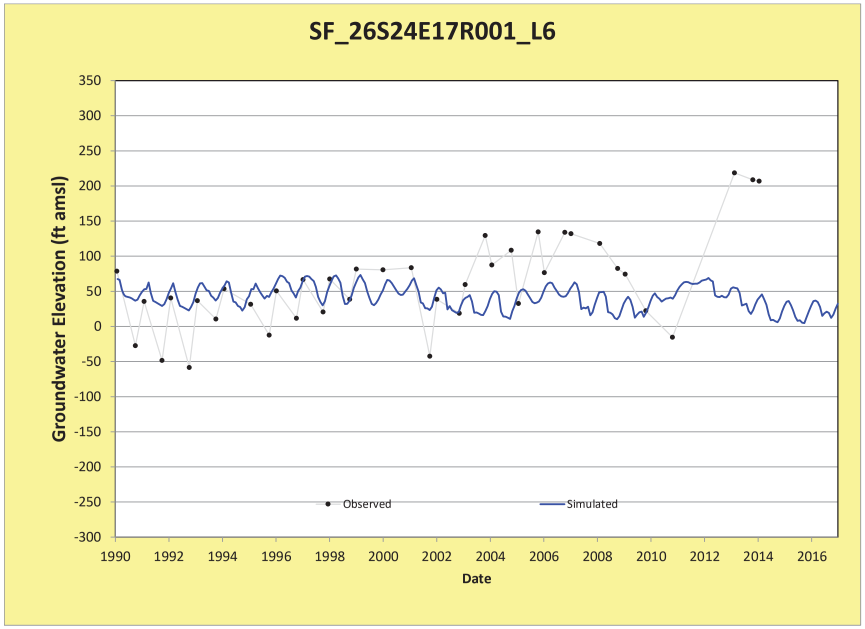

SF_23S25E32H001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_24S23E15R001_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SF_25S24E27R004_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SF_24S24E20A002_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SF_25S24E35R001_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SF_26S24E17R001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
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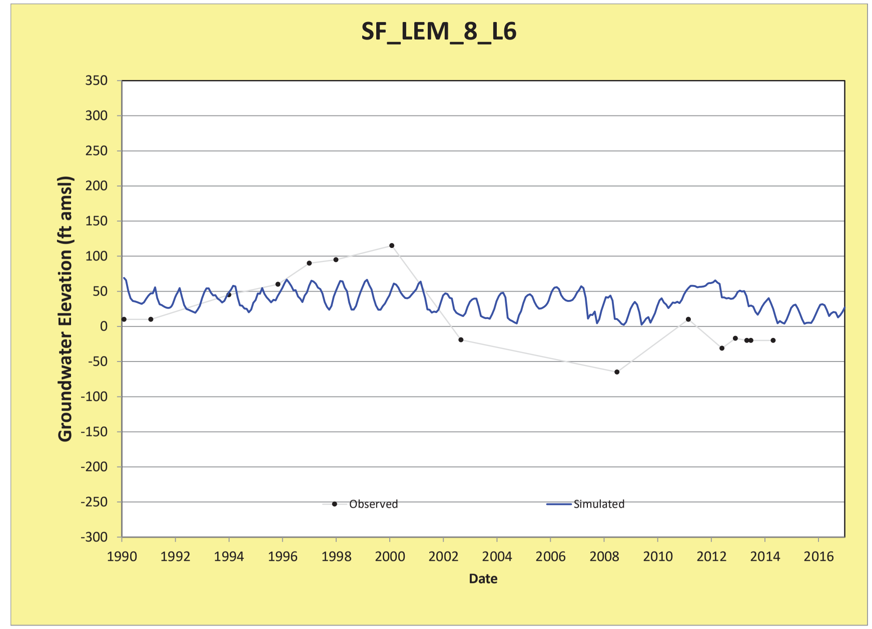
2016
Date
Observed
Simulated


SF_LEM_8_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
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2010
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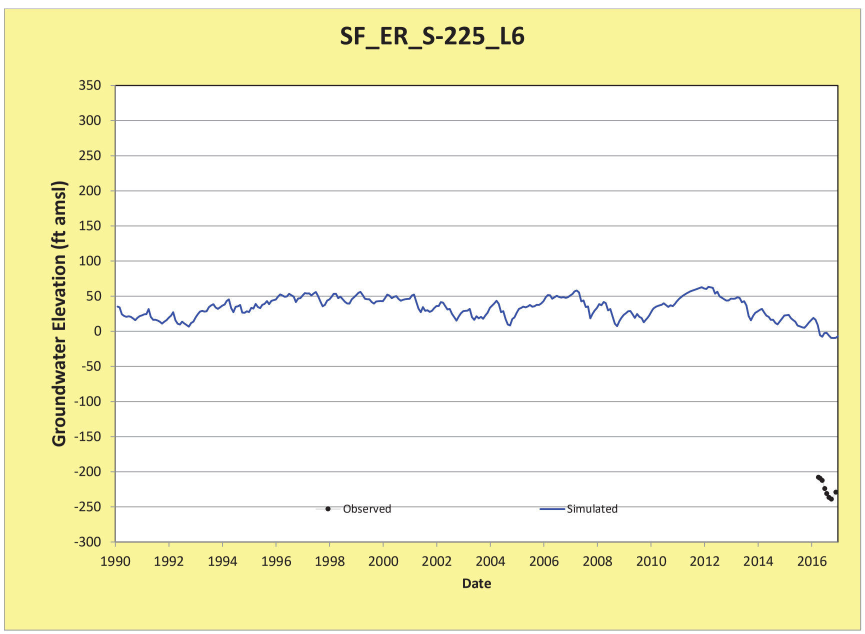
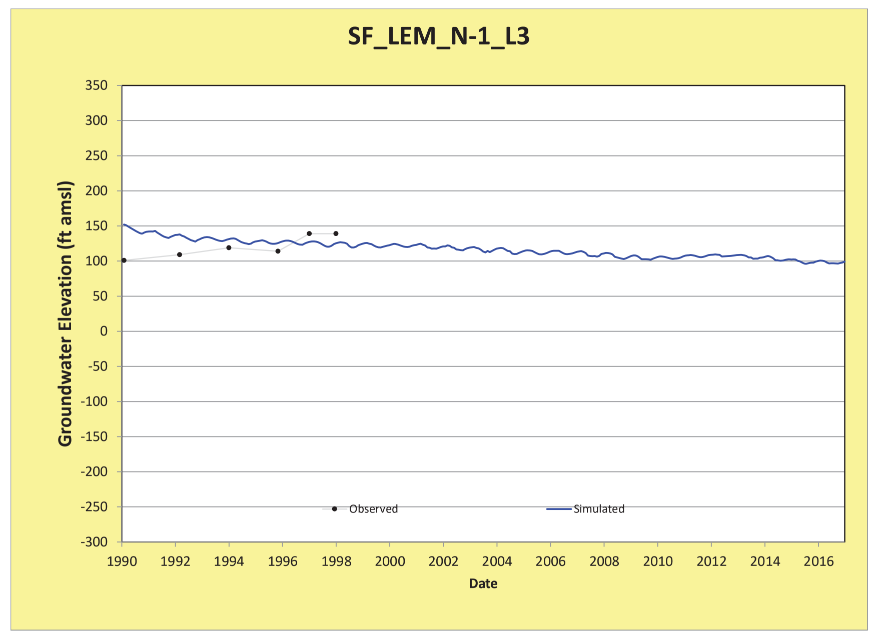
2014
2016
Date
Observed
Simulated


SF_ER_S-225_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_LEM_N-1_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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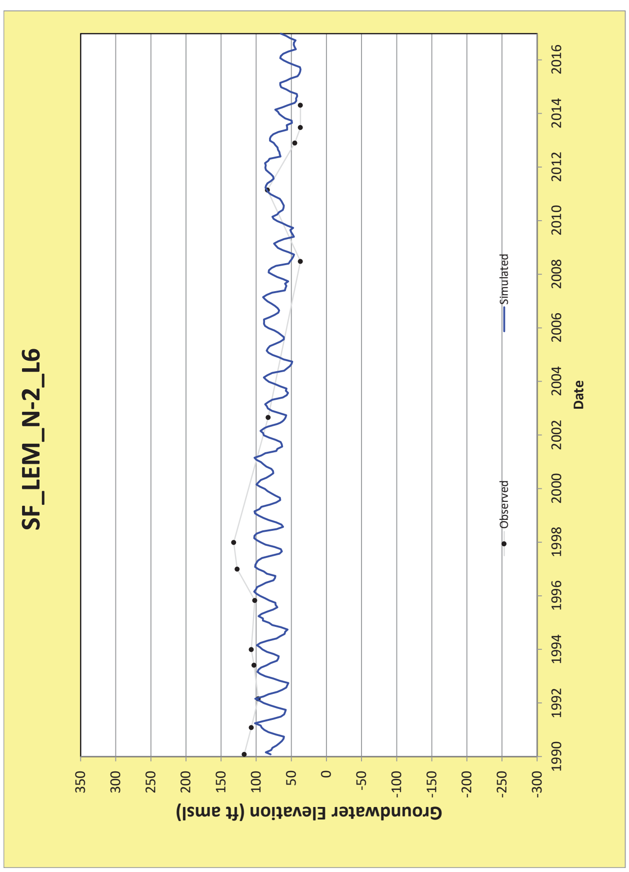
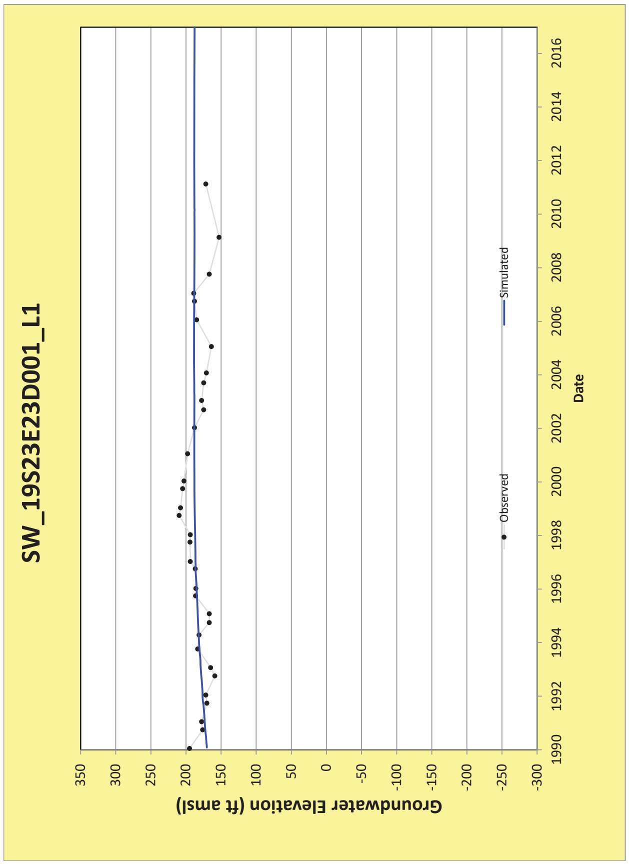
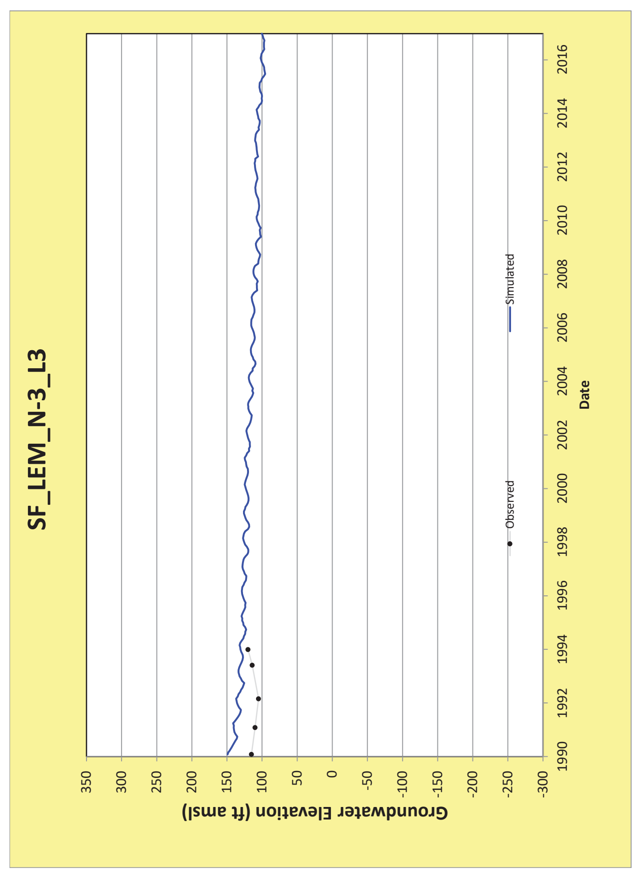
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


SF_LEM_N-2_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SW_19S23E23D001_L1
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


SF_LEM_N-3_L3
Groundwater Elevation (ft amsl)
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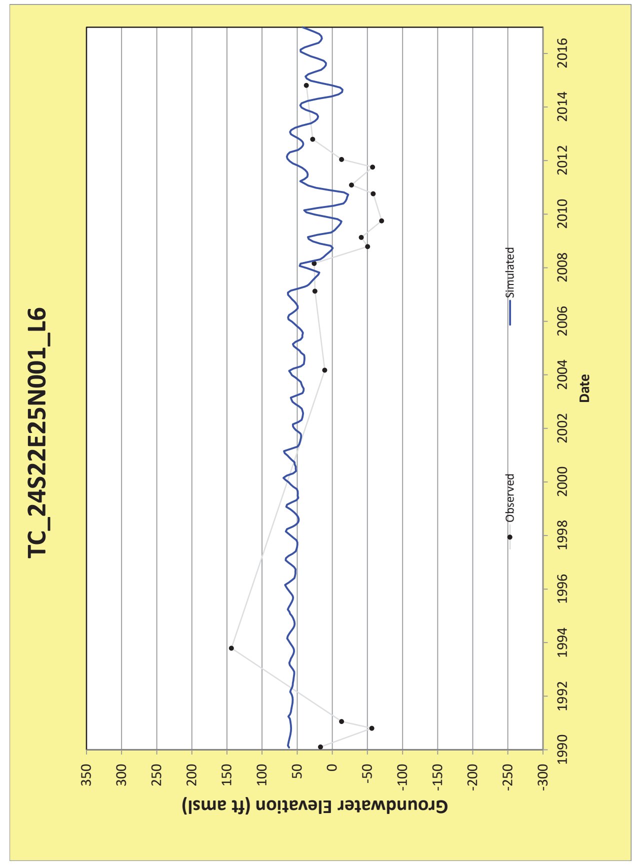
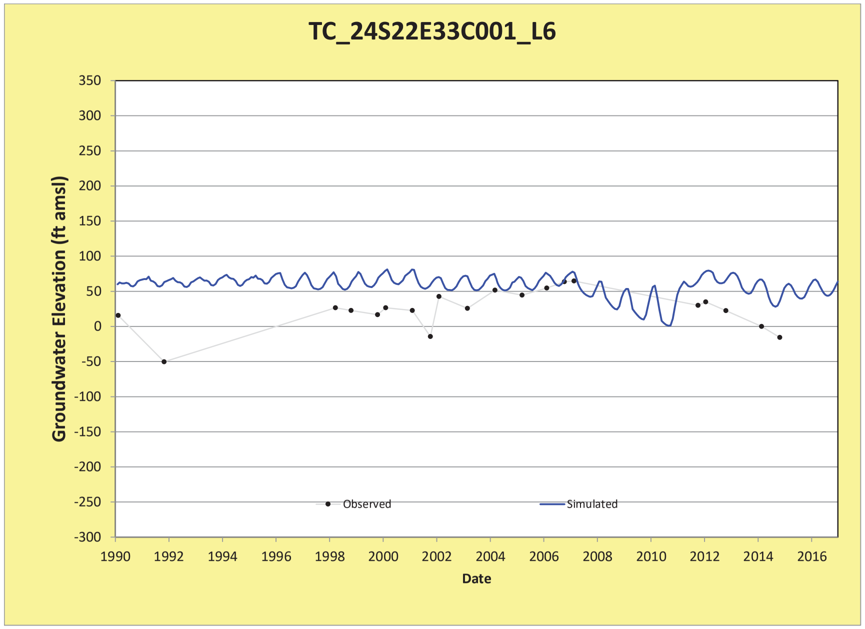
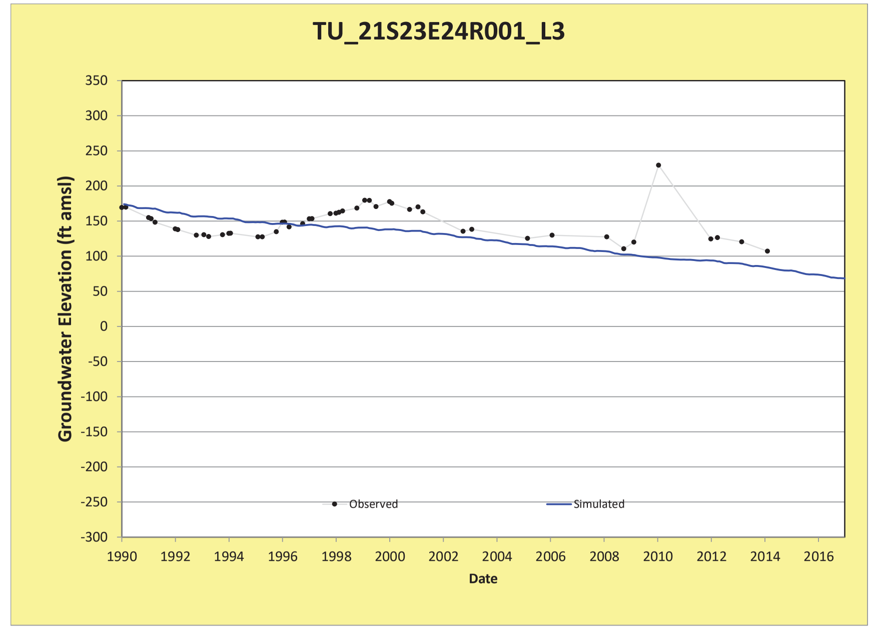
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


TC_24S22E25N001_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


TC_24S22E33C001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_21S23E24R001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
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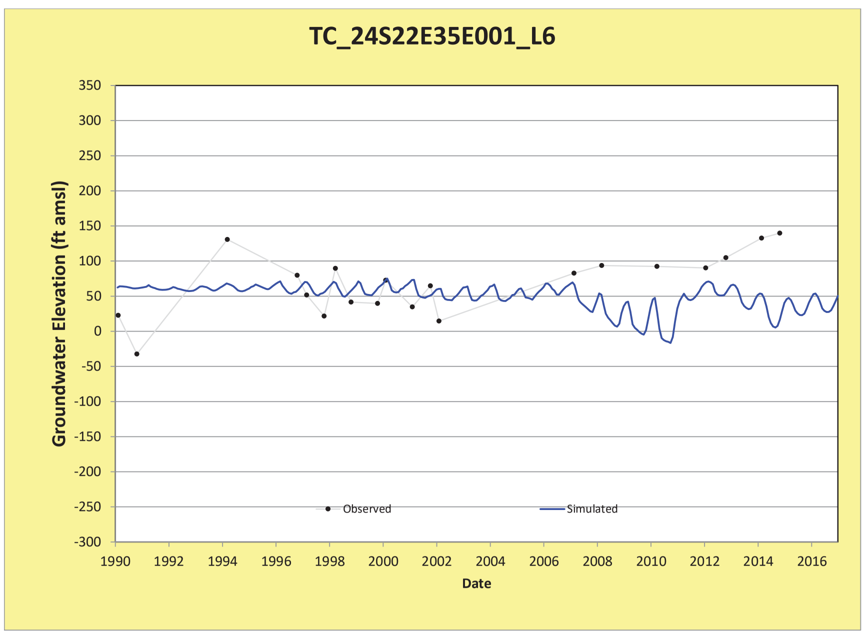
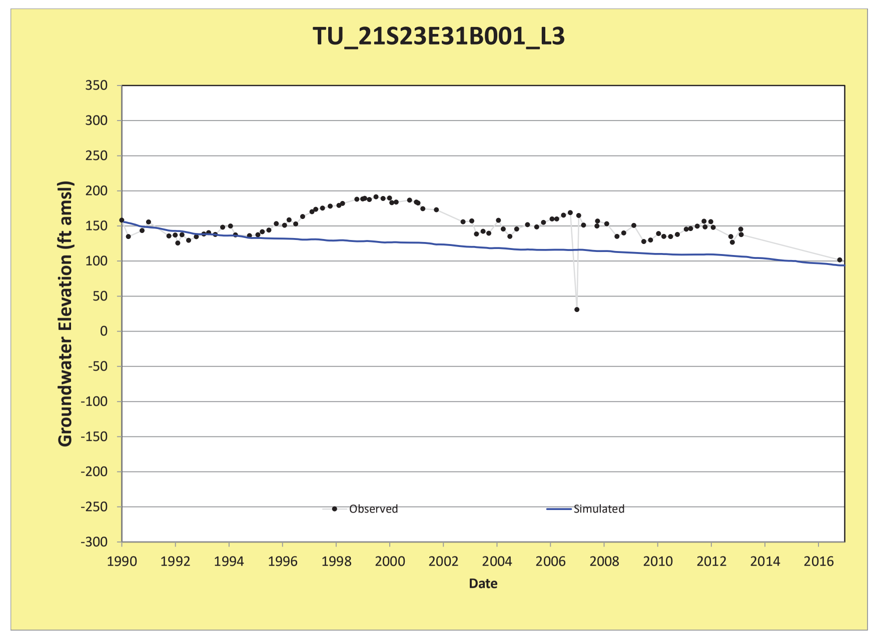
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TC_24S22E35E001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_21S23E31B001_L3
Groundwater Elevation (ft amsl)
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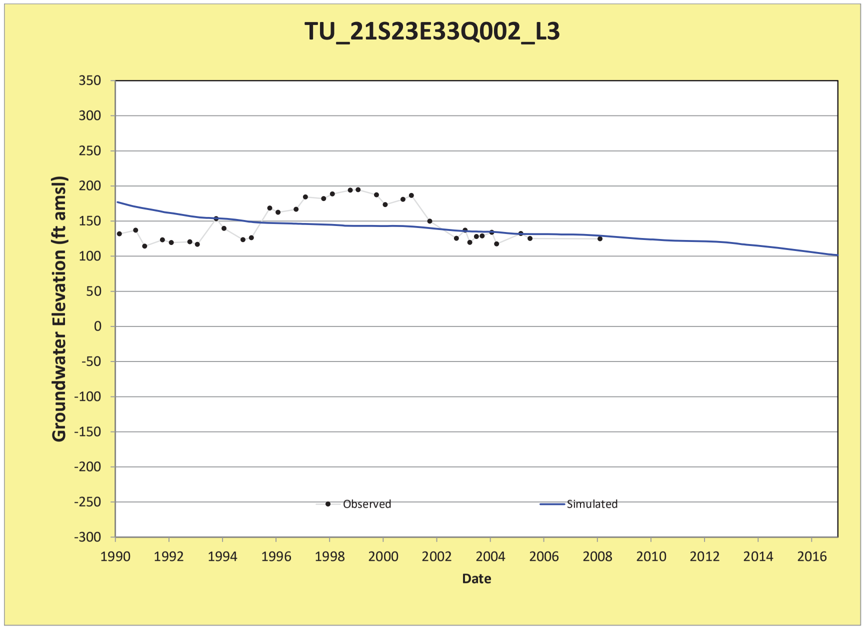
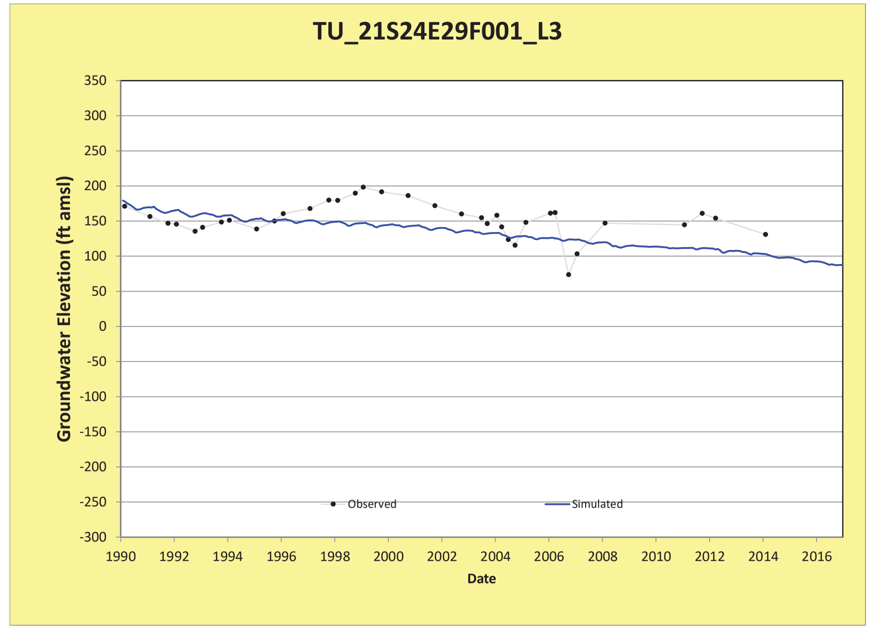
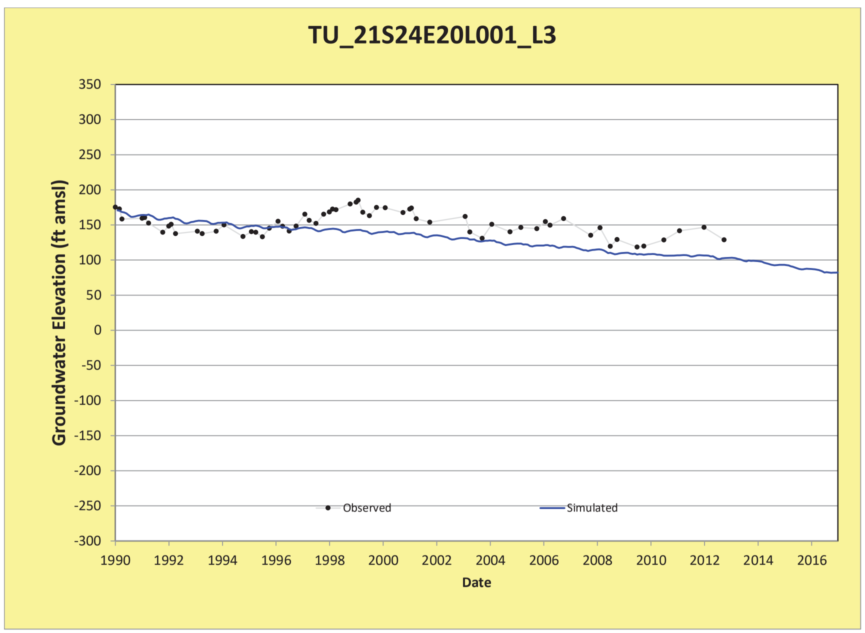
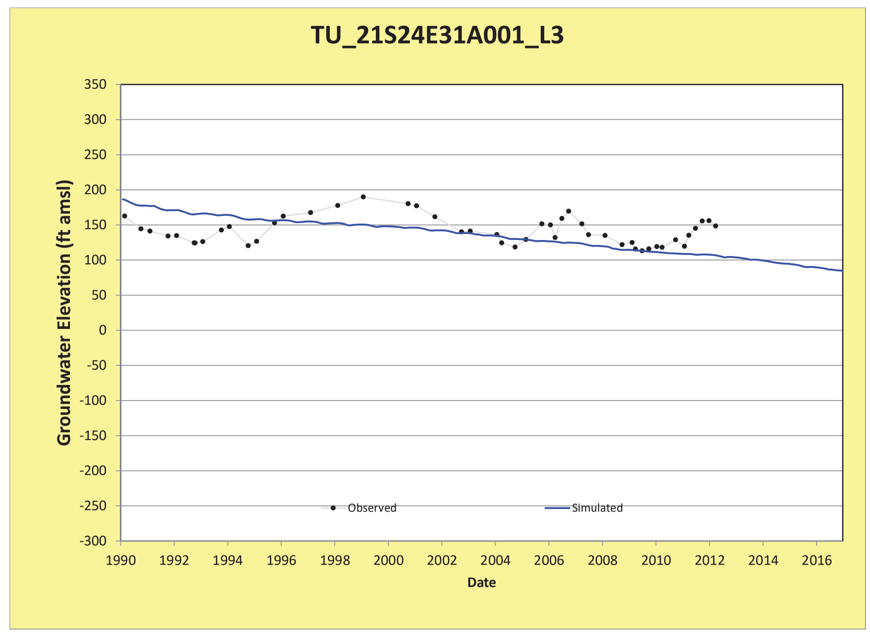
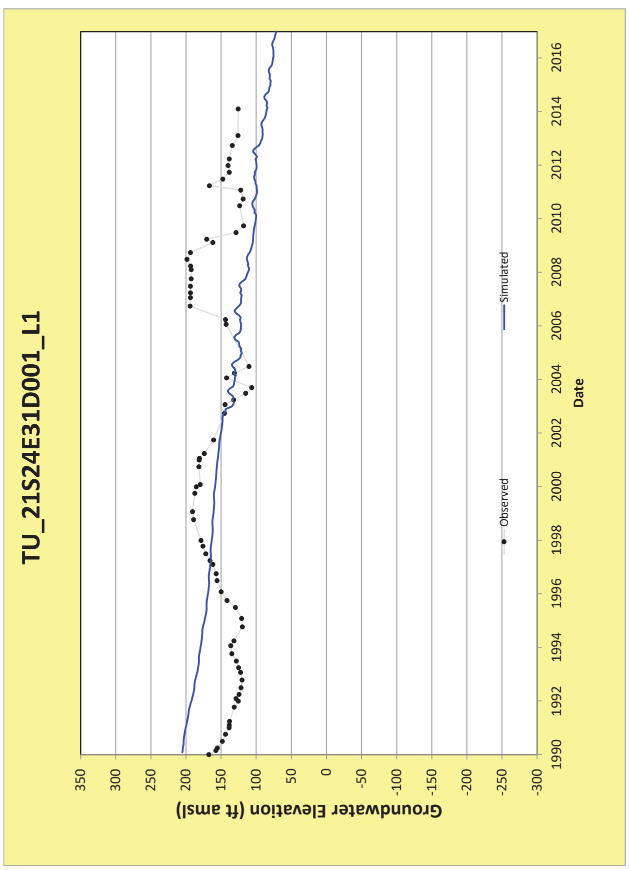
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated

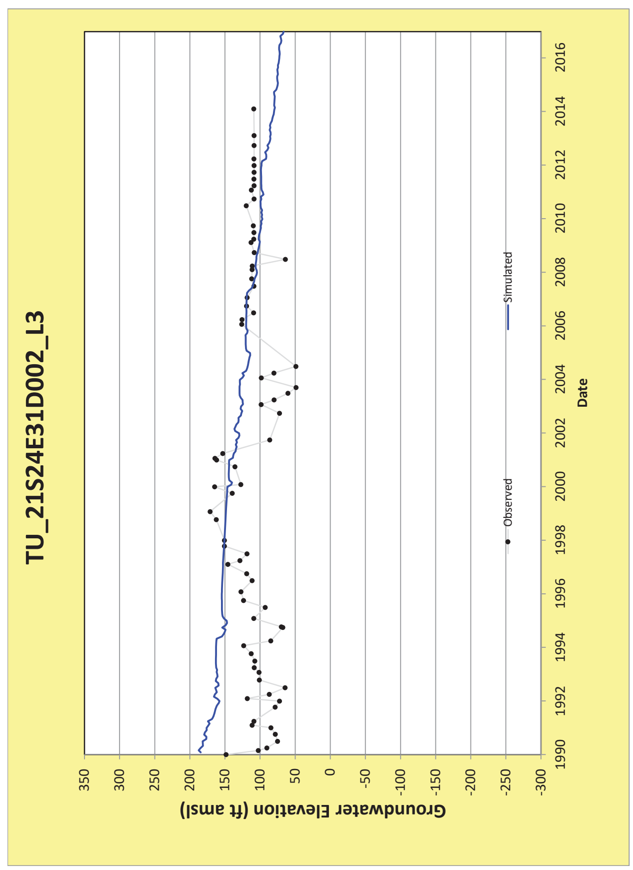

TU_21S23E33Q002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

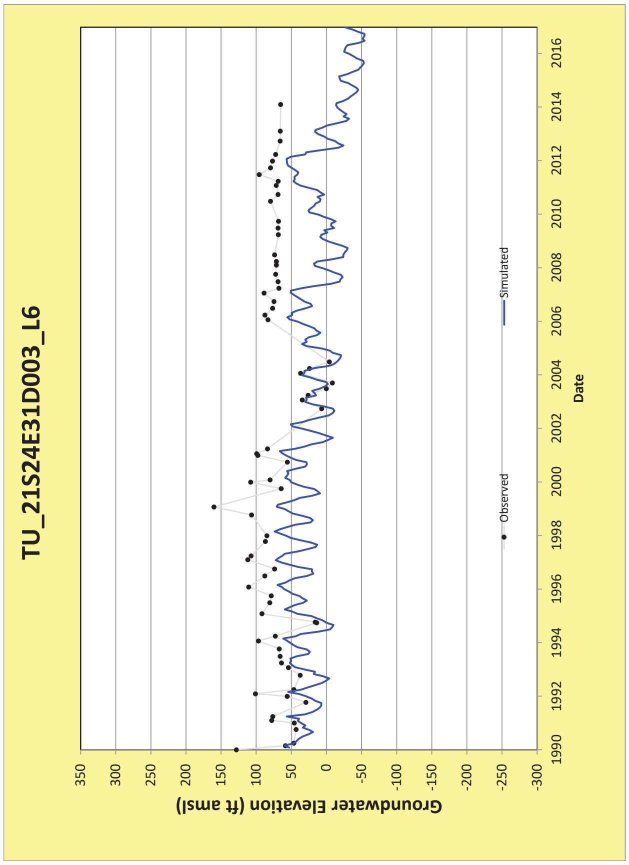

TU_21S24E29F001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

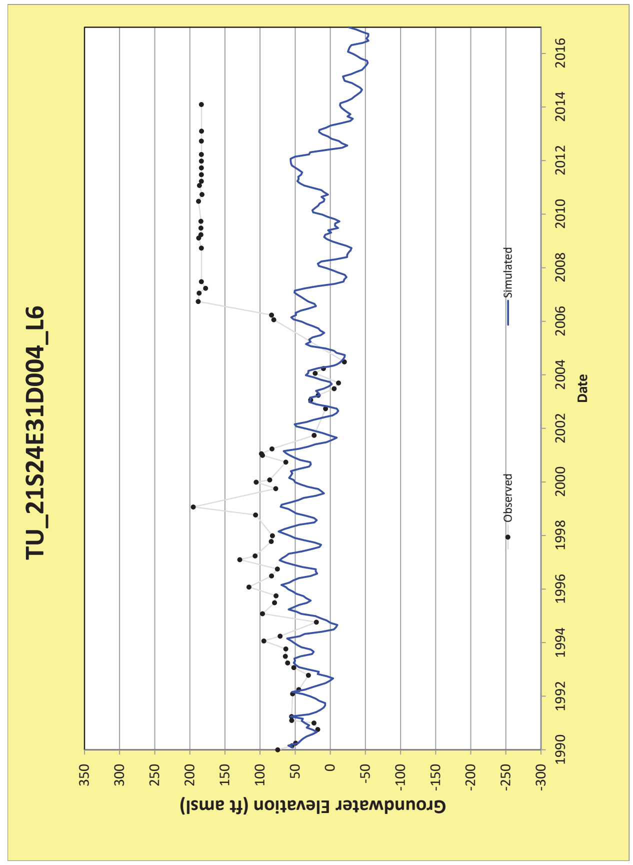

TU_21S24E20L001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

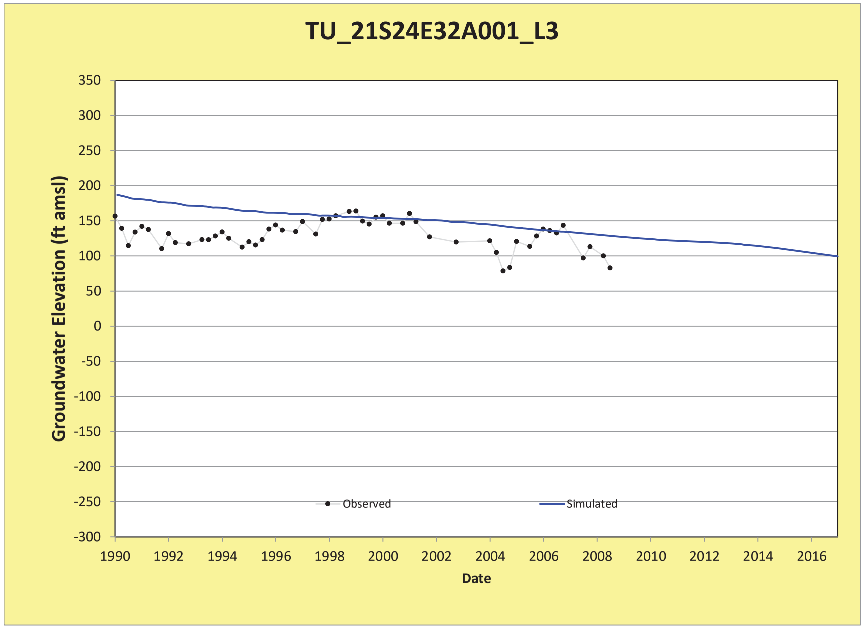

TU_21S24E31A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_21S24E31D001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_21S24E31D002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_21S24E31D003_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_21S24E31D004_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_21S24E32A001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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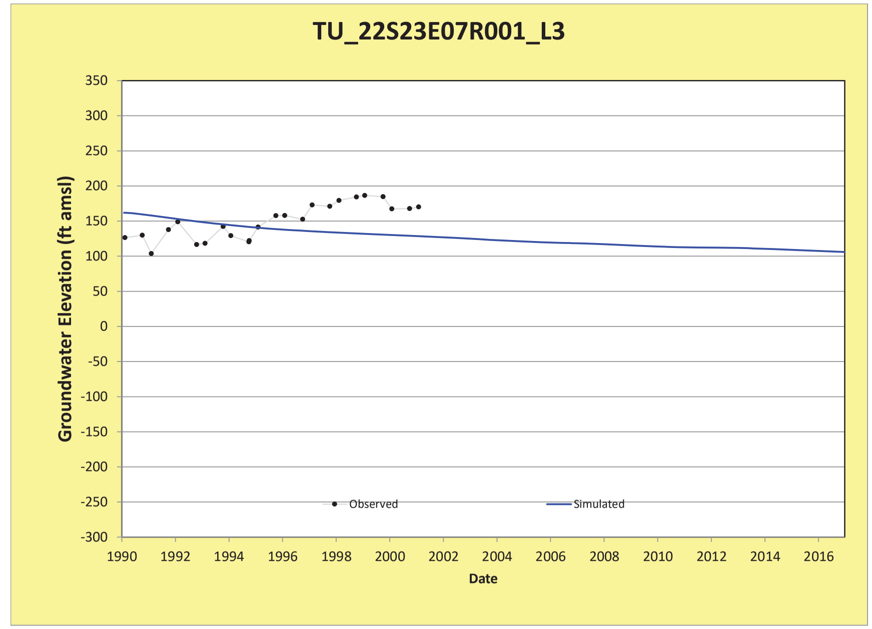
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E07R001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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2006
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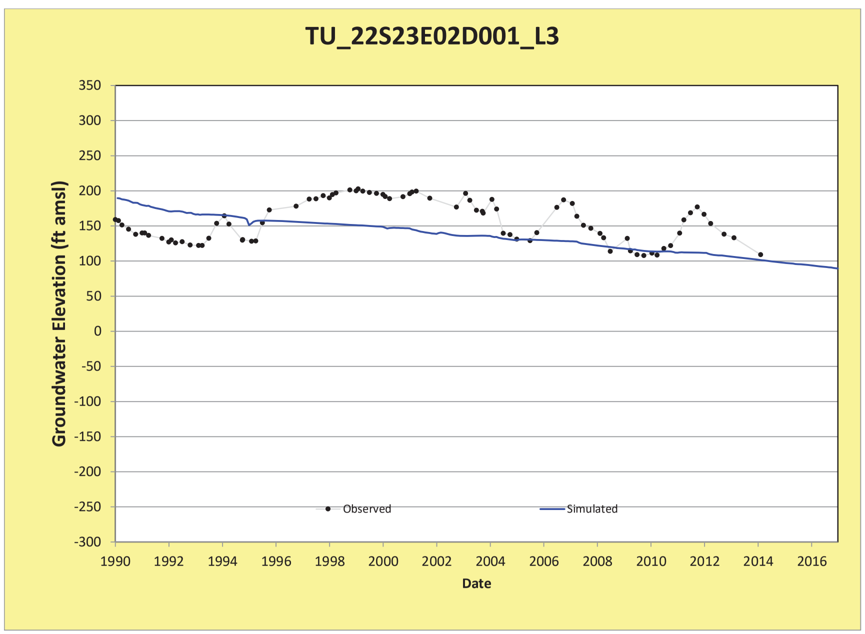
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E02D001_L3
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
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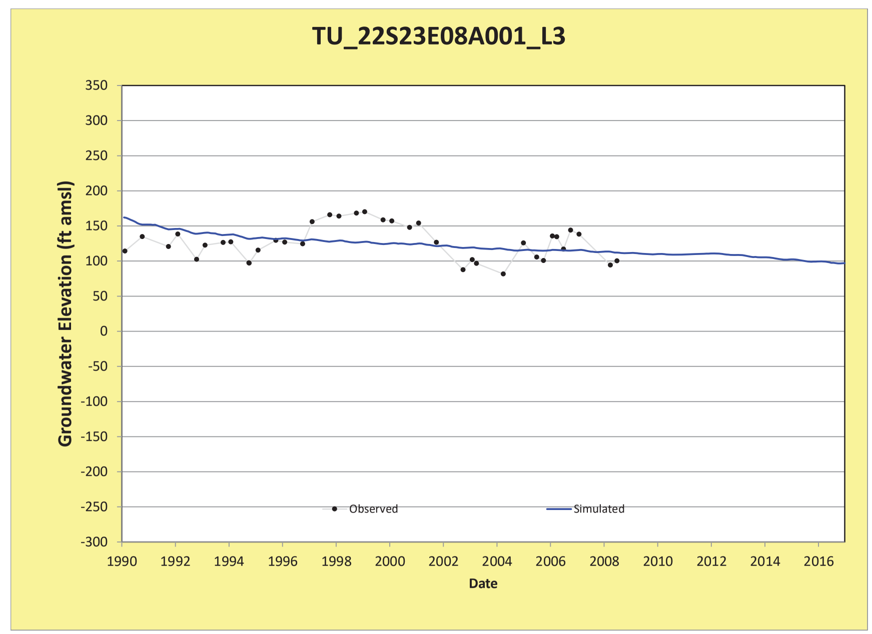
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E08A001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
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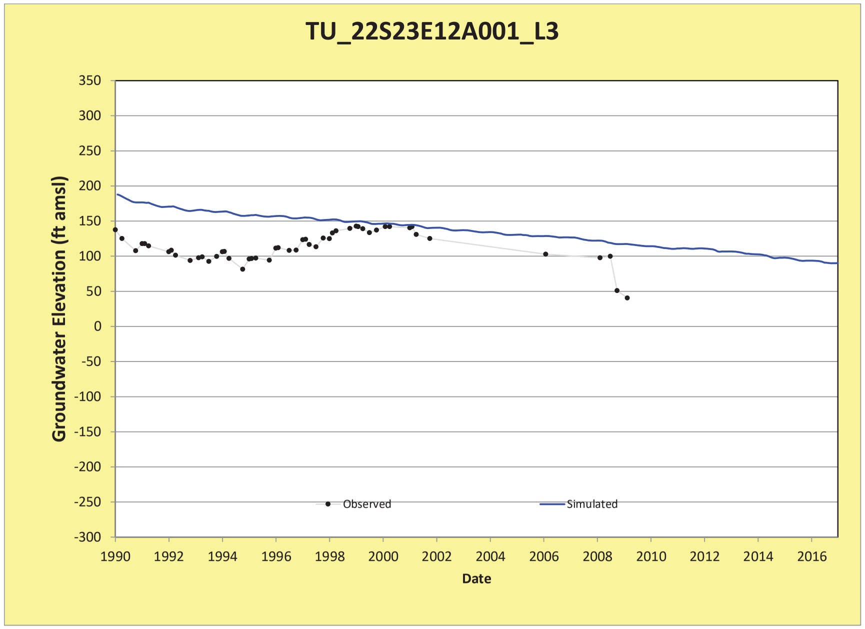
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E12A001_L3
Groundwater Elevation (ft amsl)
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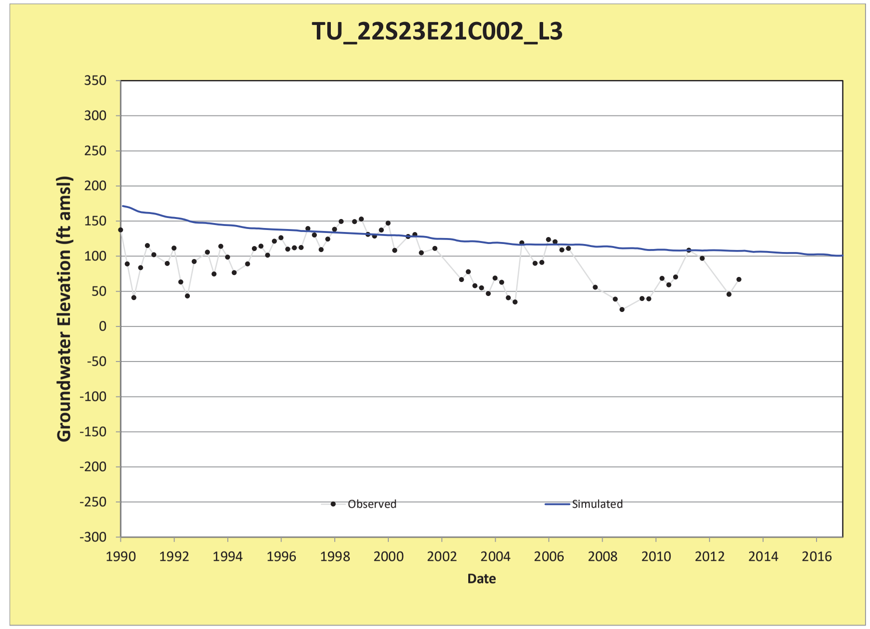
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E21C002_L3
Groundwater Elevation (ft amsl)
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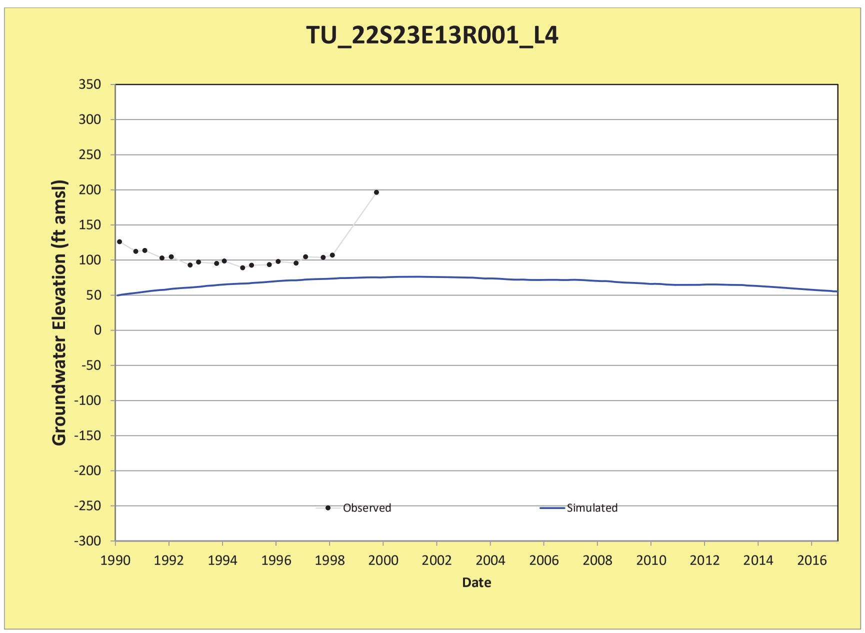
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E13R001_L4
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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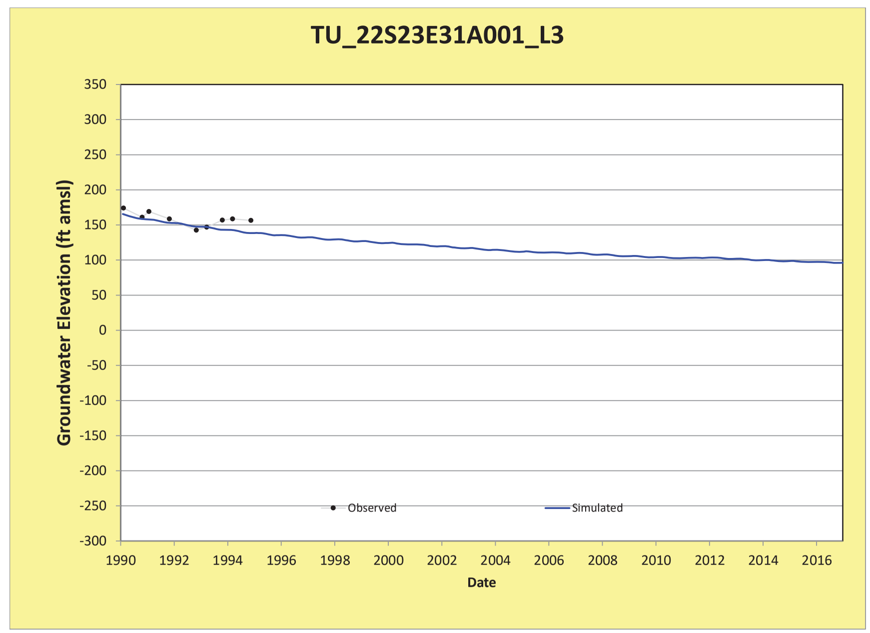
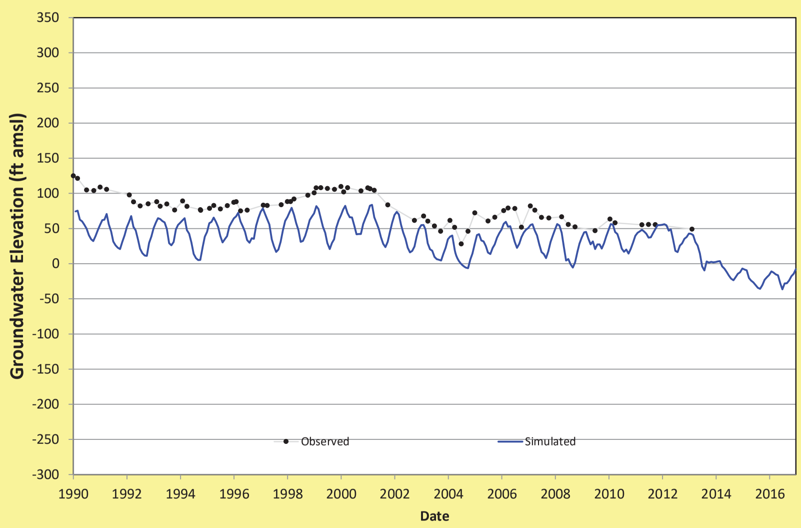
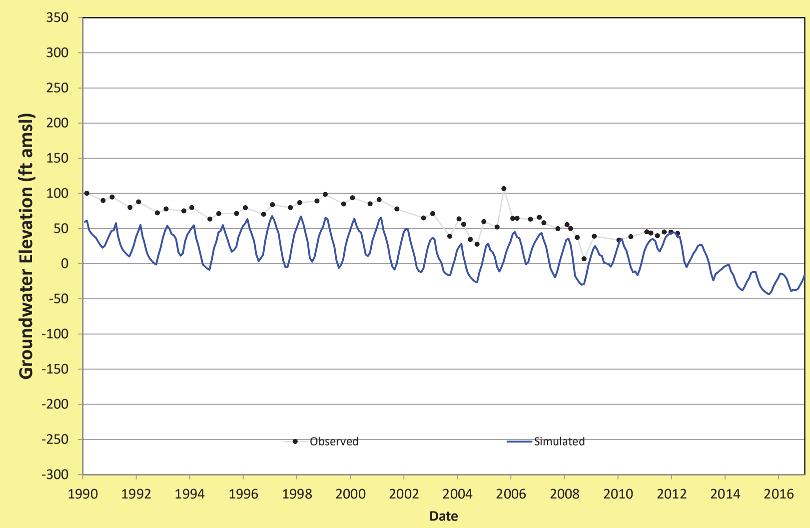
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


TU_22S23E31A001_L3
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated

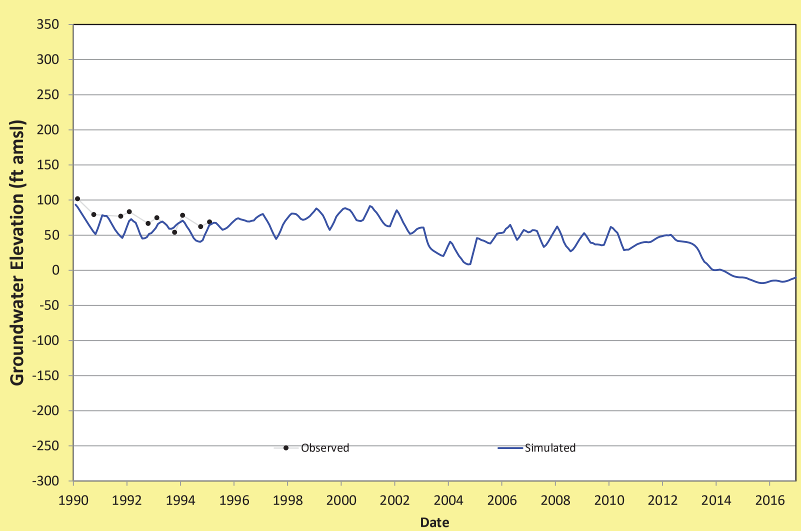
TU_22S24E09A001_L6



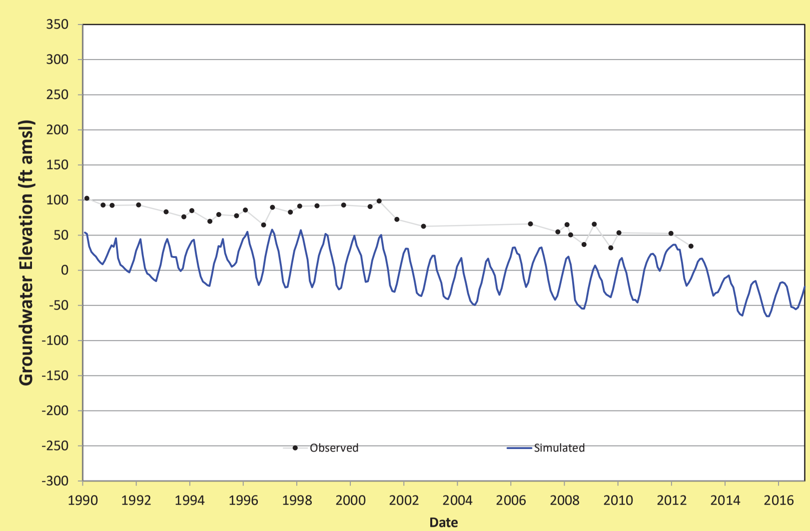
TU_22S24E17A001_L6

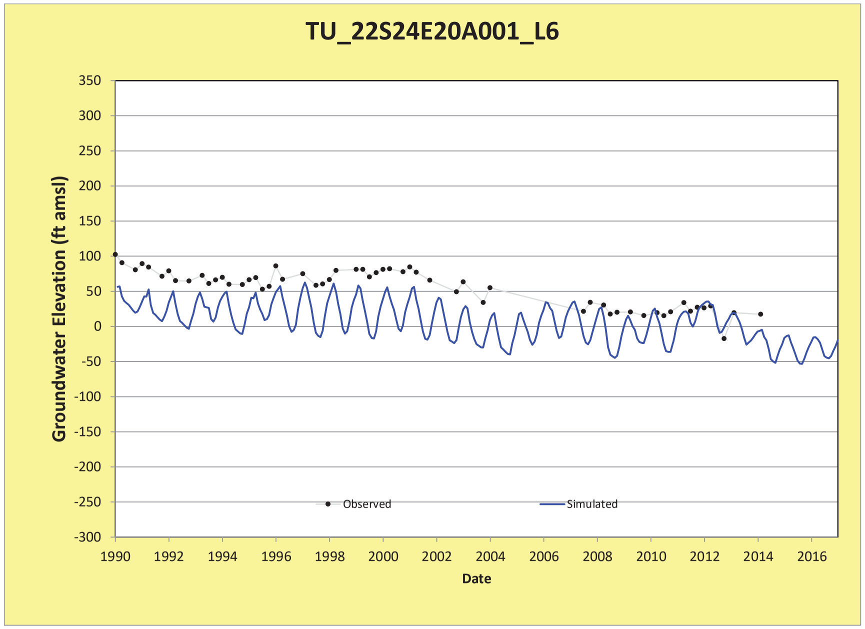


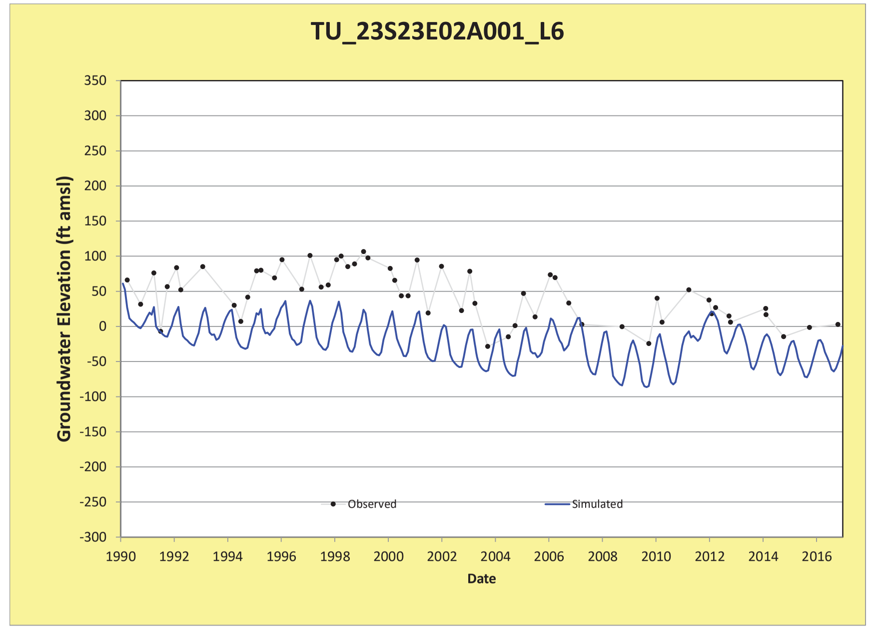
TU_22S24E15A001_L6

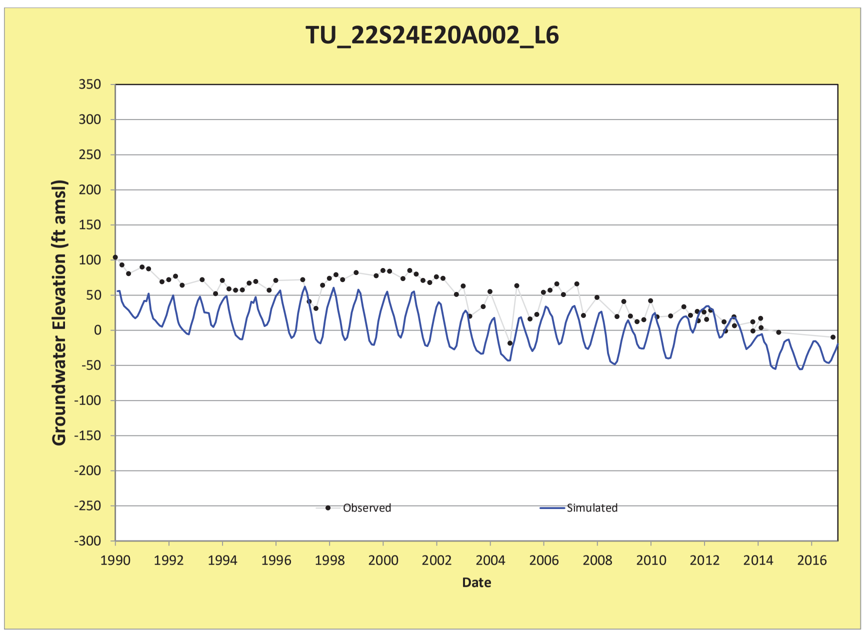


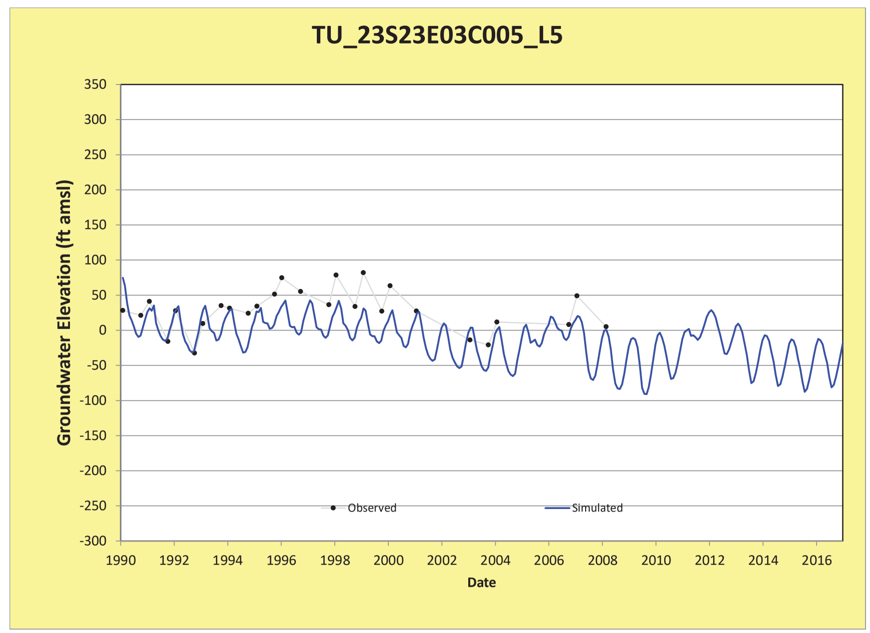
TU_22S24E18R001_L6

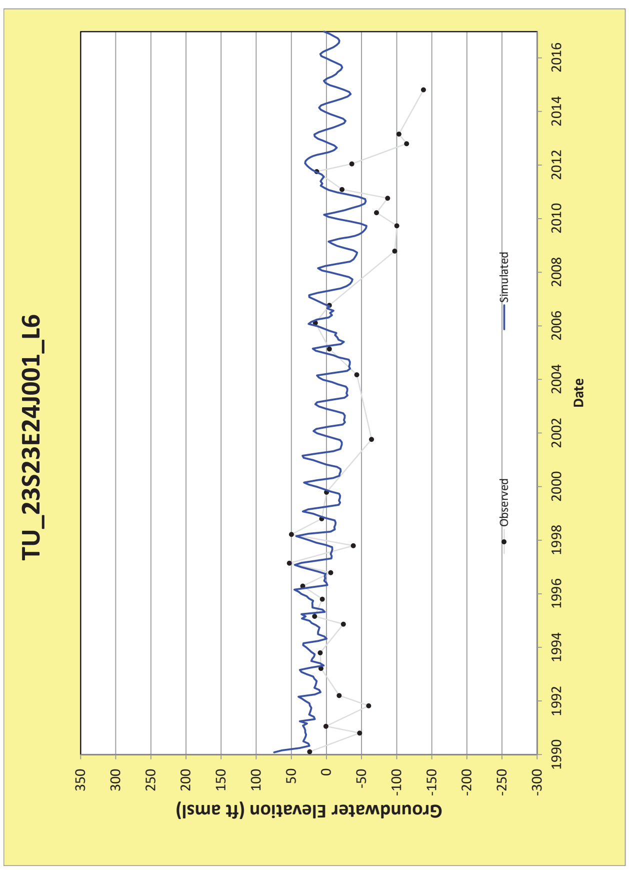



TU_22S24E20A001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S23E02A001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_22S24E20A002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S23E03C005_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S23E24J001_L6
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
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2012
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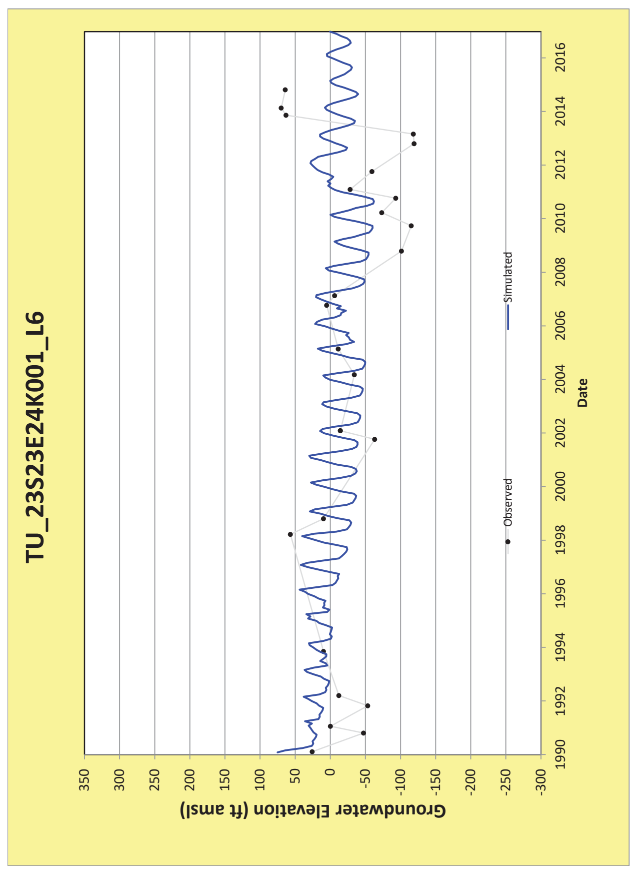
2016
Date
Observed
Simulated


TU_23S23E24K001_L6
Groundwater Elevation (ft amsl)
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300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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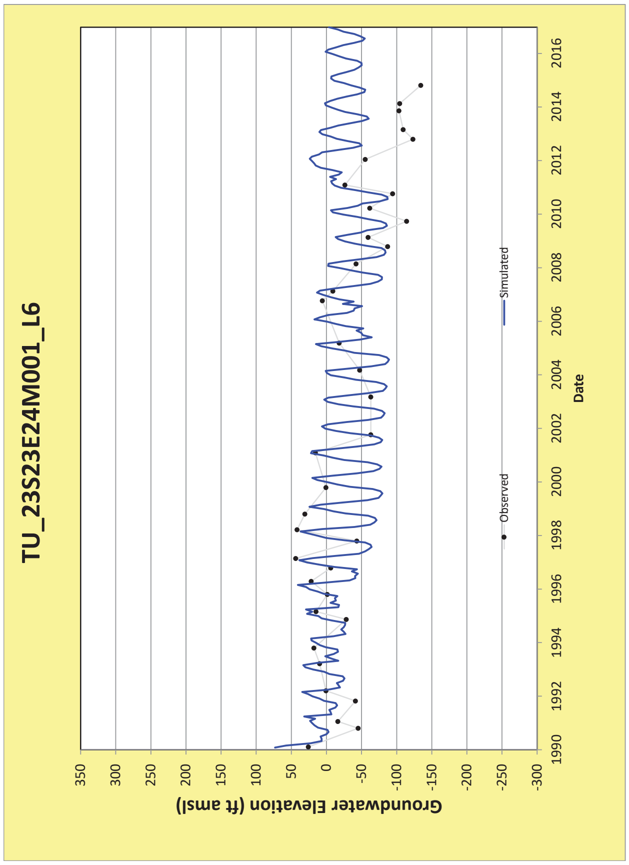
2016
Date
Observed
Simulated


TU_23S23E24M001_L6
Groundwater Elevation (ft amsl)
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300
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200
150
100
50
0
-50
-100
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-200
-250
-300
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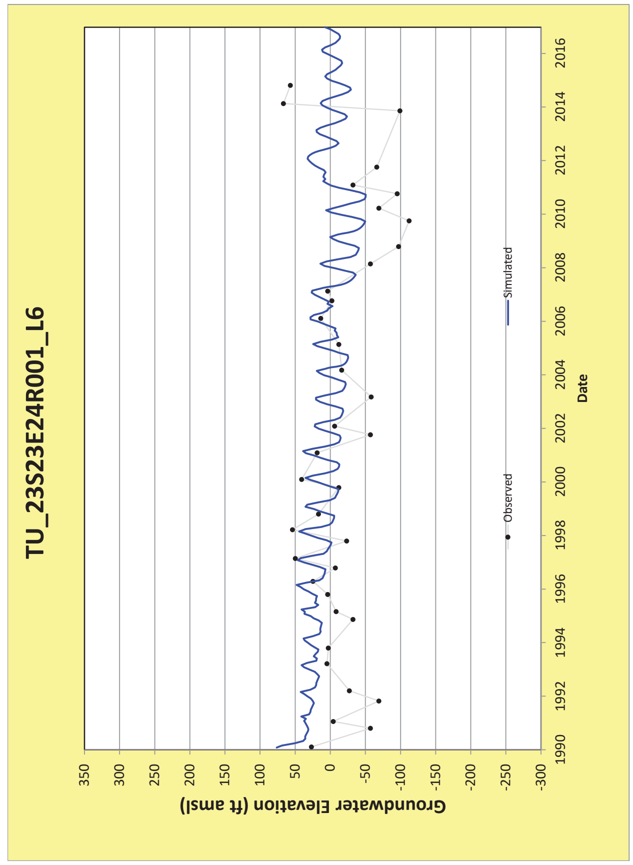
Date
Observed
Simulated


TU_23S23E24R001_L6
Groundwater Elevation (ft amsl)
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200
150
100
50
0
-50
-100
-150
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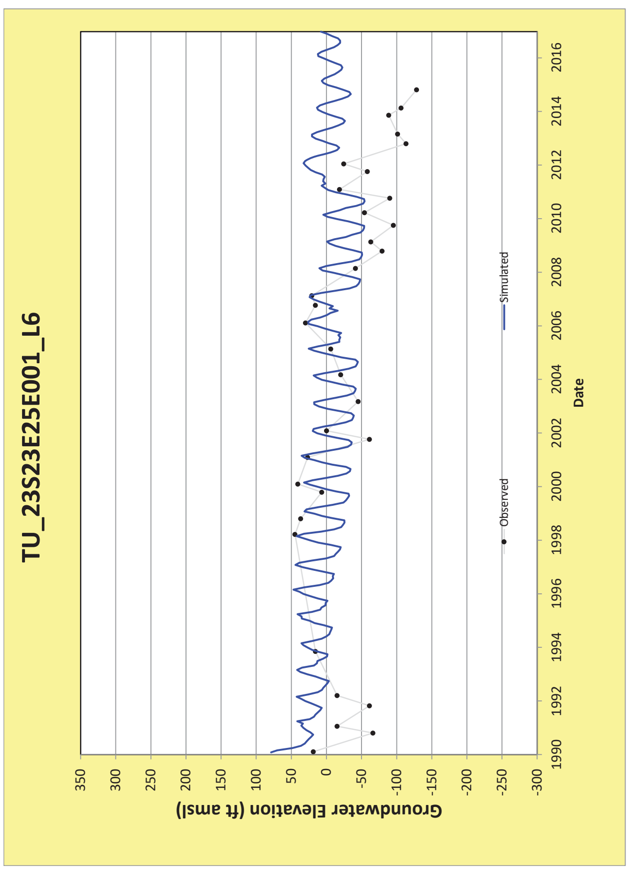
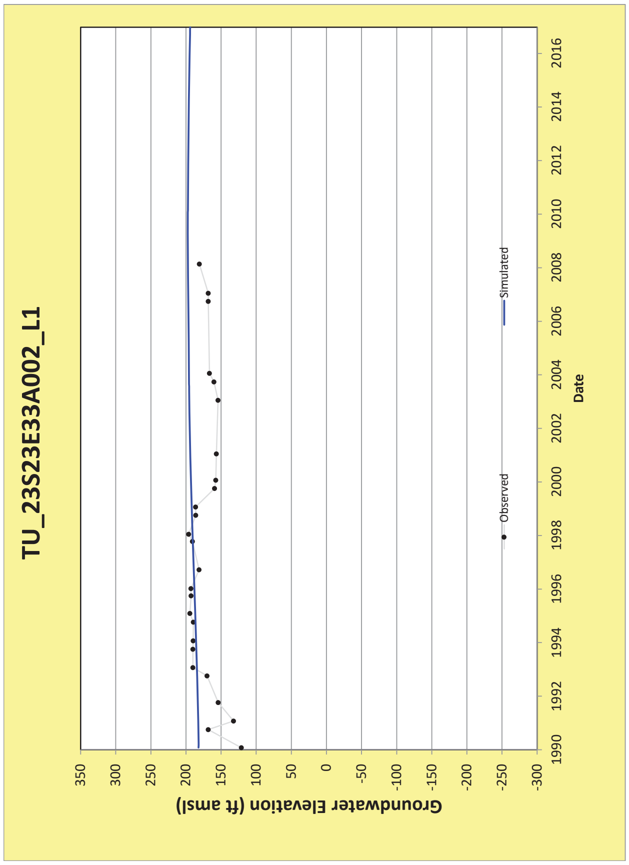
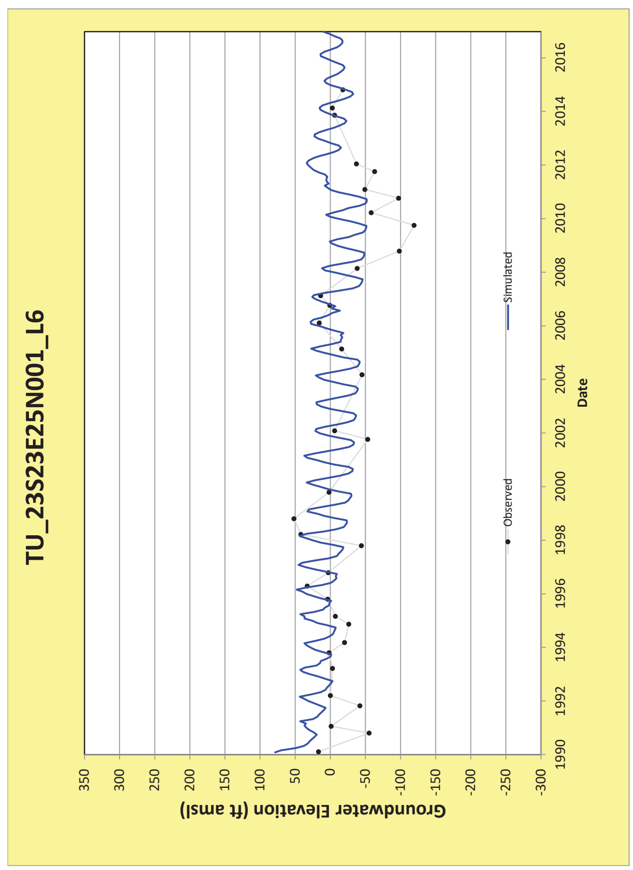
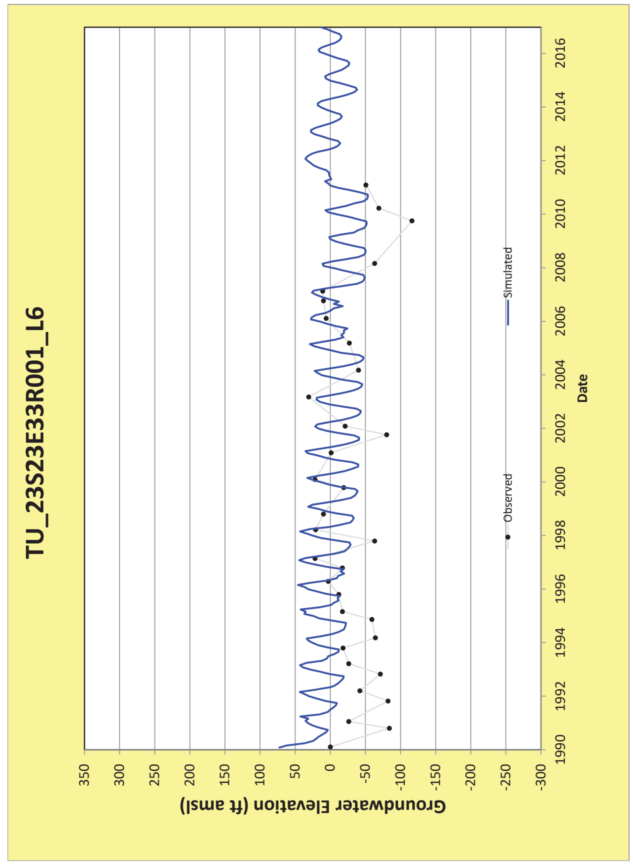
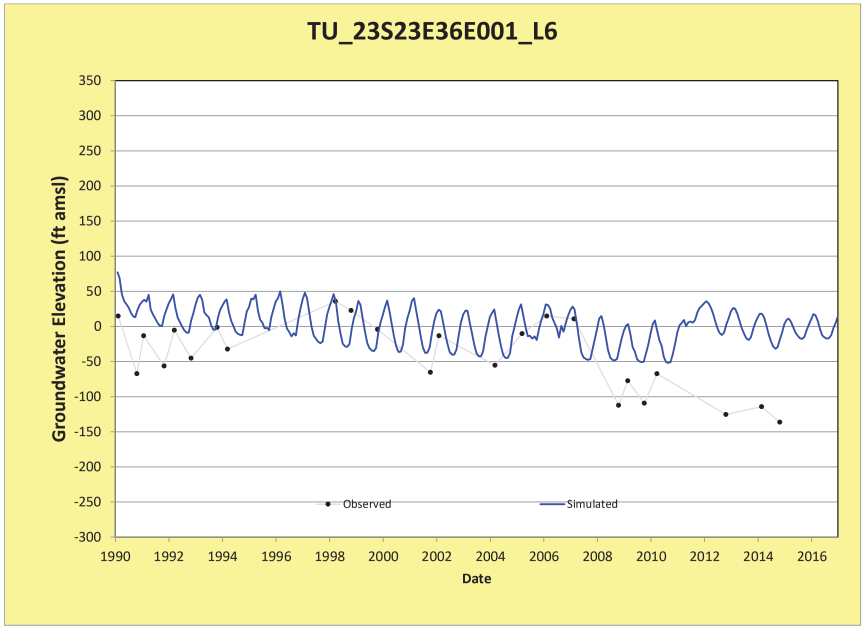
Date
Observed
Simulated

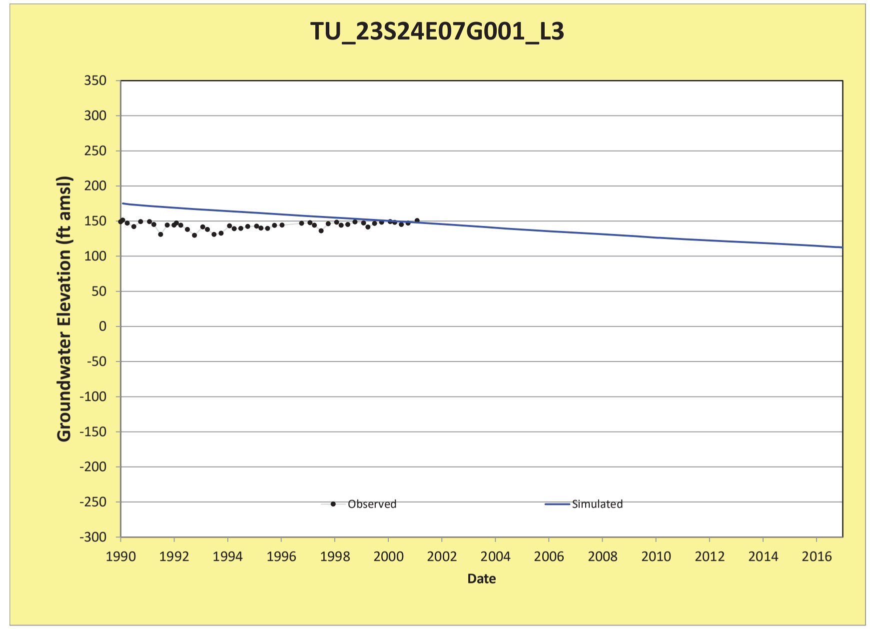

TU_23S23E25E001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

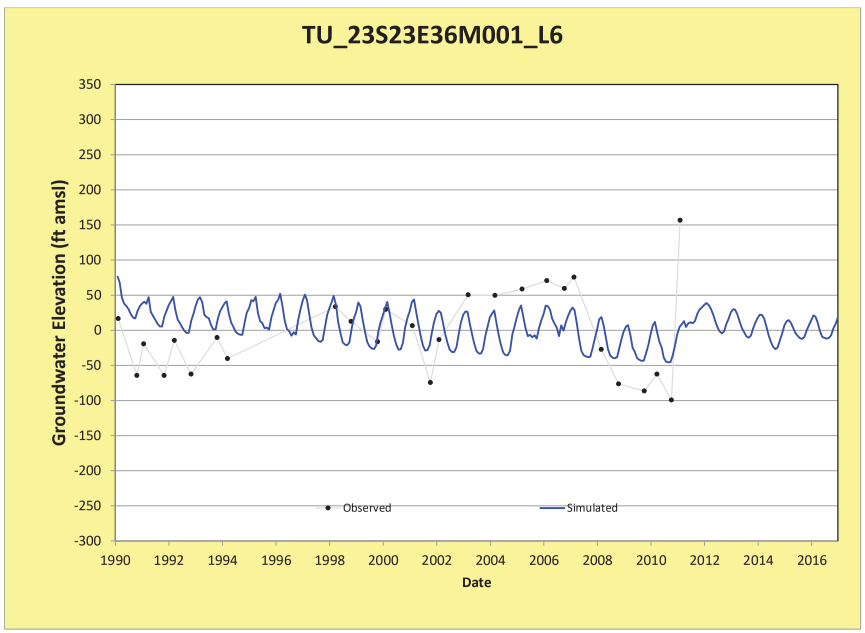

TU_23S23E33A002_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S23E25N001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S23E33R001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S23E36E001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S24E07G001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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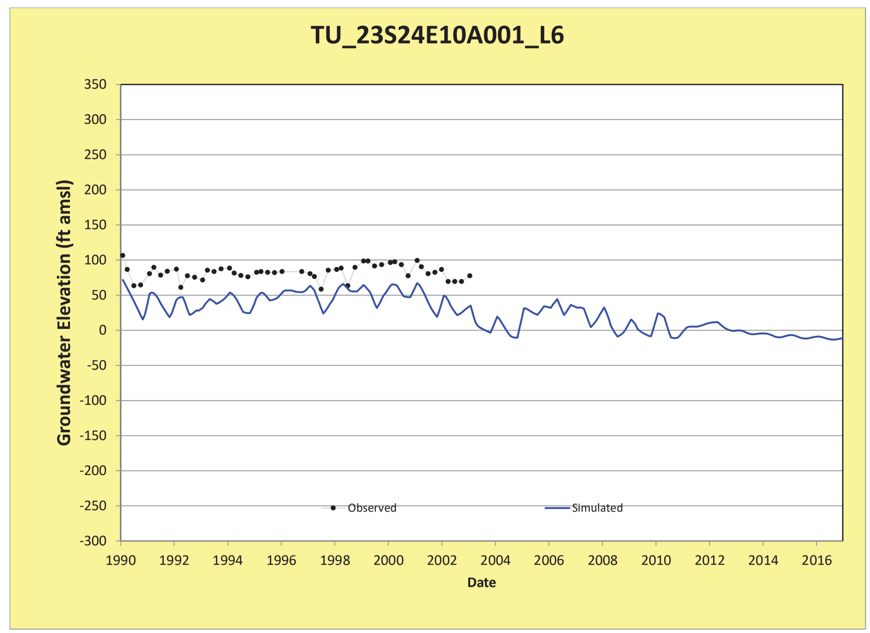
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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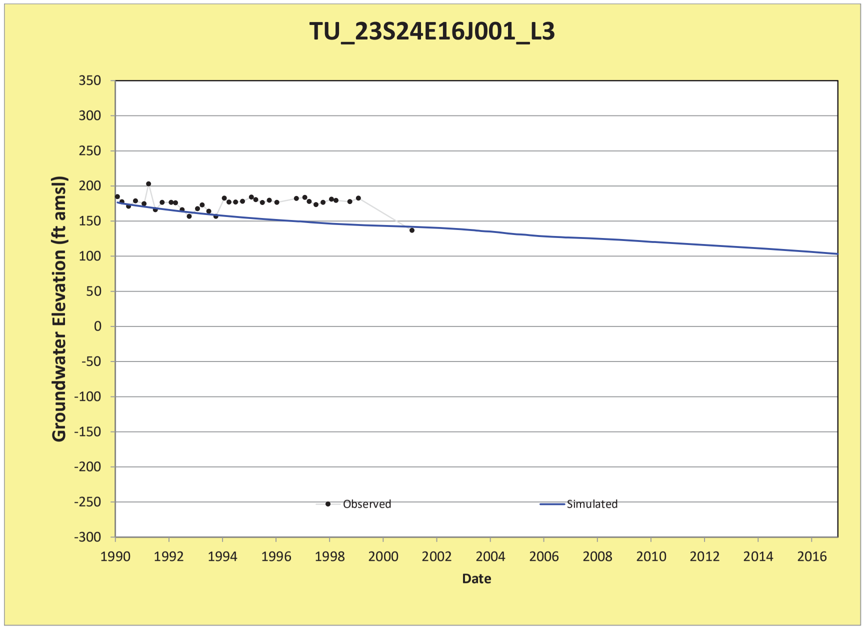
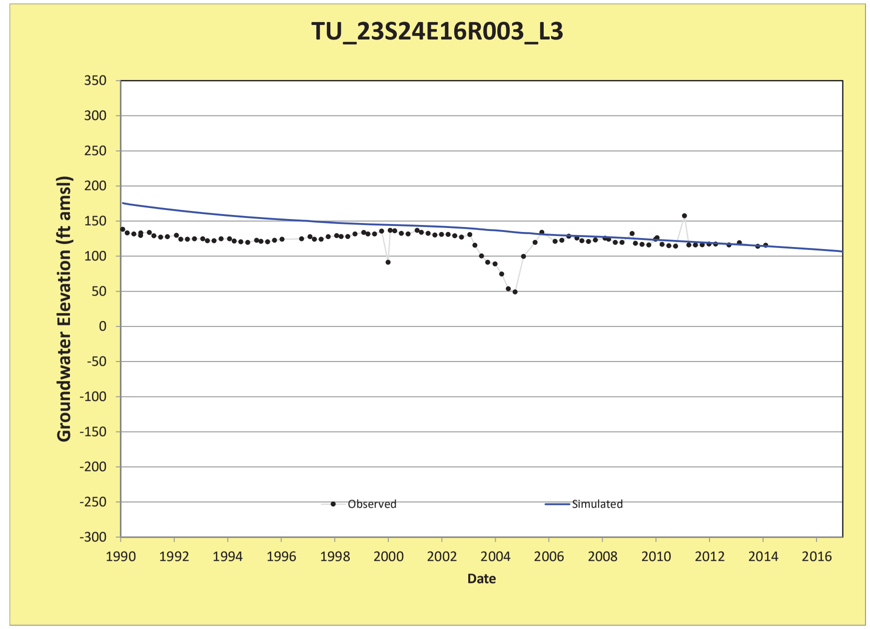
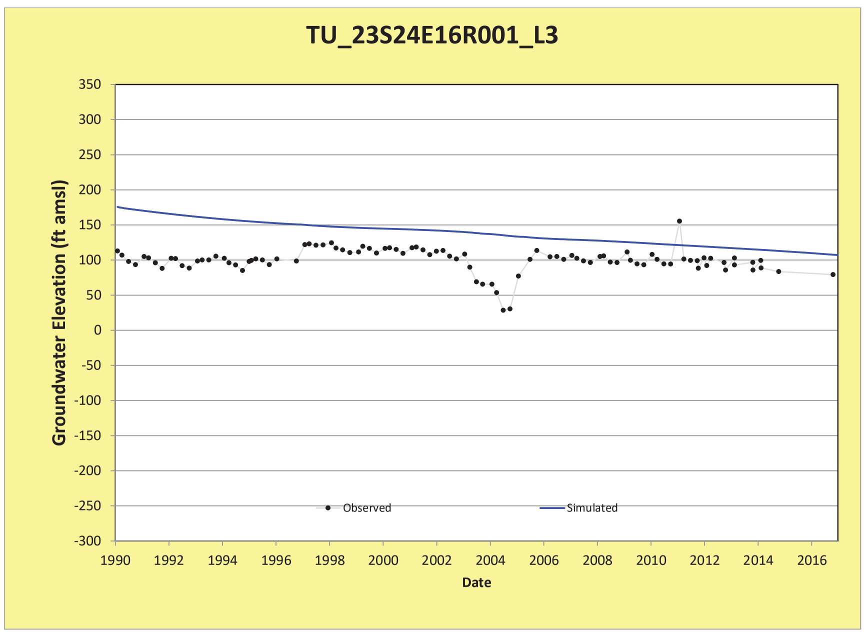
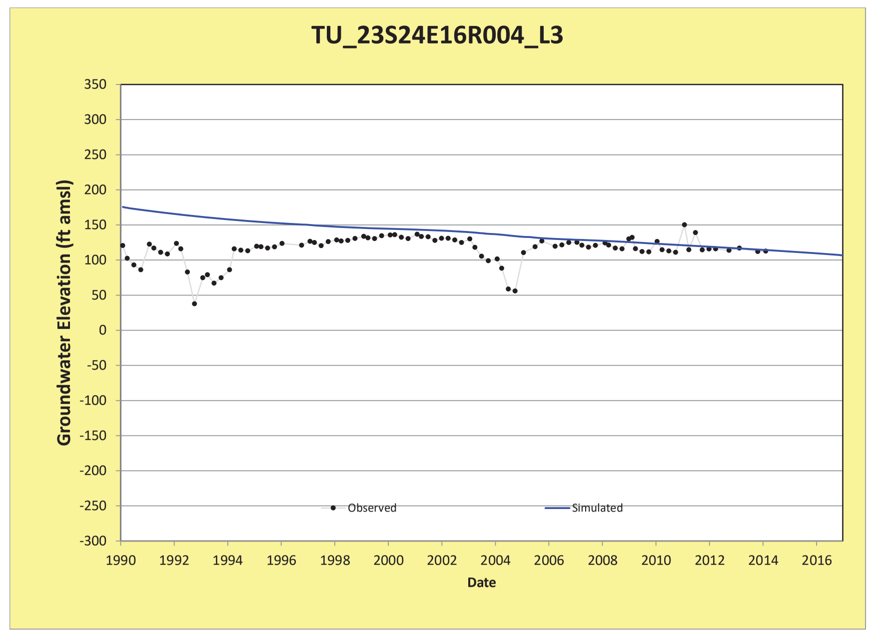
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S24E16J001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S24E16R003_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_23S24E16R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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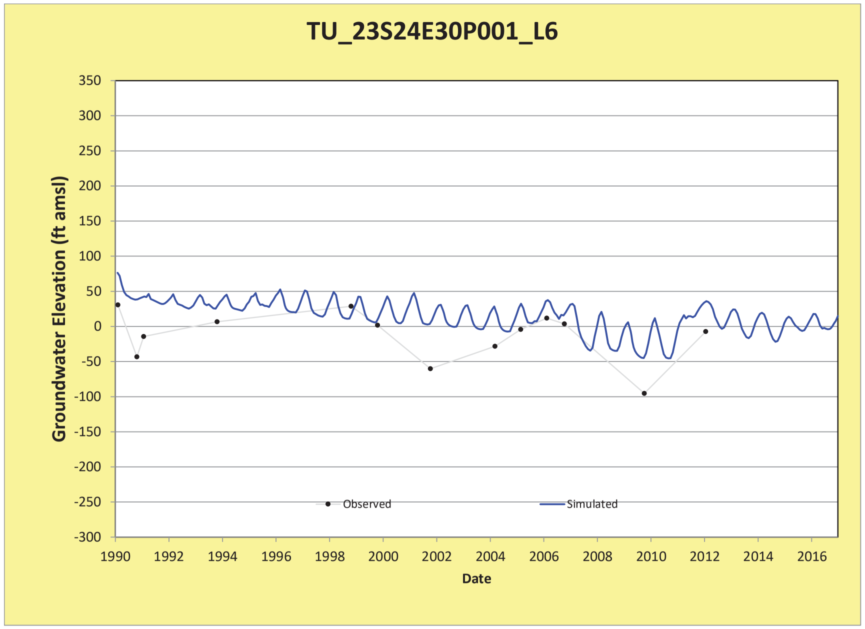
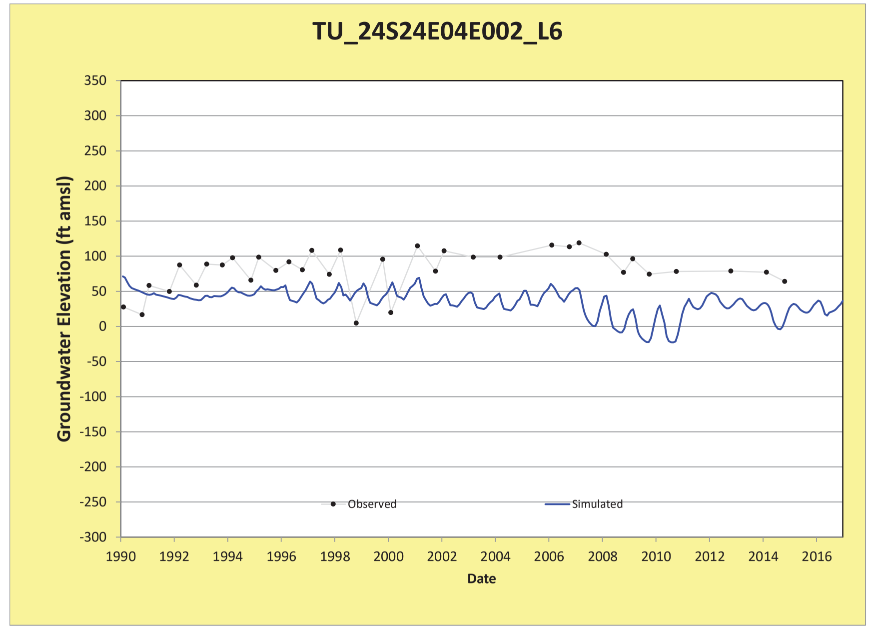
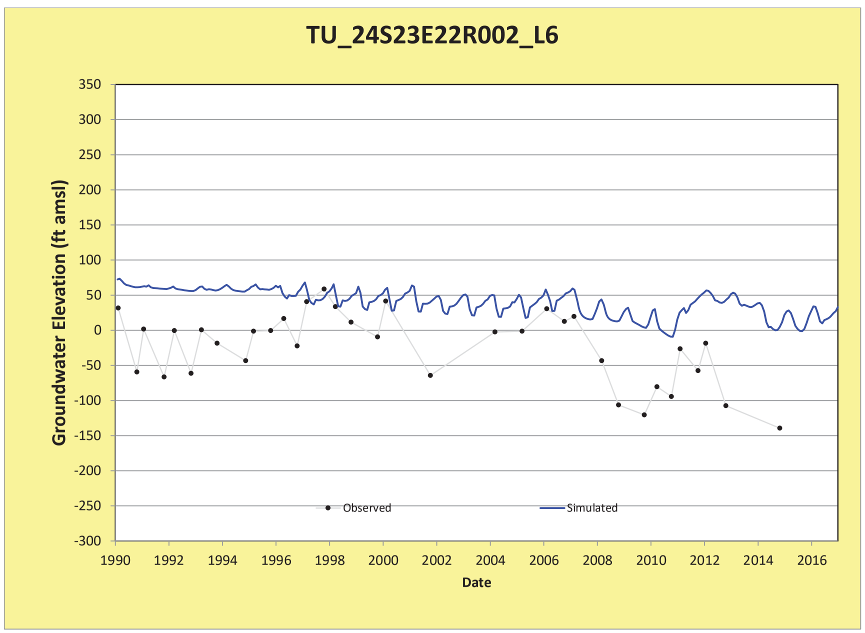
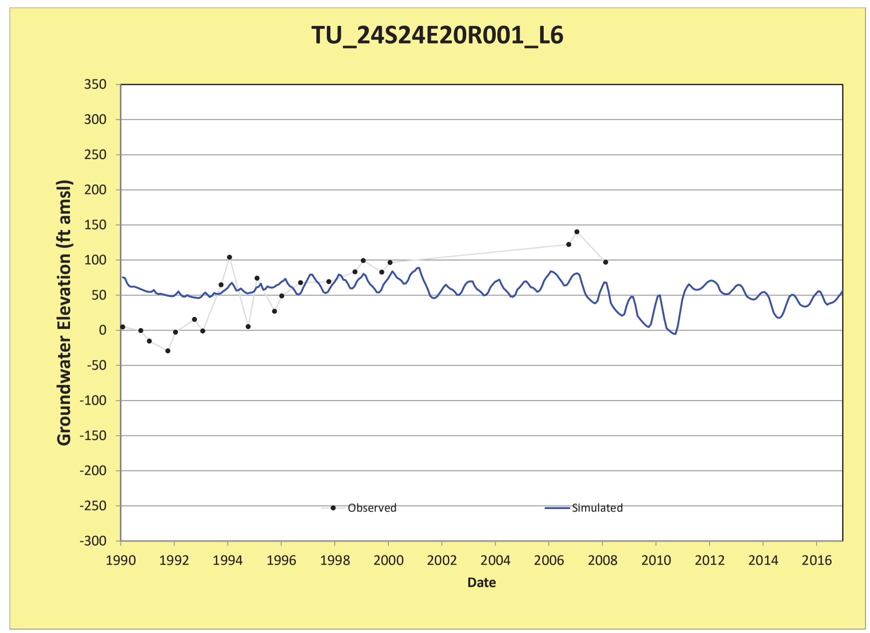
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

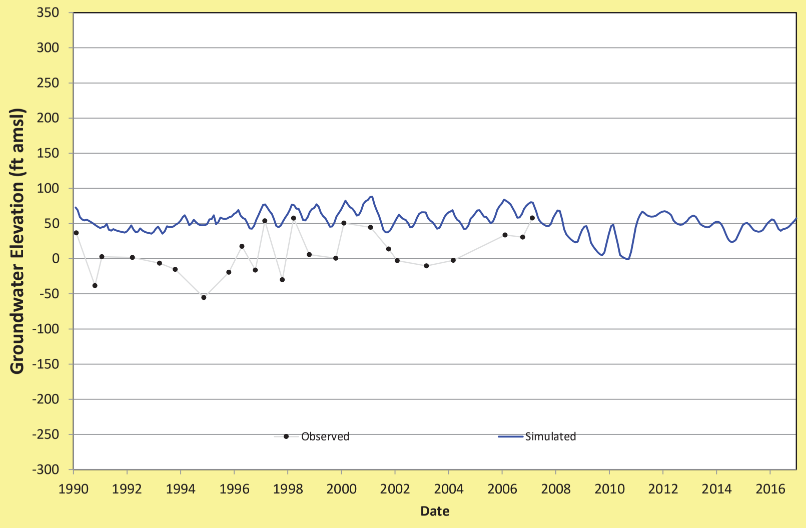

TU_23S24E30P001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_24S24E04E002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

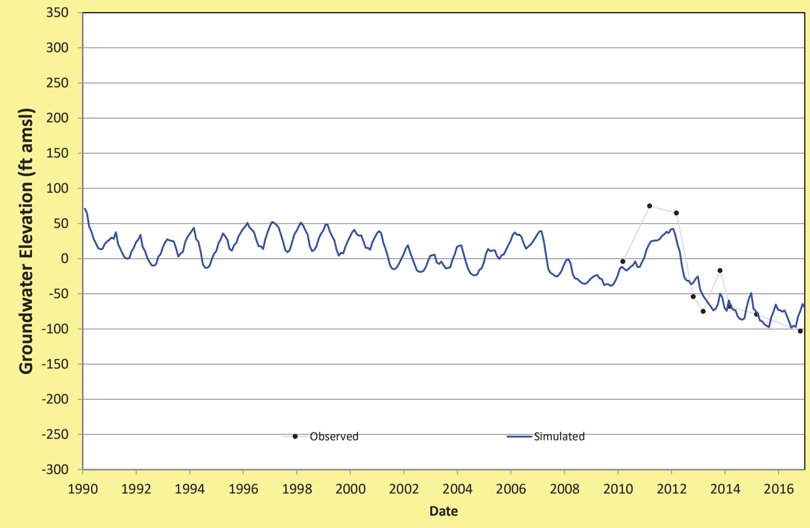

TU_24S23E22R002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


TU_24S24E20R001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

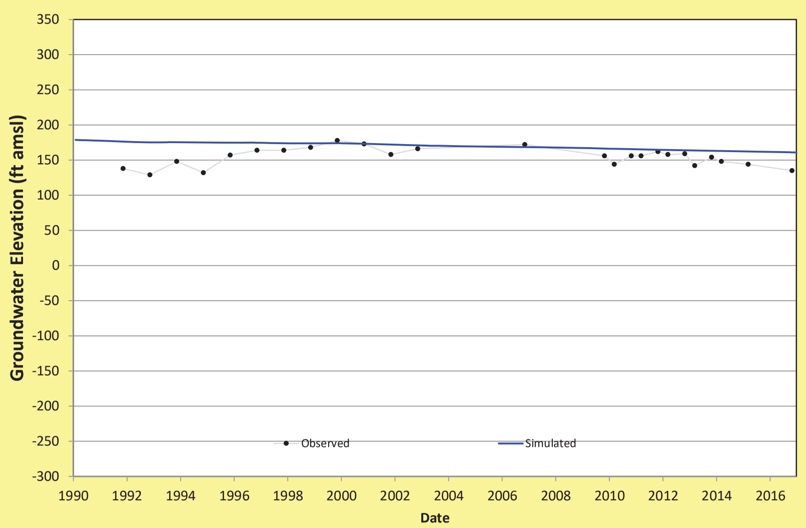
TU_24S24E21G001_L6



TU_CID_096_L5



TU_CID_071_L1



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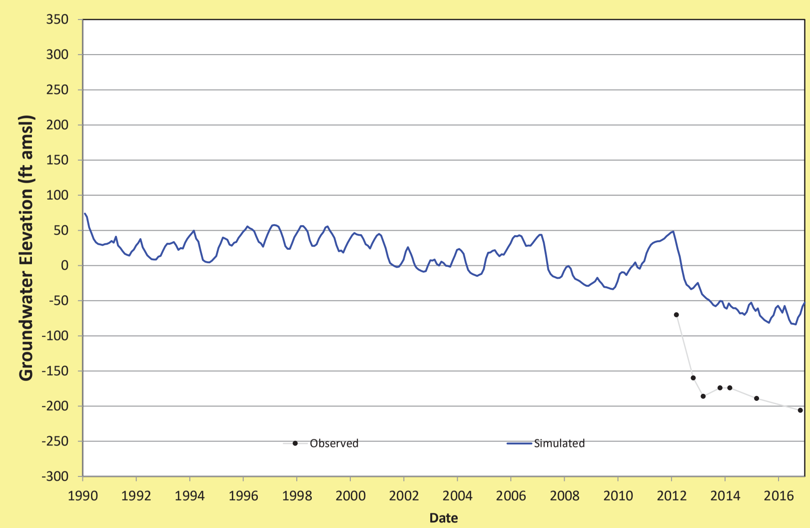
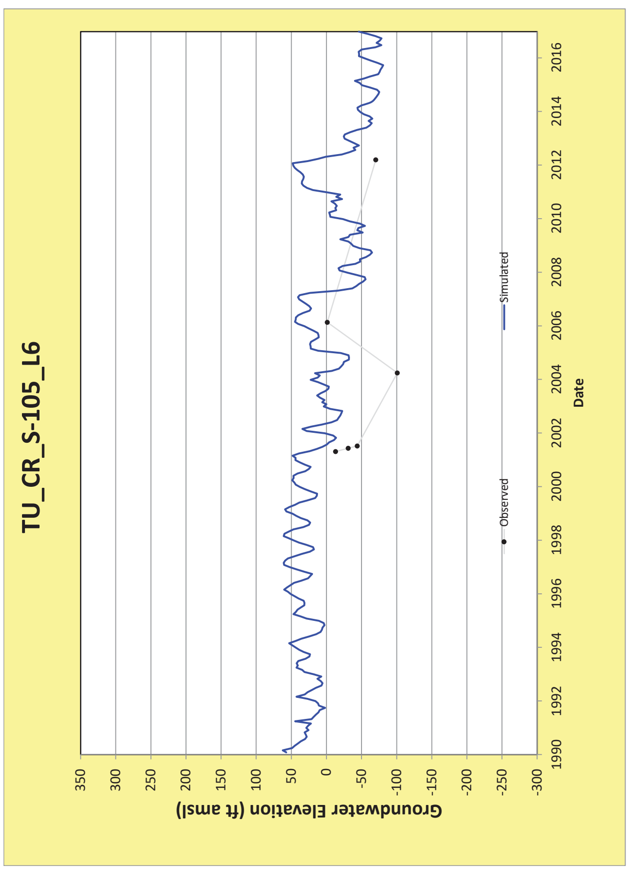
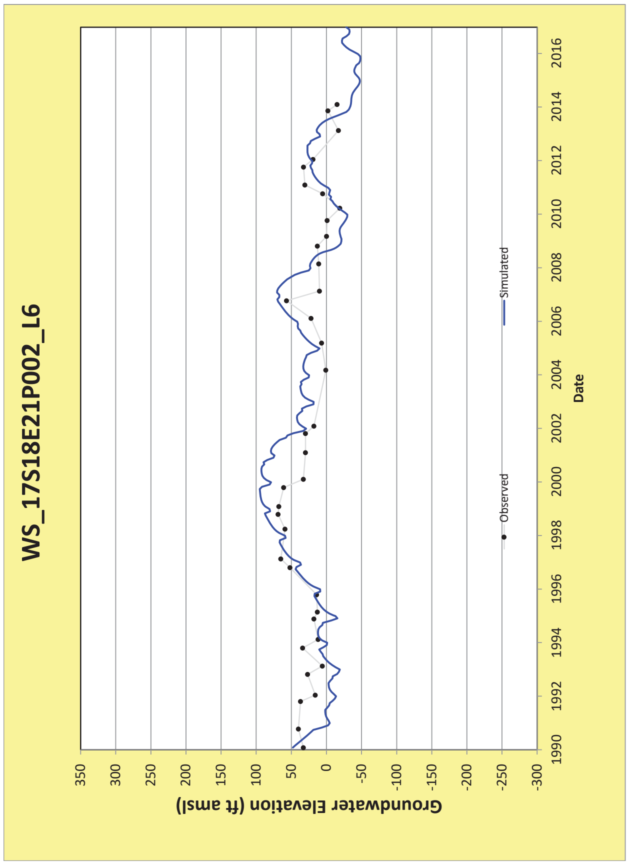
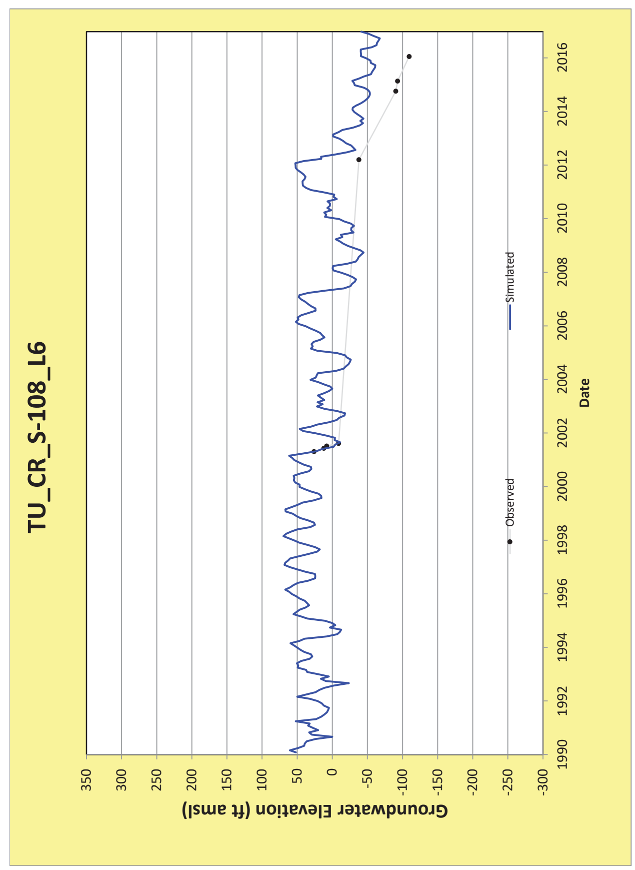



TU_CR_S-105_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_17S18E21P002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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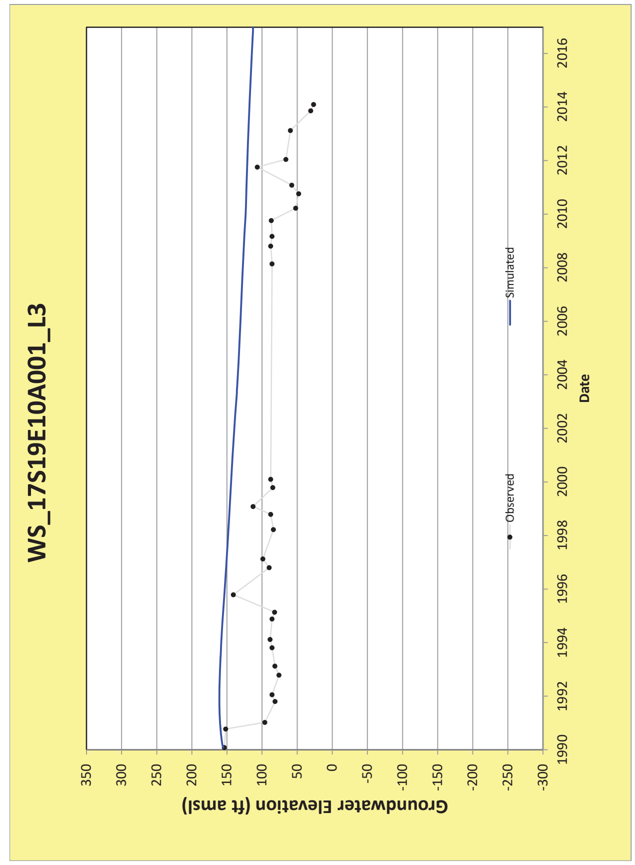
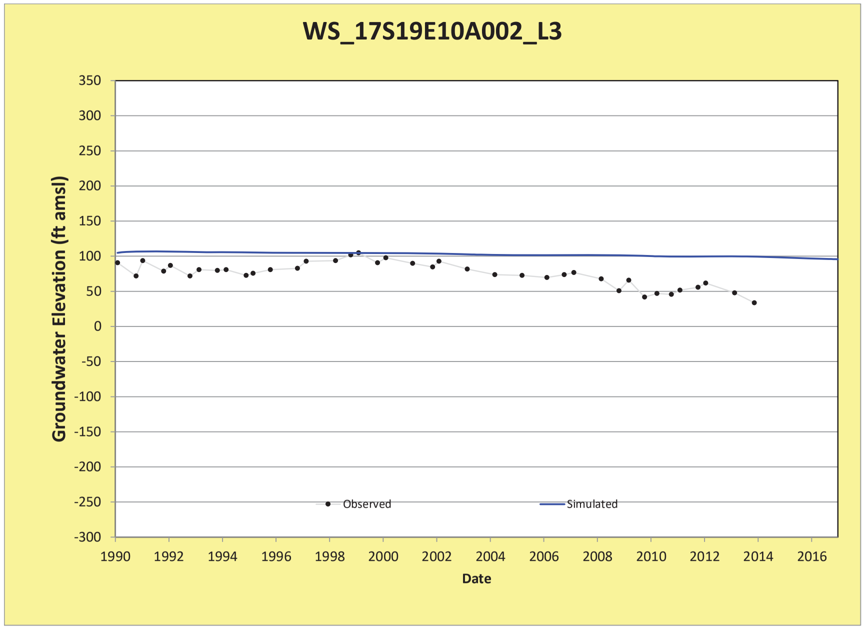
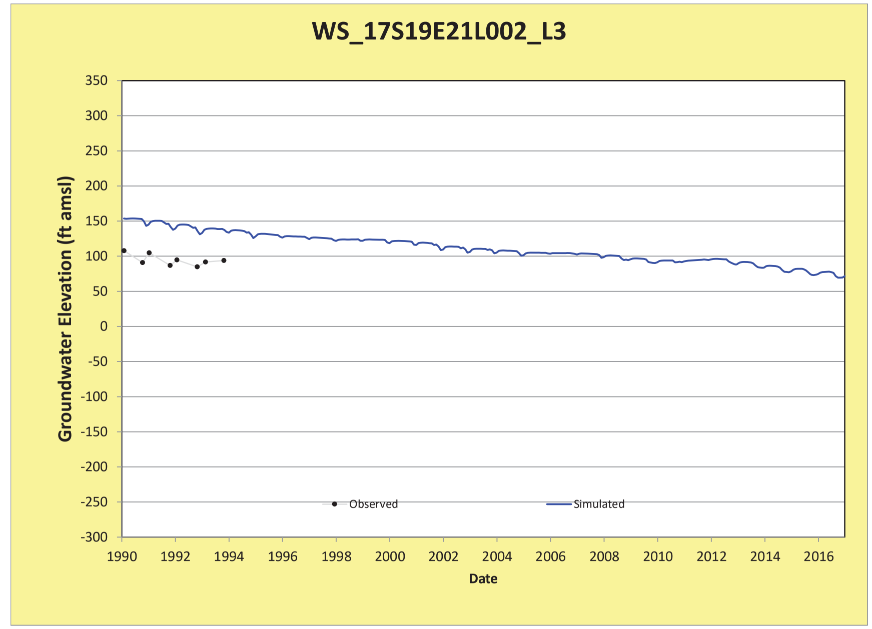
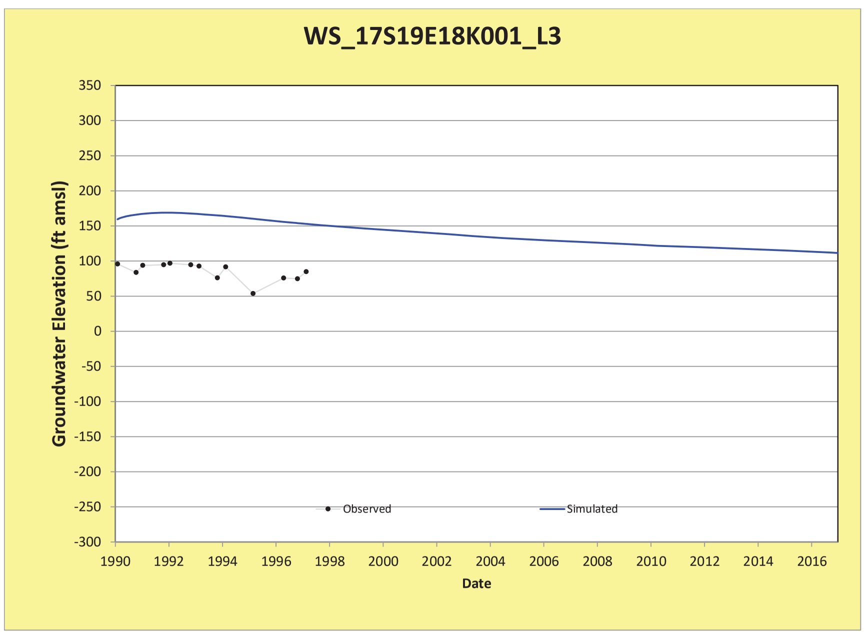
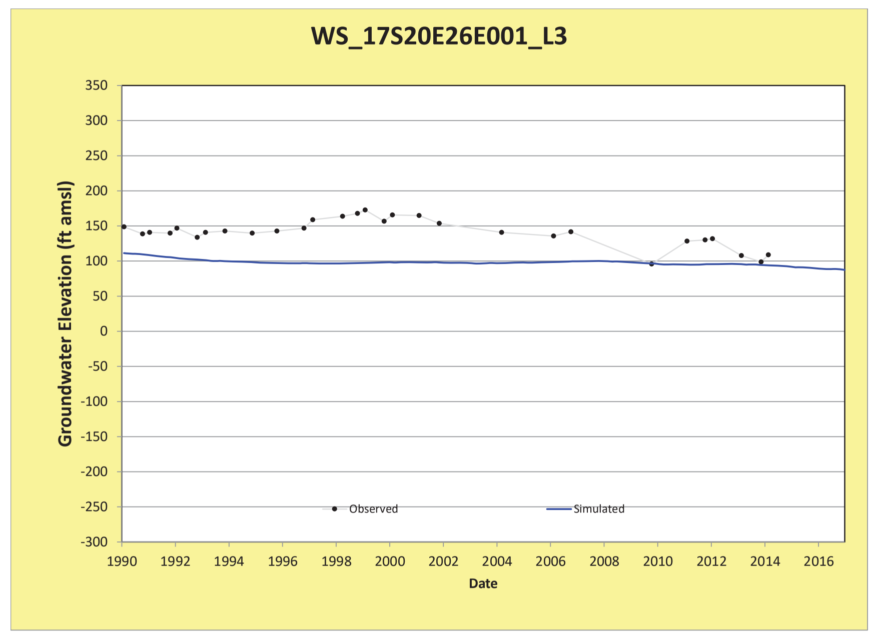
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

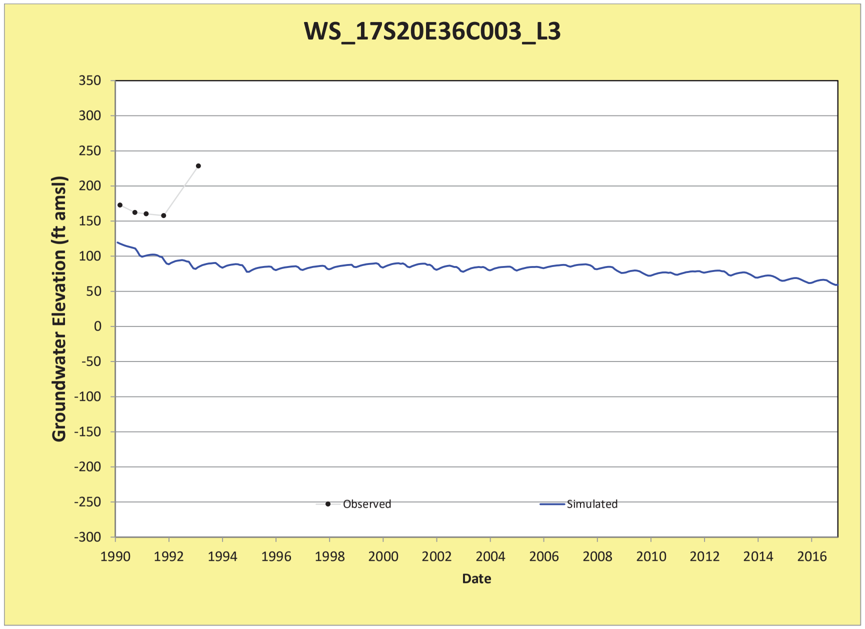

WS_17S19E10A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

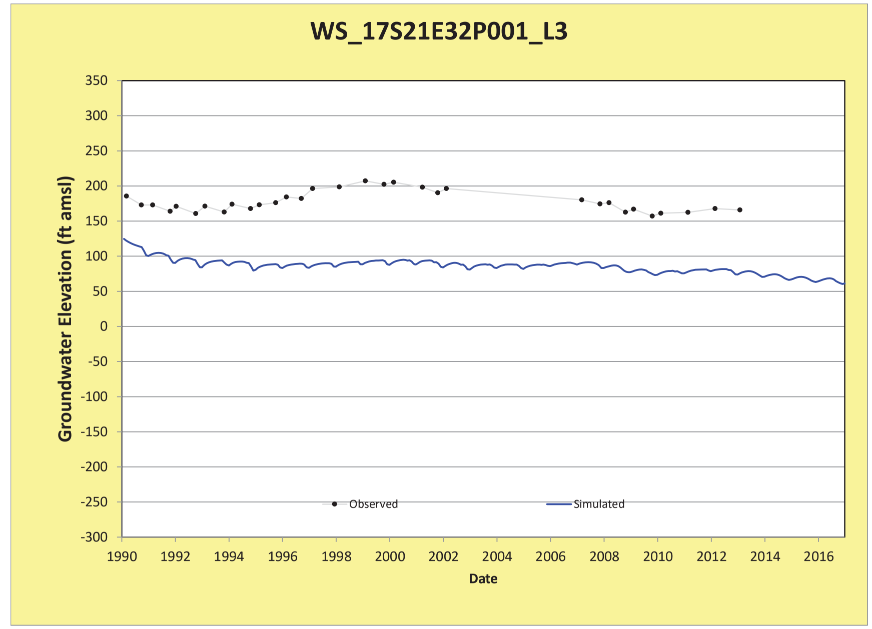

WS_17S19E10A002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

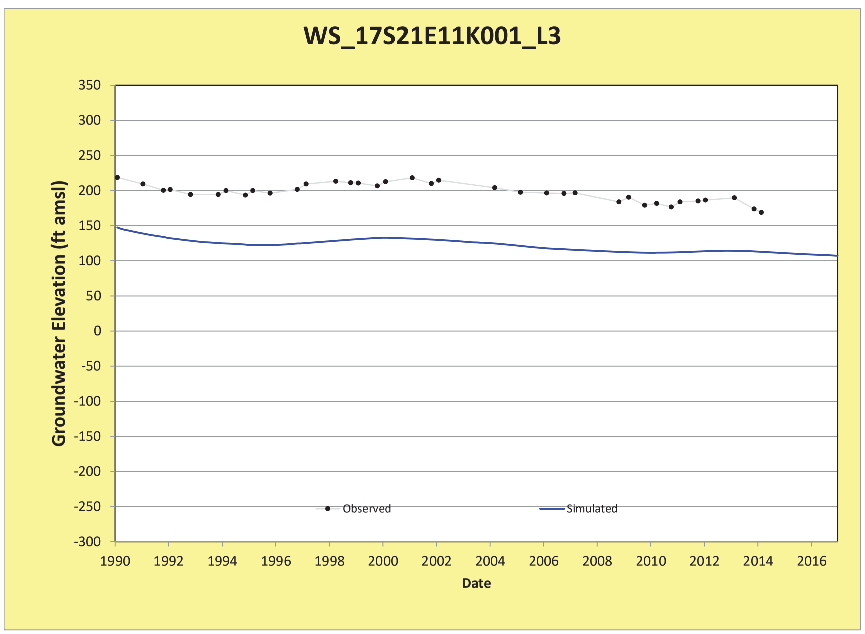

WS_17S19E21L002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

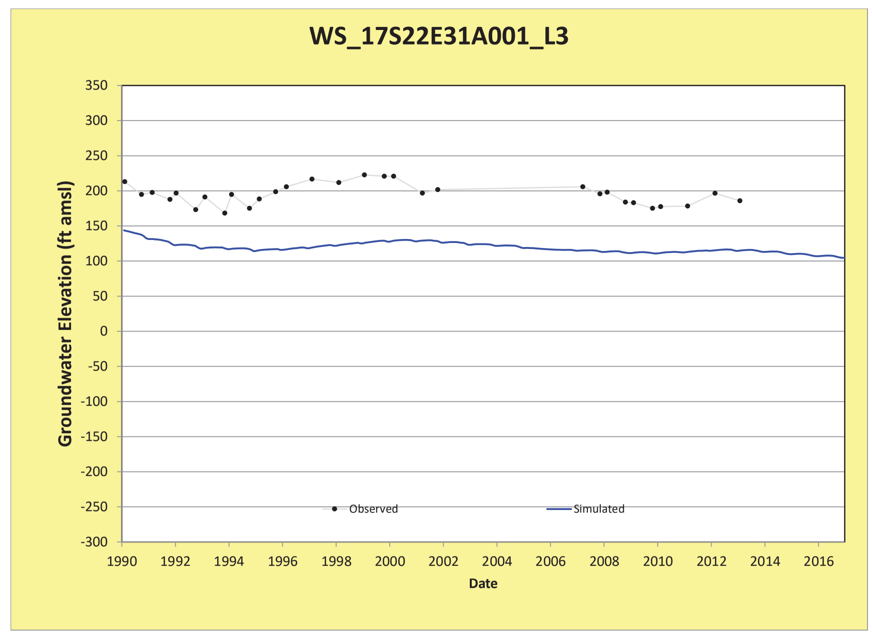

WS_17S19E18K001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

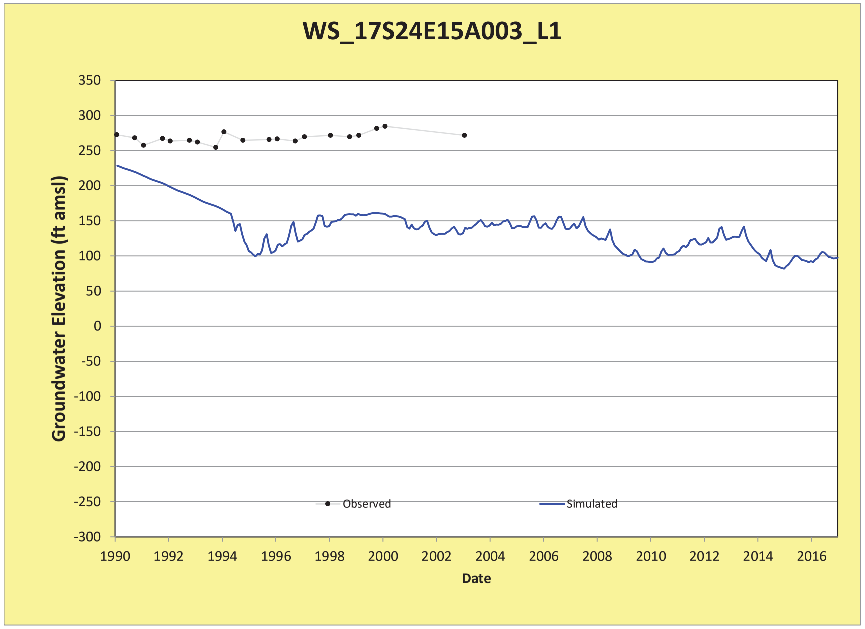

WS_17S20E26E001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

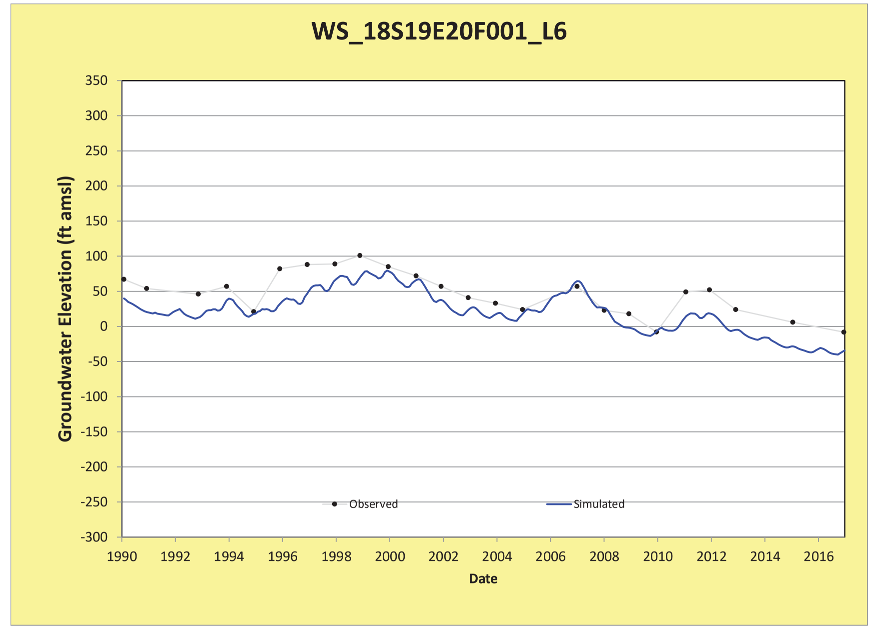

WS_17S20E36C003_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

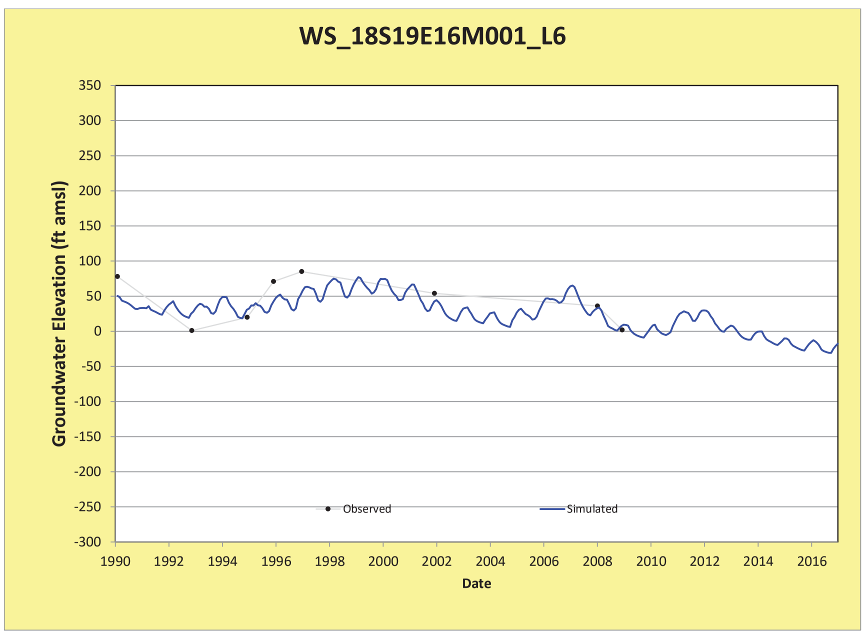

WS_17S21E32P001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

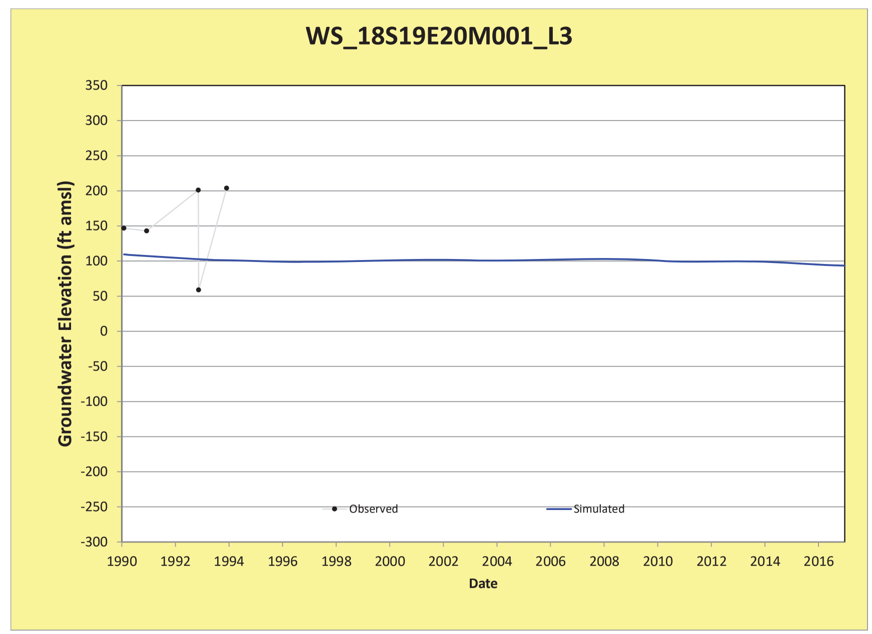

WS_17S21E11K001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_17S22E31A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_17S24E15A003_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_18S19E20F001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_18S19E16M001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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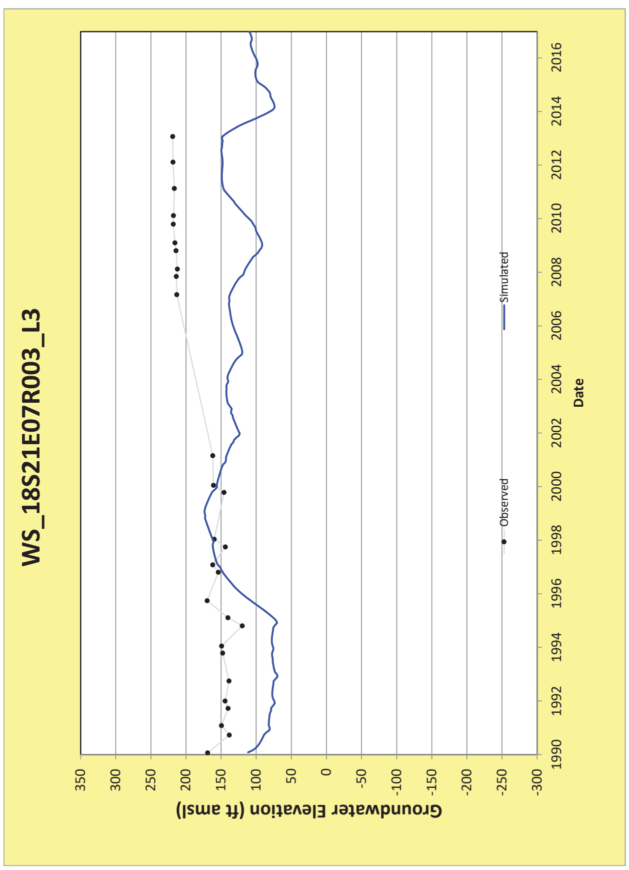
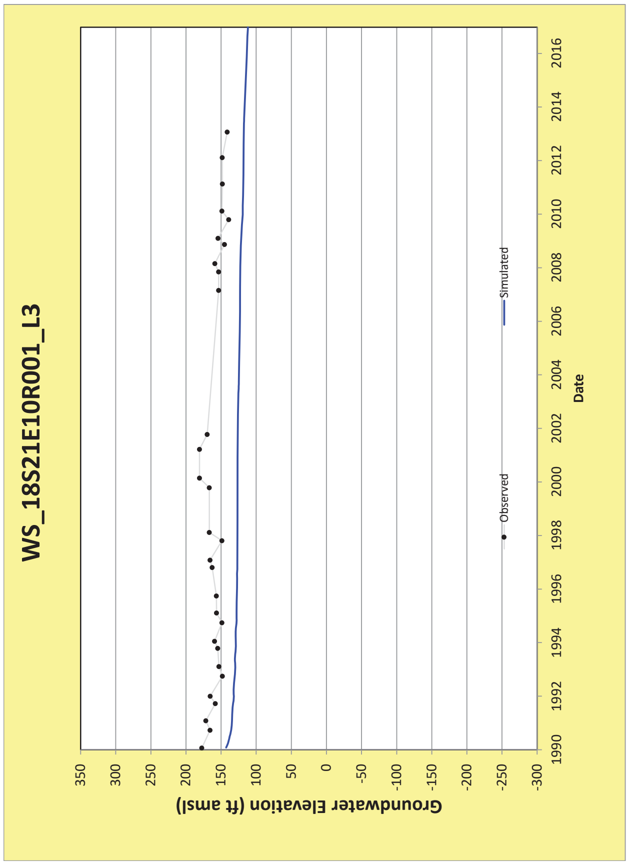
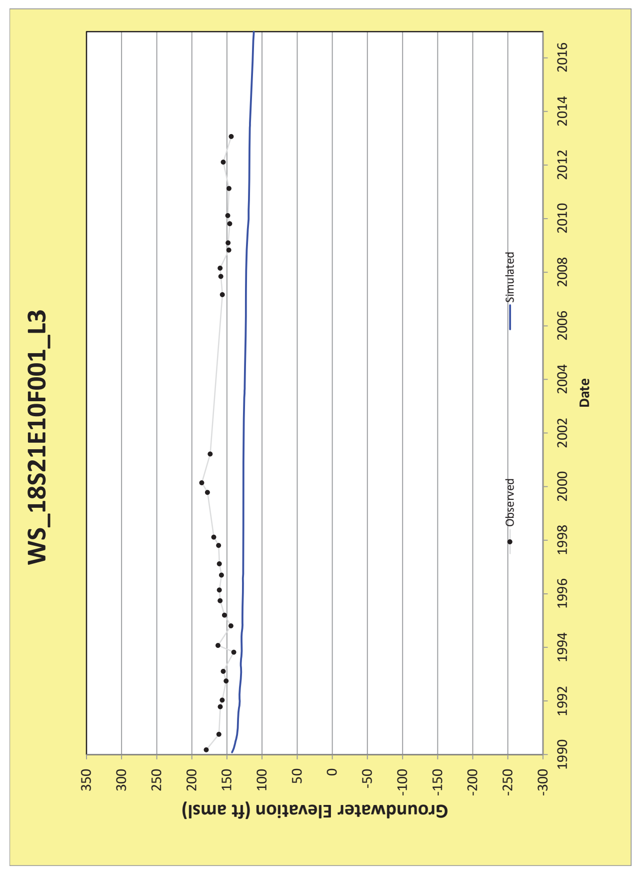
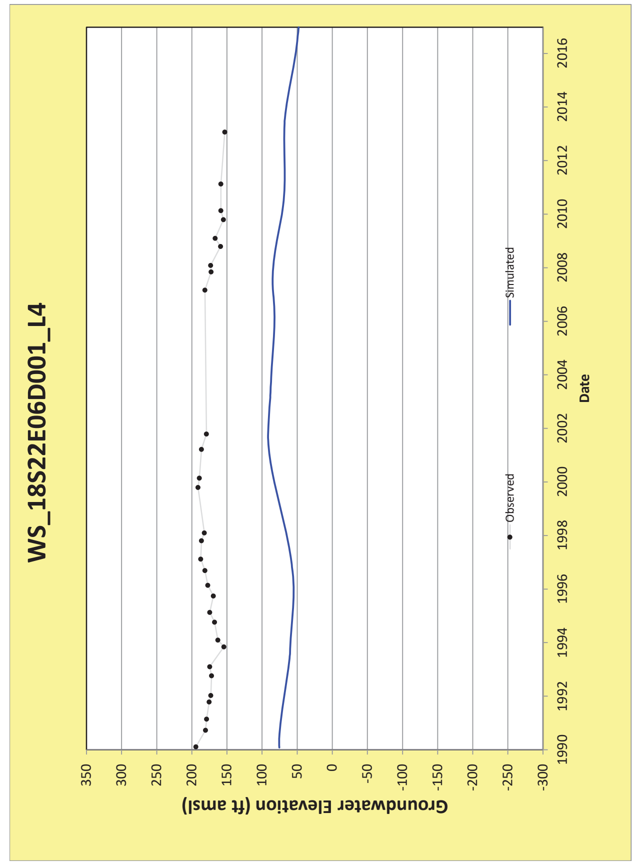
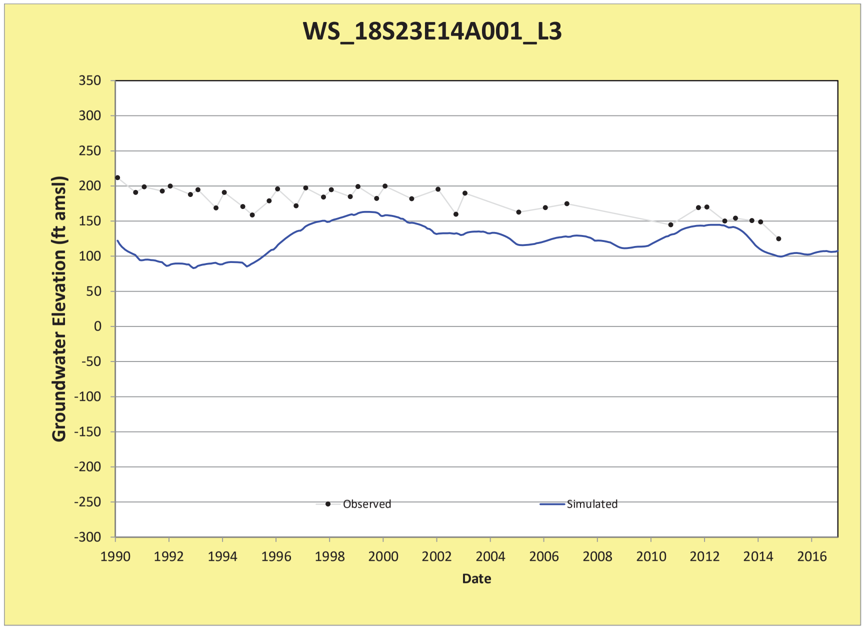
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

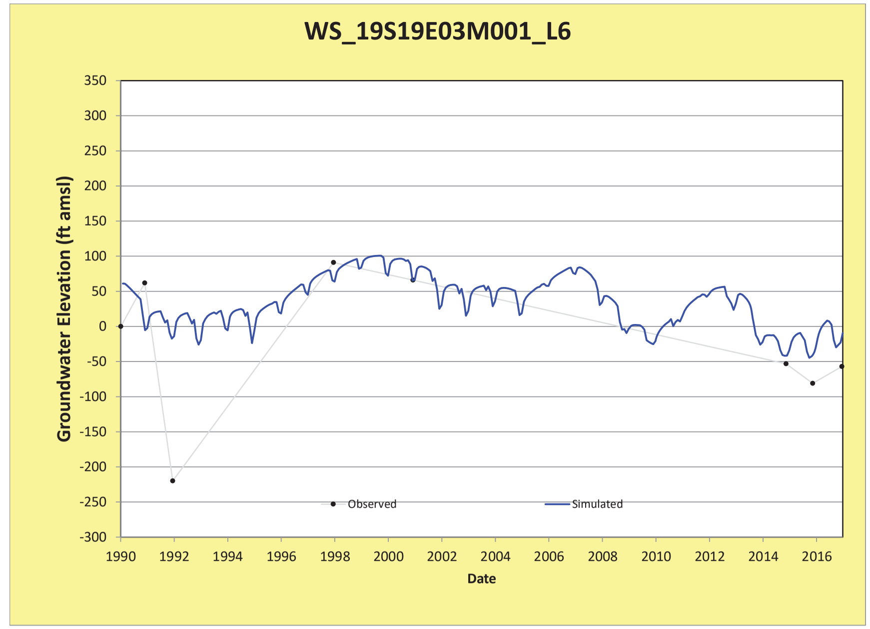

WS_18S21E07R003_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

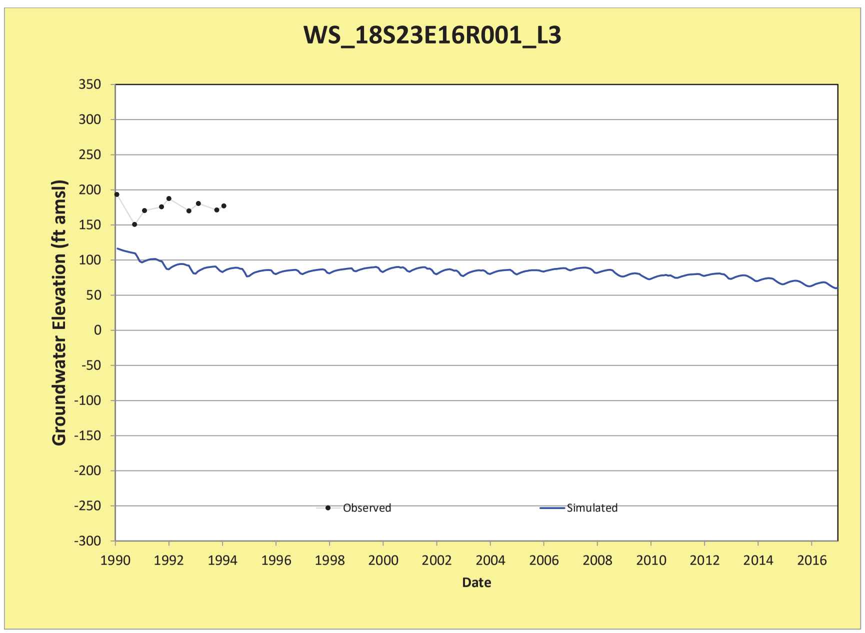

WS_18S21E10R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

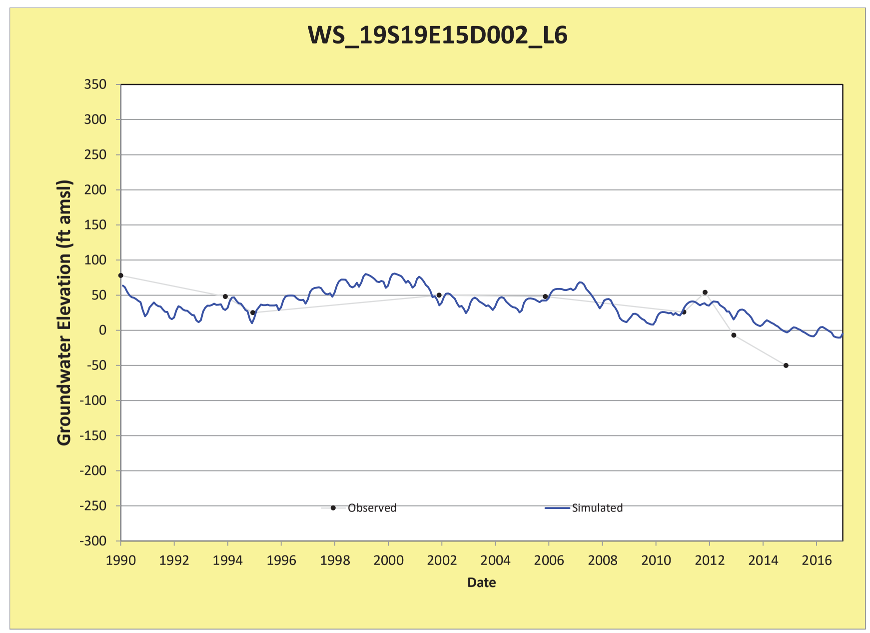

WS_18S21E10F001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

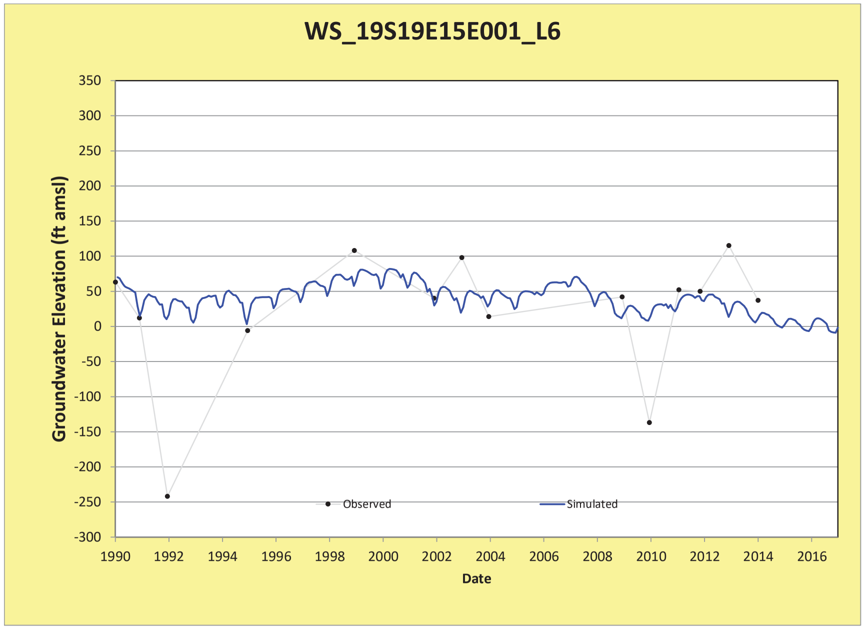

WS_18S22E06D001_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_18S23E14A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S19E03M001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_18S23E16R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S19E15D002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S19E15E001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
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-300
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2012
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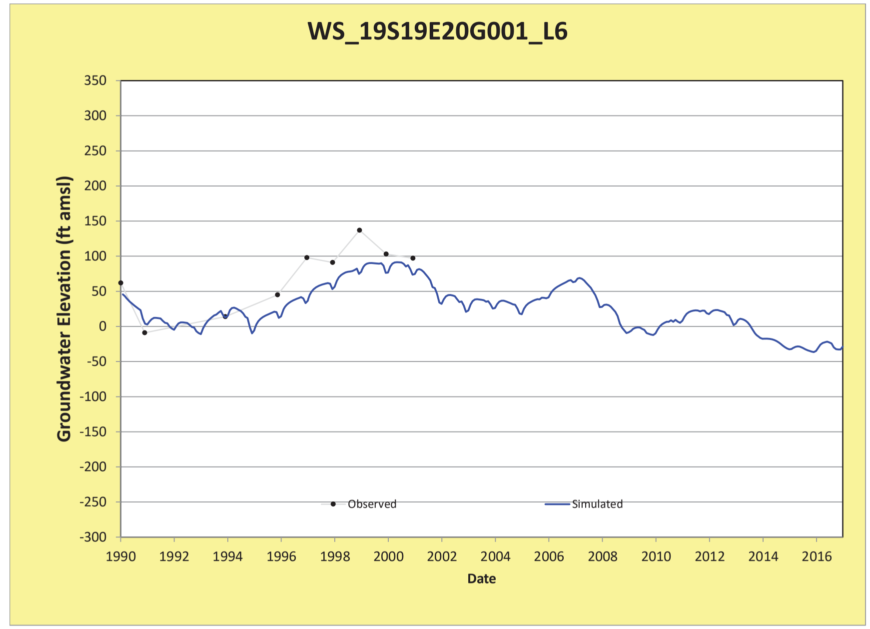
2016
Date
Observed
Simulated


WS_19S19E20G001_L6
Groundwater Elevation (ft amsl)
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150
100
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0
-50
-100
-150
-200
-250
-300
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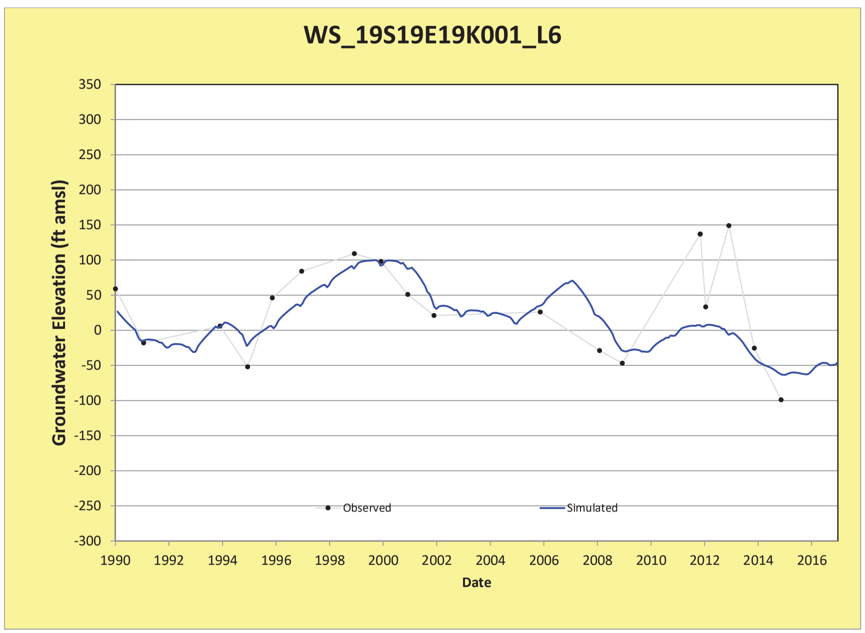
Date
Observed
Simulated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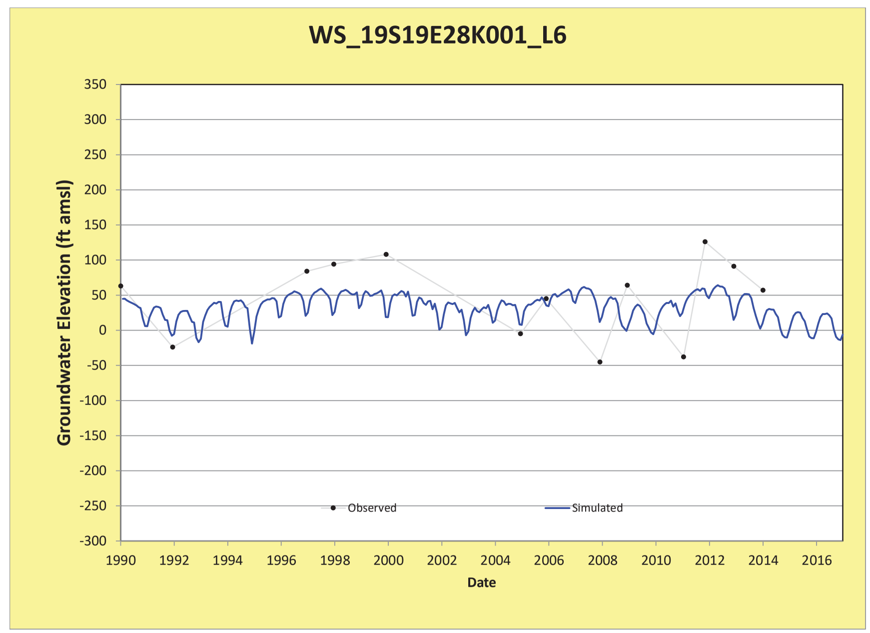
Date
Observed
Simulated


WS_19S19E28K001_L6
Groundwater Elevation (ft amsl)
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300
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150
100
50
0
-50
-100
-150
-200
-250
-300
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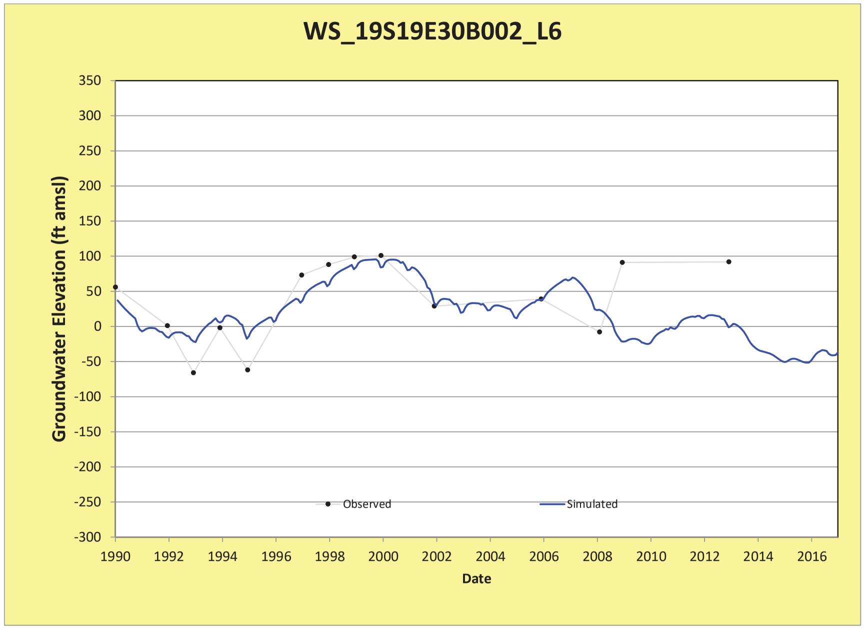
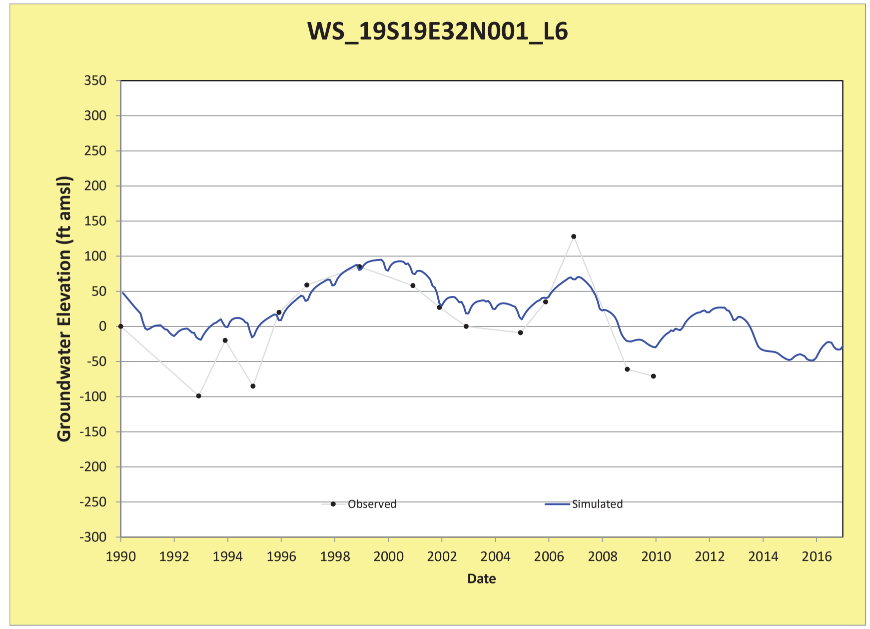
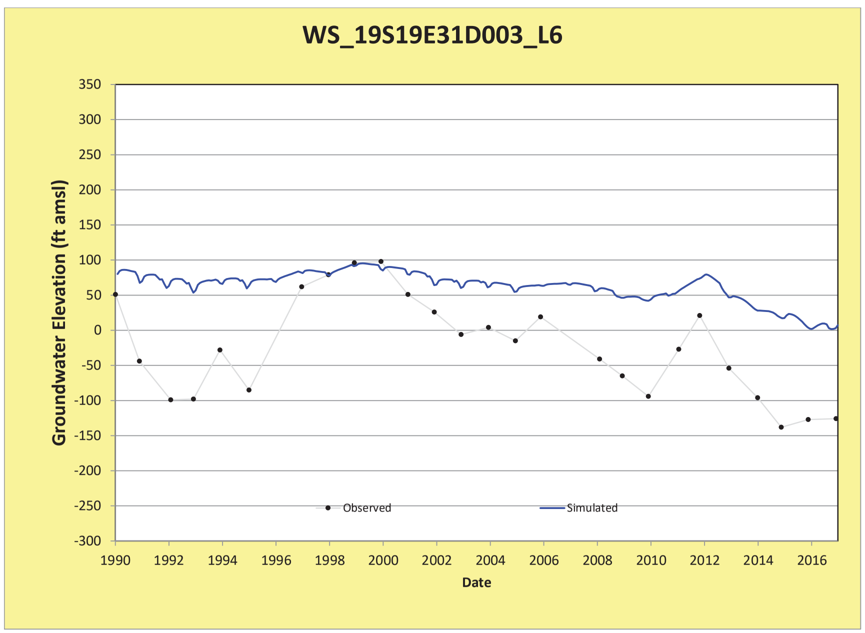
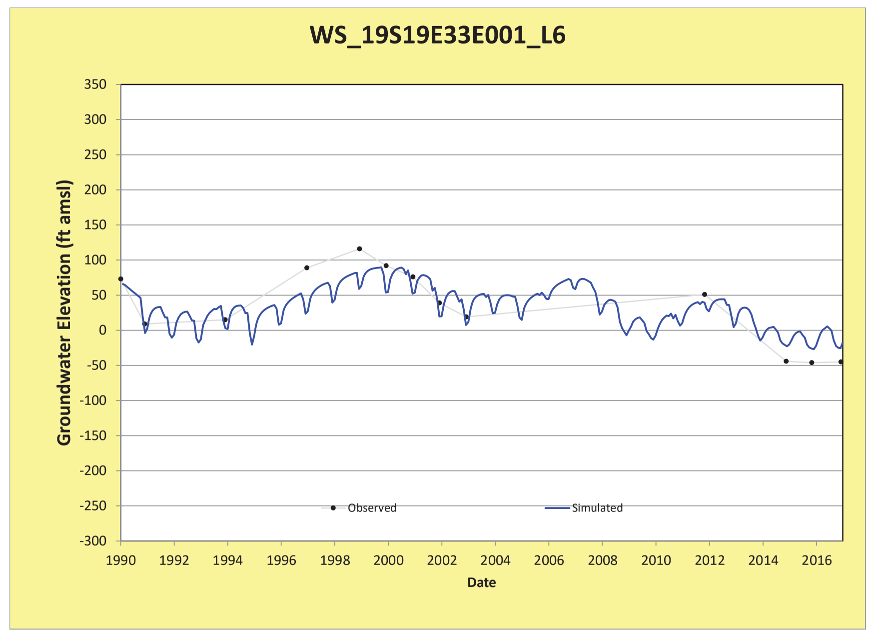
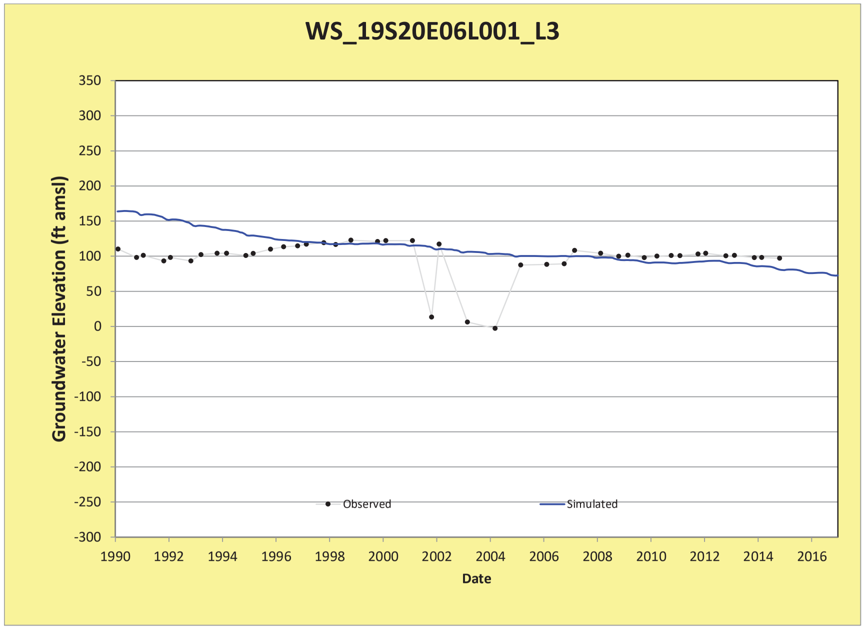
2016
Date
Observed
Simulated


WS_19S19E30B002_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S19E32N001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S19E31D003_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S19E33E001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S20E06L001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
350
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-50
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1990
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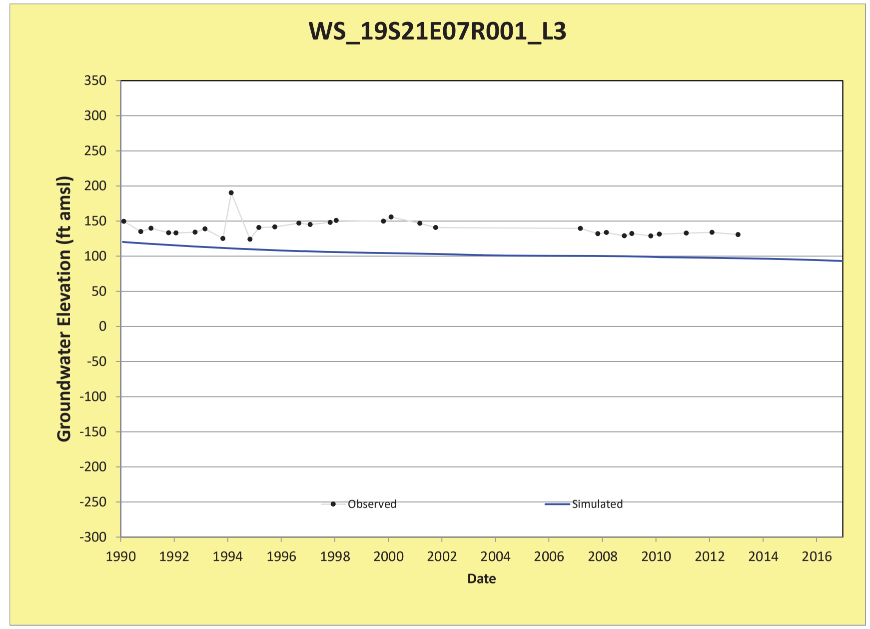
WS_19S21E07R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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-50
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-300
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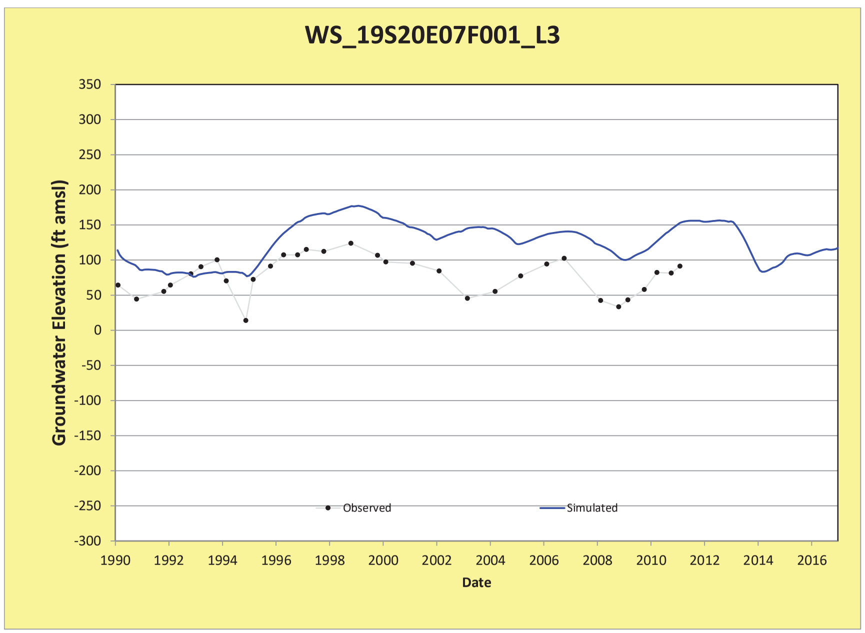
WS_19S20E07F001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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-50
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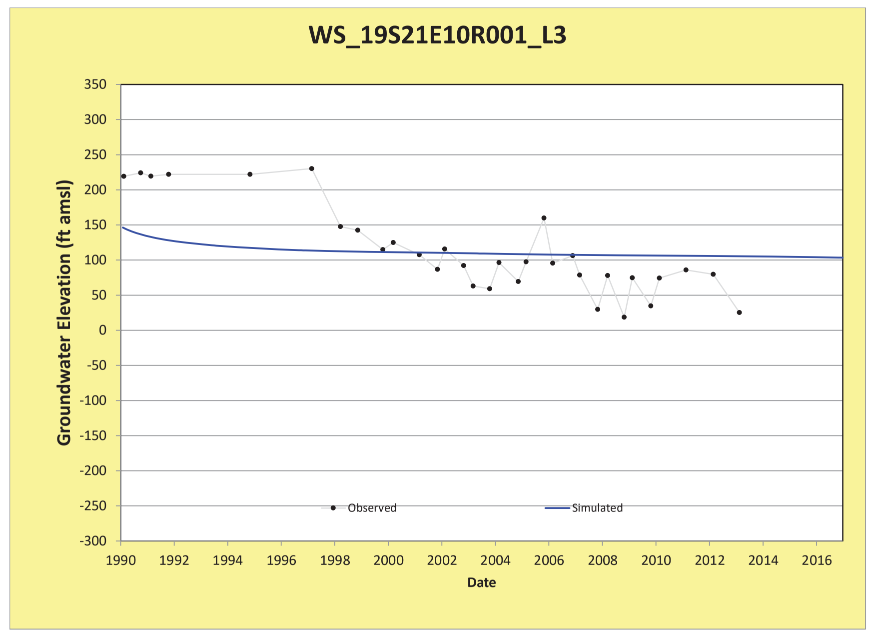
WS_19S21E10R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated
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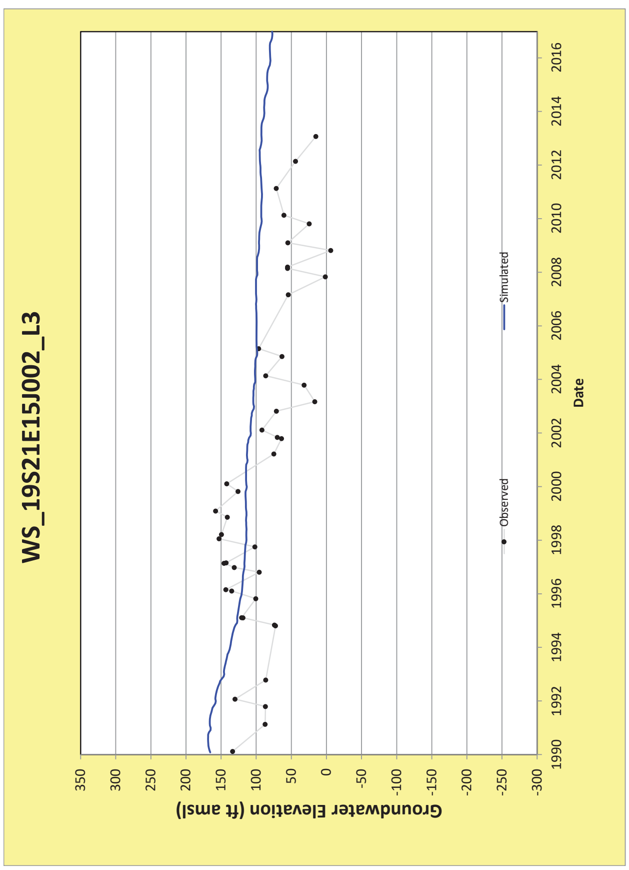
WS_19S21E15J002_L3
Groundwater Elevation (ft amsl)
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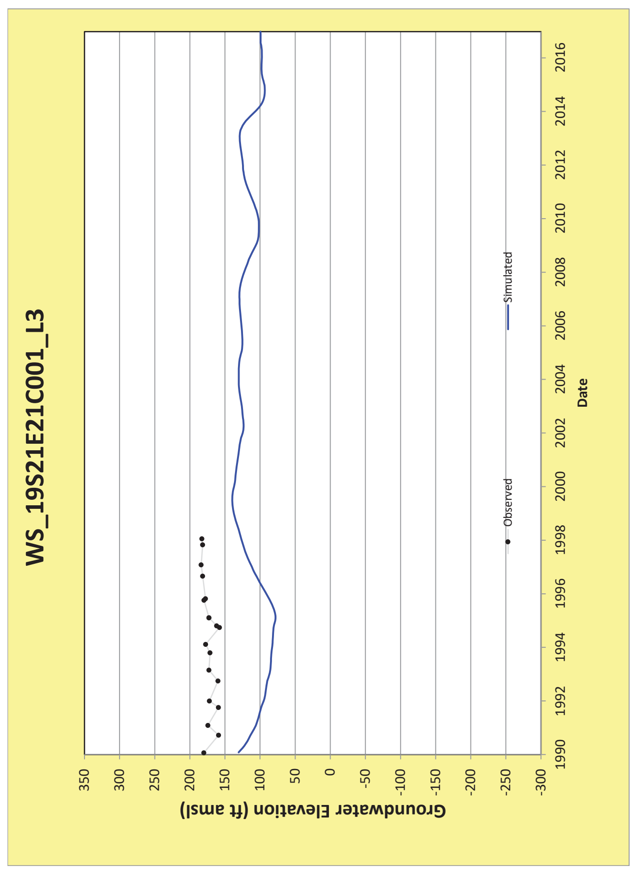
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated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Groundwater Elevation (ft amsl)
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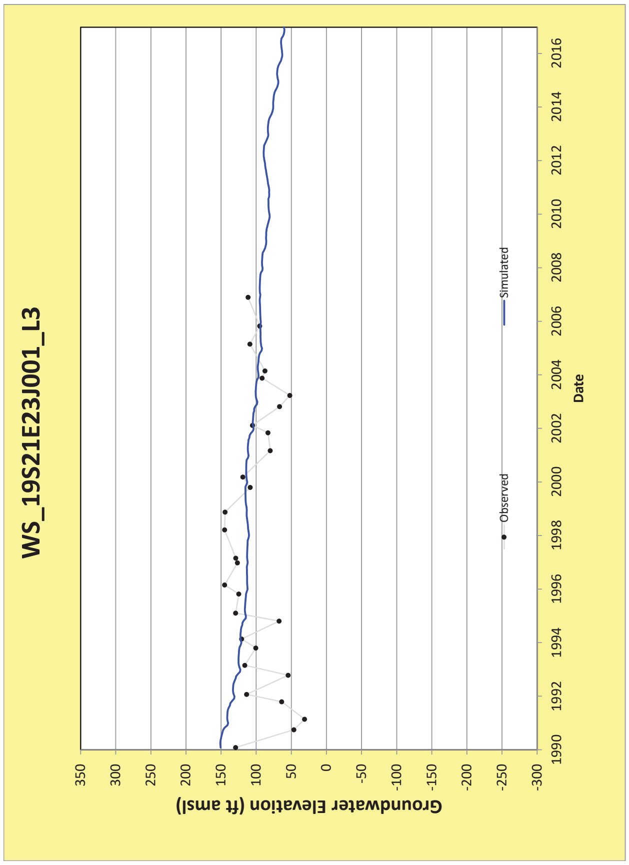
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


WS_19S21E23J001_L3
Groundwater Elevation (ft amsl)
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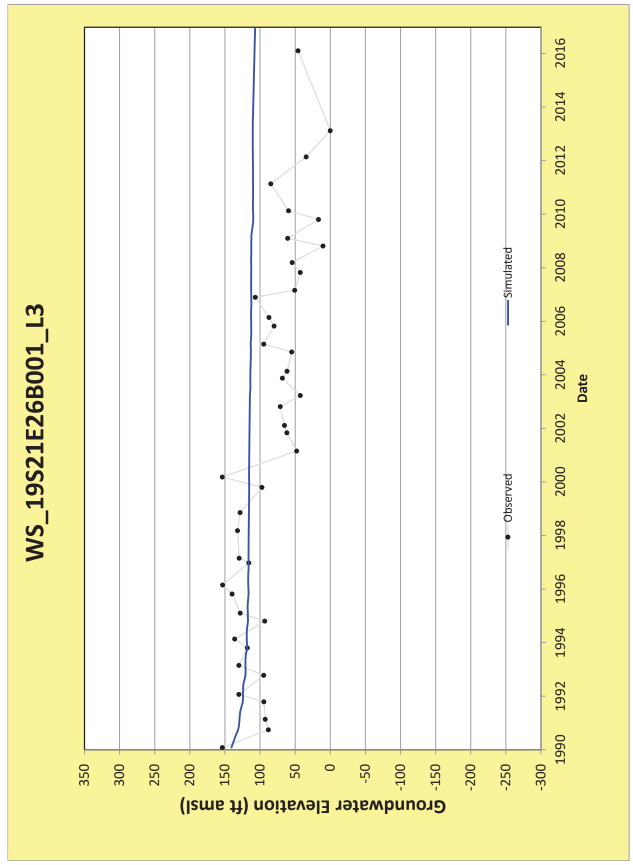
Date
Observed
Simulated


WS_19S21E26B001_L3
Groundwater Elevation (ft amsl)
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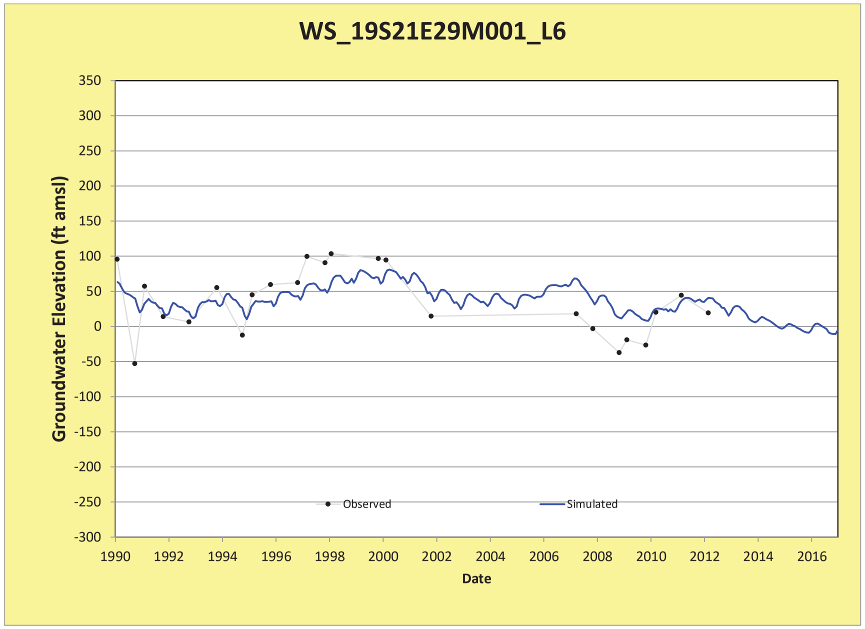
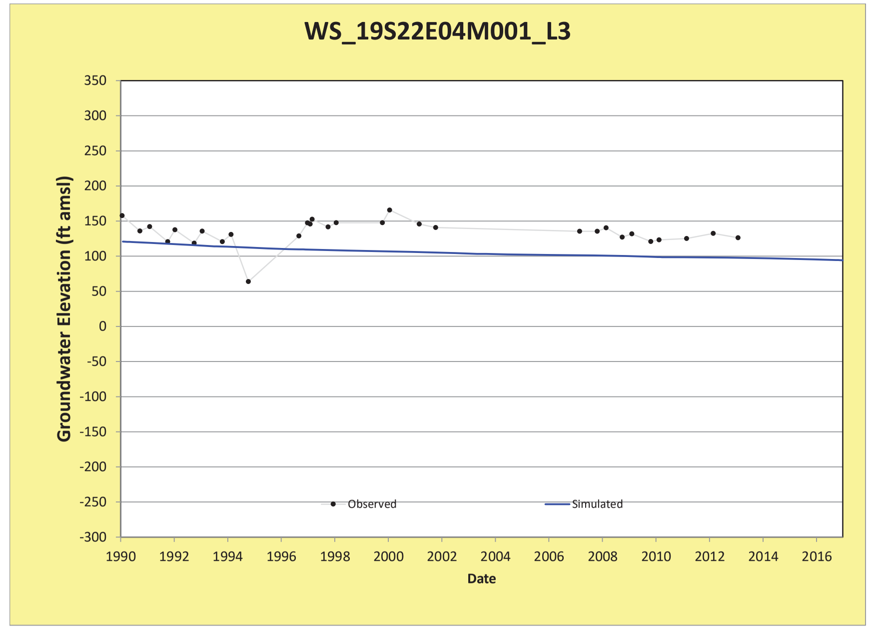
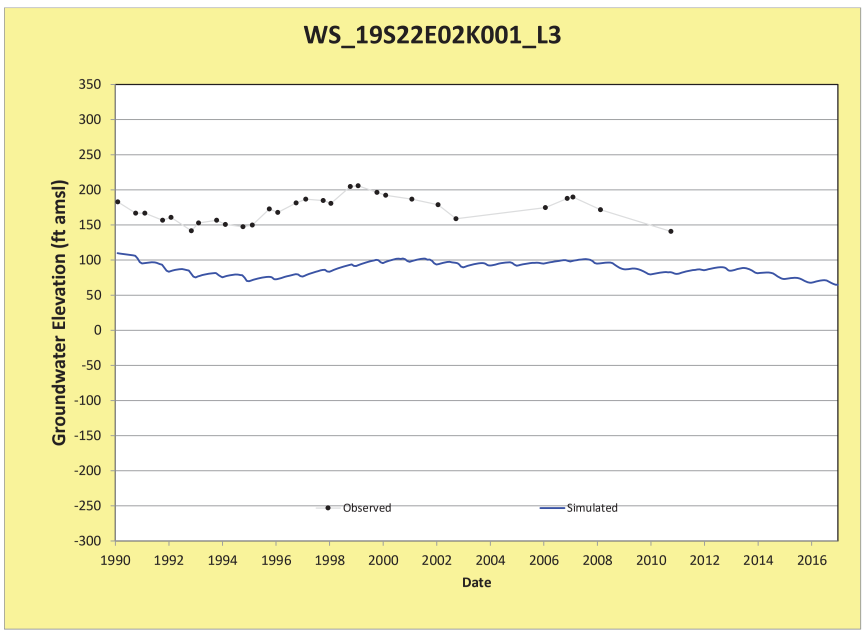
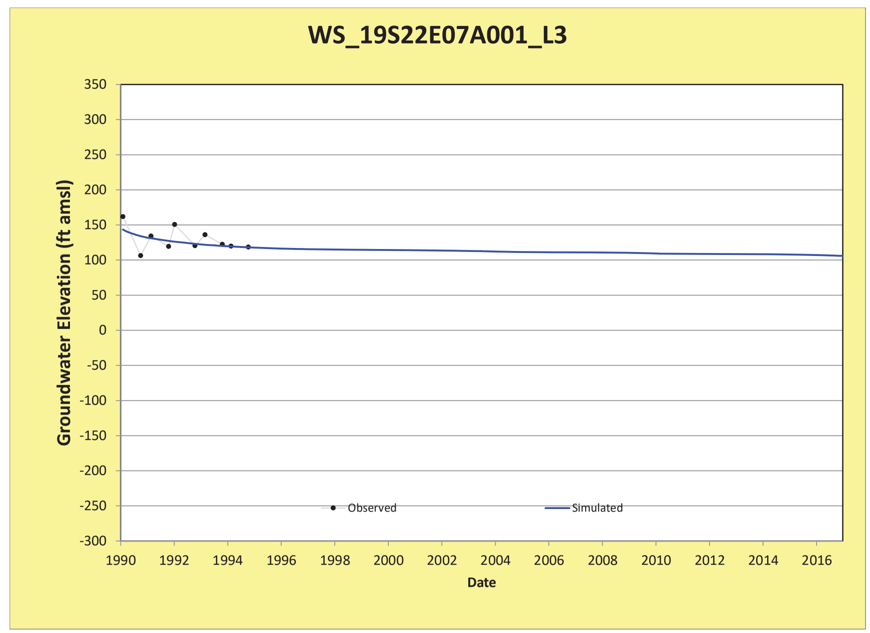
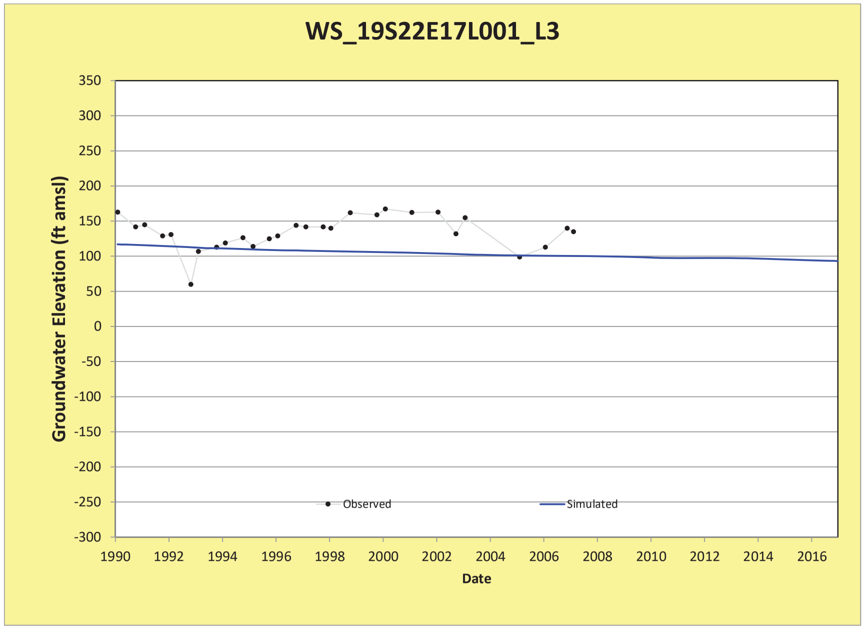
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated

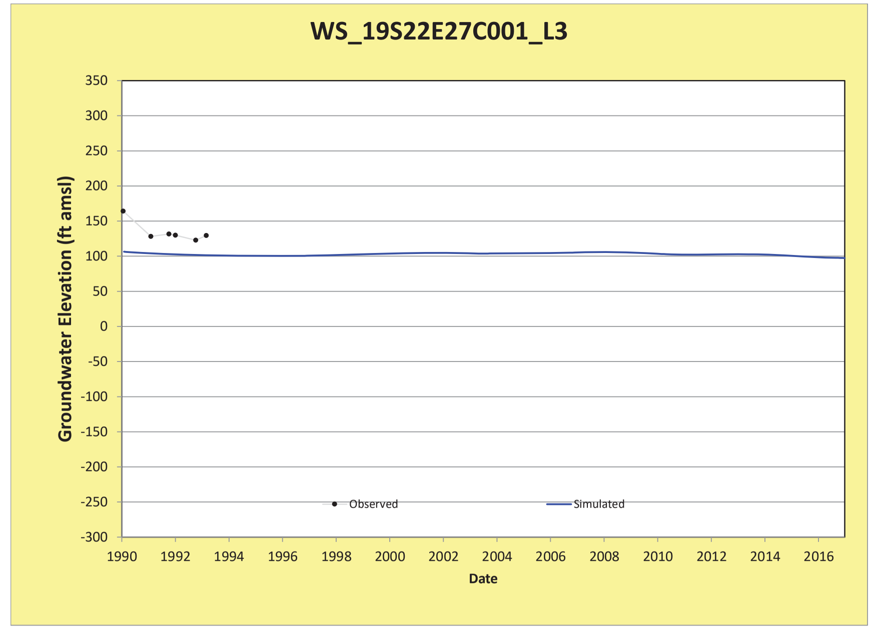

WS_19S21E29M001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

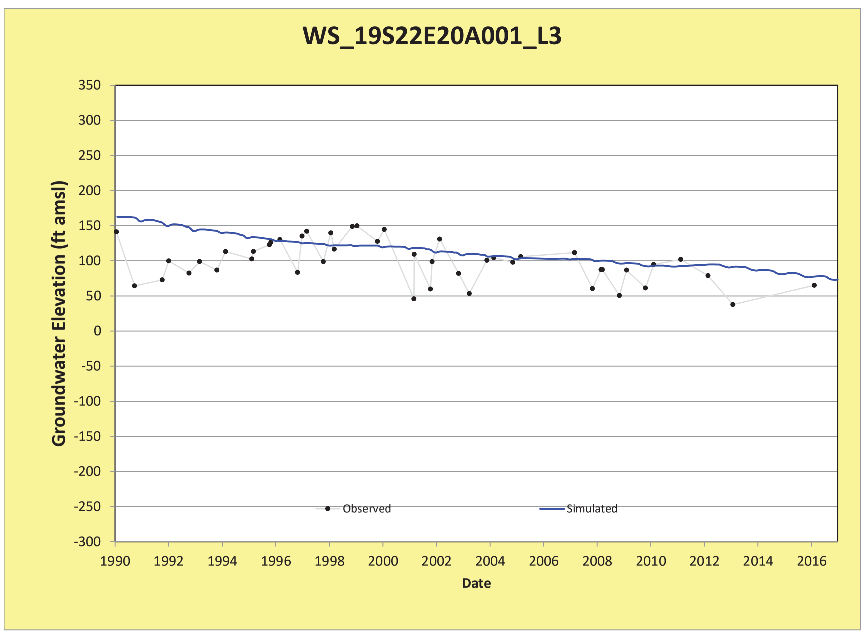

WS_19S22E04M001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

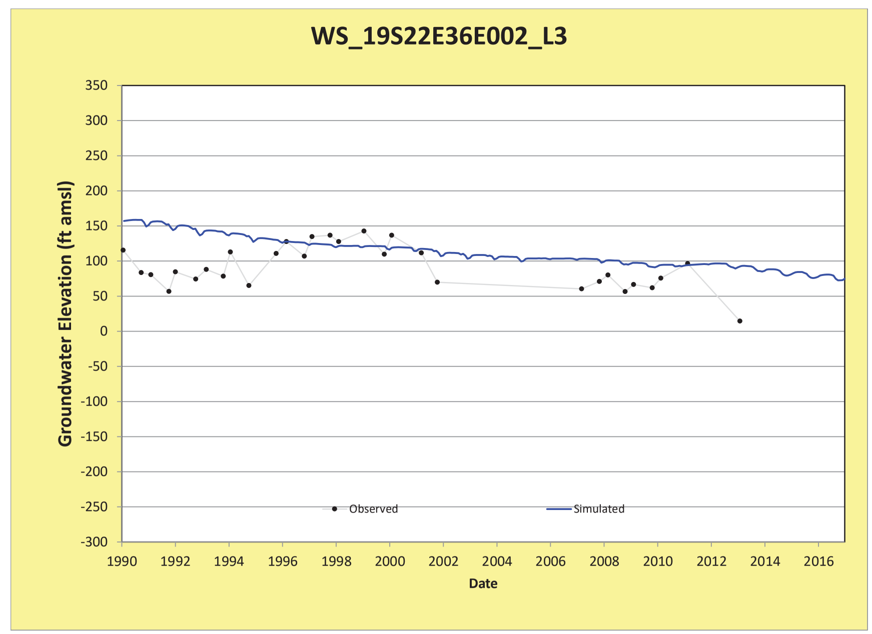

WS_19S22E02K001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S22E07A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S22E17L001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S22E27C001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S22E20A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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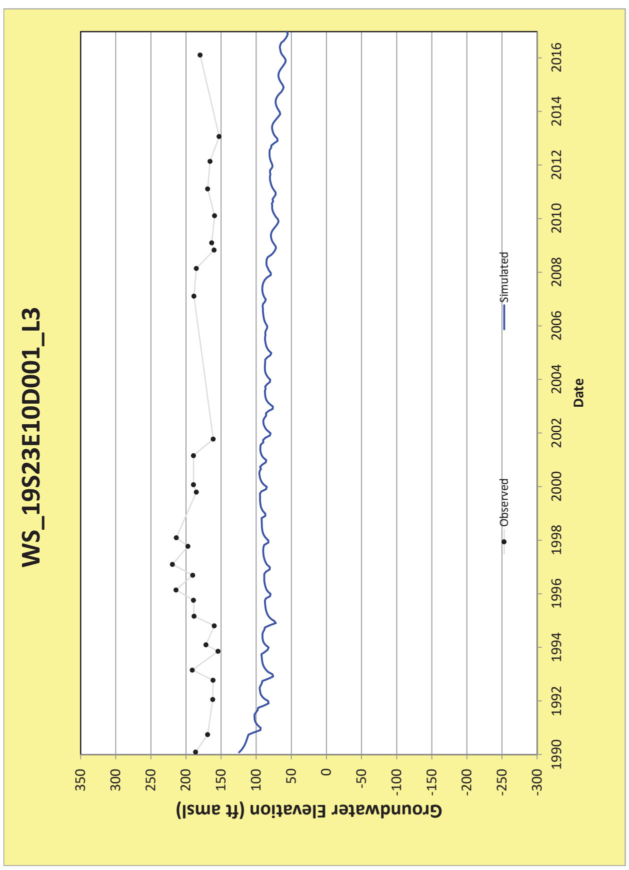
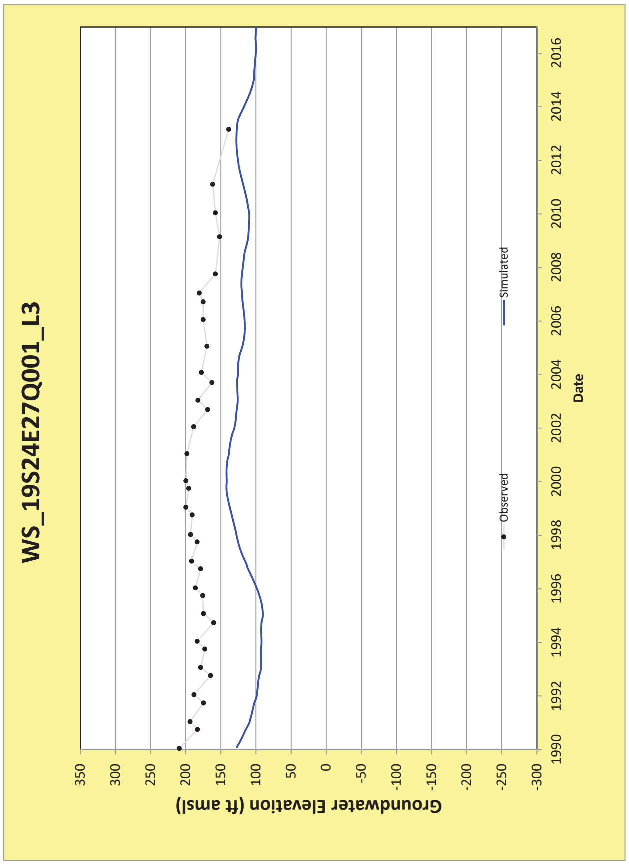
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S23E10D001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S24E27Q001_L3
Groundwater Elevation (ft amsl)
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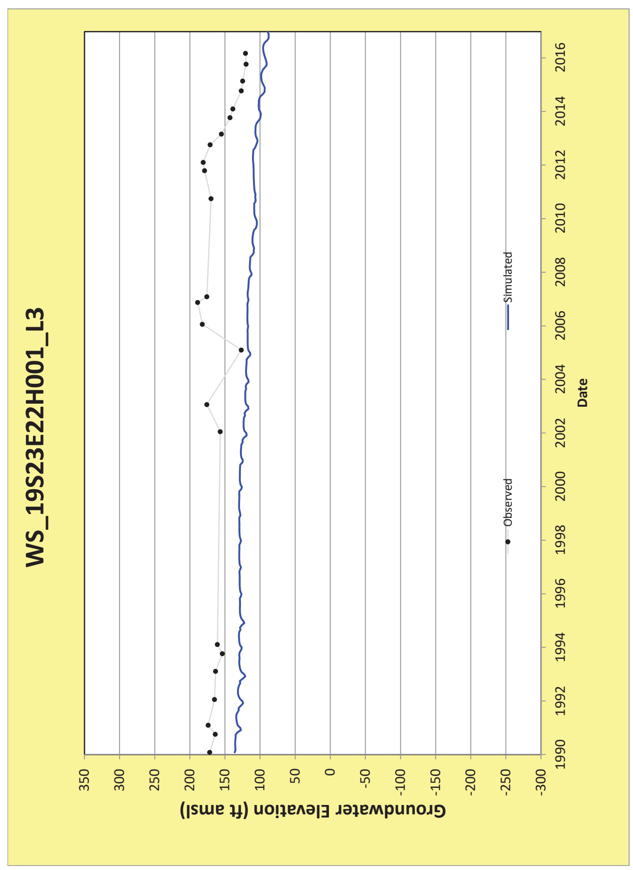
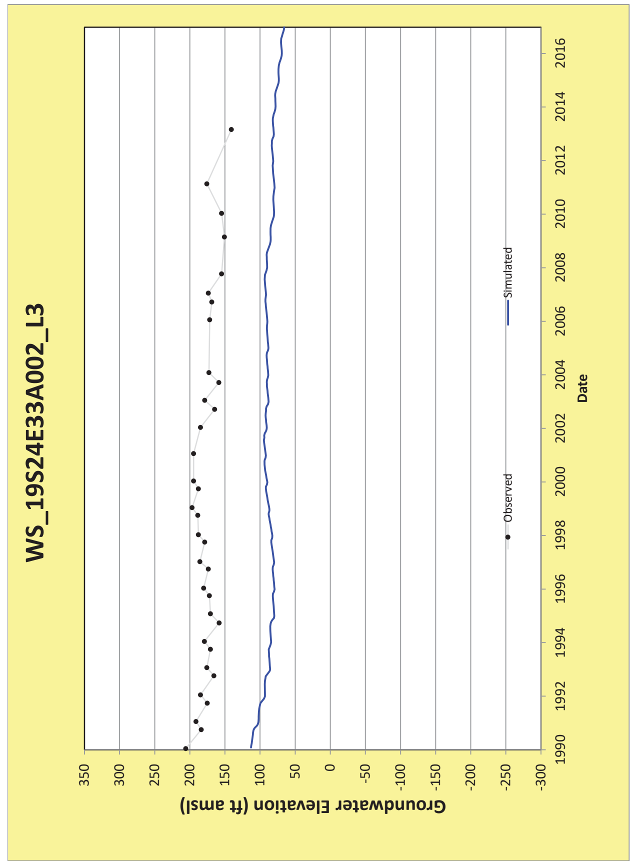
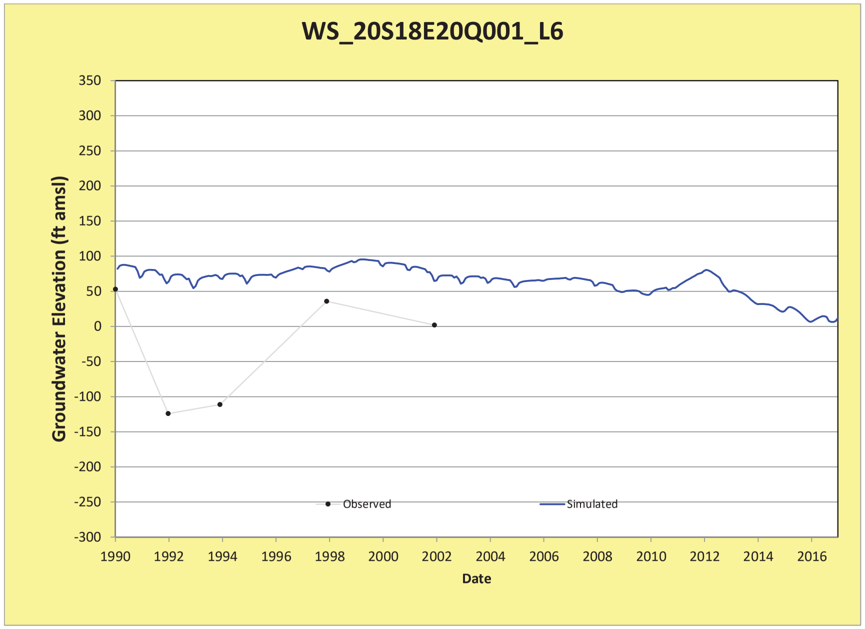
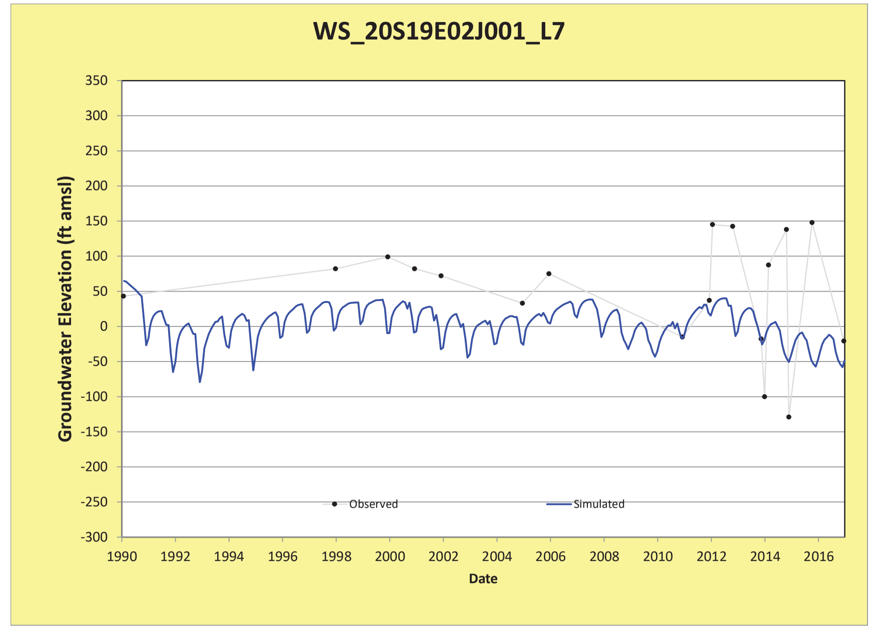
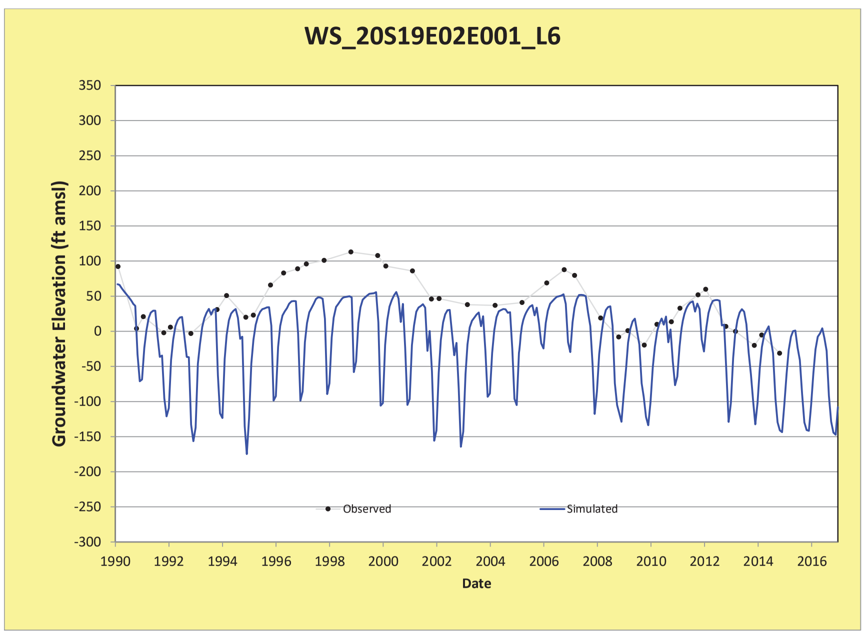
Observed
Simulated

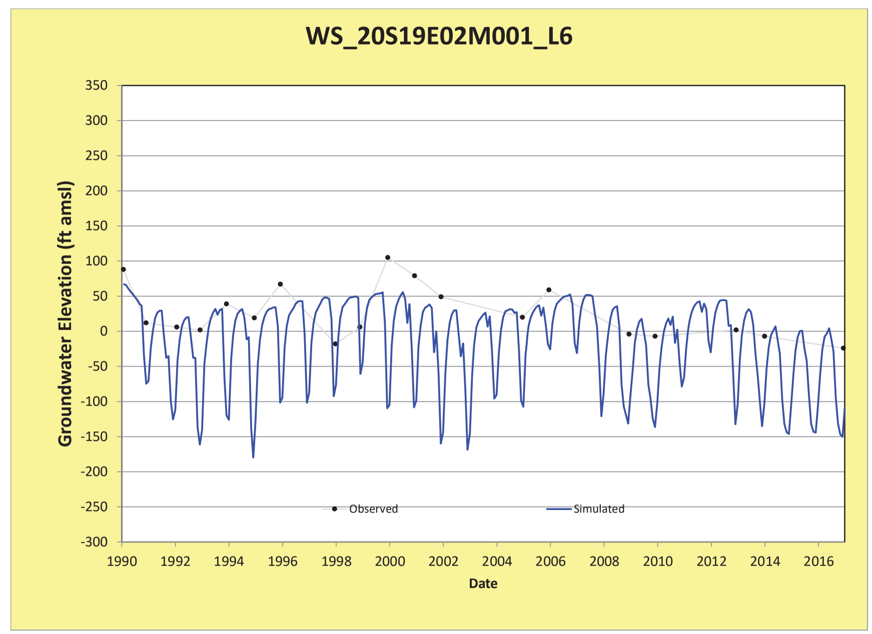

WS_19S23E22H001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_19S24E33A002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

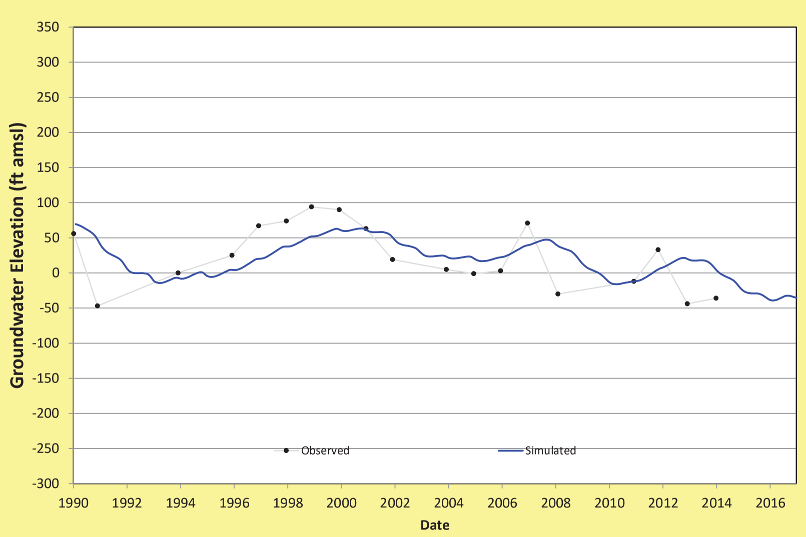

WS_20S18E20Q001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_20S19E02J001_L7
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

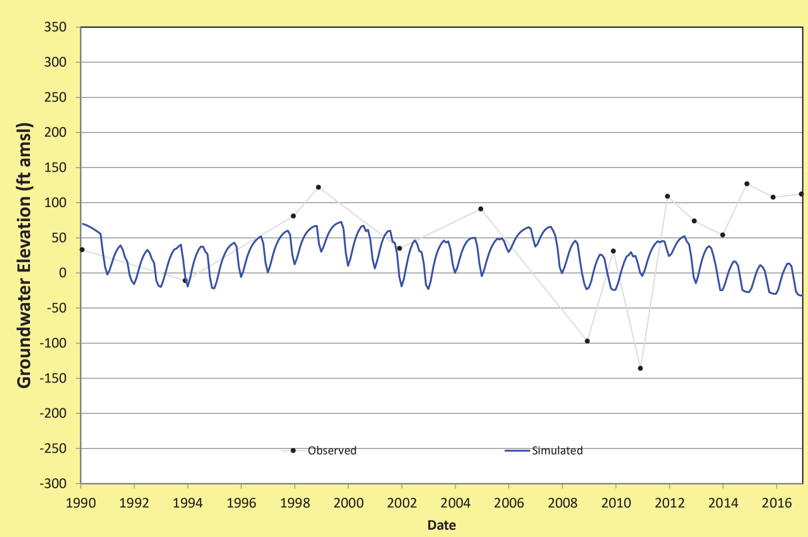

WS_20S19E02E001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_20S19E02M001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

WS_20S19E04D001_L7



WS_20S19E04R001_L5



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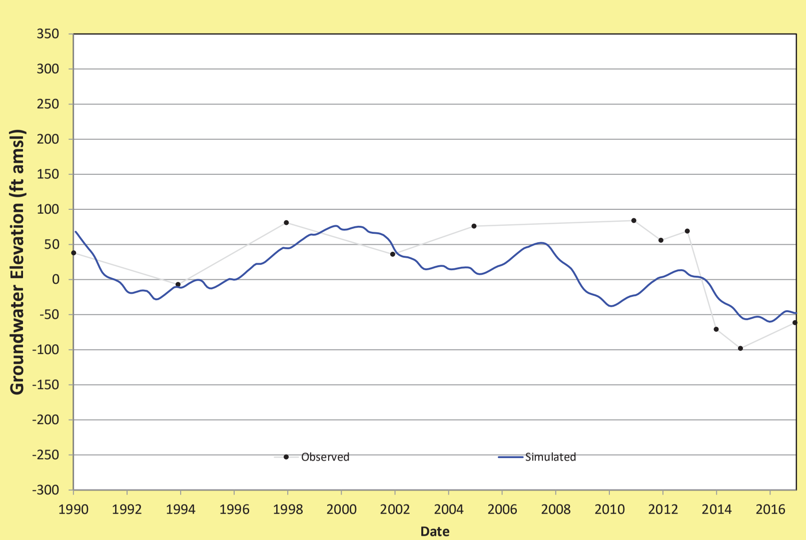
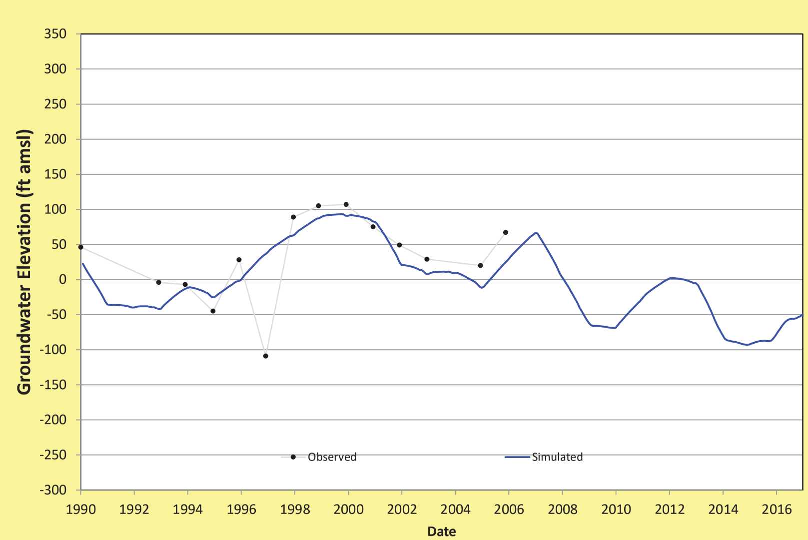
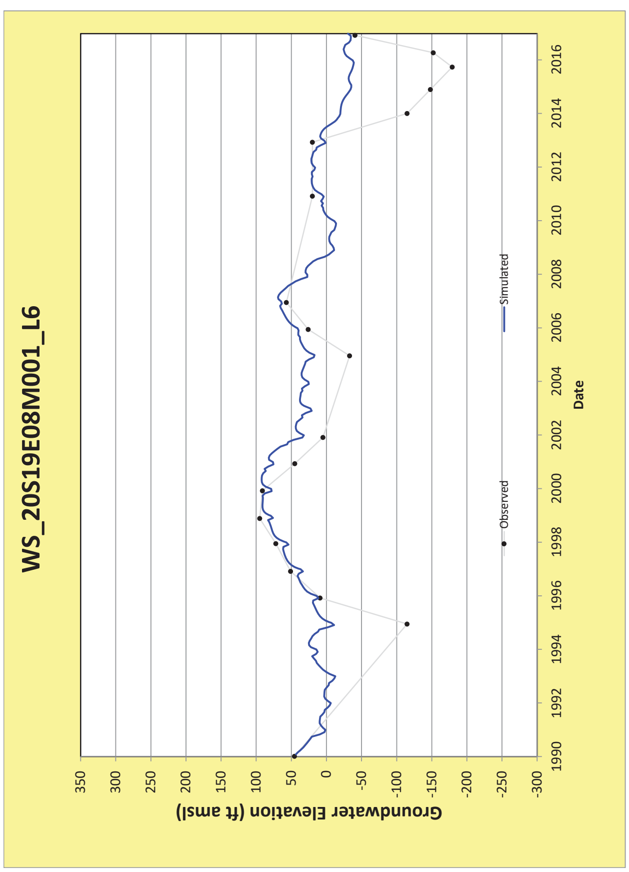


WS_20S19E06D001_L6

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Groundwater Elevation (ft amsl)
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100
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-200
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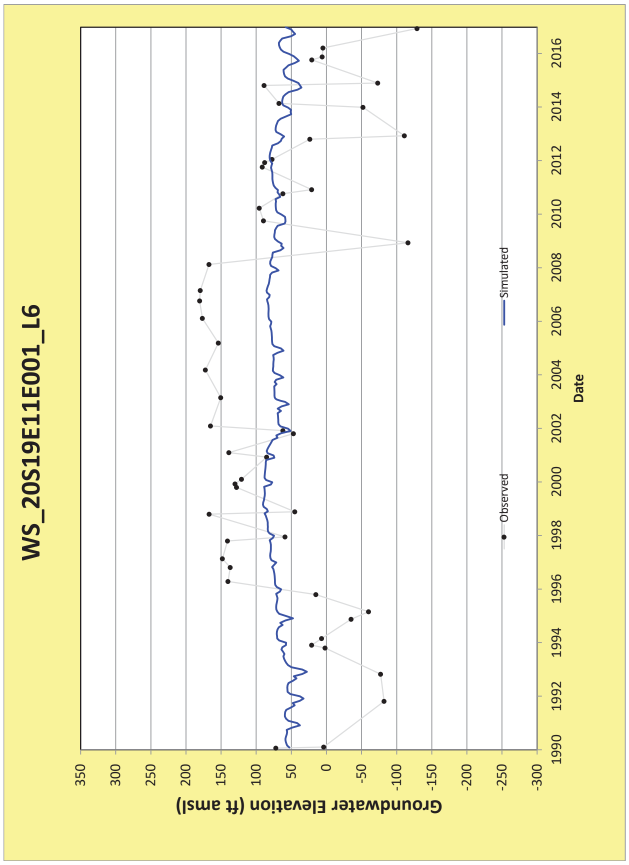
2016
Date
Observed
Simulated


WS_20S19E11E001_L6
Groundwater Elevation (ft amsl)
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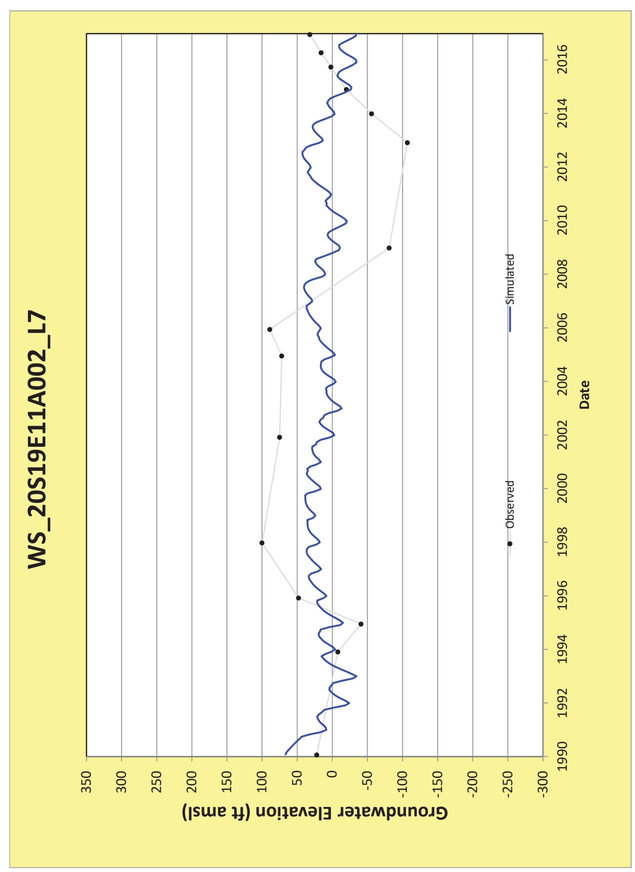
Date
Observed
Simulated


WS_20S19E11A002_L7
Groundwater Elevation (ft amsl)
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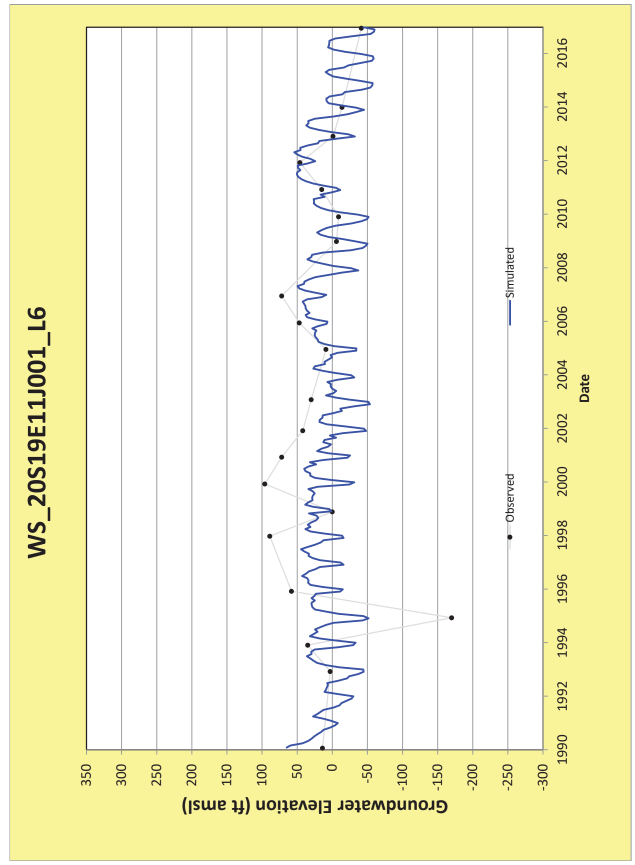
2016
Date
Observed
Simulated


WS_20S19E11J001_L6
Groundwater Elevation (ft amsl)
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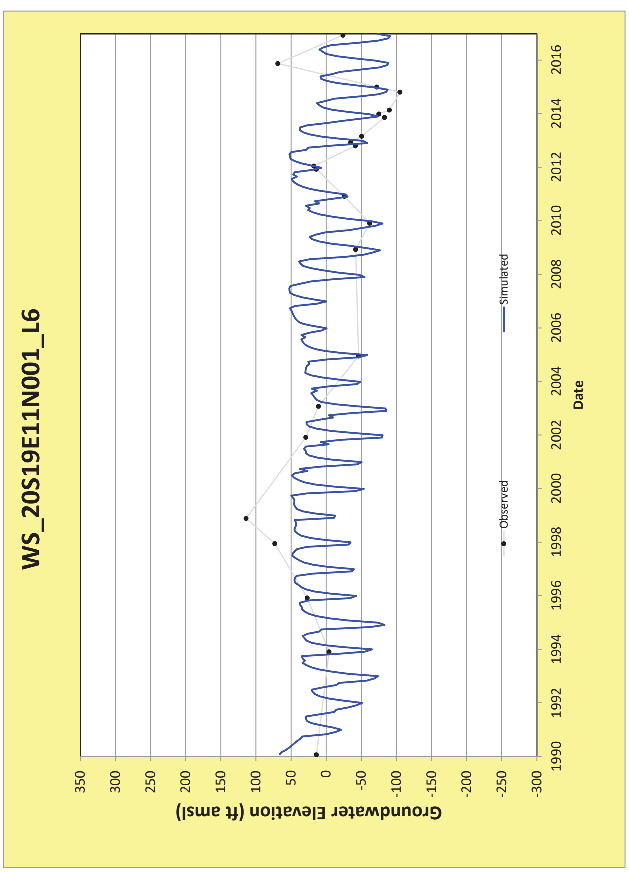
Date
Observed
Simulated


WS_20S19E11N001_L6
Groundwater Elevation (ft amsl)
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1990
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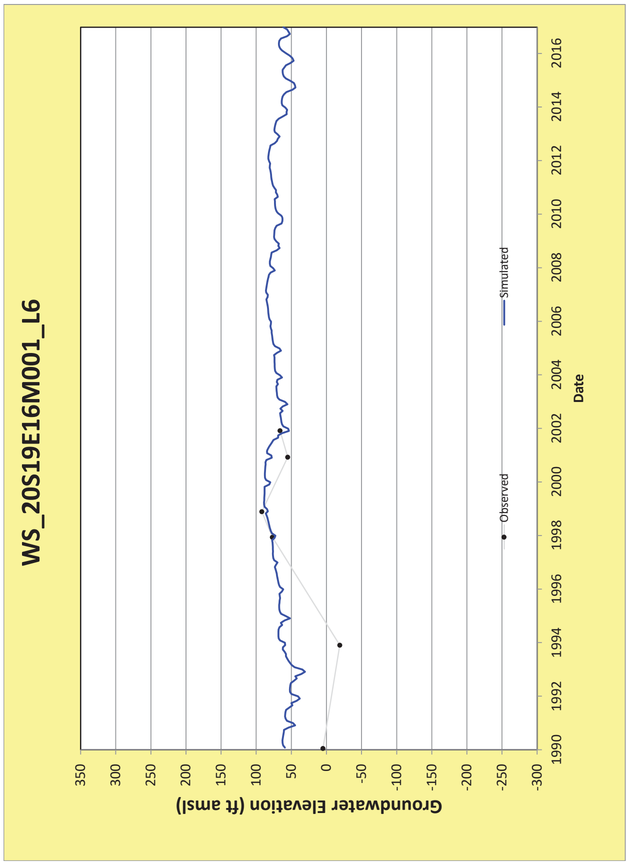
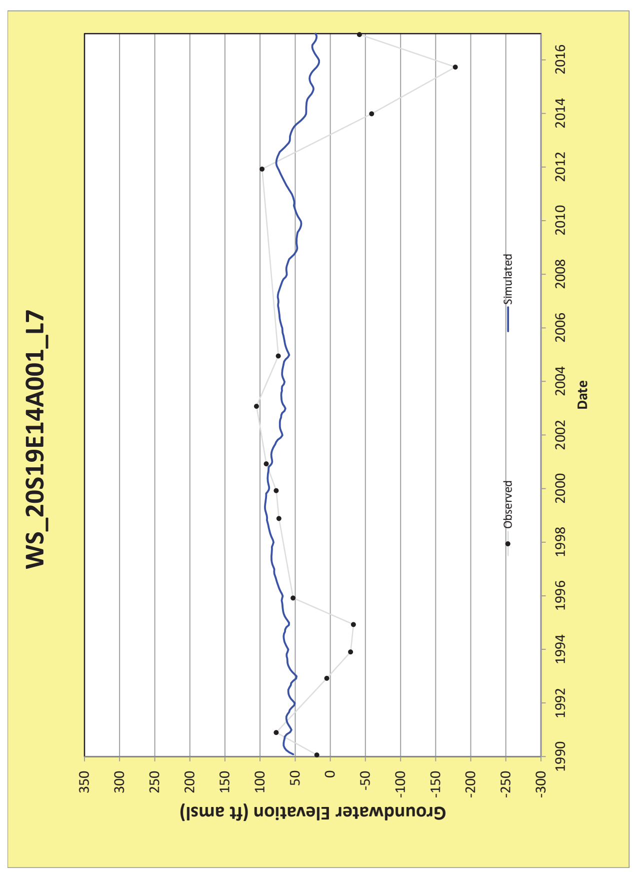
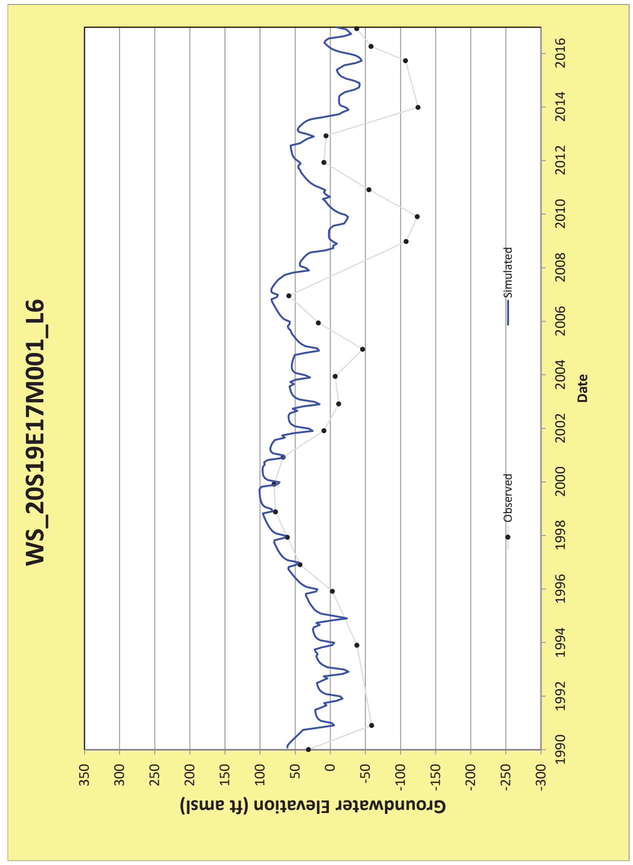
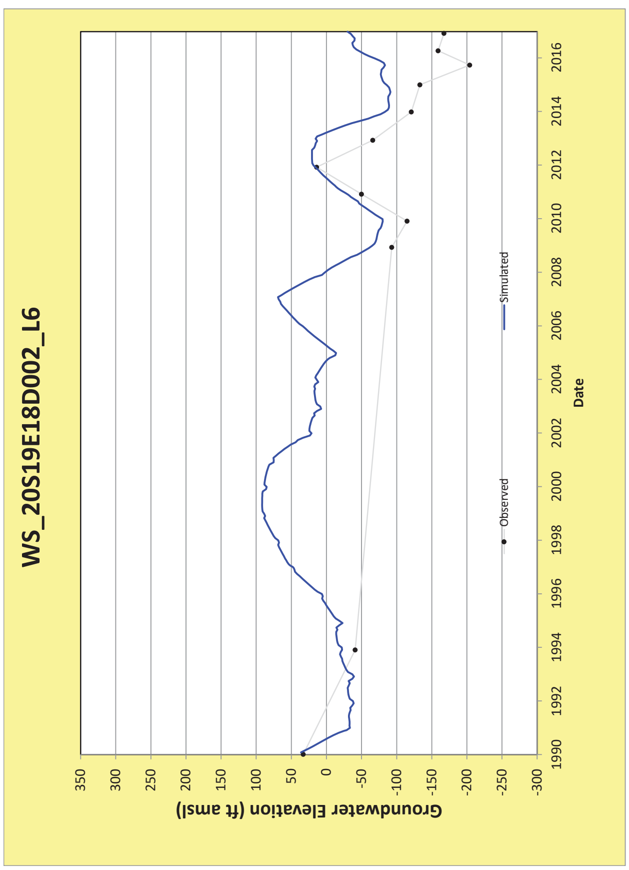
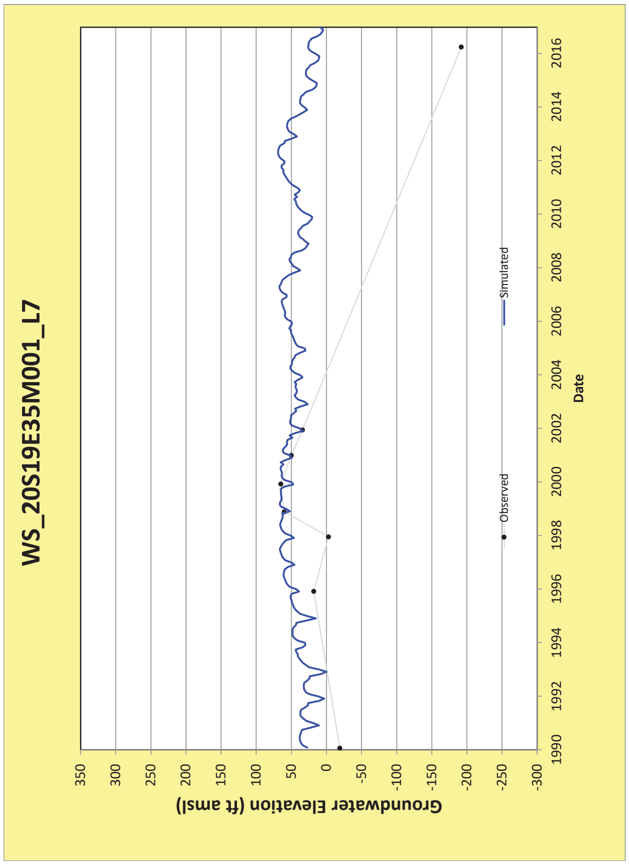
2016
Date
Observed
Simulated


WS_20S19E16M001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


WS_20S19E14A001_L7
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


WS_20S19E17M001_L6
Groundwater Elevation (ft amsl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date
Observed
Simulated


WS_20S19E18D002_L6
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


WS_20S19E35M001_L7
Groundwater Elevation (ft amsl)
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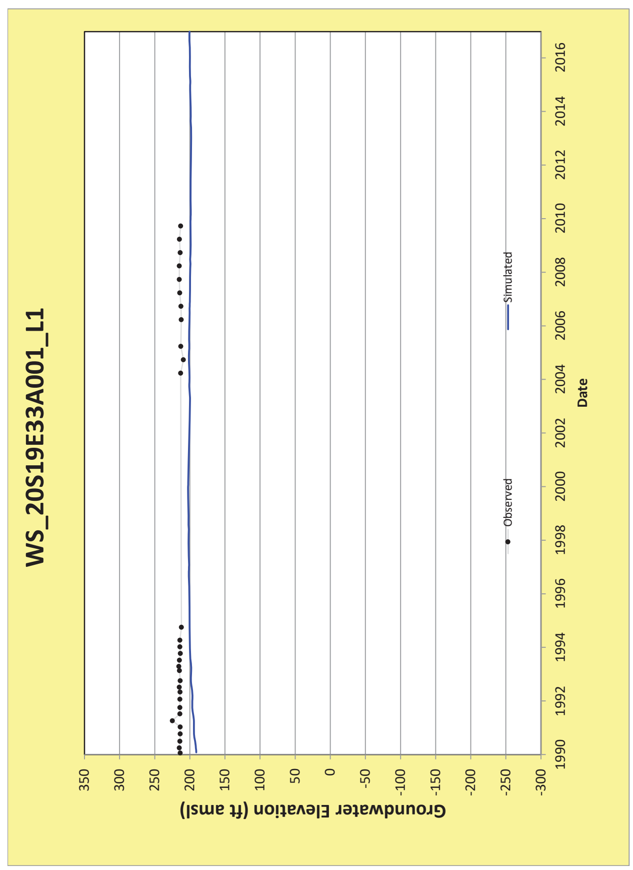
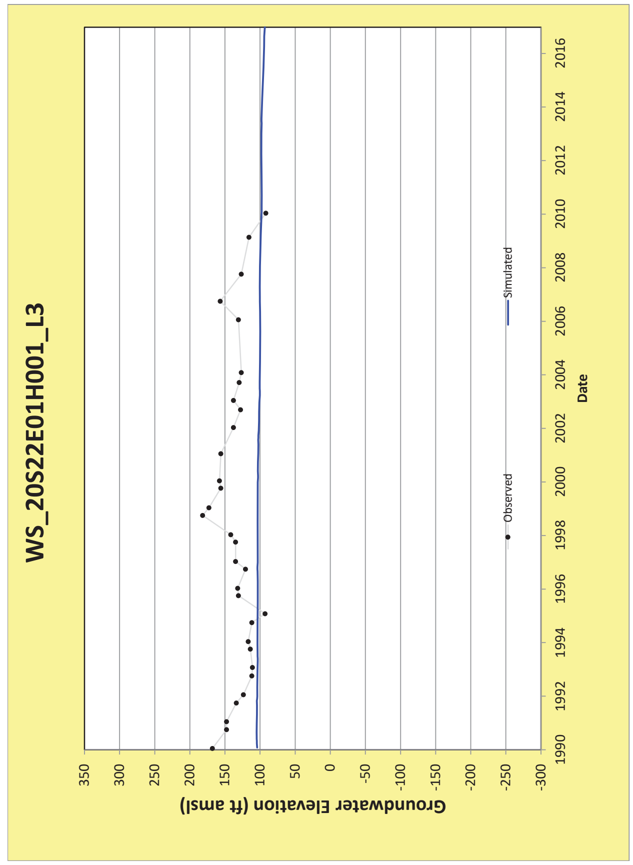
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


WS_20S19E33A001_L1
Groundwater Elevation (ft amsl)
350 300 250 200 150 100 50 0 -50 -100 -150 -200 -250 -300
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


WS_20S22E01H001_L3
Groundwater Elevation (ft amsl)
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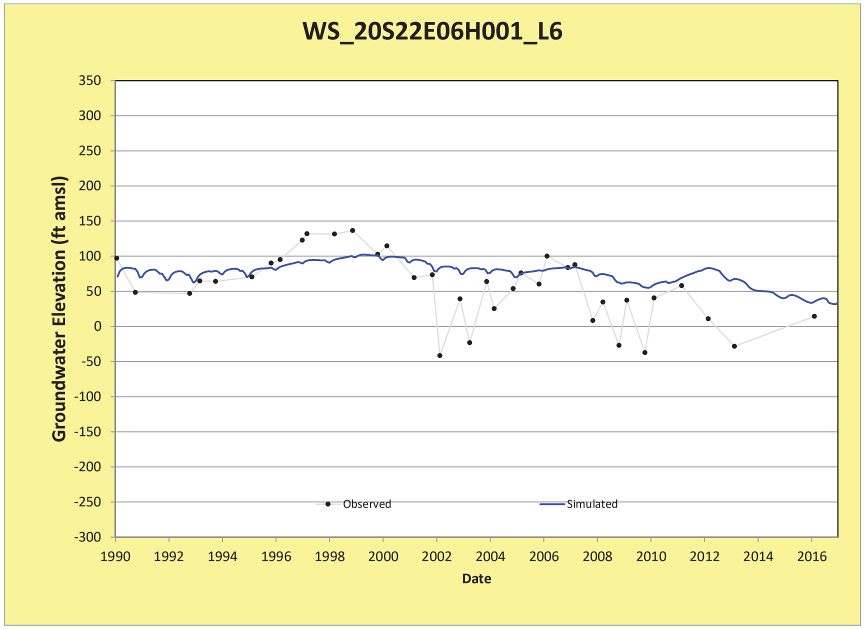
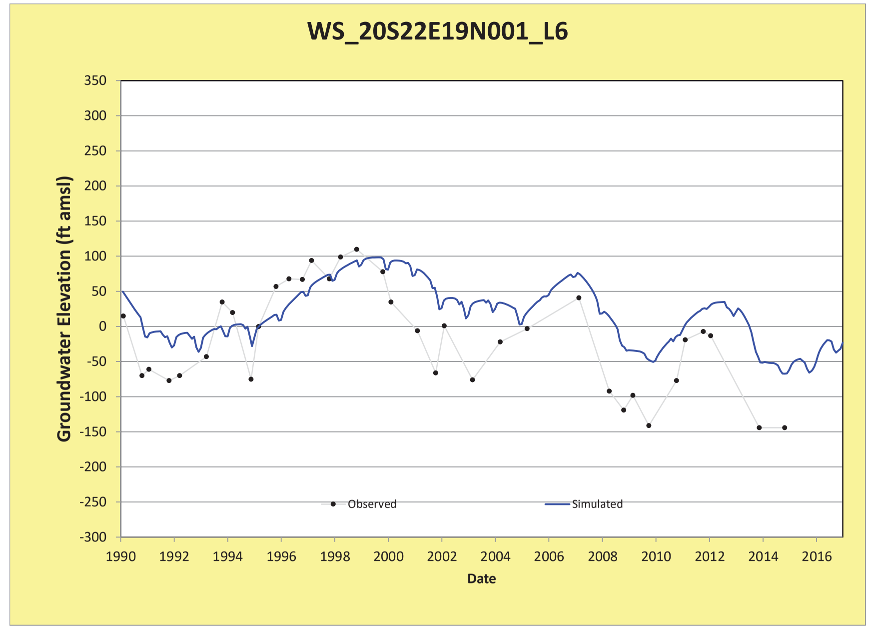
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Date
Observed
Simulated


WS_20S22E06H001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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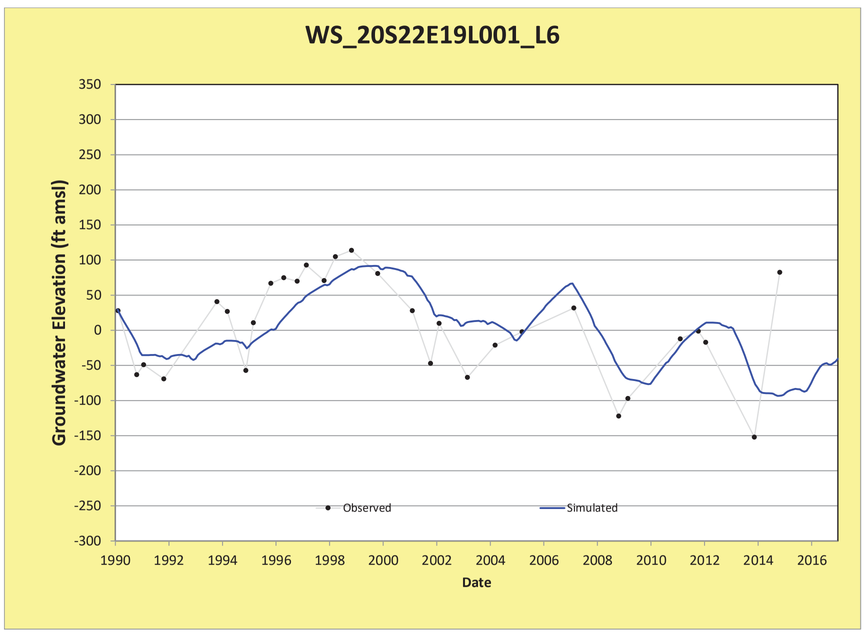
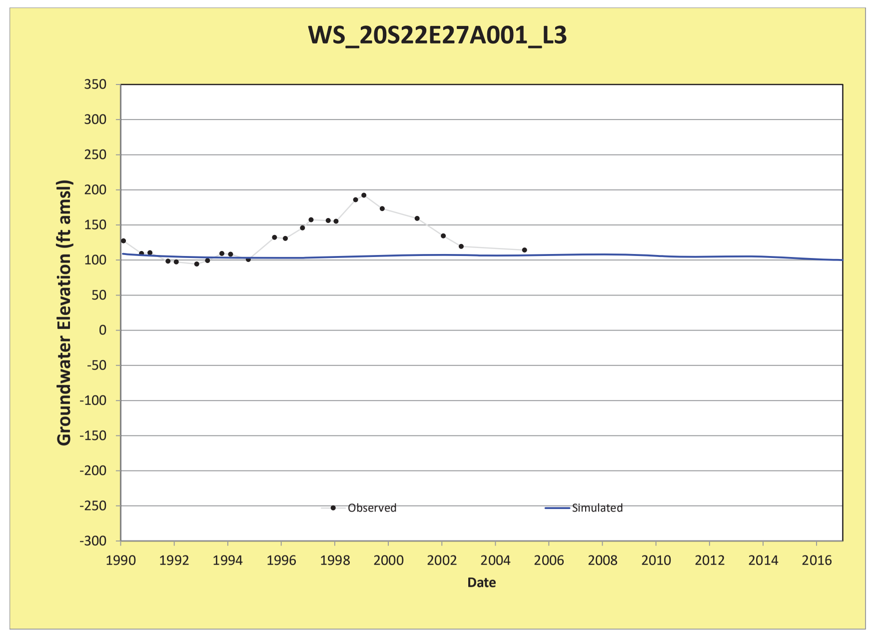
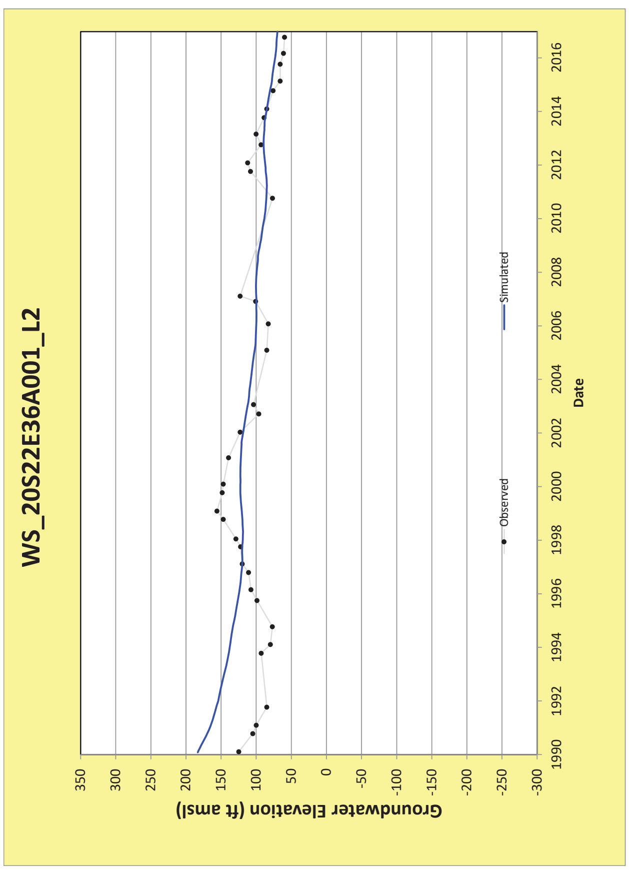
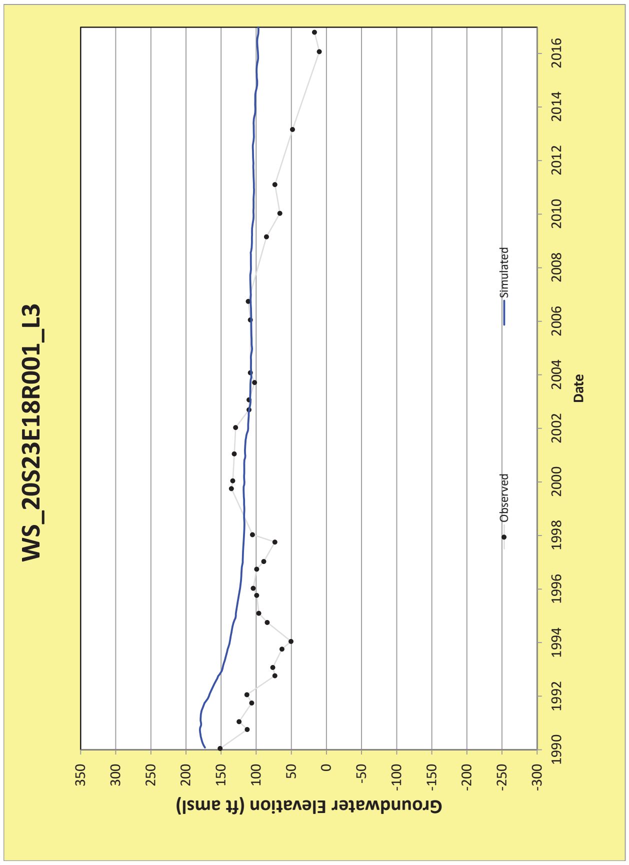
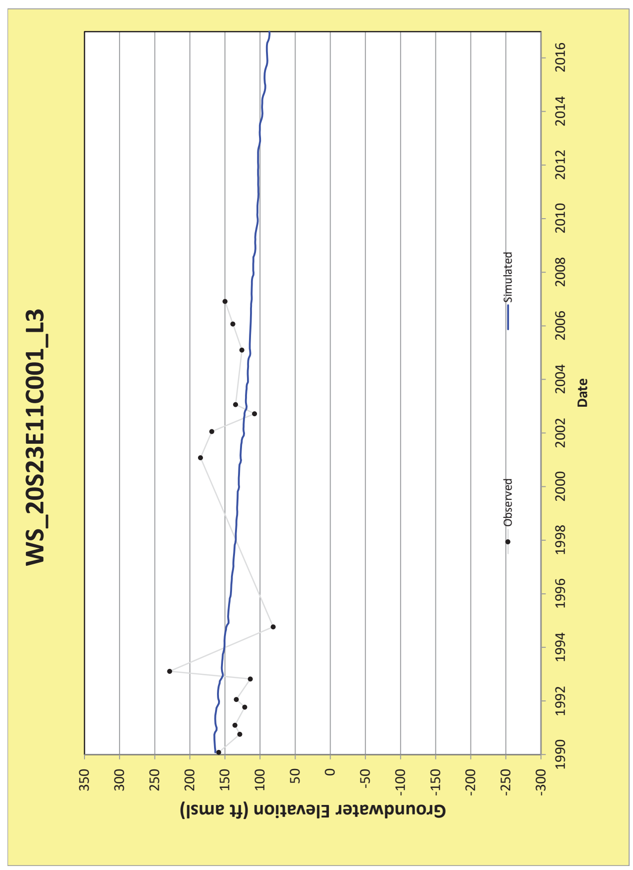
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

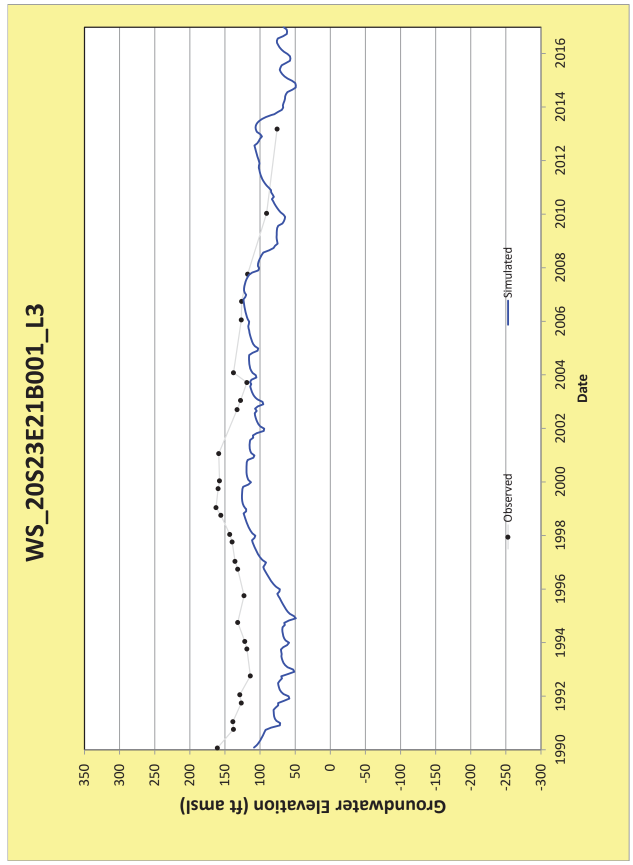

WS_20S22E19L001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_20S22E27A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

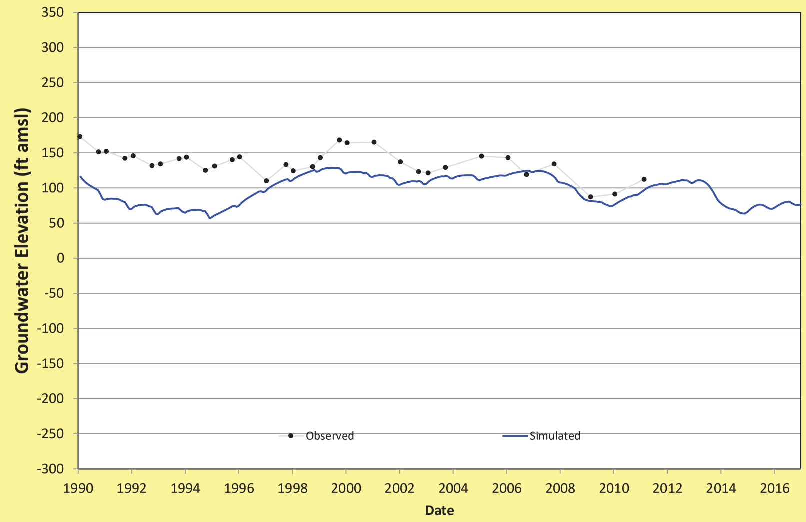

WS_20S22E36A001_L2
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_20S23E18R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

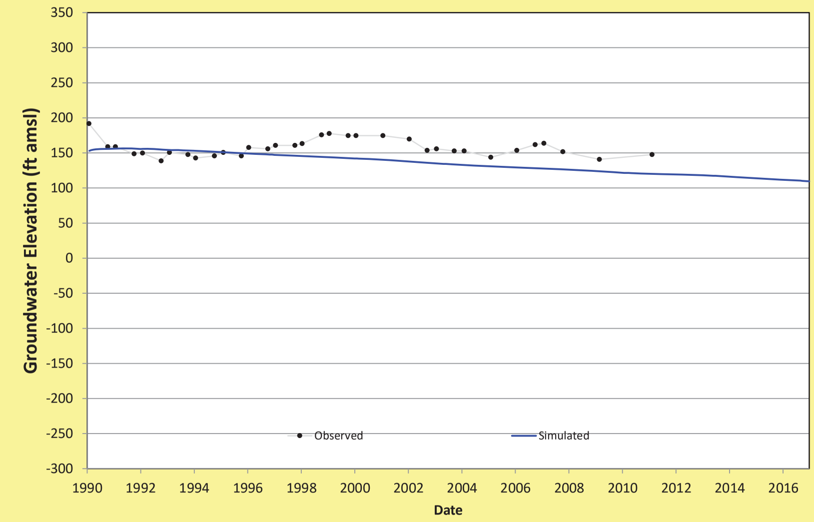

WS_20S23E11C001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_20S23E21B001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

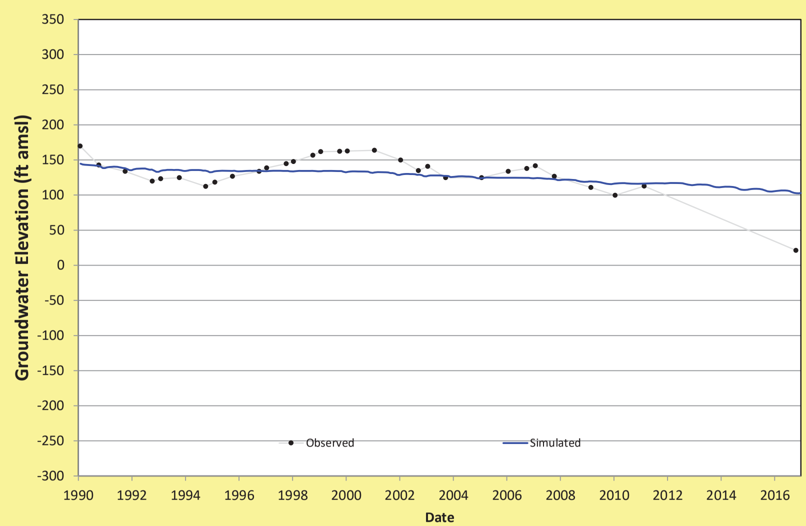
WS_20S23E26C001_L3



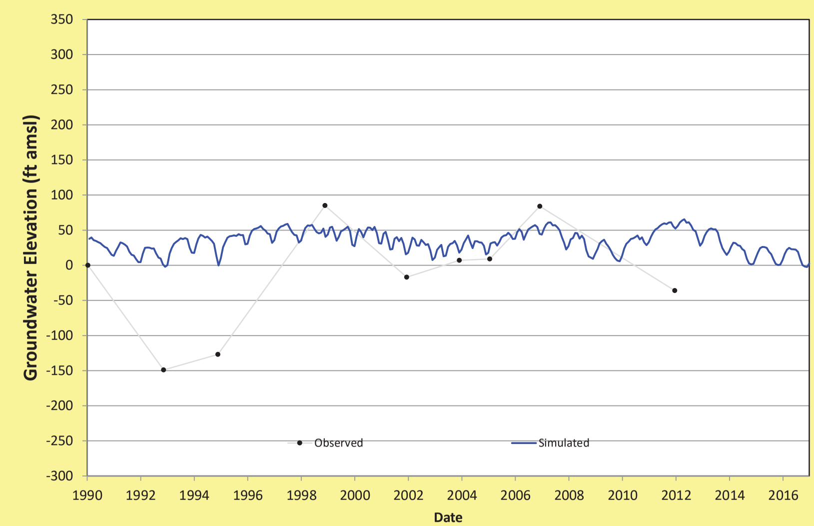
WS_20S24E30J002_L3

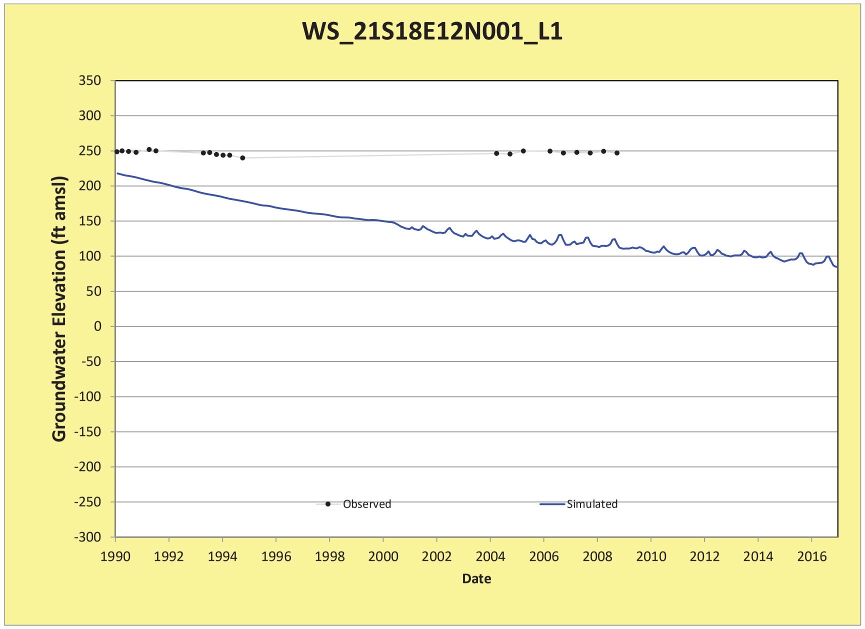


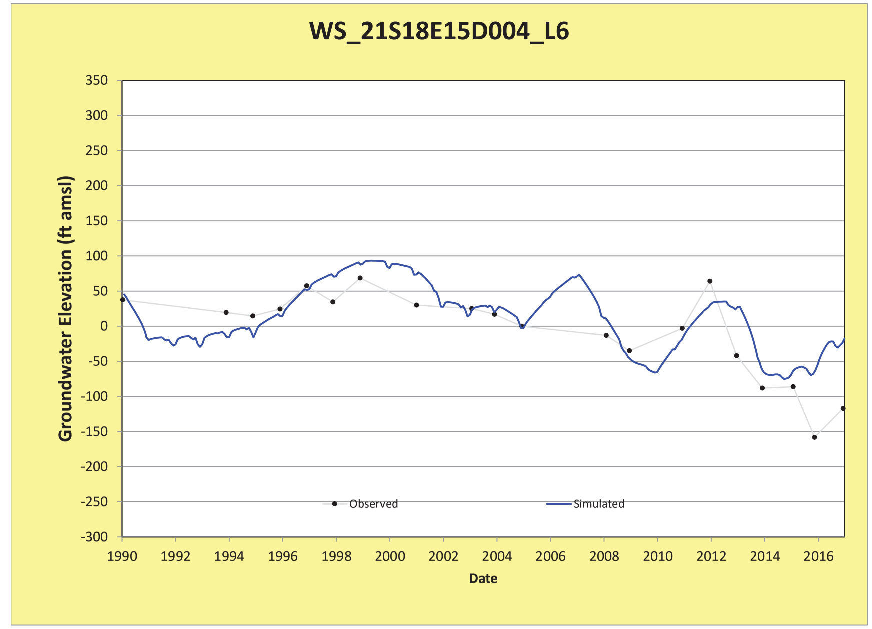
WS_20S23E27D001_L3

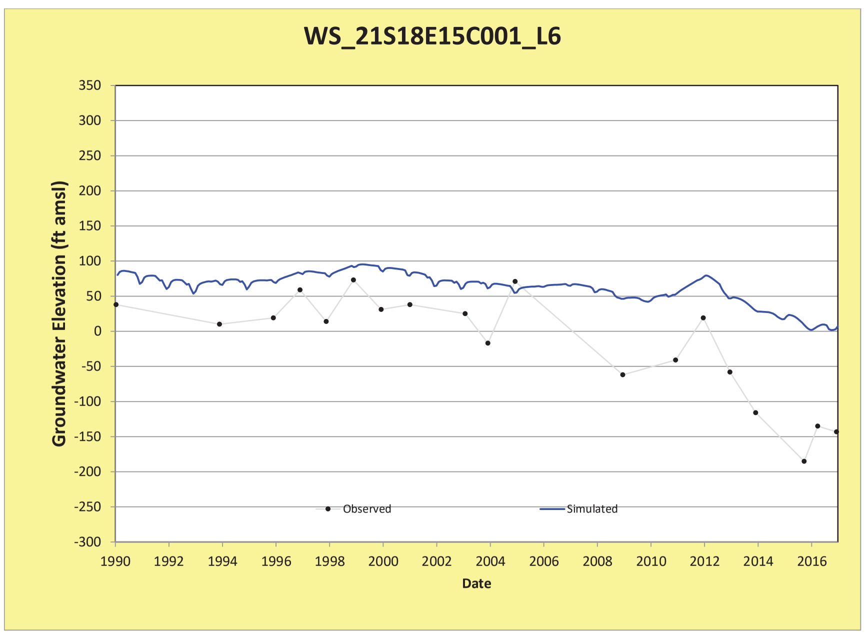


WS_21S18E11D003_L6




WS_21S18E12N001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S18E15D004_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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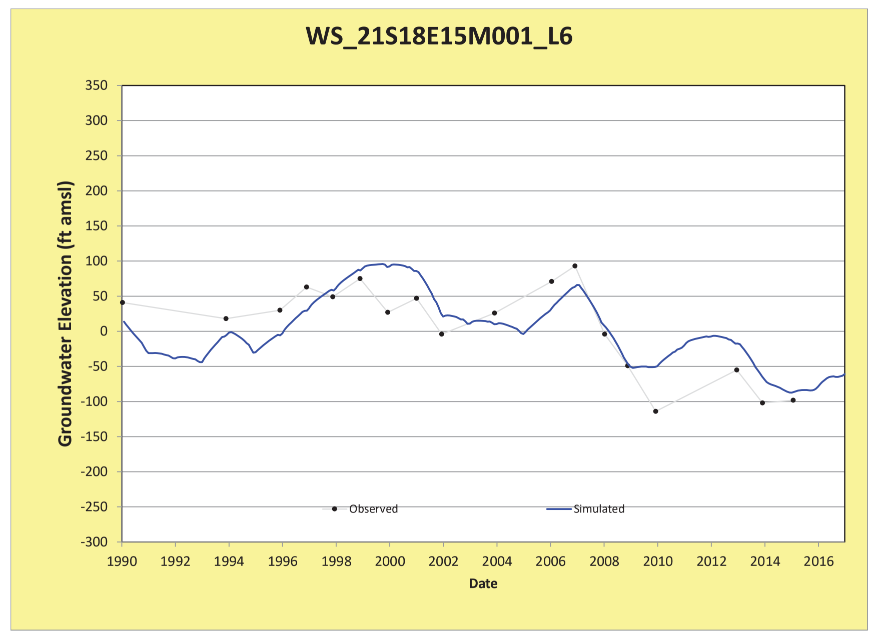
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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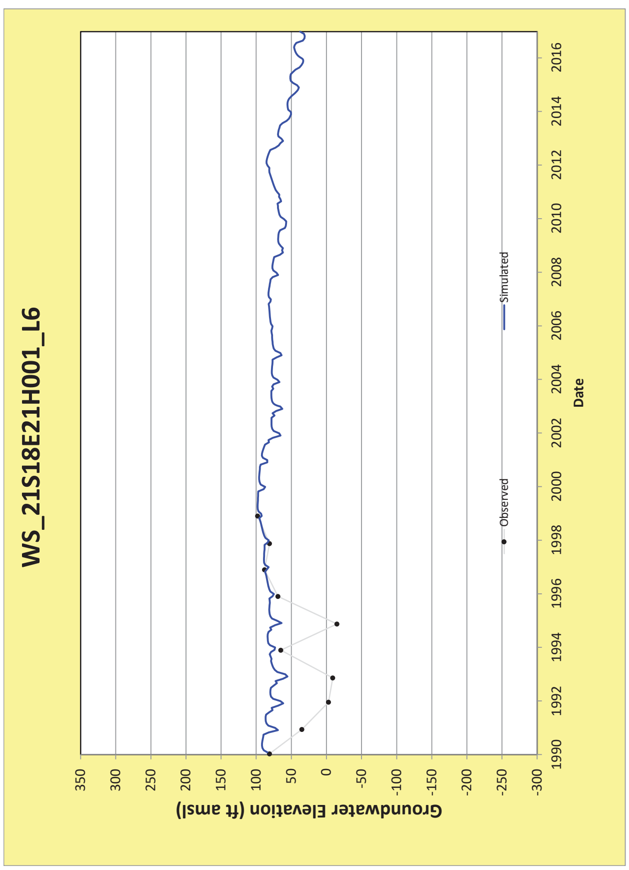
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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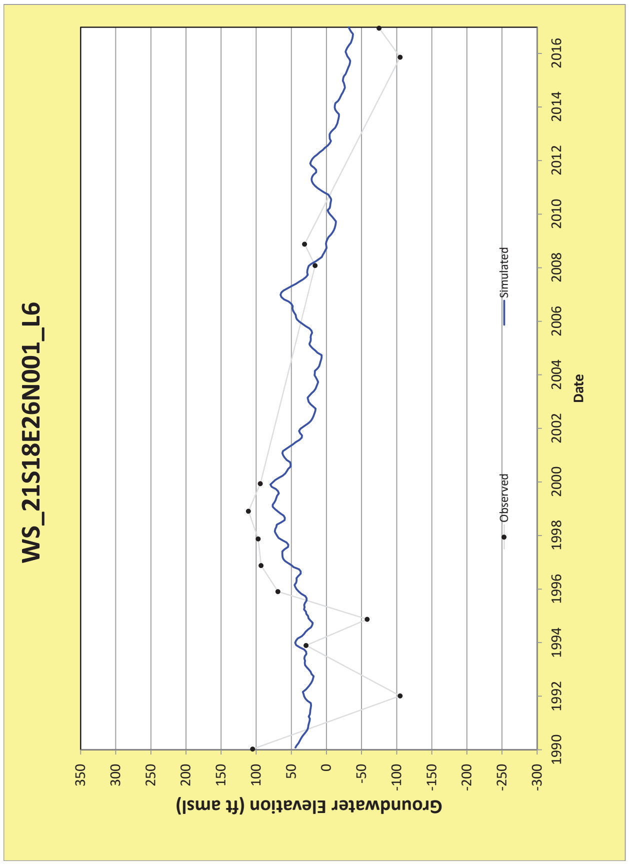
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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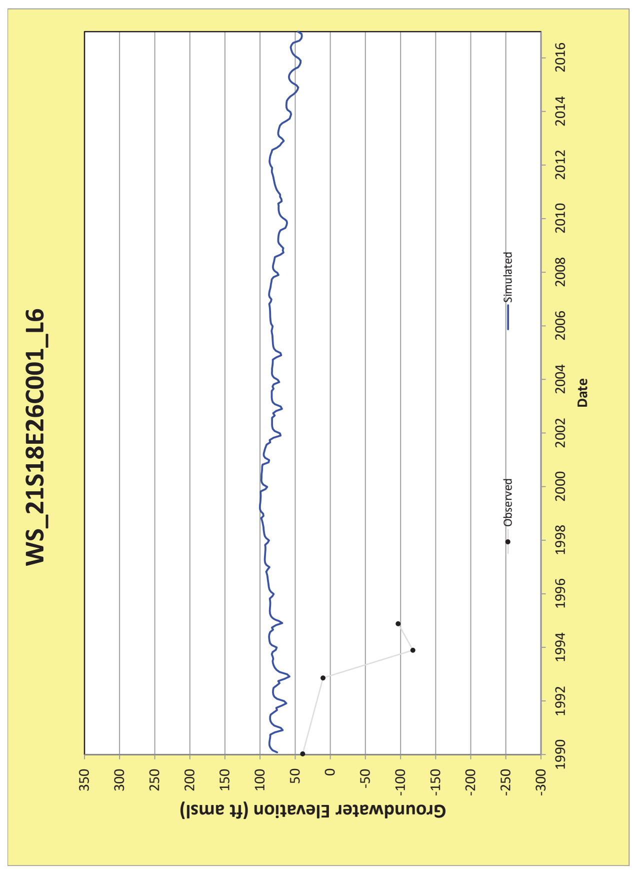
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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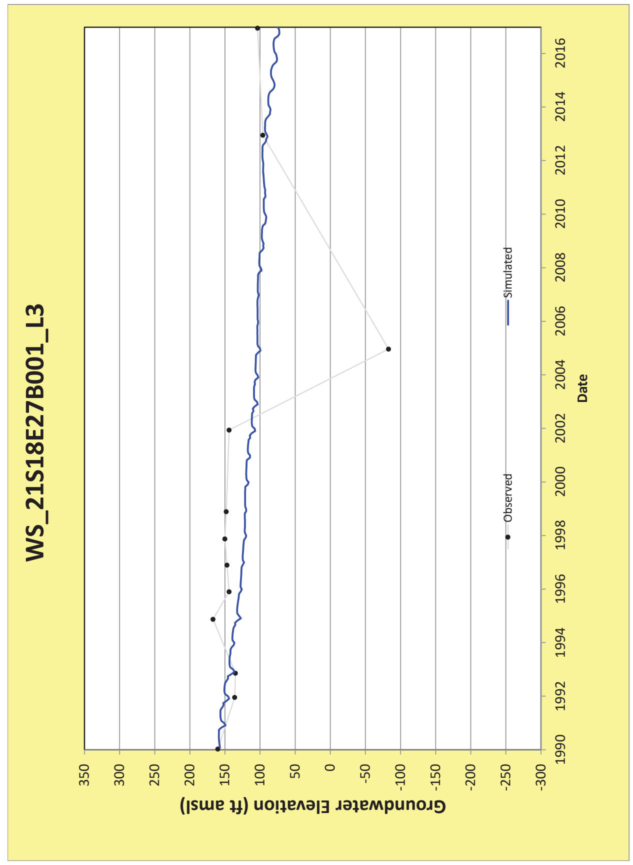
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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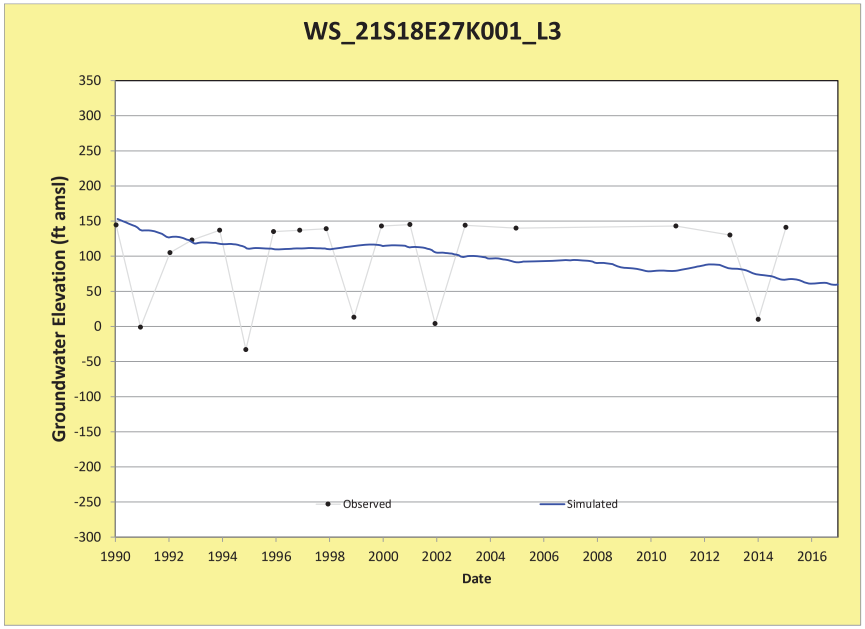
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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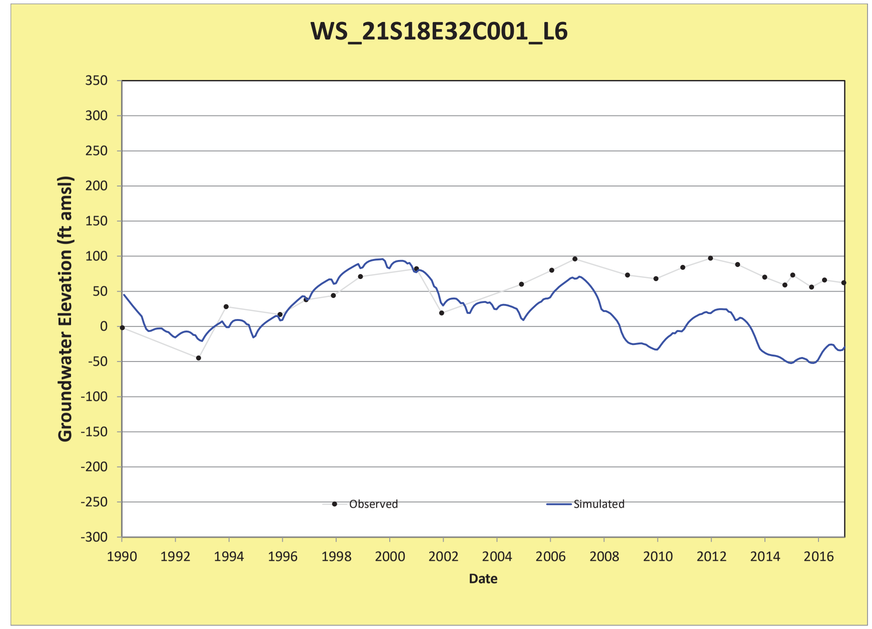
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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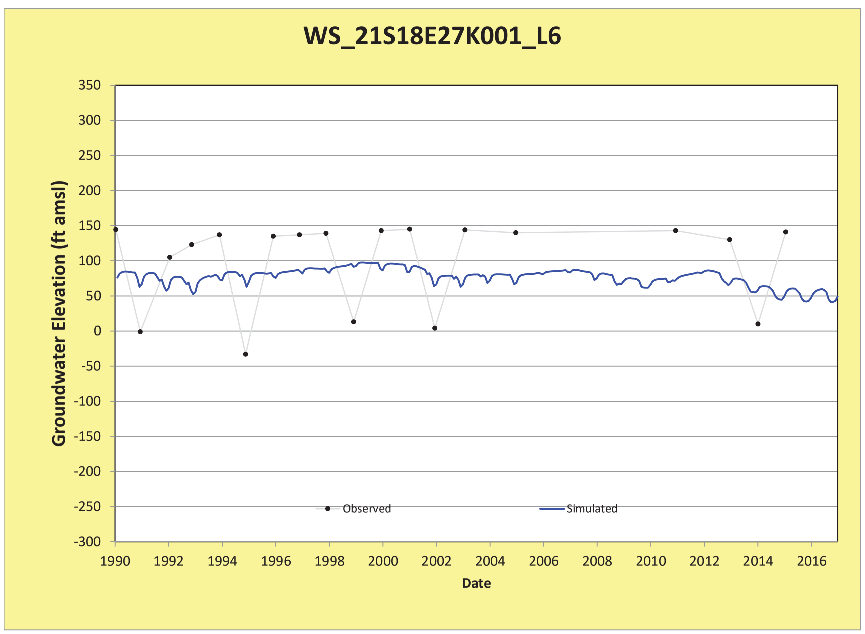
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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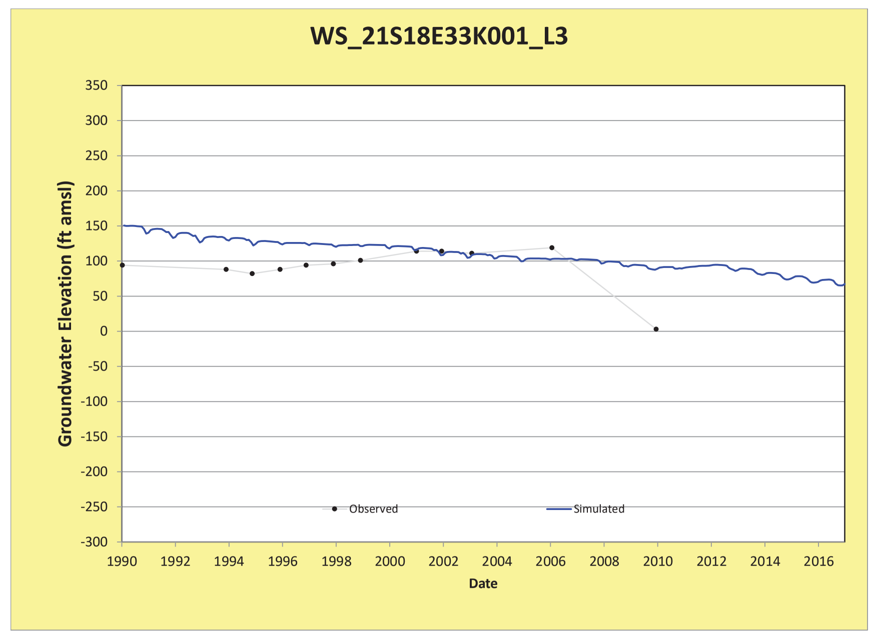
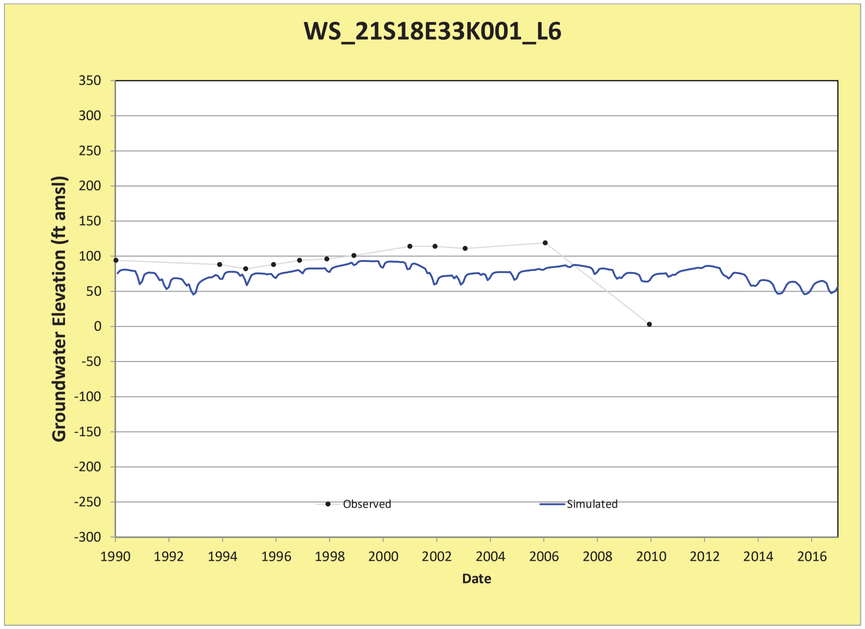
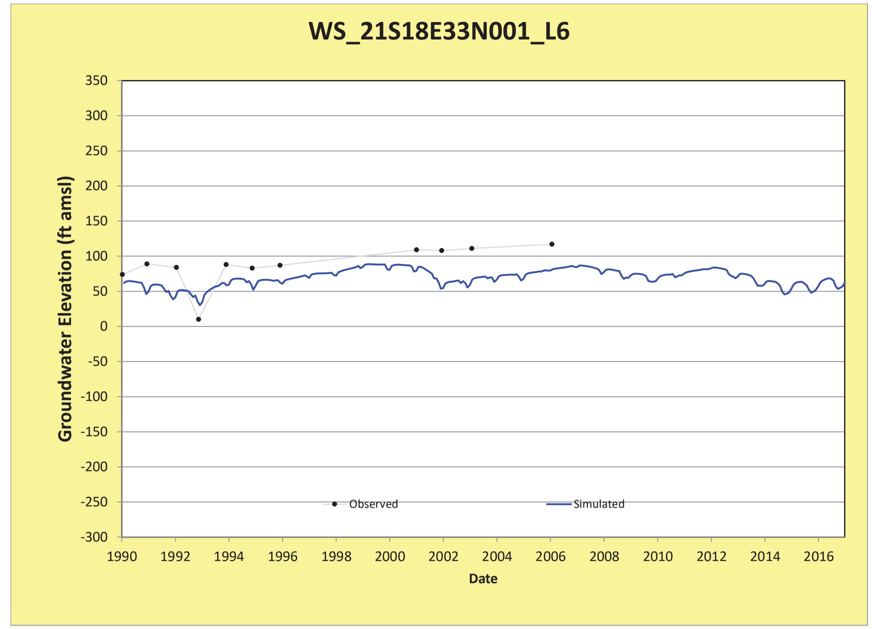
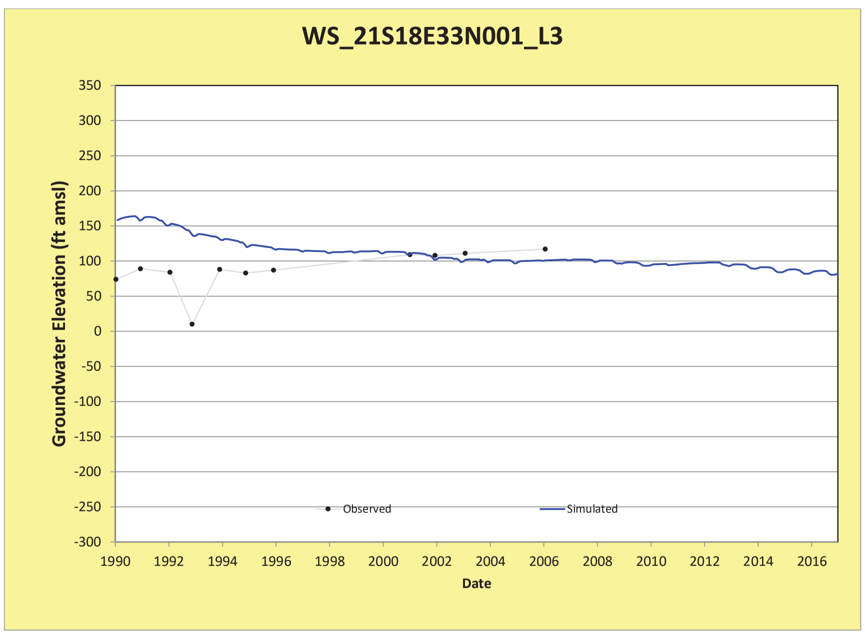
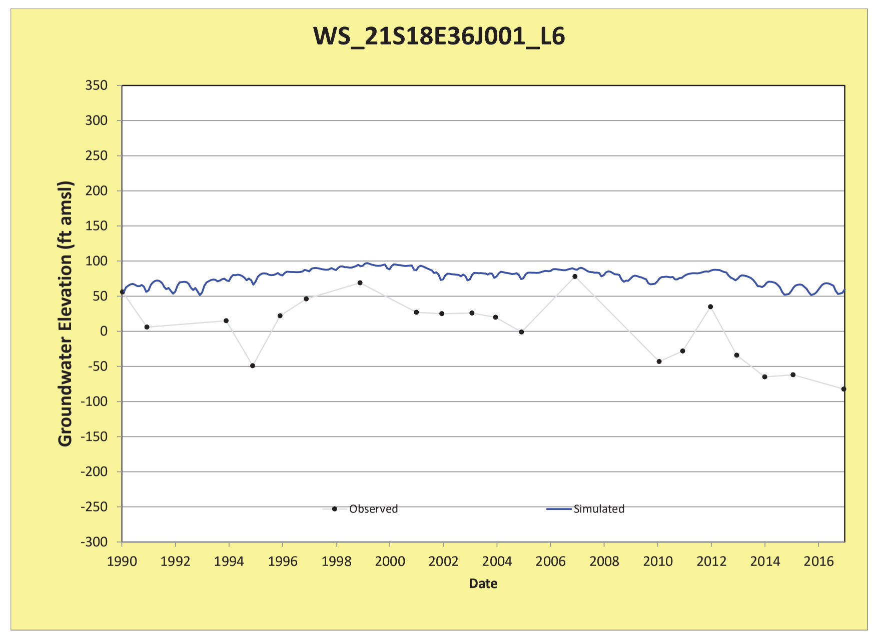
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

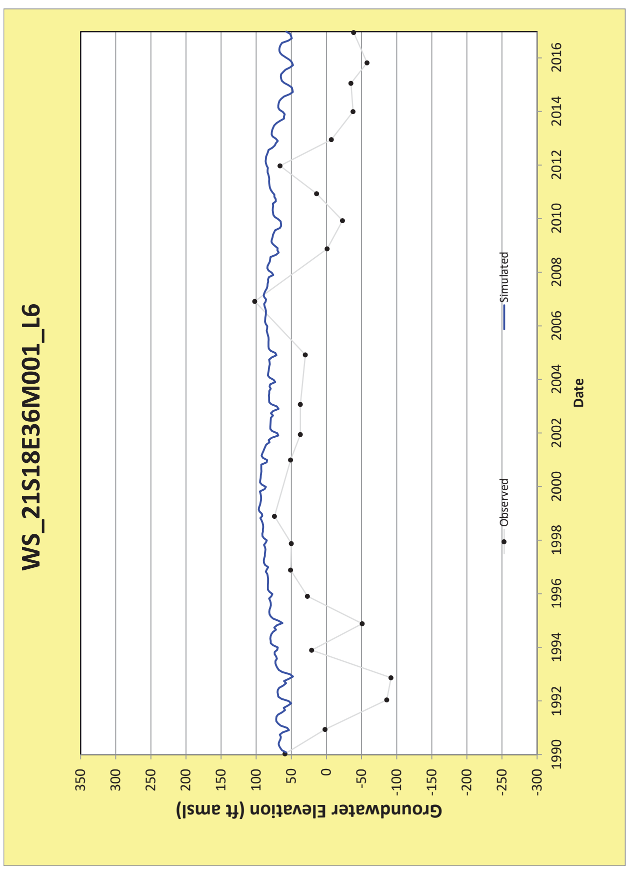

WS_21S18E33K001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

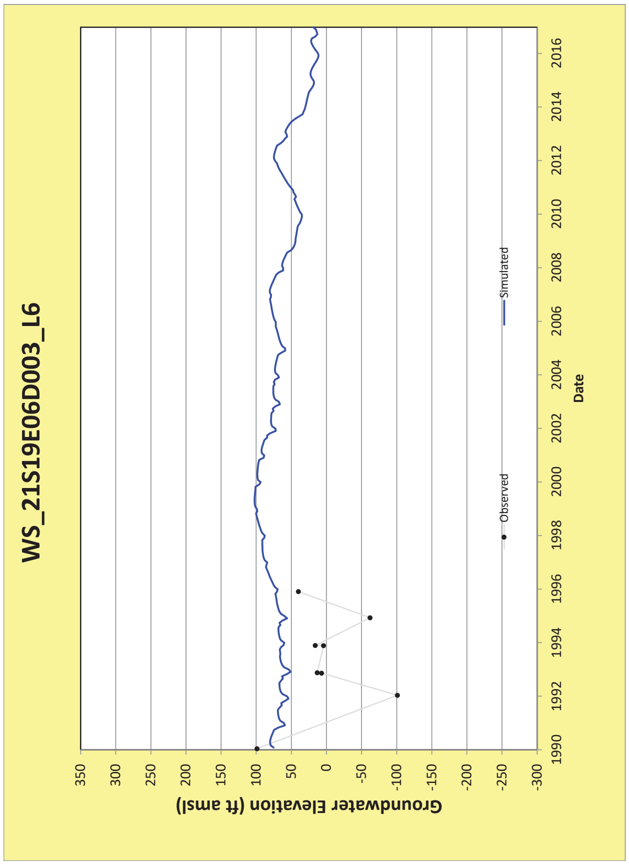

WS_21S18E33K001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

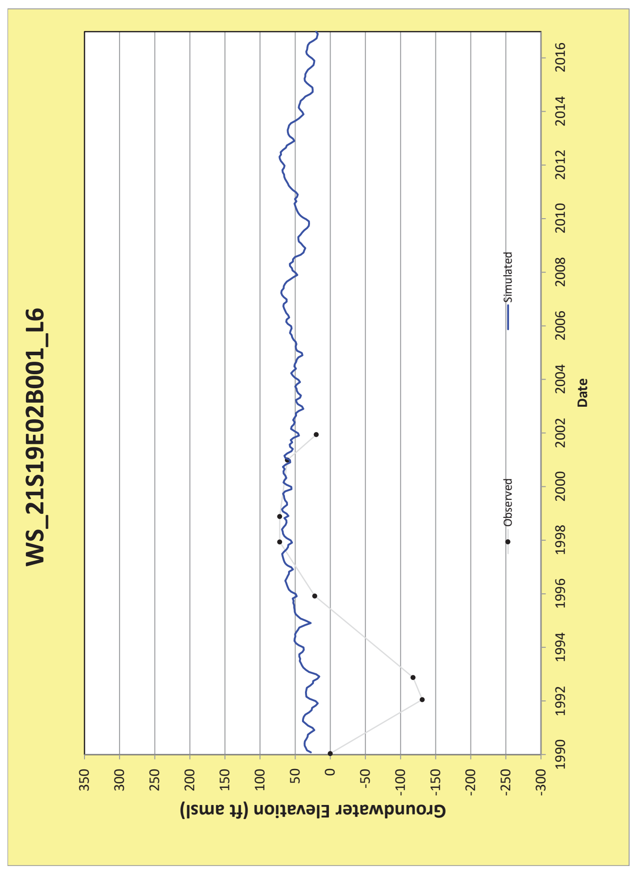

WS_21S18E33N001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

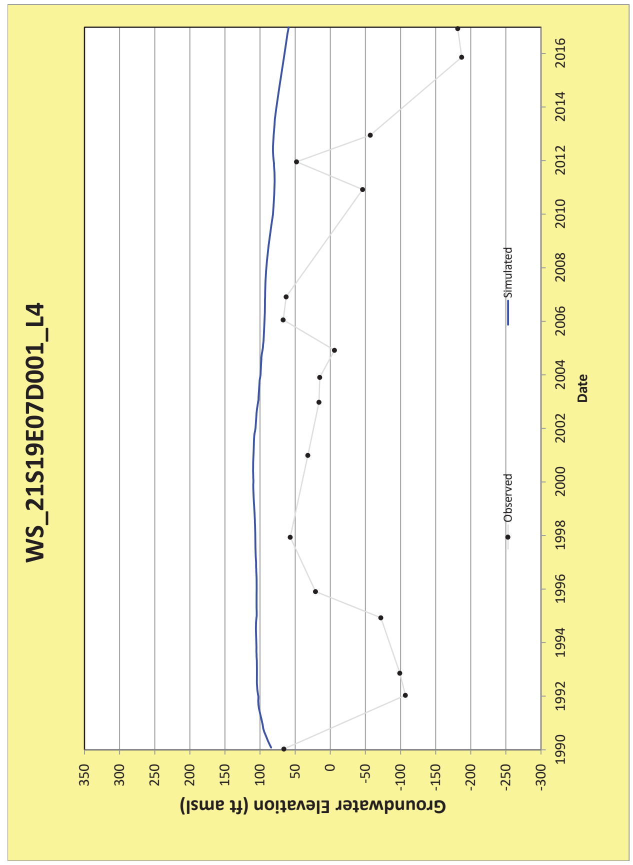

WS_21S18E33N001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

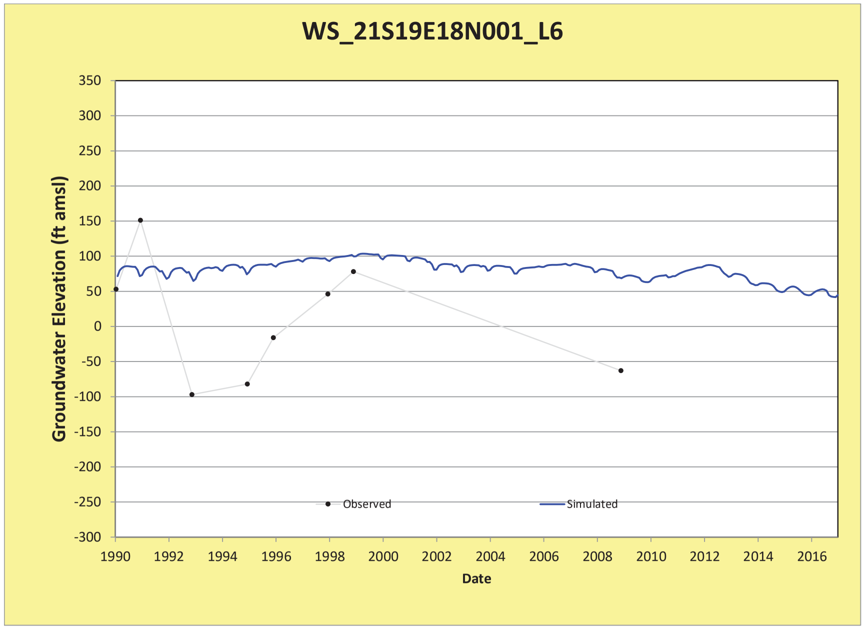

WS_21S18E36J001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

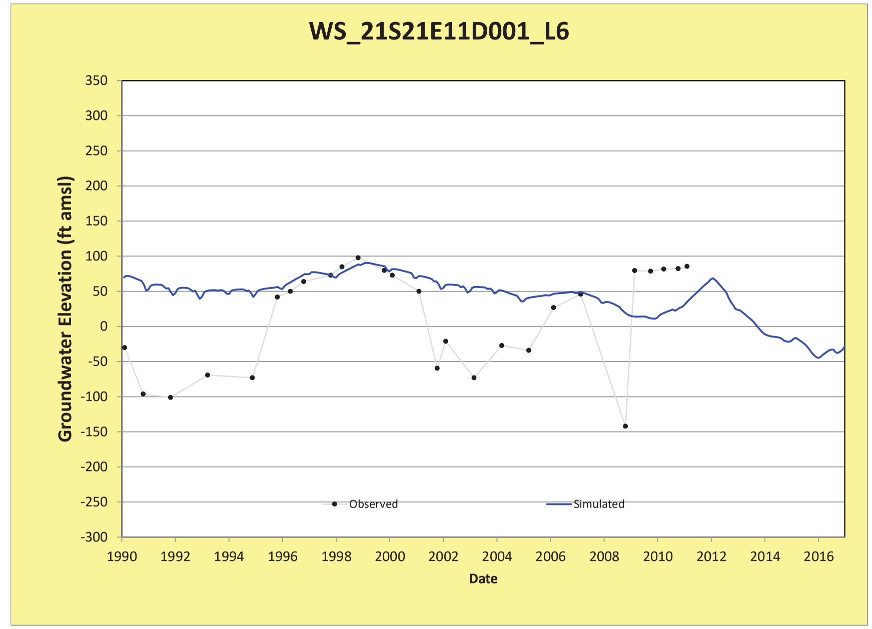

WS_21S18E36M001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

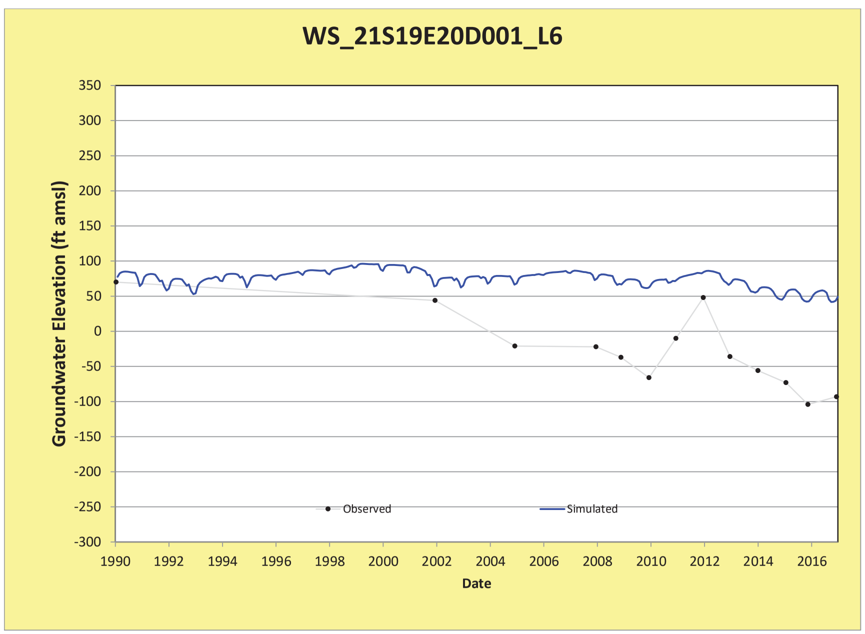

WS_21S19E06D003_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

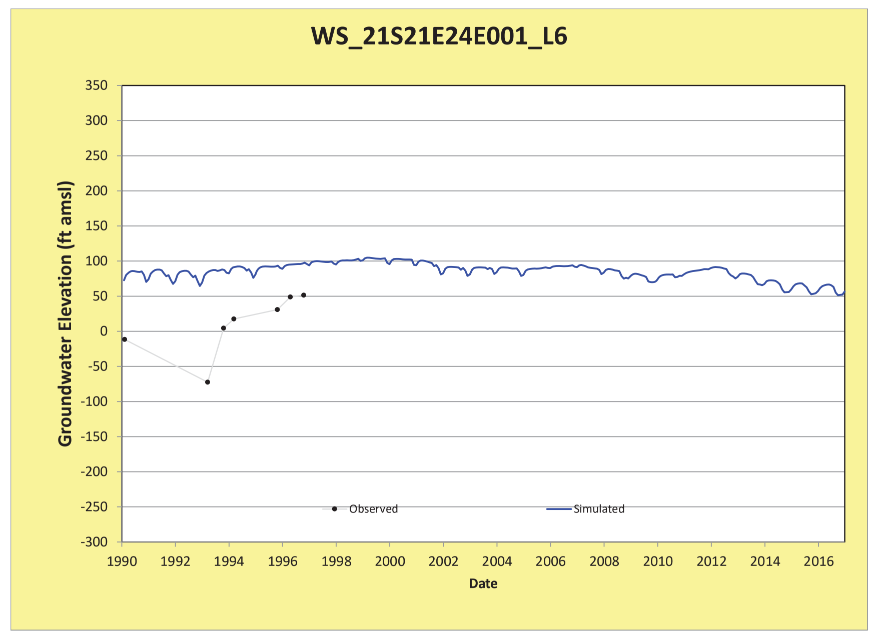

WS_21S19E02B001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

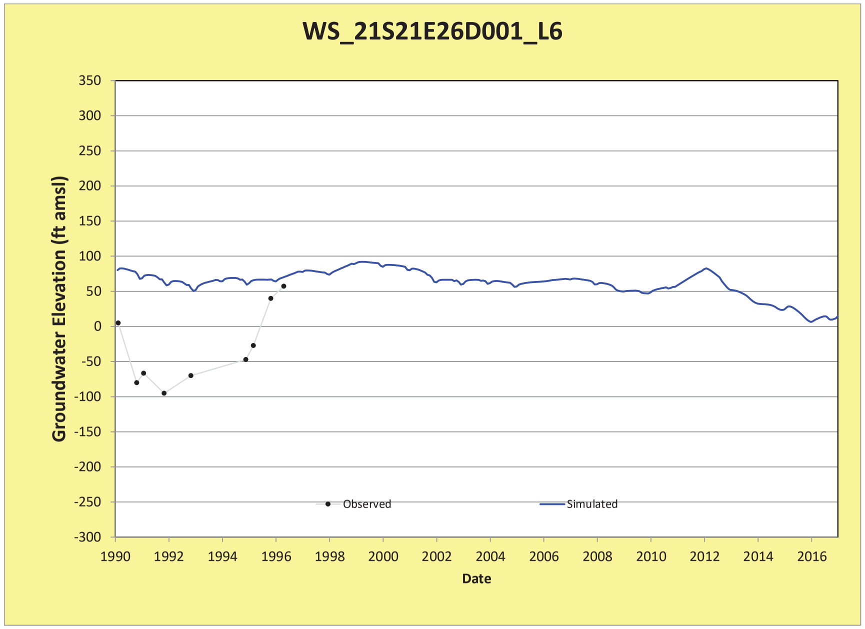

WS_21S19E07D001_L4
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S19E18N001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S21E11D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S19E20D001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S21E24E001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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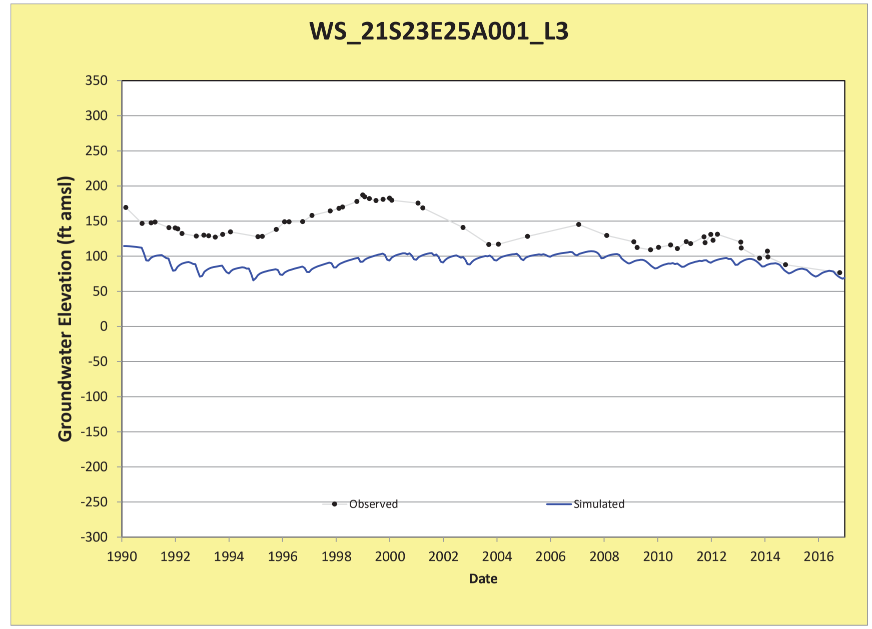
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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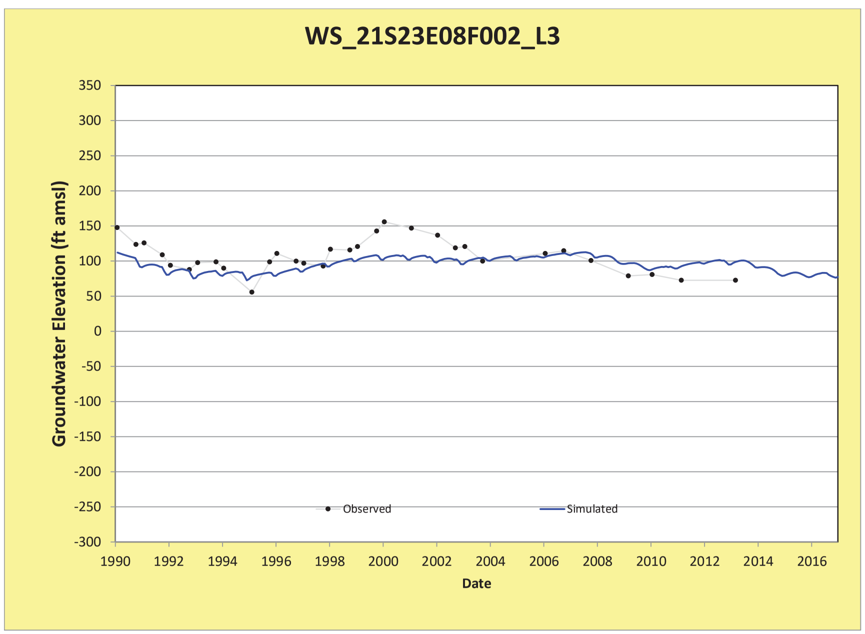
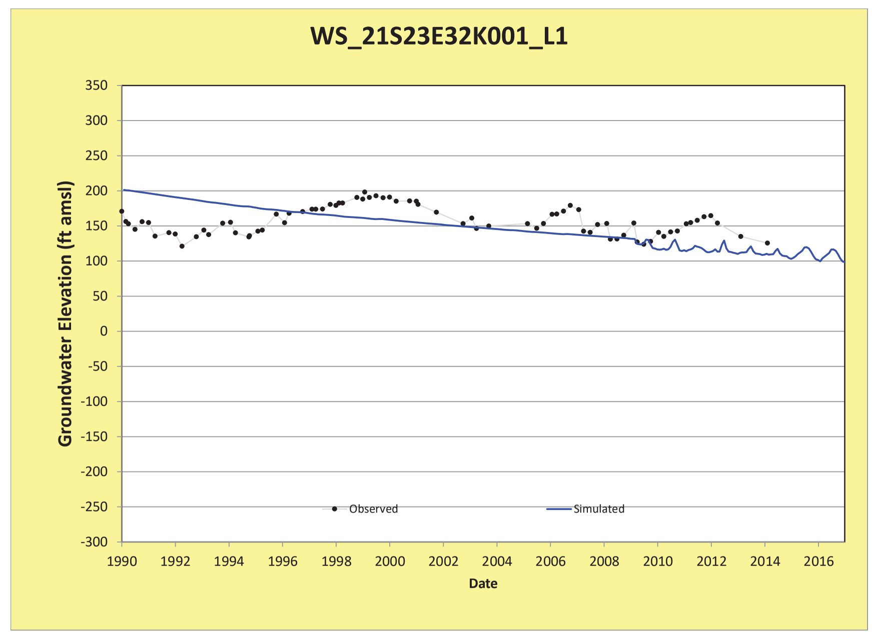
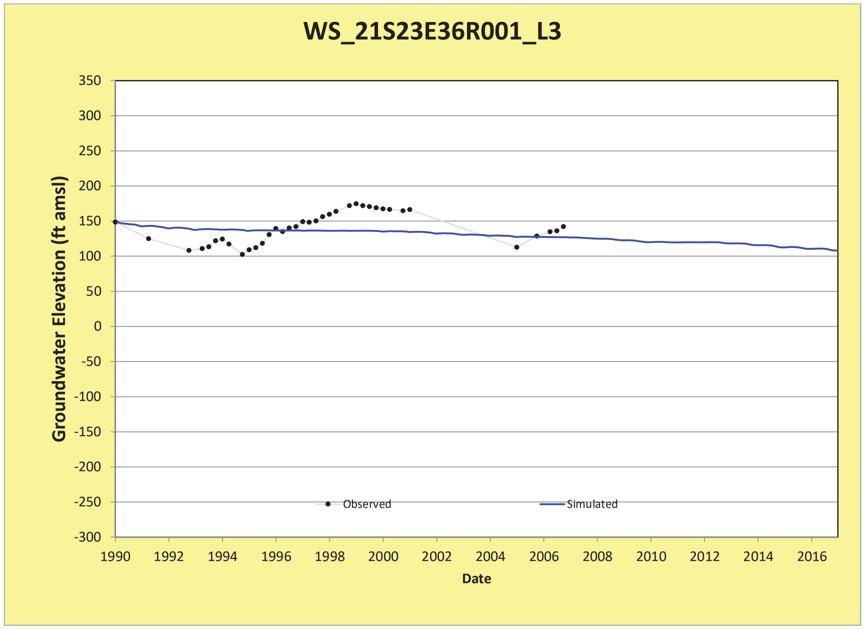
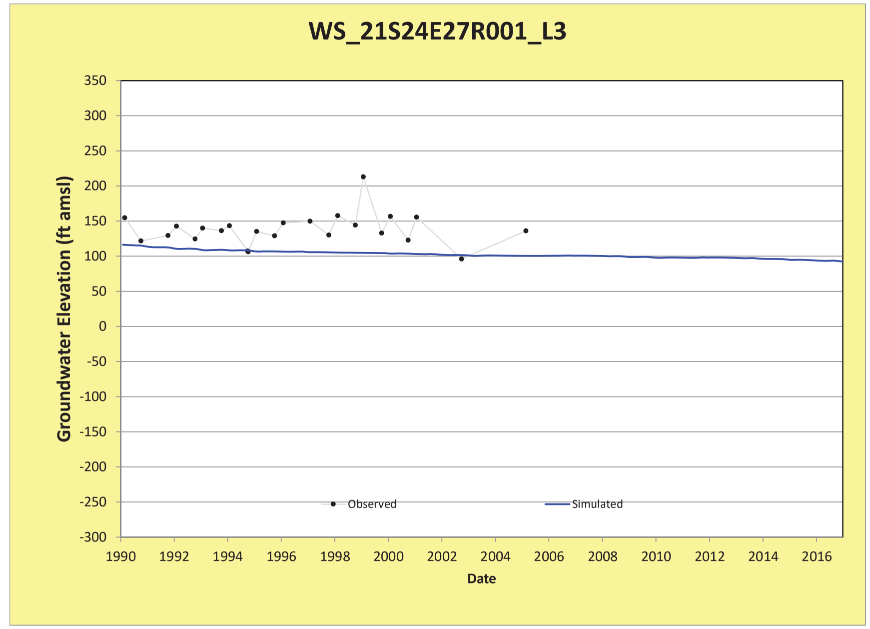
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S23E08F002_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S23E32K001_L1
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_21S23E36R001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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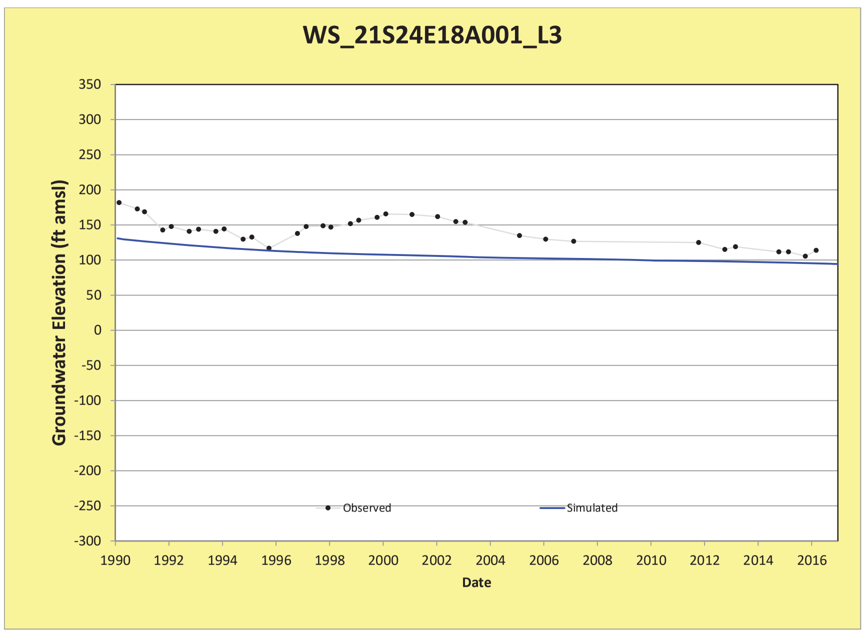
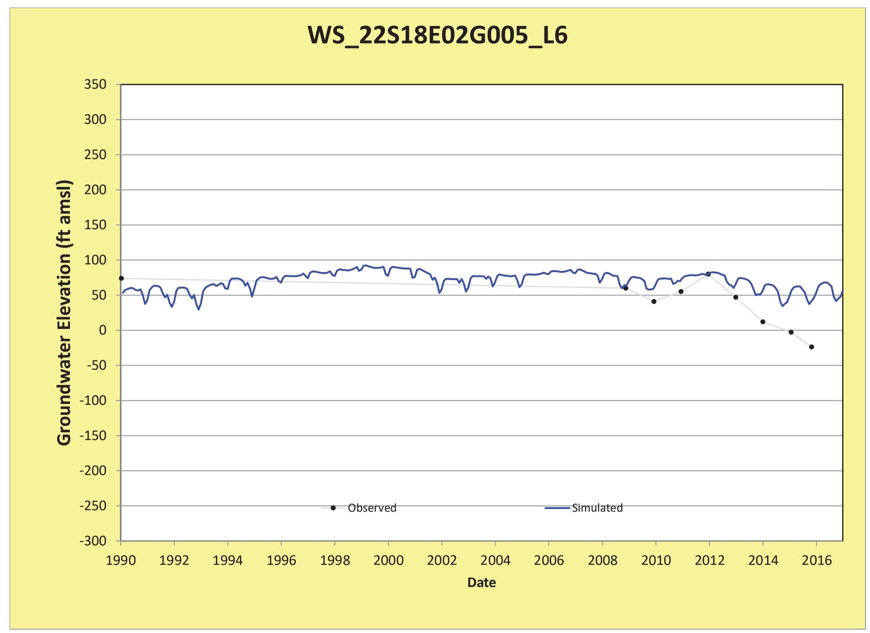
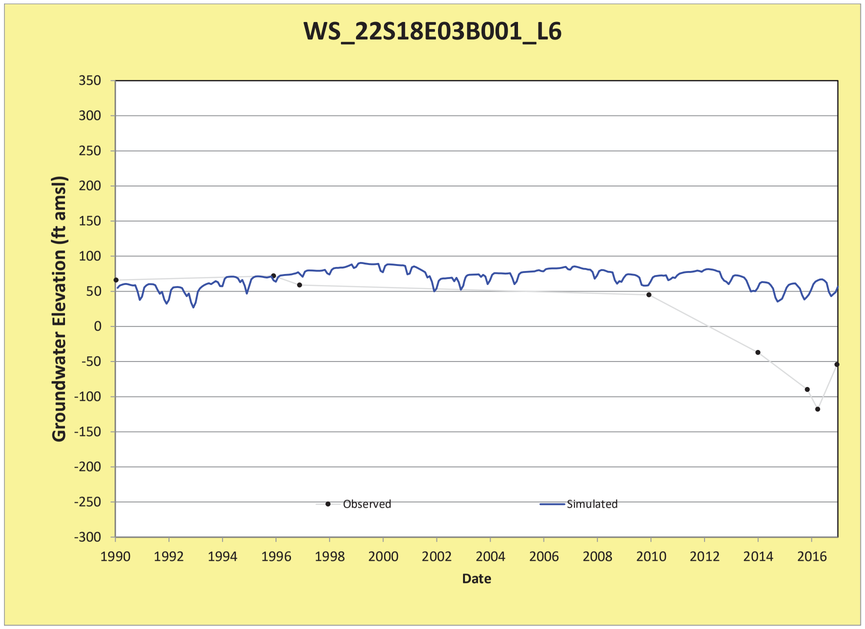
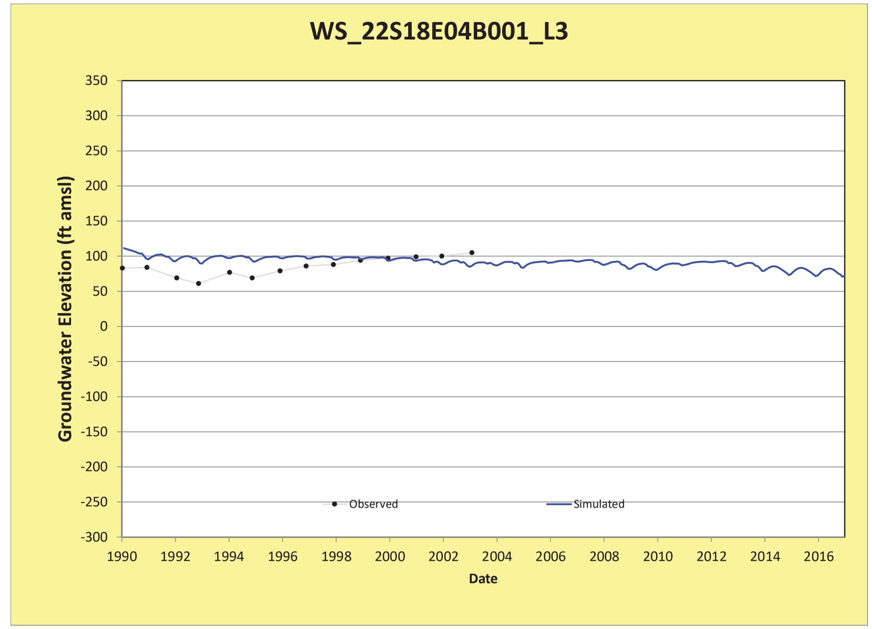
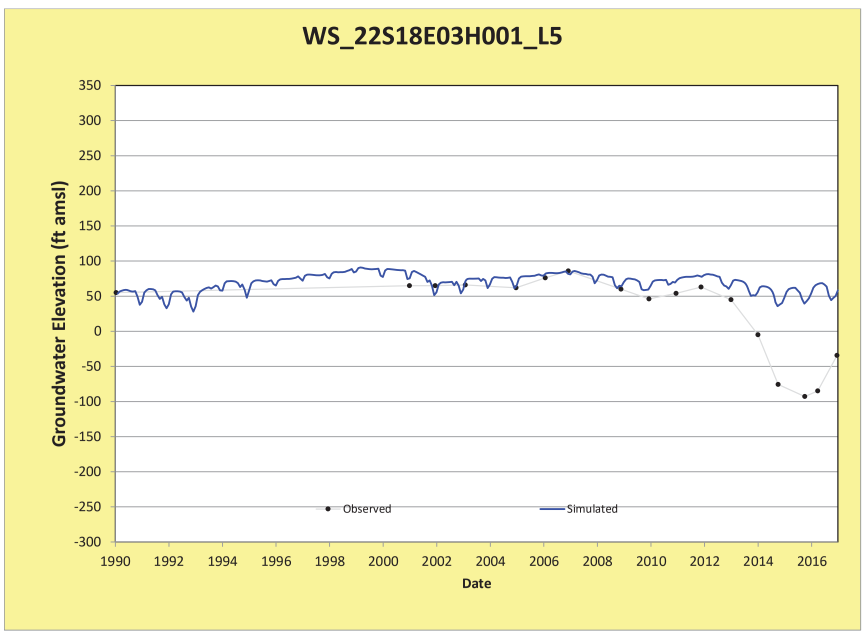
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

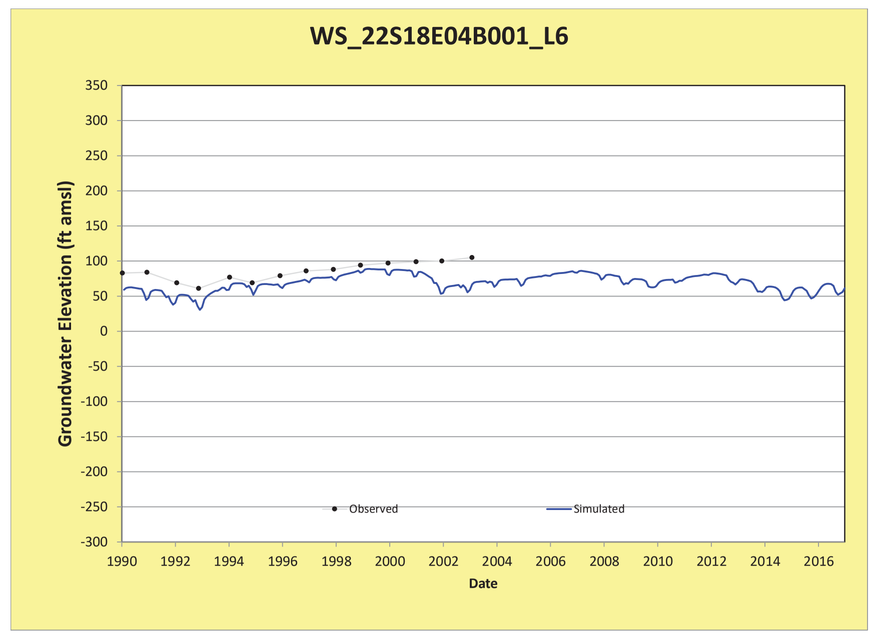

WS_21S24E18A001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated

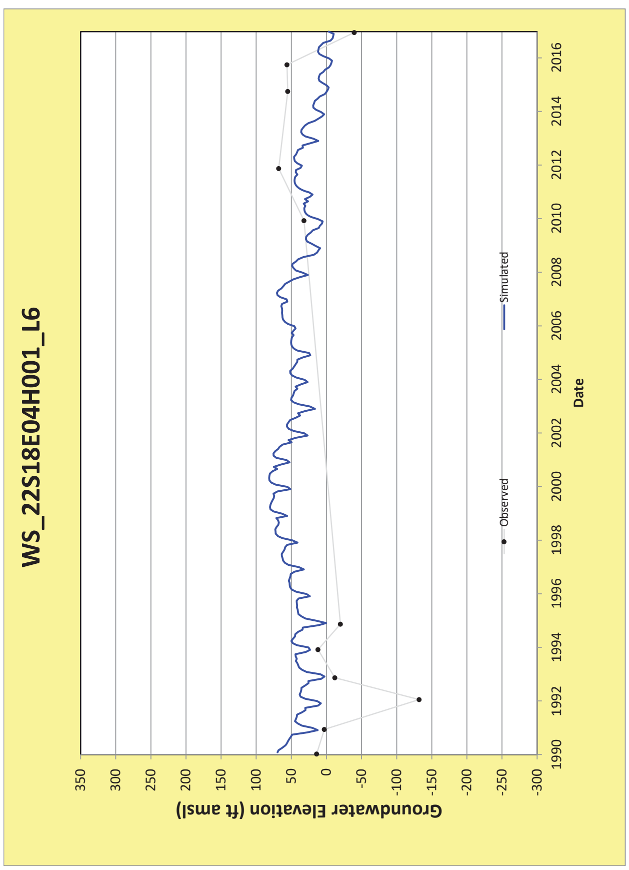

WS_22S18E02G005_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_22S18E03B001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_22S18E04B001_L3
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_22S18E03H001_L5
Groundwater Elevation (ft amsl)
Date
Observed
Simulated


WS_22S18E04B001_L6
Groundwater Elevation (ft amsl)
Date
Observed
Simulated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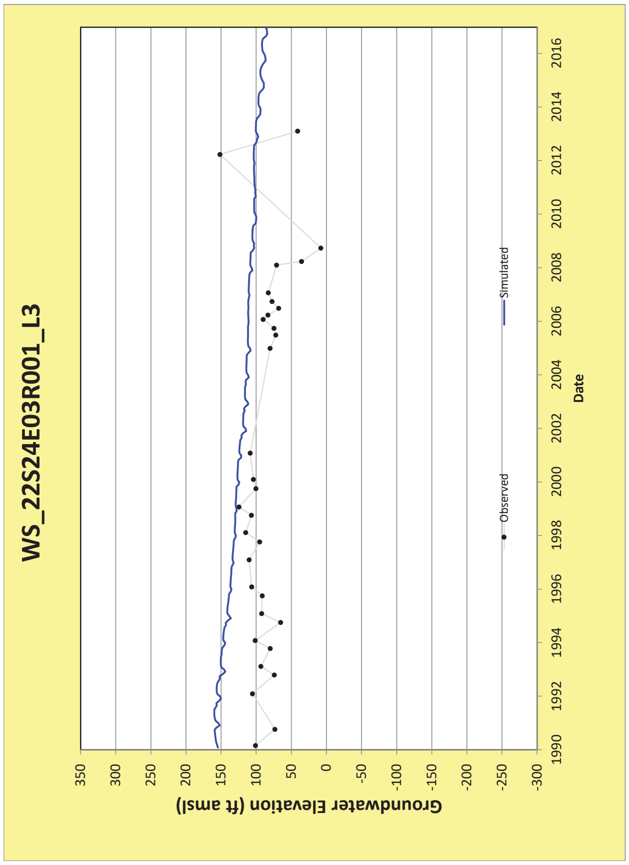
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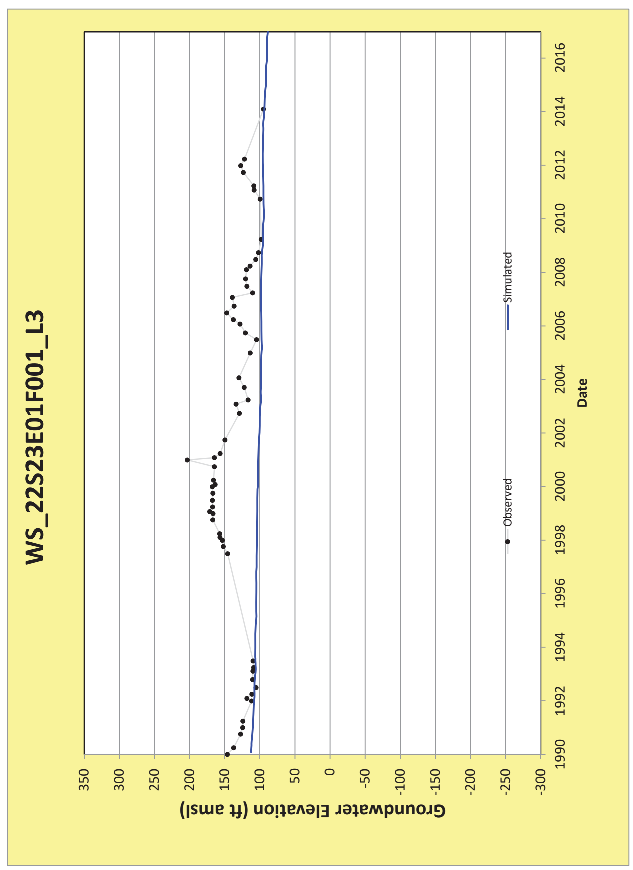
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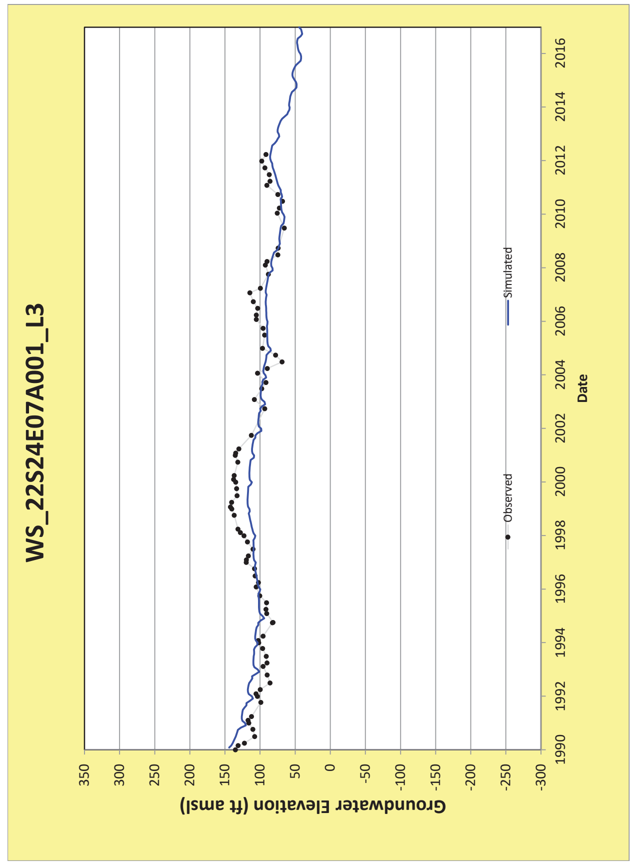
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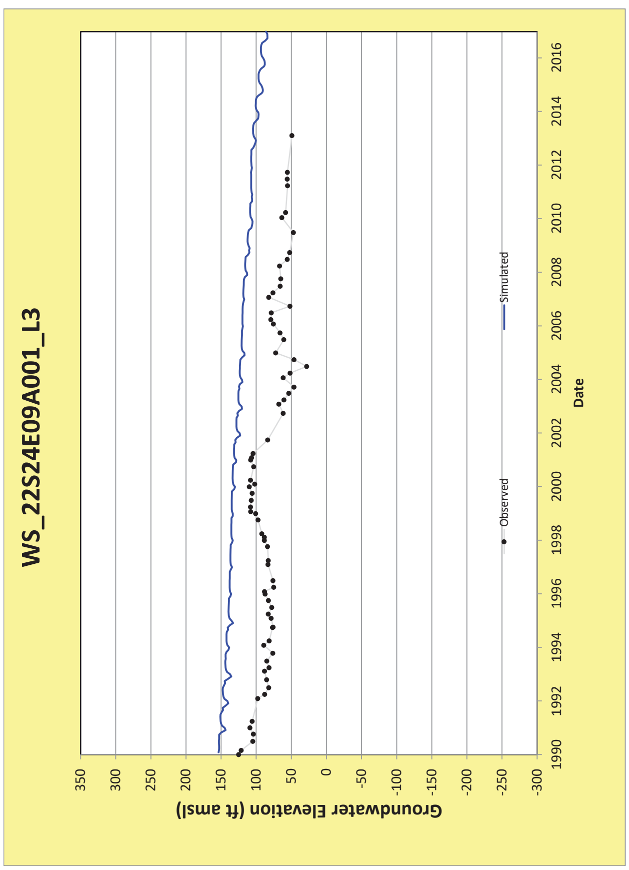
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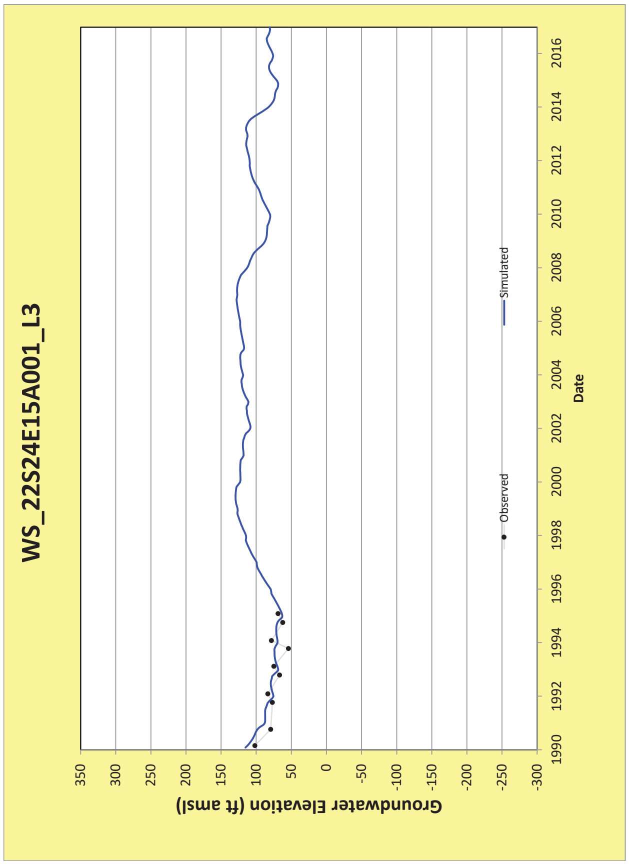
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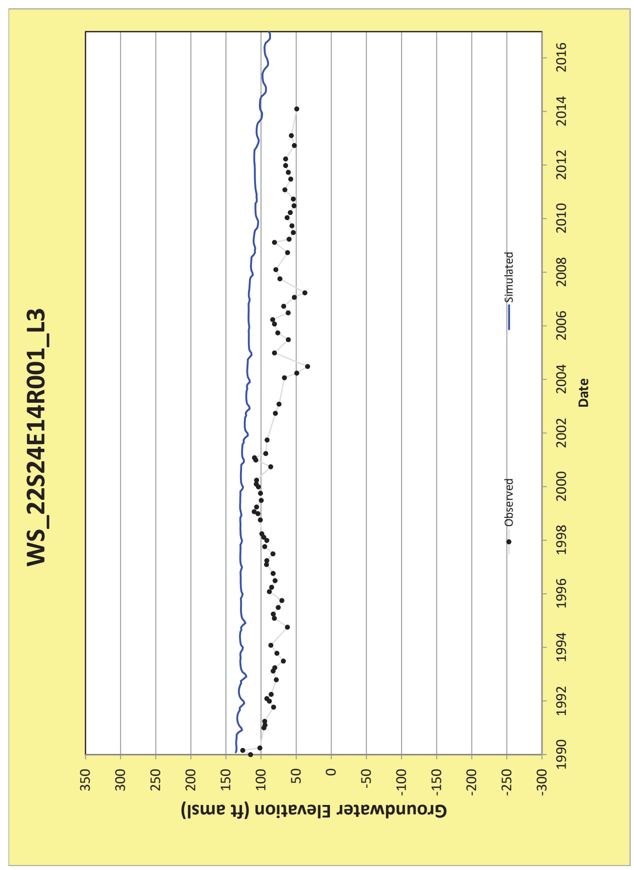
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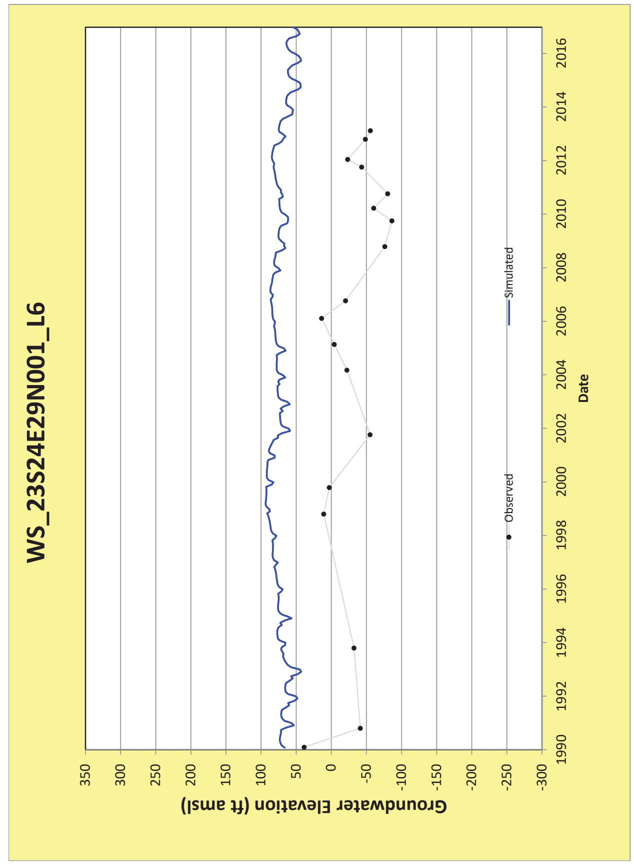
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Date
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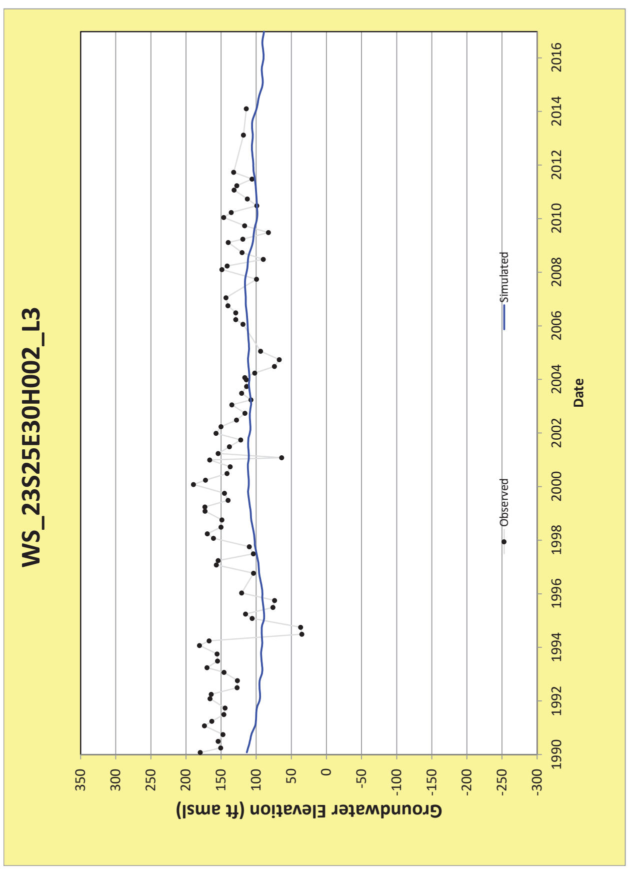
Simulated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Date
Observed
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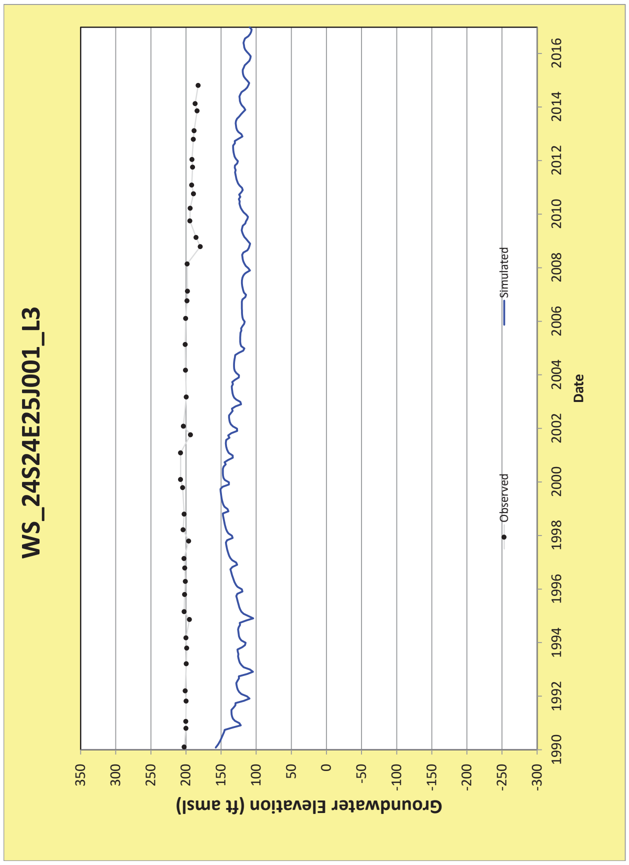
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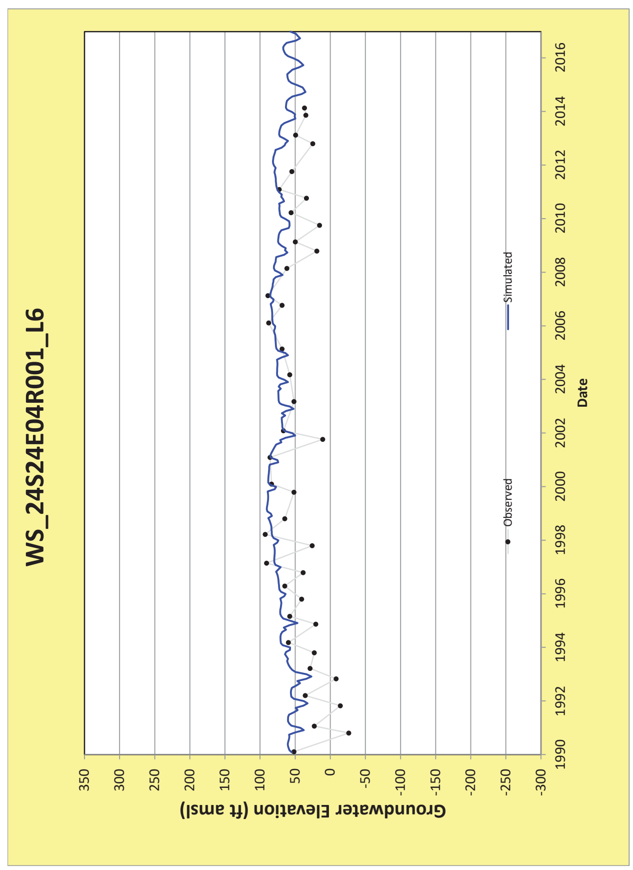
Date
Observed
Simulated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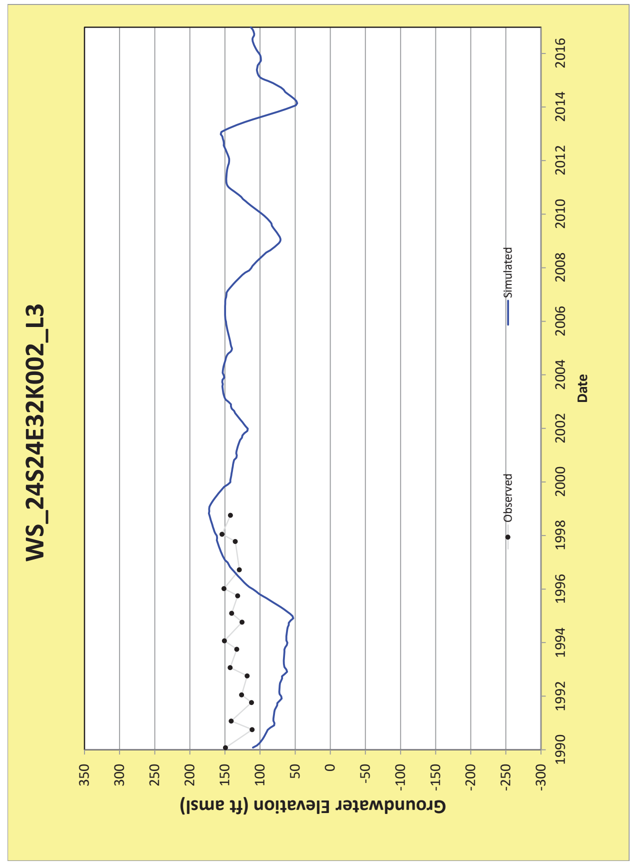
Date
Observed
Simulated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Date
Observed
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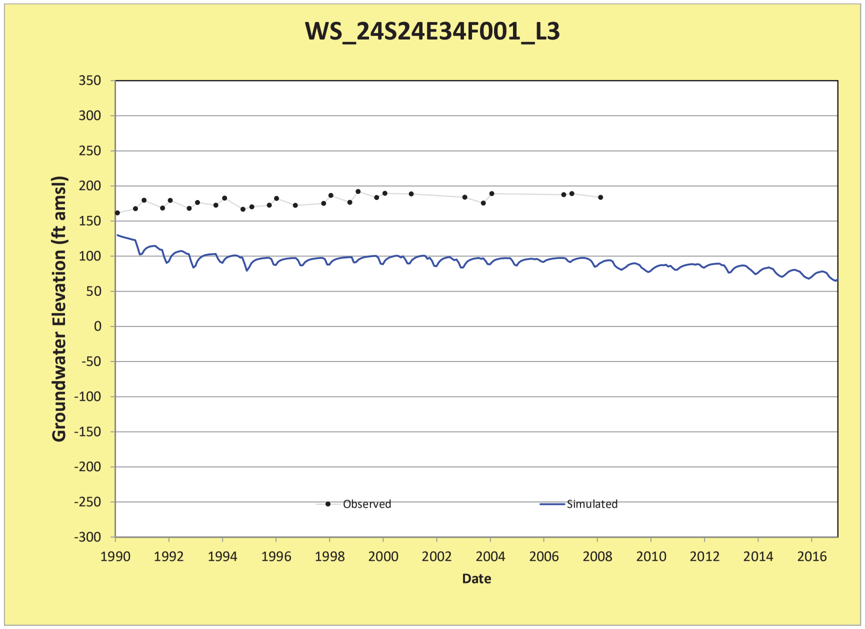
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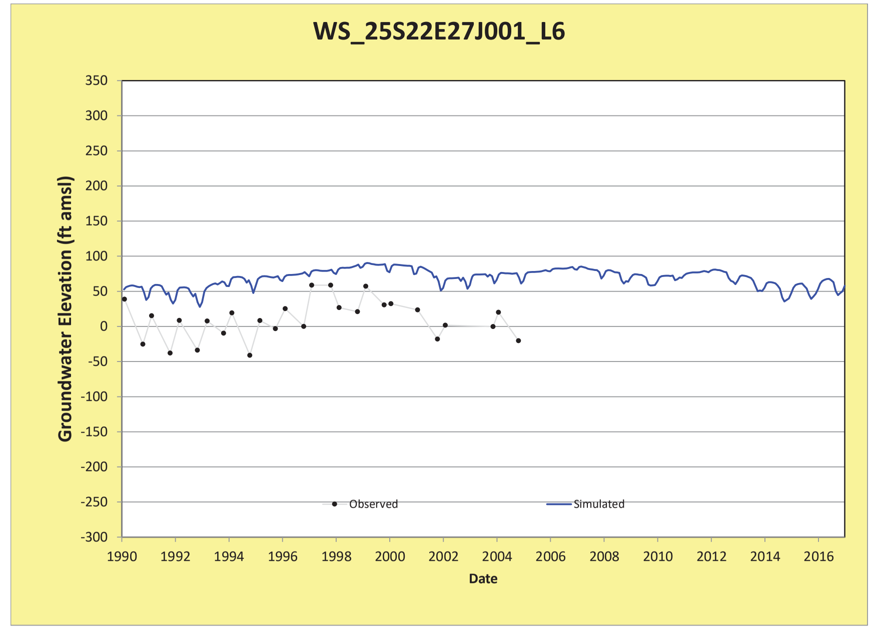
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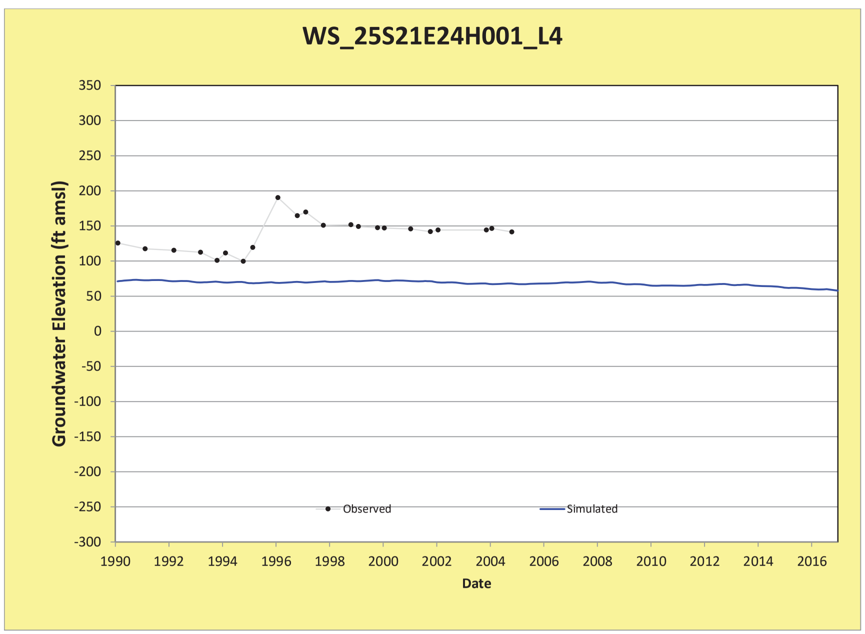
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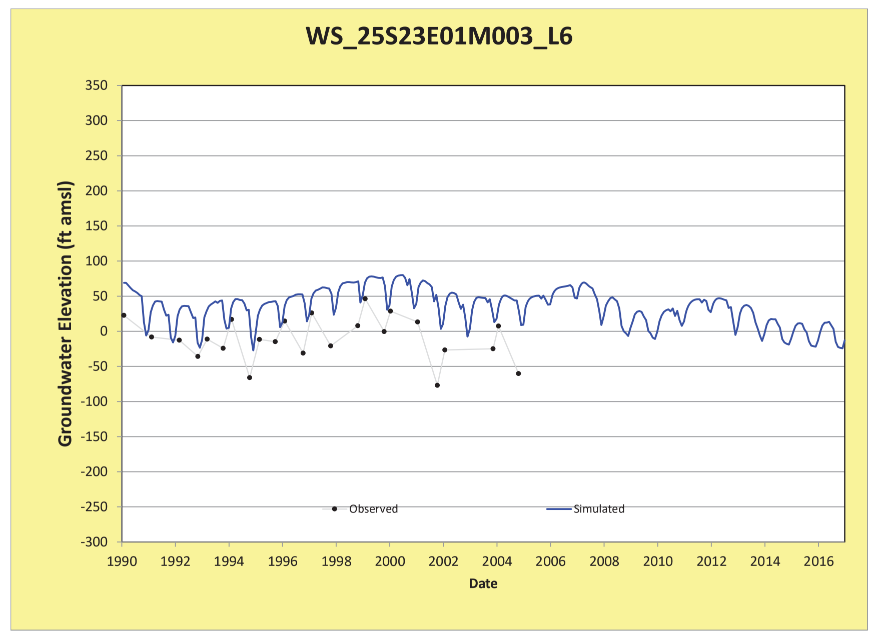
Date
Observed
Simulated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Date
Observed
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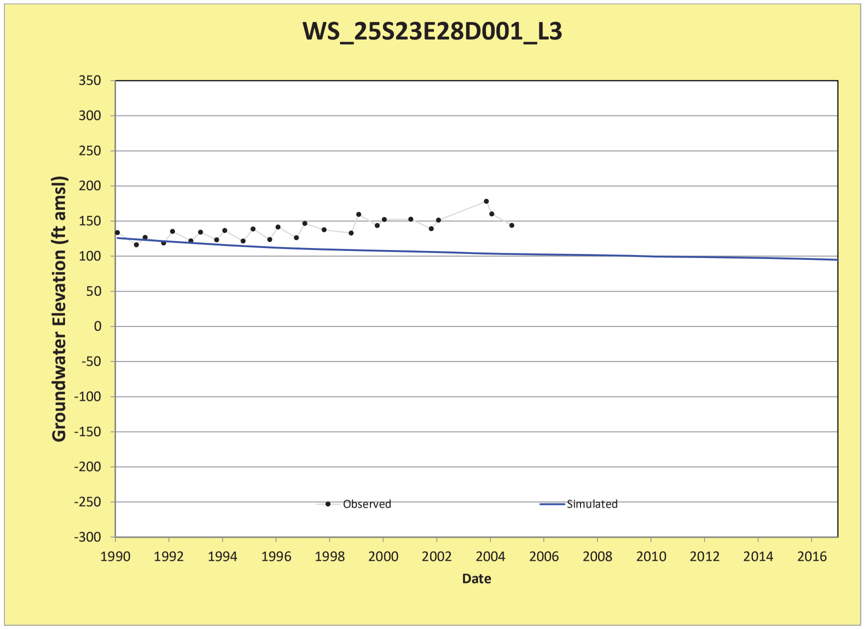
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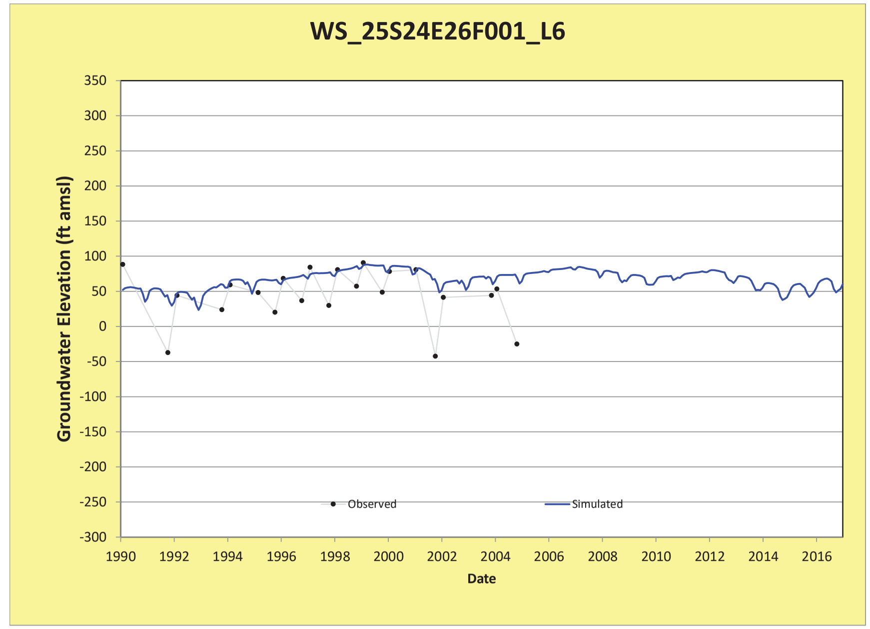
Date
Observed
Simulated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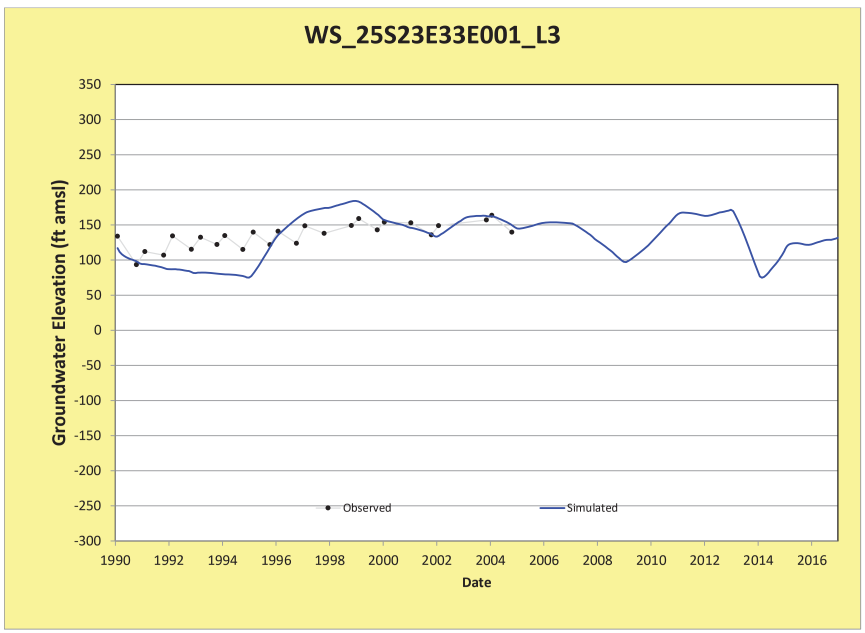
Date
Observed
Simulated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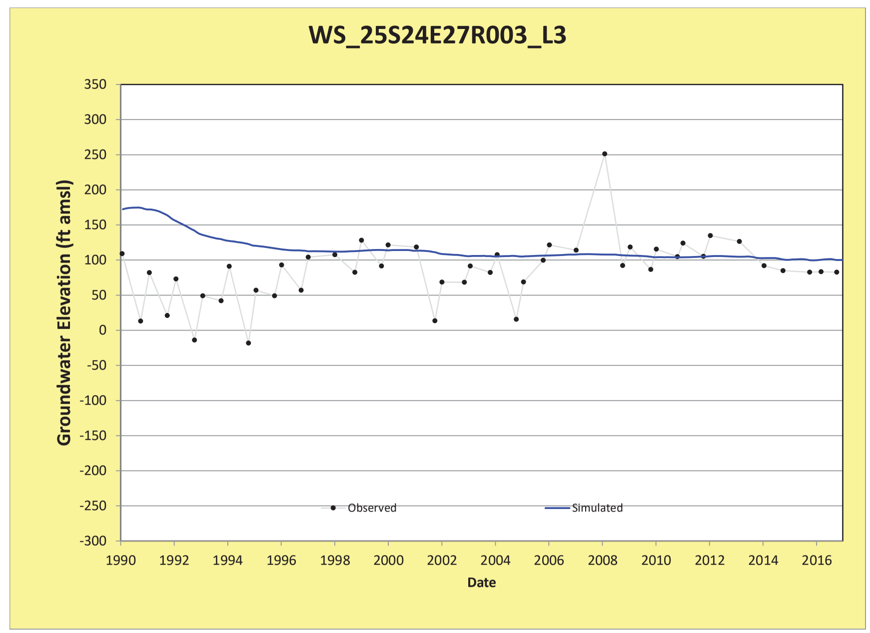
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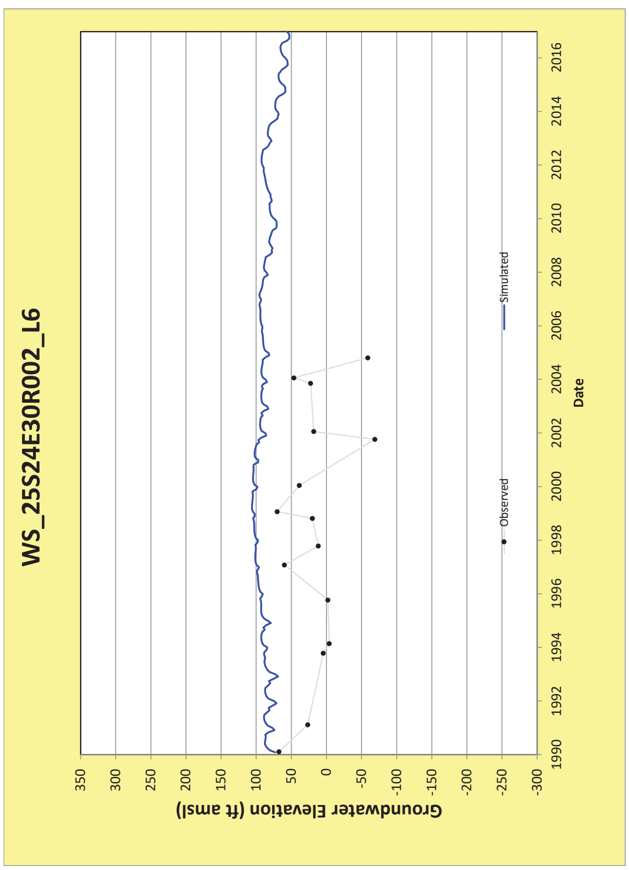

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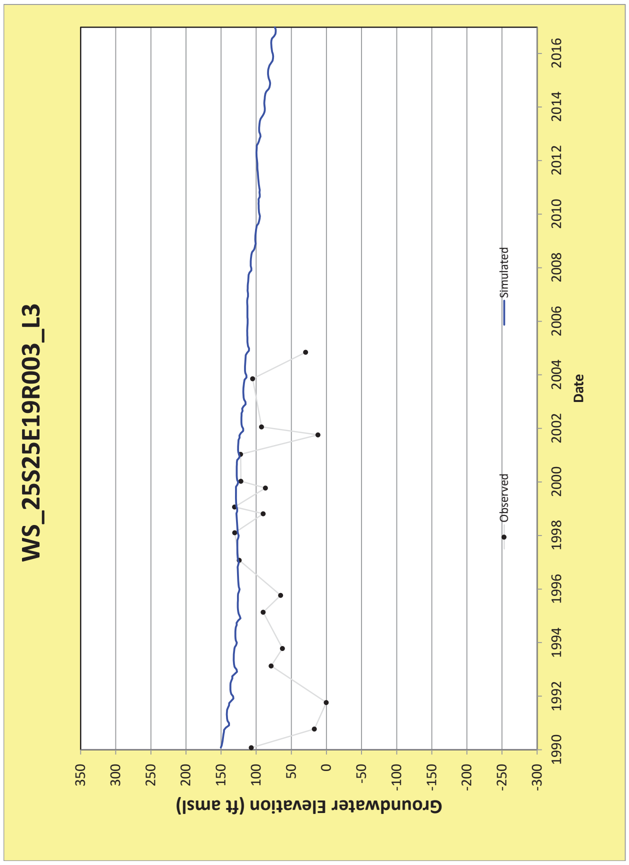

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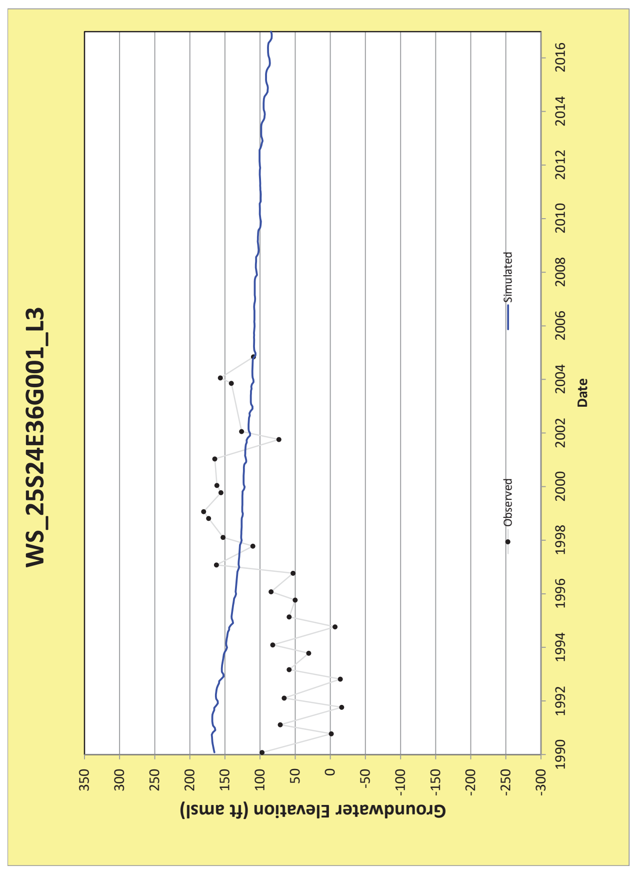

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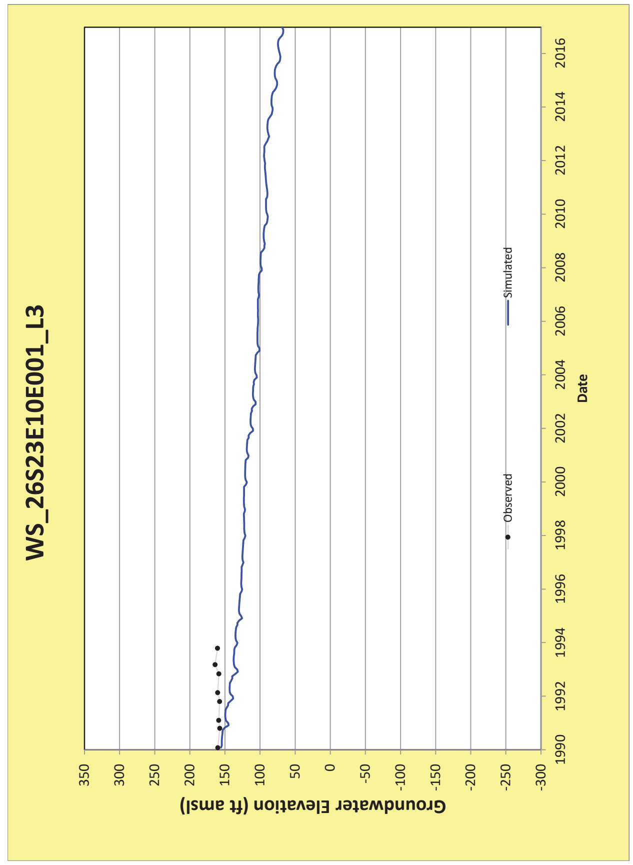

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Groundwater Elevation (ft amsl)
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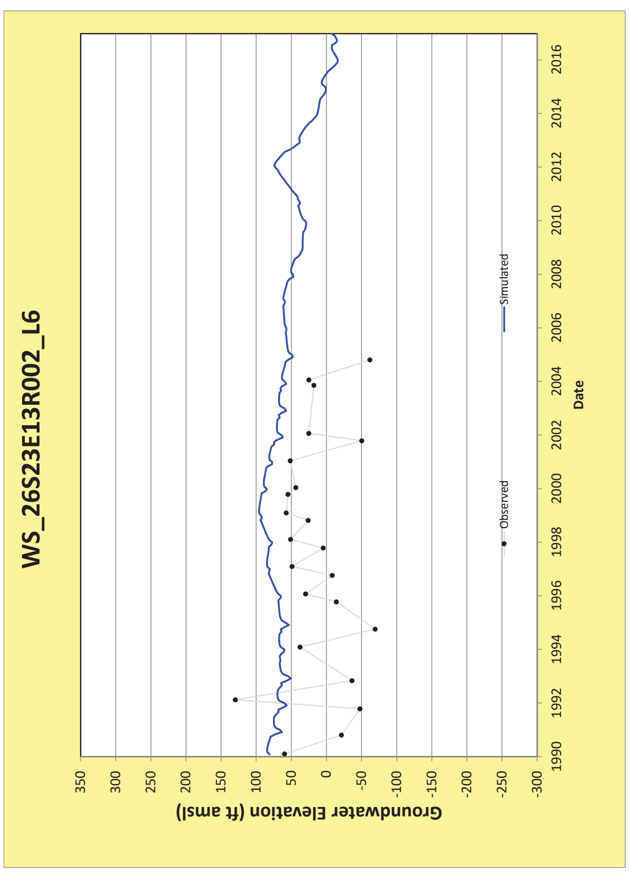
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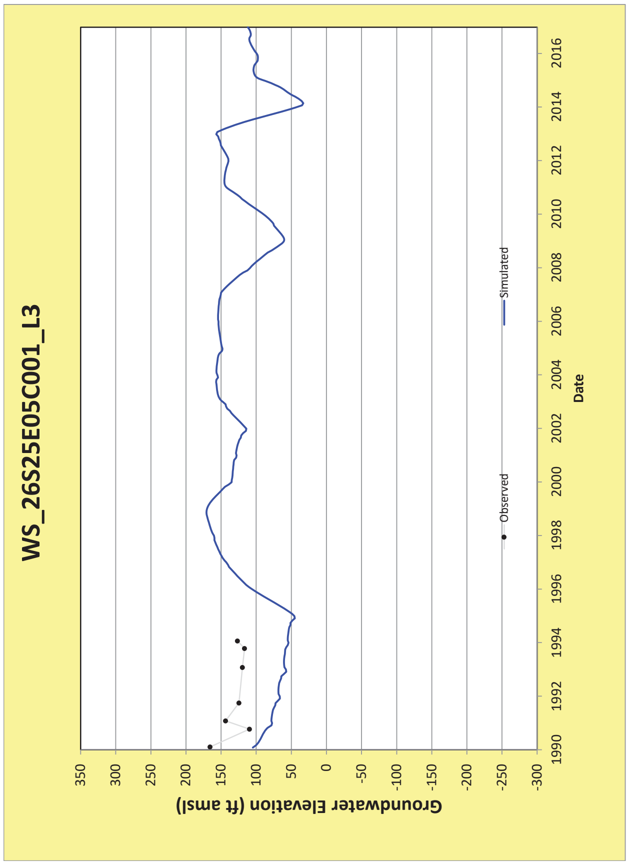
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Date
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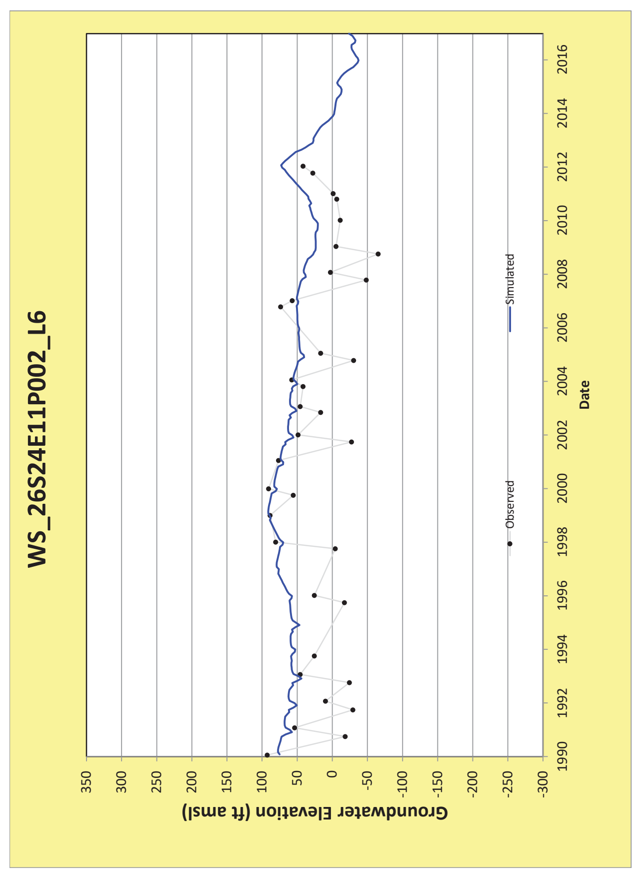
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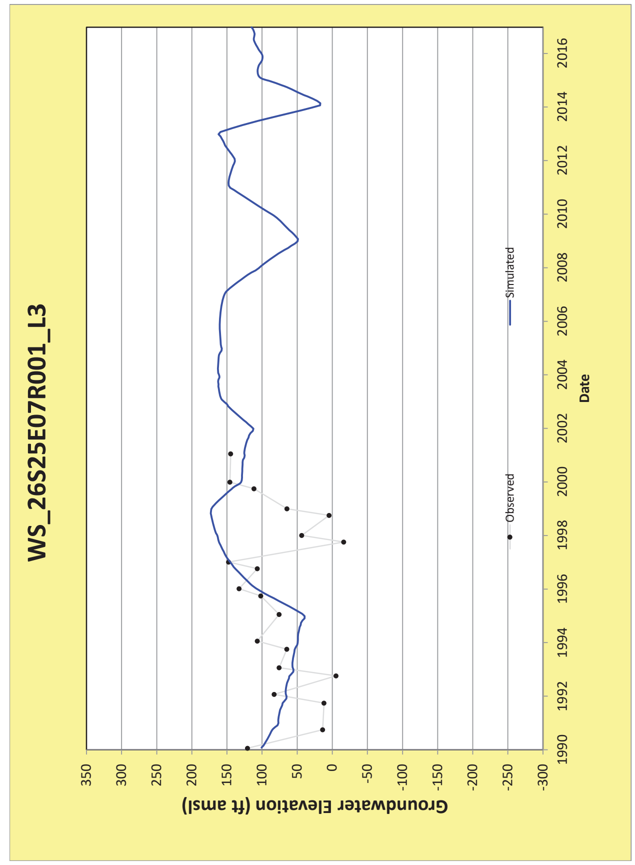
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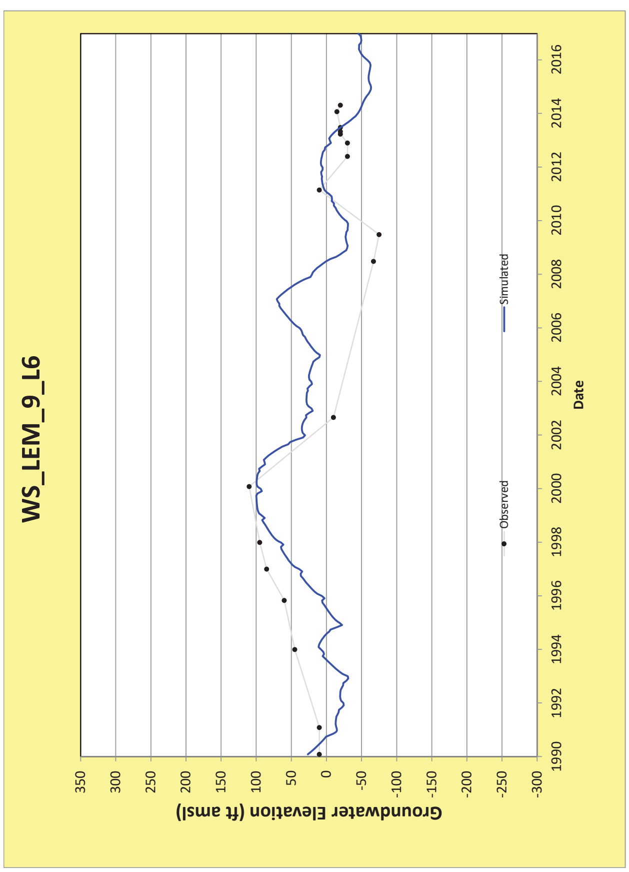
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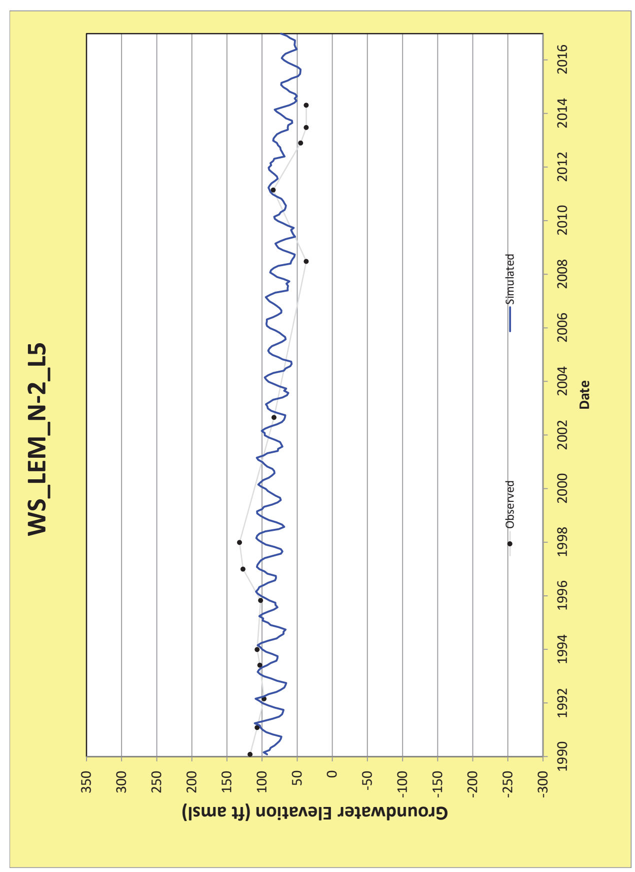
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Appendix D6
Peer Review of TLSBHM

GSA GeoSystems Analysis, Inc.
Innovations in Hydrology

08 November 2019

Bill Pipes
Principal Hydrogeologist
Wood Plc.
1281 East Alluvial Avenue, Suite 101
Fresno, CA 93720-2659

Re: Kings County – Tulare Lake Subbasin GSP Project: Groundwater Model Peer Review

As requested, I performed a technical peer review of the Tulare Lake Subbasin Hydrologic Model (TLSBHM) and associated report developed by Wood Environment & Infrastructure Solutions, Inc. ("Wood"). This model has been and is continuing to be utilized as a tool for evaluation of hydrologic impacts of future water management scenarios being considered as part of the Groundwater Sustainability Plan (GSP) for the Tulare Lake Subbasin (TLSB) as part of the required Sustainable Groundwater Management Act (SGMA) implementation for that planning region. My review focused of four aspects of the model, specifically:

- the model objectives,
- the Hydrogeologic Conceptual Model (HCM) of the TLSB,
- the development and documentation of numerical groundwater model as a predictive simulation tool based on the HCM, and
- documentation of model development and application in a report that is included as an appendix as part of the final GSP report.

Each of these topics is discussed in separate subsections below.

<u>Model Objectives</u>

Model objectives are clearly stated in Section 1.2, and importantly the stated objectives are consistent with model requirements define in the SGMA (Sustainable Groundwater Management Act of 2014) regulations. Specifically, as required by SGMA, the stated objectives include development of a model capable of forecasting groundwater management actions over a 50-year planning horizon (Cal. Water Code §10727.2(c)), establishment of measurable objectives and critical / minimum thresholds (Cal. Code of Regulations, "CCR," §354.29 and CCR §354.30), and development of a numerical model to quantify and evaluate projected water budget conditions (CCR §354.18).

Hydrogeologic Conceptual Model

A hydrogeologic conceptual model (HCM) is the fundamental basis upon which a numerical model of groundwater flow is based. The HCM is basically a narrative description of the physical system, including:

- the areal extent of the model (typically referred to as the model domain)
- the hydrostratigraphic units within the model domain, including a description of the spatial distribution (area covered, depth, continuity, and thickness)
- the water sources and sink, also referred to as the inflows and outflows, within the model domain
- a description of the flow system functioning, and a preliminary water budget.

Section 2 of the Wood report covers the HCM, utilizing block diagrams to illustrate key flow components under both pre-development and developed conditions. The report section on the HCM covers all items listed above, including a narrative description of the evolution and chronology of hydrogeologic conditions in the basin / study area since development began. The conceptual model describes all recharge sources and surface water sources available and applied to meet water demands in the study area. Land subsidence due to groundwater withdrawal is explicitly described in the HCM, setting the stage for explicit simulation of subsidence in the TLSB numerical model. The HCM section also includes a separate subsection on the basin water budget, citing ranges of values for each of the inflow and outflow components. It is recommended that a table be added that summaries the preliminary water budget documented in the HCM section.

Development and Documentation of Numerical Groundwater Model

As previously noted, CCR §354.18 requires the development of a model to quantify and evaluate projected water budget conditions for the GSP. While a simple spreadsheet model can be employed for development of historical water budgets based on available data, a more quantitative approach is need for predict basin sustainability into future conditions. A numerical model is the most common tool employed for quantitative predictions of basin response to future stresses. Per SGMA requirements, the numerical model must: include publicly available supporting documentation; be based on field or laboratory measurements and calibrated against site specific field data; and developed using public domain, open-source software (CCR §352.4(f)(1-3)) As part of the model documentation, the Wood (2019) groundwater model report notes that the model was developed using the MODFLOW-2005-NWT code, and cites publicly available background documents related to this code, its mathematical development, capabilities, and user guide. The Wood (2019) report also describes the preliminary application of the MODFLOW-OWHM code, and explains why that code ultimately was not utilized for this current phase of the TLSB GSP project. The "Model Design" section of the Wood (2019) report provides a detailed description of each of the key model inputs and data sources for assigning/developing input values, including all the boundary conditions used. The methodology employed to develop agricultural pumping estimates are well-described, as well as the methodology for accounting for in-basin storage and management of excess surface inflows in wet years (for subsequent irrigation when surface inflow supplies are insufficient to meet demands).

The model calibration section describes in detail calibration criteria employed, as well as a description of the calibration data. It appears that that significant effort was invested in gathering and compiling whatever calibration data could be obtained from public sources, as well as from stakeholders / participants in the GSP process. For example, the 1990 – 2016 calibration period included 16,621 groundwater level observations collected from 593 observation wells across the model domain. The 1998 – 2010 "normal hydrology" calibration period included 7,028 groundwater level observations collected from 544 observation wells across the model domain. Wood (2019) also note that additional data was available and reviewed as part of the calibration process, but ultimately was not used due to data uncertainty / data quality concerns. The trial & error calibration procedure is well described, and plots are presented showing "goodness-of-fit for wells employed in the calibration process. The final calibration statistics are presented, showing that the final calibrated model generally meets defined criteria for an adequately calibrated model (e.g., Normalized Root Mean Squared Error < 10%).

Detailed water balance results are presented for the calibrated model, including for interactions between the TLSB and adjacent subbasins in the southern San Joaquin Valley. The calibration model simulated subsidence is also presented, although Wood (2019) notes that additional calibration of the model to observed subsidence is needed.

Consistent with good model practice, a model parameter sensitivity analysis is presented to show that the sensitivity of the model results to changes in hydraulic conductivity and storage parameters. The sensitivity analysis showed the calibrated model to be quite robust to changes in model parameters, and the importance of the Kv parameter of the Corcoran Clay layer, and Kh for the shallow and deeper aquifers (above and below the Corcoran, respectively).

Finally, the Wood (2019) report summarizes forecast models to predictive TLSB hydrologic condition 50 years into the future under two future scenarios:

- a Baseline Forecast scenario projecting current cropping patterns into the future, a slow growth rate in municipal pumping(0.3% per year) with a 50-year hydrology driver that accounts for climate change following the guidelines of the California Natural Resources Association (CNRA) for applying "change factors" to historical precipitation, ET demand, and surface water delivery data to make historical data consistent with forecasted conditions under climate change.
- multiple Project Forecast simulations; that involved by modifying the Baseline Forecast and incorporating various potential projects and management actions developed by the GSAs for the TLSB and surrounding subbasins. Potential projects and management action considered include: (i) Above ground surface water storage projects, (ii) Intentional recharge basins, (iii) On-Farm Recharge, (iv) Aquifer Storage and Recovery (ASR), and (v) Agricultural demand reductions.

The results for the Forecast model results include projected water budgets into the future, as well as piezometric levels and changes to basin storage (both elastic and inelastic) for the Baseline and Sustainability Project scenarios. The forecast model results are also presented for water level hydrographs for selected Compliance Wells (which were identified in the main body of the GSP report) in Figures 7-6 and 7-15 and predicted subsidence for Subsidence Compliance

Monitoring points (Figures 7-8 and 7-17). Identification of and calculation of responses at designated Compliance Monitoring points meets the SGMA requirement that the model be able to quantify Sustainability Indicators (23 CCR §354.28(b)), which are clearly defined in Chapter 4 of the GSP report.

Summary

The TLSB groundwater model developed to support groundwater sustainability planning for the TLSB was reviewed and evaluated against explicit needs and requirements for basin sustainability planning under SGMA. Based on this Peer Review of the model, it was found that the model was developed following good groundwater modeling practice in terms of compilation and integration of historical available data and information, groundwater calibration criteria, sustainability analyses, forecasts of future conditions under Baseline and implementation of sustainability Projects, and clear documentation of model development and application. As required under SGMA, the model develops a rigorous groundwater budget under the historical calibration period as well as under the two future Forecast scenarios (Baseline and Project). In addition, it also quantifies groundwater response at key monitoring points in the basin in the context of sustainability criteria and thresholds identified in Chapter 4 of the GSP.

If you have any questions, please do not hesitate to contact me. As always, we appreciate this opportunity to work with the Wood – Provost & Pritchard team.

Best Regards,

James T. McCord

Jim McCord, PhD, PE
Principal Hydrogeologist

Appendix E
Groundwater Sustainability Plan Checklist

Appendix E - Groundwater Sustainability Plan Reguulation Checklist

GSP Regulation Section	Water Code Section	Requirement	Description	Section(s) and Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4	10733.2	General Information	a. Executive Summary- written in plain language b. A list of references and technical studies. Groundwater Sustainability Agencies (GSAs) must provide the California Department of Water Resources (DWR) an electronic copy of documents that are not available to the public	a. Executive Summary p. ES-1 to ES-33 b.Ch. 8, References p. 8-1 to 8-12
354.6	10733.2	Agency Information	a. GSA Mailing Address b. Organization and Management Structure including persons with management authority for Groundwater Sustainability Plan (GSP) implementation c. Contact Information of Plan Manager d. Legal Authority of GSA e. Estimate of Implementation Costs	a. Appendix A b. Section 1.5.1 (p. 1-5 to 1-6) c. Appendix A d. Section 1.5.2 (p. 1-6) e. Section 7.1 (p. 7-1 and Table 7.1.1-1
354.8.(a)	10733.2	Map(s)	1. Area covered by GSP 2. Adjudicated areas, other agencies within the basin, and areas covered by an Alternative 3. Jurisdictional boundaries of federal or state land 4. Existing Land Use Designations & identification of water use sector/water source type 5. Density of wells per square mile	1. Section 2.0 (p. 2-2) and Figures ES-1, 2.0.0-1 2. Section 2.0 (p. 2-1 to 2-2) and Figures 2.0.0-1 to 2.0.0-6 3. Section 2.1, (p. 2-2), Figures 2.0.0-1 to 2.0.0-6 4. Section 2.1, (p. 2-2 to 2-8) and Figures 2.0.0-7 to 2.0.0-11 5. Section 2.1 (p. 2-2) and Figure 2.0.0-12
354.8.(b)	10733.2	Description of the Plan Area	b. Written summary of jurisdictional areas and other features	Section 2.1, (p. 2-2)
354.8.(c, d, e)	10733.2	Water resource monitoring and management programs	c. Description of water resources monitoring and management programs d. Description of how water resource monitoring or management programs may limit operational flexibility e. Description of Subbasin's conjunctive use programs	c. Section 2.2.1 (p. 2-8) d. Section 2.2.2 (p. 2-10) e. Section 2.2.3 (p. 2-12)
354.8.(f)	10733.2	Land Use Elements or Topic Categories of Applicable General Plans	1. Summary of general plans and other land use plans 2. Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects 3. Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans 4. Summary of the process for permitting new or replacement wells in the basin 5. Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	1. Section 2.3.1 (p. 2-12) 2. Section 2.3.2 (p. 2-13) 3. Section 2.3.3 (p. 2-13) 4. Section 2.3.4 (p. 2-14) 5. Section 2.3.5 (p. 2-16)
354.8.(g)	10727.4	Additional GSP Contents	Additional GSP elements	Section 2.4 (p. 2-16)
354.10	10733.2	Notice and Communication	a. Description of beneficial uses and users b. List of public meetings c. GSP comments and responses d. Communication section including the following: 1. Explanation of GSA's decision making process 2. Identification of opportunities for public engagement and how public input will be used 3. How agencies will encourage diverse active involvement from community 4. How the GSAs will inform the public about progress of the GSP	a. Section 2.5.3 (p. 2-23) and Appendix B b. Appendix B c. Appendix C d. Appendix B 1. Section 2.5.2 (p. 2-22) 2. Section 2.5.3 (p. 2-23) 3. Section 2.5.4 (p. 2-23) 4. Section 2.5.3 (p. 2-23)
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.12		Physical Setting and Basin		Chapter 3 (p. 3-1)
354.14.(a-b)	10727.2	Hydrogeologic Conceptual Model (HCM), descriptive text	a. Hydrogeologic Conceptual Model and maps of the physical components and interaction of the surface water and groundwater systems in the basin. b. The HCM will include: 1. Regional geologic and structural setting of the Subbasin, as well as surrounding areas 2. Lateral basin boundaries including major geologic features 3. Definable bottom of the basin 4. Principal aquifers and aquitards including: a. formation names b. physical properties of aquifers and aquitards c. structural properties of the Subbasin that restrict groundwater flow within the aquifers d. General water quality of principal aquifers e. identification of primary uses of each aquifer including domestic, irrigation, municipal water supplies f. Identification of data gaps and uncertainty in the HCM	a. Section 3.1 (p. 3-2) and Appendix D b. HCM summarized in written descriptions within: 1. Sections 3.1.1 to 3.1.3 (p. 3-2) 2. Section 3.1.6 (p. 3-10) 3. Section 3.1.7 (p. 3-12) 4a. Section 3.1.8 (p. 3-14) 4b. Section 3.1.8 (p. 3-14) 4c. Section 3.1.8 (p. 3-14) 4d. Section 3.2.5 (p. 3-24) 4e. Section 3.1.11 (p. 3-19) 4f. Section 3.1.12 (p. 3-20)

GSP Regulation Section	Water Code Section	Requirement	Description	Section(s) and Page Number(s) in the GSP
354.14.(c-d)	10733.2	HCM, Maps	c. Include at least 2 cross section maps of the HCM that depict major stratigraphic and structural features of the Subbasin d. Map(s)pf physical characteristics of the Subbasin 1. Topographic information 2. Surficial geology (by USGS or other applicable agency) 3. Soil characteristics (by NCRS or other applicable agency) 4. Delineation of existing recharge areas, potential recharge areas, and discharge areas 5. Surface water bodies 6. Source and point of delivery for imported water supplies	c. Figures 3.1.4a to 3.1.4c, 3.1.2-7. Figure 3.1.1-7 d2. Figure 3.1.2-1 d3. Figures 3.1.1-9 to 3.1.1-10 d4. Figure 3.1.10-1 d5. Figure 3.1.1-5 d6. Section 3.1.1.6 (p. 3-6)
354.16	10733.2	Groundwater Conditions	a. Groundwater elevation data 1. Groundwater elevation contour maps (depict groundwater table or potentiometric surface) 2. Hydrographs for long term groundwater elevations, historic levels, and hydraulic gradients b. Estimate of groundwater storage (graph). Graph must include annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions including annual use and water year type c. Seawater intrusion conditions (including maps and cross sections for each principal aquifer) d. Groundwater quality issues including locations of known groundwater contamination sites and plumes e. Extent, cumulative total, and annual rate of land subsidence (including map of total subsidence based on data from DWR) f. Identification of interconnected surface water systems and estimate of quantity and timing of the depletions using DWR data g. Identification of groundwater-dependent ecosystems	a. Groundwater Elevation Data 1. Figures 3.2.1-2 to 3.2.2-2 2. Figures 3.2.1-1 through 3.2.2-3d and Appendix D b. Figures 3.2.4-1a,b,c c. Figures 3.1.4a to 3.1.4c, 3.1.2-7. Figure 3.1.1-7 d. Section 3.2.5 (p. 3-24) e. Section 3.2.6 (p. 3-25) f. Section 3.2.8 (p. 3-27) g. Section 3.2.8.1 (p. 3-27)
354.18.(a-b)	10733.2	Water Budget Information	a. Water budget that provides an assessment of total annual volume of groundwater and surface water entering and leaving the Subbasin (including historic, current, and projected) b. The water budget shall quantify the following through estimates or direct measurements: 1. Total surface water entering and leaving the Subbasin (by water source type) 2. Inflow to the groundwater system by water source type 3. Outflows from the groundwater system by water use sector 4. Change in annual volume of groundwater in storage 5. Quantification of overdraft over a period of years including water year and water supply conditions compared to average conditions 6. Water year type associated with annual supply, demand, and change in groundwater	a. Section 3.3 (p. 3-29) b. 1. Section 3.3.1 (p. 3-29) 2. Section 3.3.1 (p. 3-29) 3. Section 3.3.1 (p. 3-29) 4. Section 3.3.2 (p. 3-35) 5. Section 3.3.3 (p. 3-36) 6. Section 3.3.4 (p. 3-37) 7. Section 3.3.4 (p. 3-37)
354.18.(c)	10733.2	Quantification of Water Budget	c. Each Plan shall quantify the current, historic, and projected water budget including: 1. Current water budget information including current inflows and outflows 2. Historical water budget must include the following: A. Quantitative evaluation of availability/reliability of historical surface water supply (by water source type and water year type) and based on the most recent 10 years of data B. Quantitative evaluation of historic water budget to project the future water budget information and future aquifer response to GSP implementation C. Description of how historical conditions have impacted GSA ability to create sustainable yield 3. Projected water budget to estimate future baseline conditions for GSP implementation and identify uncertainties. This section should include the following: A. Projected hydrology must include 50-year historical precipitation, evapotranspiration, and streamflow information as the baseline *climate change must also be incorporated B. Projected water demand will utilize the most recent land use, evapotranspiration, and crop coefficient data. Projected changes in local land use planning, pop growth and climate must be included C. Projected surface water supply will use most recent data and also consider historical surface water supply	1. Section 3.3.5 (p. 3-37) 2. Section 3.3.6 (p. 3-38) 3. Section 3.3.7 (p. 3-39)

GSP Regulation Section	Water Code Section	Requirement	Description	Section(s) and Page Number(s) in the GSP
354.18 (d)	10733.2	Water Budget Data Source	d. The Agency shall utilize the following information provided by the DWR (or other comparable data) to develop the Water Budget 1. Historical water budget information: use mean annual temperature, mean annual precipitation, water year type, and land use 2. Current water budget information for temperature, water year type, evapotranspiration, and land use 3. Projected water budget information for population, population growth, climate change.	d. Section 3.3 (p. 3-29) 1. Section 3.3.6 (p. 3-38) 2. Section 3.3.5 (p. 3-38) 3. Section 3.3.7 (p. 3-39)
354.18 (e, f)	10733.2	Water Budget	e. Must use a numerical groundwater and surface water model or the Plan must identify and describe an alternate method f. DWR will provide the Ca Central Valley Groundwater-Surface Water Simulation Model and the Integrated Water Flow Model for GSA use. (GSA can also select an alternate method but must be called out by type)	e. Appendix D f. Noted
354.20	10733.2	Management Areas	a. Define management areas and if they will have different measurable objectives (MOs) and minimum thresholds (MTs) b. Describe the following on Management areas: 1. Reason for creation of each management area 2. MO/MTs for each management area and why those values were selected if vary from Subbasin 3. Level of monitoring and analysis in each management area 4. Why MO/MTs can differ without causing undesirable results c. GSP must include descriptions and maps of management areas.	a. Section 3.4 (p. 3-42), Section 4.3.1, Appendix I b. 1. Section 3.4 (p. 3-42), Section 4.3.1 (p 4-5), Appendix I 2. Section 3.4 (p. 3-42), Section 4.3.1 (p 4-5), Appendix I 3. Section 3.4 (p. 3-42), Section 4.3.1 (p 4-5), Appendix I 4. Section 3.4 (p. 3-42), Section 4.3.1 (p 4-5), Appendix I c. Section 3.4 (p. 3-42), Section 4.3.1 (p 4-5), Appendix I
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24	10733.2	Sustainability Goal	Description of the Sustainability Goal	Section 1.4 (p. 1-4) Section 4.1.1 (p. 4-2)
354.26	10733.2, 10721, 10723.2, 10727.2, 10733.2, 10733.8	Undesirable Results	a-b. Description of Undesirable Results, including: 1. Cause of Groundwater Conditions that would lead to Undesirable Results 2. Criteria used to define Undesirable Results for each sustainability indicator 3. Potential effects of Undesirable Results on beneficial uses and users of groundwater c. Evaluation of multiple MTs and monitoring sites to determine undesirable results	a-b. Section 4.3.2 (p. 4-6) 1. Section 4.3.2 (p.4-6) 2. Section 4.3.2 (p.4-6), Section 4.4.2 (p.4-15), Section 4.5.2 (p. 4-18), Section 4.7.2 (p.4-23), Appendix I, Appendix J 3. Section 4.3.2 (p.4-6), Section 4.4.2 (p.4-15), Section 4.5.2 (p. 4-18), Section 4.7.2 (p.4-23), Appendix I, Appendix J c. Section 4.3 (p. 4-11)
354.28 (a-b)	10723.2, 10727.2.(d).1, 10727.2.(d).2,	Minimum Thresholds	a-b. Description of each MT and how they were established for each sustainability indicator, including numeric values. 1. Information and criteria that establish and justify the MTs for each sustainability indicator 2. Relationship between MTs for each sustainability indicator 3. How MTs have been selected to avoid undesirable results for each sustainability indicator 4. How MTs may affect the interest of beneficial uses and users of groundwater 5. How state, federal, or local standards relate to the relevant sustainability indicator 6. How each MT will be quantitatively measured	a-b. Section 4.3 (p. 4-5) 1. Section 4.3.3 (p.4-10), Section 4.4.3 (p.4-17), Section 4.5.3 (p.4-21), Section 4.7.3 (p.4-25), Appendix I, Appendix J 2. Section 4.3.3 (p.4-10), Section 4.4.3 (p.4-17), Section 4.5.3 (p.4-21), Section 4.7.3 (p.4-25), Appendix I, Appendix J 3. Section 4.3.3 (p.4-10), Section 4.4.3 (p.4-17), Section 4.5.3 (p.4-21), Section 4.7.3 (p.4-25), Appendix I, Appendix J 4. Section 4.3.3 (p.4-10), Section 4.4.3 (p.4-17), Section 4.5.3 (p.4-21), Section 4.7.3 (p.4-25), Appendix I, Appendix J 5. Section 4.1 (p. 4-2) 6. Section 4.3.3 (p.4-10), Section 4.4.3 (p.4-17), Section 4.5.3 (p.4-21), Section 4.7.3 (p.4-25), Appendix I, Appendix J
354.28 (c-d)	10733.2	Minimum Thresholds	c. Definition of MTs for each sustainability indicator: 1. Chronic lowering of groundwater levels a. Rate of groundwater elevation decline based on historical trends, water year type, and projected use b. Potential effects on other sustainability indicators 2. Reduction of groundwater storage 3. Seawater intrusion 4. Degraded water quality 5. Land subsidence a. Identification of land uses and property interests affected by land subsidence and explanation of how the GSAs have determined and considered those uses and interests b. Maps and graphs showing the extent and rate of land subsidence 6. Depletions of interconnected surface water a. The location, quantity, and timing of depletions of interconnected surface water b. Description of the groundwater and surface water model used to quantify surface water depletion (or an equally effective method) d. Representative MT for groundwater elevation to serve as the value for multiple sustainability indicators e. Undesirable results related to sustainability indicators that are not present in the basin are not required to establish MTs	c. Section 4.3.3 (p.4-10), Section 4.4.3 (p.4-17), Section 4.5.3 (p.4-21), Section 4.7.3 (p.4-25), Appendix I, Appendix J 1. Section 4.3.3 (p.4-10), Appendix I a. Section 4.3.3 (p.4-10) b. Section 4.3.3 (p.4-10) 2. Section 4.4.3 (p.4-17) 3. N/A 4. Section 4.5.3 (p.4-21) 5. Section 4.7.3 (p.4-25) a. Section 4.7 (p.4-25), Section 3A.5, Appendix J b. Section 4.7 (p.4-25), Section 3A.5, Appendix J 6. Section 4.6 (p.4-22) a. N/A b. N/A d. Section 4.3.3 (p.4-10), Appendix I e. N/A

GSP Regulation Section	Water Code Section	Requirement	Description	Section(s) and Page Number(s) in the GSP
354.30	10727.2.(b).1, 10727.2.(b).2, 10727.2.(d).1 10727.2.(d).2, 10727.4, 10733.2	Measureable Objectives	a-b. Establishment of the measureable objectives for each sustainability indicator c. Description of how a reasonable margin of operational flexibility was established for each measureable objective d-e. Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones f-g. Optional inclusion of additional MOs, interim milestones	a-b. Section 4.3.4 (p.4-12), Section 4.4.4 (p.4-17), Section 4.5.4 (p.4-21), Section 4.7.4 (p.4-27), Appendix I, Appendix J c. Section 4.3.5 (p.4-13), Section 4.4.5 (p.4-17), Appendix I d-e.Section 4.3.6 (p.4-13), Section 4.4.6 (p.4-17), Section 4.5.5 (p.4-22), Section 4.7.5 (p. 4-27), Appendix I, Appendix J
Article 5. Plan Contents, Subarticle 4. Monitoring Network				
354.34.(a-b)	10727.2.(d).1, 10727.2.(d).2, 10727.2.(e), 10727.2.(f)	Monitoring Network	a-b. Description of Monitoring Network objectives and how the network will be developed and implemented with sufficient spatial and temporal frequency to: 1. Demonstrate progress towards achieving MOs 2. Monitor impacts to beneficial uses or users of groundwater 3. Monitor changes in groundwater conditions relative to MOs and MTs 4. Quantify annual changes in water budget components	a-b. Section 5.1.1. (p. 5-4) 1. Sections 5.2 through 5.6 (p. 5-6 through 5-22) 2.Sections 5.2 through 5.6 (5-6 through p.5-22) 3.Sections 5.2 through 5.6 (5-6 through p.5-22) 4.Sections 5.2 through 5.6 (5-6 through p.5-22)
354.34.(c)	10727.2.(d).1, 10727.2.(d).2, 10727.2.(e), 10727.2.(f)	Monitoring Network	c. Description of how the monitoring network provides adequate coverage of sustainability indicators: 1. Chronic lowering of groundwater levels a. Sufficient density of monitoring wells b. Static groundwater elevation measurements collected two times per year 2. Reduction of groundwater storage 3. Seawater intrusion 4. Degraded water quality 5. Land subsidence 6. Depletions of interconnected surface water d. Adequate coverage of sustainability indicators to evaluate conditions in the basin e. Site information and monitoring data from existing sources	c. Sections 5.2 through 5.6 (5-6 through p.5-22) 5-8 through 5-12) 1.Section 5.2 (p.5-6) and Appendix I 2.Section 5.3 (p.5-12) 3. Section 5.4 (p.5-14) 4. Section 5.5 (p.5-14) 5. Section 5.6 (p.5-17) and Appendix J 6. N/A d. Section 5.8 (p.5-24) e. Table 5.1.0-2, Section 5.7.1 (p.5-22), Section 5.9 (p.5-25)
354.34.(e-i)		Monitoring Network	f. Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends determined by: 1. Amount of current and projected water use 2. Aquifer characteristics that affect groundwater flow 3. Impacts to beneficial uses and users 4. Whether the Agency has long-term existing monitoring results to demonstrate aquifer response g. Scientific rational (or reason) for site selection 1. Consistency with data and reporting standards 2. Corresponding sustainability indicator, MTs, MOs, and interim milestone h. Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used i. Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	f. Section 5.1 (p. 5-3) Table 5.1.0-2, Figures 5.2.1-1 through 5.2.3-1 1. Section 3.3.5 (p. 3-37) 2. Section 3.1 (p. 3-2) 3. Section 3.1.11 (p. 3-19) 4. Section 5.1.3 (p. 5-5) g. 1. Section 5.7 (p. 5-22) 2. Section 5 (p. 5-1) h. Table 5.1.0-2, Figures 5.2.1-1 through 5.2.3-1 i. Section 5.7 (p.), Section 5.8 (p.), Section 5.9 (p.), Section 5.10 (p.)
354.36		Representative Monitoring	a. Description of representative sites with defined quantitative MTs, MOs, and interim milestones b. Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators c. Adequate evidence demonstrating representative monitoring sites reflects general conditions in the area	a. Section 5 (p. 5-1) Appendix I,Appendix J, Tables 4.3.1-1a,b,c b. N/A c. Section 3A.2 (p.3-1)
354.38		Assessment and Improvement of Monitoring Network	a. Review and evaluation of the monitoring network b-c. Identification and description of data gaps 1. Location and reason for data gaps 2. Local issues and circumstances that limit or prevent monitoring d. Description of steps to fill data gaps before the next 5-year assessment e. Adjustment of monitoring frequency and site density to provide site-specific surface water and groundwater conditions	a. Section 5 (p. 5-1) b-c. Section 5.2.4 (p.5-9), Section 5.3.4 (p.5-13), Section 5.5.4 (p.5-17), Section 5.6.4 (p.5-21) 1. Section 5.2.4 (p.5-9), Section 5.3.4 (p.5-13), Section 5.5.4 (p.5-17), Section 5.6.4 (p.5-21) 2. Section 5.8 (p.5-24) d. Section 5.8 (p.5-24) e. Section 5.8 (p.5-24)
354.40	10733.2	Reporting Monitoring Data to the Department	Monitoring data stored in the data management system developed pursuant to Section 352.6 and included in the Annual Report	Section 5.9 (p.5-24), Section 7.4 (p.7-2)
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				

GSP Regulation Section	Water Code Section	Requirement	Description	Section(s) and Page Number(s) in the GSP
354.44 (a-b)		Projects and Management Actions	a-b. Description of projects and management actions, including the following: 1. List of projects and management actions with a description of the MO that it addresses a. The circumstances and criteria to trigger project implementation and the process by which the GSAs will determine the conditions requiring implementation b. How the GSAs will notice the public and other agencies that projects will be implemented	a-b. Section 6 (p.6-1) and Table 6.1.0-1 1. Section 6 (p.6-1) and Table 6.1.0-1 a. Section 4 (p. 4-1), Appendix I, Appendix J b. Section 2.5 (p.2-21)
354.44 (c-d)			c. Projects and management actions shall be supported by the best available science d. Level of uncertainty associated with the basin should be taken into account when developing projects or management	c-d. Discussed throughout Chapter 6.

Appendix F
Interim Operating Agreement

Interim Operating Agreement for the Tulare Lake Subbasin to Develop and Implement a Groundwater Sustainability Plan

THIS INTERIM OPERATING AGREEMENT FOR THE TULARE LAKE SUBBASIN TO DEVELOP AND IMPLEMENT A GROUNDWATER SUSTAINABILITY PLAN (this “Agreement") is effective September 1, 2017, among the MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY, SOUTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, EL RICO GROUNDWATER SUSTAINABILITY AGENCY, SOUTHWEST KINGS GROUNDWATER SUSTAINABILITY AGENCY, TRI-COUNTY WATER AUTHORITY, and ALPAUGH IRRIGATION DISTRICT. The signatories to this Agreement are hereinafter referred to collectively as the "Parties" or individually as "Party".

RECITALS

WHEREAS, the Parties are all located within the Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Tulare Lake Subbasin, a groundwater subbasin recognized by the California Department of Water Resources ("DWR") Bulletin 118 (2016) as Groundwater Basin No. 5-22.12 (hereinafter “Subbasin”) and a depiction of the Subbasin is attached hereto as Exhibit "A" and incorporated herein by this reference; and

WHEREAS, the State of California has classified the entire Subbasin as an Economically Distressed Area and each community within the Subbasin as a Disadvantaged Community; and

WHEREAS, all lands within the Subbasin are included within one of the six groundwater sustainability agencies (“GSAs”) that are the Parties to this Agreement, and each Party has been or are in the process of being determined an “exclusive” GSA by DWR; and

WHEREAS, the Sustainable Groundwater Management Act ("SGMA") requires the development and establishment of groundwater sustainability plans ("GSPs"), which are designed to ensure the sustainability of groundwater basins and subbasins; and

WHEREAS, DWR has identified the Subbasin as a critically overdrafted subbasin; and

WHEREAS, SGMA allows local agencies or a combination of local agencies overlying a groundwater basin to serve as a GSA to develop and implement a GSP over an entire basin, subbasin, or a portion of a basin; and

WHEREAS, pursuant to Water Code §10727, SGMA allows for the preparation of a GSP by three methods: (a) a single GSP covering the entire basin/subbasin developed and implemented by one GSA, (b) a single GSP covering the entire basin/subbasin developed and implemented by multiple GSAs, or (c) multiple GSPs implemented by two or more GSAs that are subject to a single Coordination Agreement that covers the entire basin/subbasin; and

WHEREAS, Water Code §10727.6 requires that if multiple GSPs will be implemented within a subbasin, then a Coordination Agreement must be prepared to ensure that the GSPs utilize the same data and methodologies within that subbasin for the following items: (a) groundwater elevation data, (b) groundwater extraction data, (c) surface water supply, (d) total water use, (e) change in groundwater storage, (f) water budget, and (g) sustainable yield; and

WHEREAS, the Parties acknowledge that multiple GSAs have been formed within the Subbasin and those GSAs currently seek to explore the possibility of developing and implementing a single GSP. The Parties also acknowledge the desire to have a single GSP may not be achievable, but regardless of whether one or more GSPs are developed for the Subbasin, an interim agreement is beneficial to the Parties in proceeding to initially develop and coordinate the data and methodologies required by SGMA for the Subbasin; and

WHEREAS, the Parties acknowledge that the GSAs need to do further data collection prior to making decisions with regard to GSP preparation and implementation, but the Parties agree that in the future a Coordination Agreement or an amendment to or replacement of this Agreement will be necessary based on the additional information obtained and decisions made by the Parties under this Agreement; and

WHEREAS, the purpose of this Agreement is to provide a framework among the Parties for a cooperative means of gathering the initial data and information for a single GSP, applying for grant funding, selecting consultants, and coordinating on other SGMA-related issues for the Subbasin.

NOW, THEREFORE, in consideration of the mutual promises, covenants, and conditions hereinafter set forth and the above Recitals, which are hereby incorporated herein by this reference, it is agreed by and among the Parties hereto as follows.

SECTION 1. DEFINITIONS

1.1 "Tulare Lake Subbasin" or "Subbasin" refers to that subbasin identified and described in California Department of Water Resources Groundwater Bulletin 118 as part of the Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Tulare Lake Subbasin, also identified as Groundwater Basin No. 5-22.12, and is depicted in Exhibit “A” of this Agreement.

1.2 "Groundwater Sustainability Agency" or "GSA" means one or more local agencies that implement the provisions of SGMA as defined by Water Code §10721(j).

1.3. "Groundwater Sustainability Plan" or "GSP" means a plan of one or more GSAs proposed or adopted under SGMA as defined in Water Code §10721(k).

1.4 "Coordination Agreement" shall be the agreement (whether one or more GSPs are developed within the Subbasin) to ensure coordination of the data and methodologies used by each GSA in developing the GSP(s) within the Subbasin for the following assumptions: (a) groundwater elevation data, (b) groundwater extraction data, (c) surface water supply, (d) total water use, (e) change in groundwater storage, (f) water budget, and (g) sustainable yield (Water Code §10721(d); 10727.6).

SECTION 2. PURPOSES AND GOALS

2.1 The Parties are entering into this Agreement to perform the following:

(a) Set forth their mutual intent to work towards the development of a single GSP for the Subbasin.

(b) Authorize research and collection of the data required for the GSP according to a mutually agreeable timeline.

(c) The Parties agree to utilize their best efforts in selecting and fully cooperating with the consultants gathering the information, preparing grant applications, and preparing the GSP.

(d) The Parties agree that after they gather data and determine an appropriate governance structure, they will either (1) amend or replace this Agreement to reflect specifics required to finalize a GSP or (2) if a single GSP is not to occur, prepare and enter into a Coordination Agreement setting forth appropriate assumptions based on information gathered and developed as a result of this Agreement.

SECTION 3. COST SHARING AND GOVERNANCE

3.1 The Parties agree that if grant funds are available for grant applications, efforts necessary to develop a GSP(s), facilitation and/or consultant costs, and similar efforts to develop a GSP(s) for the Subbasin, then the Parties have the authority to and shall act jointly in applying for and seeking to obtain such grant funds. Any grant funds received on behalf of the Subbasin and/or all of the Parties, shall first be applied to eligible costs incurred after July 1, 2017; should any funds then remain, the Parties may develop a method for reimbursing relevant costs incurred by the Parties prior to the effective date of this Agreement.

3.2 The Parties agree to the following formula, identified in the table below, for sharing costs to develop and implement the actions taken within the confines of this Agreement. As shown below, after combining the El Rico GSA and Alpaugh Irrigation District, one-half the costs shall be allocated one-fifth to each of the participants and one-half of the costs shall be allocated in proportion to the relative acreage of each Party. The overall proportionate cost of each Party is shown as the Total Cost Allocation in the table below.

GSA	Acres	Acreage Portion	Participant Portion	Total Cost Allocation
Mid-Kings River GSA	97,384.6	0.09084	0.1	0.19084
South Fork Kings GSA	71,310.9	0.06652	0.1	0.16652
El Rico GSA/Alpaugh ID	228,653.4	0.21328	0.1	0.31328
Southwest Kings GSA	90,037.1	0.08398	0.1	0.18398
Tri-County WA	48,656.5	0.04538	0.1	0.14538
Totals	536,042.5	0.50000	0.5	1.00000

3.3 All decisions related to implementing or amending this Agreement shall require a unanimous vote of the authorized representatives of each of the five (5) entities[1] identified in the table shown in Section 3.2 of this Agreement; a quorum is represented by any four (4) authorized representatives of these five (5) entities. Decisions may include, but are not limited to hiring experts or consultants to prepare and draft documents associated with this Agreement that would exceed $100,000, developing the Coordination Agreement (if necessary), applying for grant funding, and/or developing all or portions of a GSP(s).

SECTION 4. GENERAL PROVISIONS

4.1. Term. This Agreement shall become effective on the date first above written and shall remain in effect until superseded by amendment to this Agreement or another agreement among the Parties which shall address more specifics that are not available at this time for the final development and implementation of the GSP(s).

4.2 Withdrawal. Any Party shall have the right to withdraw from this Agreement by giving each of the other Parties written notice at least 30 days prior to its date of withdrawal ("Withdrawal Date"). The withdrawing Party shall be responsible for its share of any costs incurred under this Agreement up to its Withdrawal Date. Except as set forth in the preceding sentence, and except for the withdrawing Party's obligations under Section 5 hereof relating to confidential information, effective as of the Withdrawal Date, the withdrawing Party shall be

[1] For purposes of cost sharing and voting, the El Rico GSA and Alpaugh ID are to be considered as one entity; it shall be up to those two GSAs to determine their internal cost-sharing and voting process.

relieved and released of all obligations under this Agreement.

4.3 Construction of Terms. This Agreement is for the sole benefit of the Parties and shall not be construed as granting rights to or imposing obligations on any person other than the Parties.

4.4 Good Faith. Each Party shall use its best efforts and work in good faith for the completion of the purposes and goals of this Agreement and the satisfactory performance of its terms.

4.5 Rights of the Parties and Constituencies. This Agreement does not contemplate the Parties taking any action that would (a) adversely affect the rights of any of the Parties or (b) adversely affect the constituencies of any of the Parties.

4.6 Counterparts. This Agreement may be executed in counterparts and the signed counterparts shall constitute a single instrument. The signatories to this Agreement represent that they have the authority to sign this Agreement and to bind the Party for whom they are signing.

4.7 Governing Law. This Agreement and all documents provided for herein and the rights and obligations of the Parties hereto shall be governed in all respects, including validity, interpretation and effect, by the laws of the State of California (without giving effect to any choice of law principles).

4.8 Waiver. The failure of any Party to insist on strict compliance with any provision of this Agreement shall not be considered a waiver of any right to do so, whether for that breach or any subsequent breach. The acceptance by any Party of either performance or payment shall not be considered to be a waiver of any preceding breach of the Agreement by any other Party.

4.9 Recitals and Exhibits. The Recitals and Exhibits are incorporated into the Agreement.

SECTION 5. CONFIDENTIALITY PROVISIONS

5.1 Confidential Information. The confidential information to be disclosed under this Agreement ("Confidential Information") includes data, information, modeling, projections, estimates, plans, that are not public information and in which each Party has a reasonable expectation of confidentiality, regardless of whether such information is designated as Confidential Information at the time of its disclosure.

5.2 Duty to Protect. In addition to the above, Confidential Information shall also include, and the Parties shall have a duty to protect, other confidential and/or sensitive information which is (a) disclosed in writing and marked as confidential (or with other similar designation) at the time of disclosure; and/or (b) disclosed in any other manner and identified as confidential at the time of disclosure or is summarized and designated as confidential in a written memorandum delivered within thirty (30) days of the disclosure.

5.3 Limited Use. The Parties shall use the Confidential Information only for the purposes set forth in this Agreement.

5.4 Limited Disclosure. The Parties shall limit disclosure of Confidential Information within its own organization to its directors, officers, partners, members and/or employees having a need to know and shall not disclose Confidential Information to any third party (whether an individual, corporation, or other entity) without prior written consent of all the Parties. The Parties shall satisfy their obligations under this paragraph if they take affirmative measures to ensure compliance with these confidentiality obligations through their employees, agents, consultants and others who are permitted access to or use of the Confidential Information.

5.5 Allowable Disclosure. This Agreement imposes no obligation upon the Parties with respect to any Confidential Information (a) that was possessed before receipt; (b) is or becomes a matter of public knowledge through no fault of receiving Party; (c) is rightfully received from a third party not owing a duty of confidentiality; (d) is disclosed without a duty of confidentiality to a third party by, or with the authorization of the disclosing Party; or (e) is independently developed.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement to be effective as of the date first above written.

(the remainder of this page has been intentionally left blank)

Mid-Kings River Groundwater Sustainability Agency

By: Barry McCutcheon

Title: Chairman

Name: Barry McCutcheon

South Fork Kings Groundwater Sustainability Agency

By:______________________________

Title:______________________

Name: ______________________________

El Rico Groundwater Sustainability Agency

By:______________________________

Title:__________________

Name: ______________________________

Southwest Kings Groundwater Sustainability Agency

By:______________________________

Title:__________________

Name: ______________________________

Tri-County Water Authority

By:______________________________

Title:__________________

Name: ______________________________

Alpaugh Irrigation District

By:______________________________

Title: ____________________

Name: ______________________________

Mid-Kings River Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ______________________________

South Fork Kings Groundwater Sustainability Agency

By: Joe Neves Title: Chairman

Name: Joe Neves

El Rico Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ______________________________

Southwest Kings Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ______________________________

Tri-County Water Authority

By:______________________________ Title:________________

Name: ______________________________

Alpaugh Irrigation District

By:______________________________ Title: ________________

Name: ______________________________

Mid-Kings River Groundwater Sustainability Agency

By:____________________________ Title:________________

Name: ____________________________

South Fork Kings Groundwater Sustainability Agency

By:____________________________ Title:____________________

Name: ____________________________

El Rico Groundwater Sustainability Agency

By: [signature] Title: CHAIRMAN

Name: JEOF WYRICK

Southwest Kings Groundwater Sustainability Agency

By:____________________________ Title:________________

Name: ____________________________

Tri-County Water Authority

By:____________________________ Title:________________

Name: ____________________________

Alpaugh Irrigation District

By:____________________________ Title: ____________________

Name: ____________________________

Mid Kings Groundwater Sustainability Agency

By:________________________ Title:________________

Name: ________________________

South Fork Kings Groundwater Sustainability Agency

By:________________________ Title:________________

Name: ________________________

El Rico Groundwater Sustainability Agency

By:________________________ Title:________________

Name: ________________________

Southwest Kings Groundwater Sustainability Agency

By: [signature] Title: President

Name: William D Phillimore

Tri-County Water Authority

By:________________________ Title:________________

Name: ________________________

Alpaugh Irrigation District

By:________________________ Title: ________________

Name: ________________________

Mid Kings Groundwater Sustainability Agency

By:________________________ Title:________________

Name: ________________________

South Fork Kings Groundwater Sustainability Agency

By:________________________ Title:________________

Name: ________________________

El Rico Groundwater Sustainability Agency

By:________________________ Title:________________

Name: ________________________

Southwest Kings Groundwater Sustainability Agency

By:________________________ Title:________________

Name:________________________

Tri-County Water Authority

By:________________________ Title: Chairman

Name: MATTHEW H. HURLEY

Alpaugh Irrigation District

By:________________________ Title: ________________

Name: ________________________

Mid-Kings River Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ____________________________

South Fork Kings Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ____________________________

El Rico Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ____________________________

Southwest Kings Groundwater Sustainability Agency

By:______________________________ Title:________________

Name: ____________________________

Tri-County Water Authority

By:______________________________ Title:________________

Name: ____________________________

Alpaugh Irrigation District

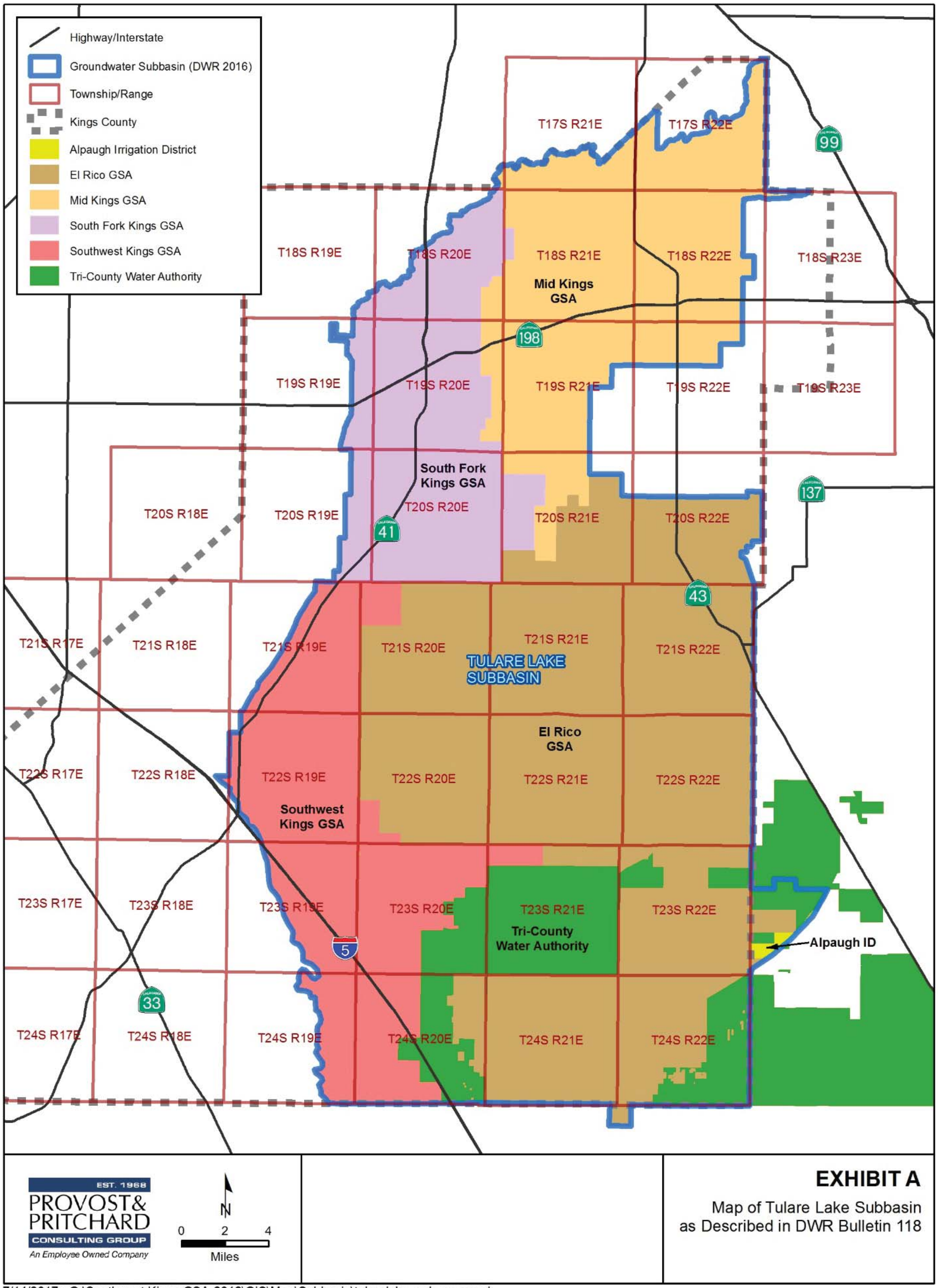
By: [signature] Title: G.M.

Name: BRUCE HOWARTH

Exhibit "A"

Map of Tulare Lake Subbasin as Described in

DWR Bulletin 118



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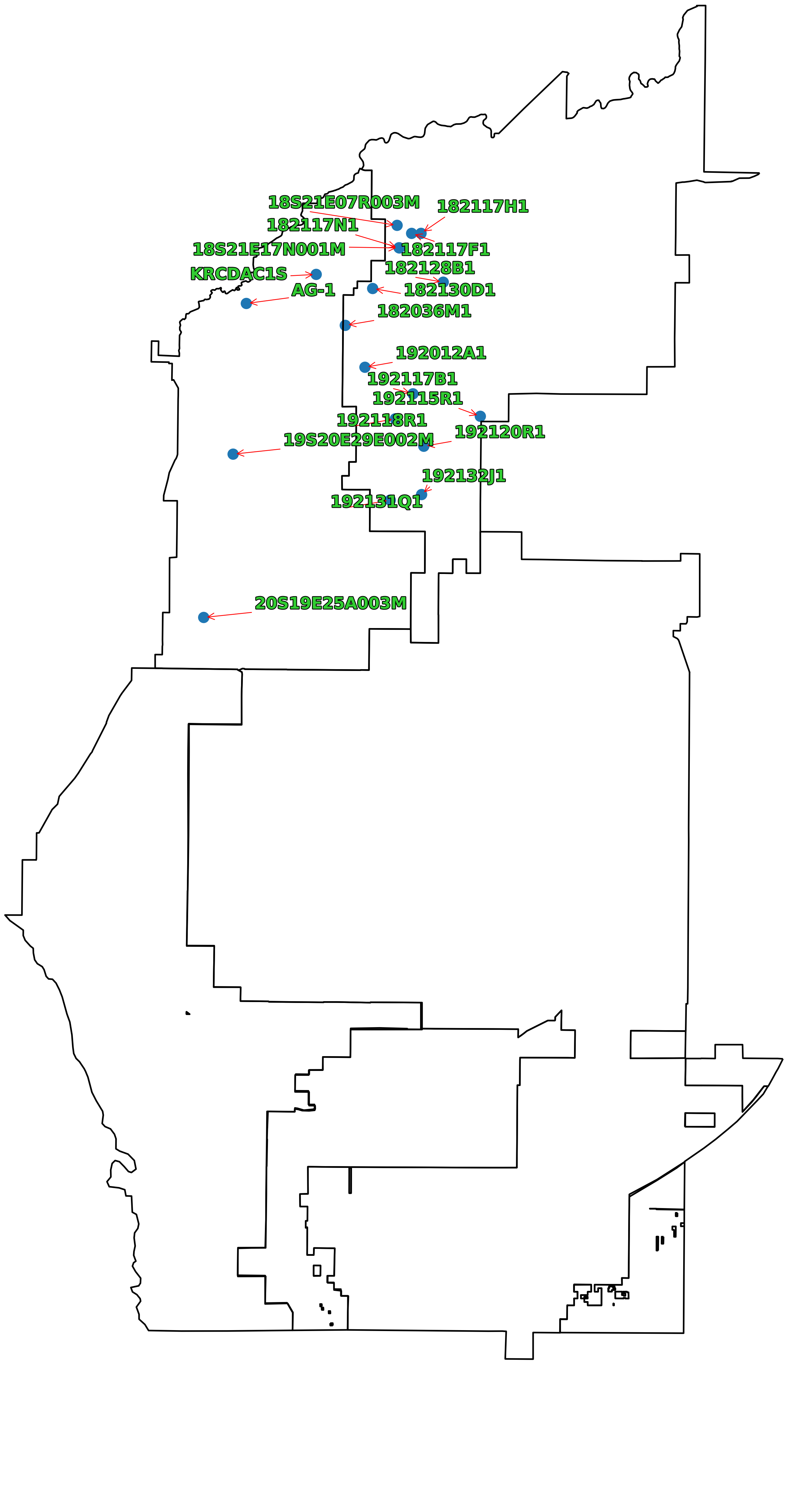
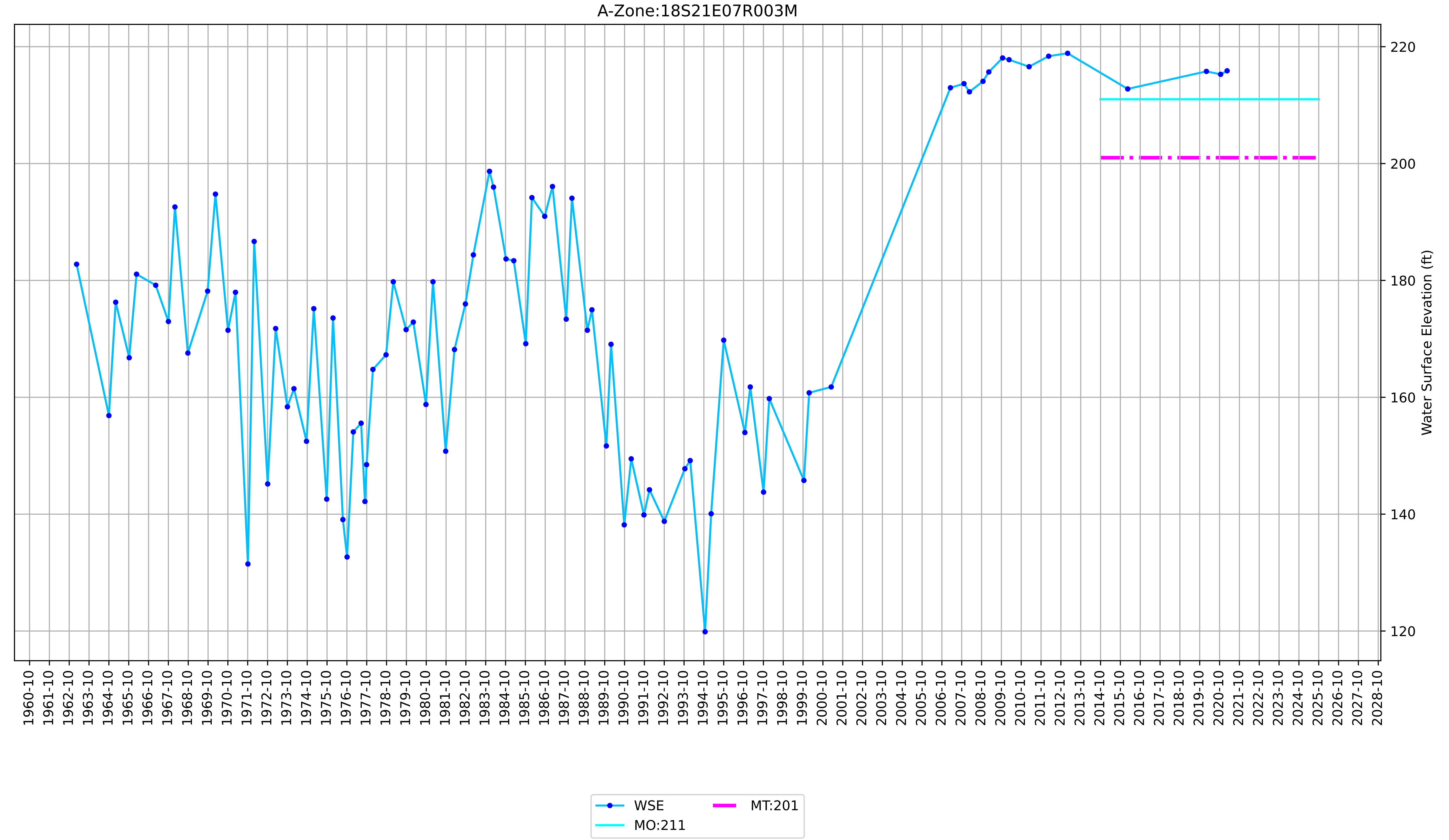
Appendix G
Well Hydrographs with MO and MT & Transducer Graphs

A-Zone RMS Wells

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Water Surface Elevation (ft)
220
200
180
160
140
120
1960-10
1961-10
1962-10
1963-10
1964-10
1965-10
1966-10
1967-10
1968-10
1969-10
1970-10
1971-10
1972-10
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2016-10
2017-10
2018-10
2019-10
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2025-10
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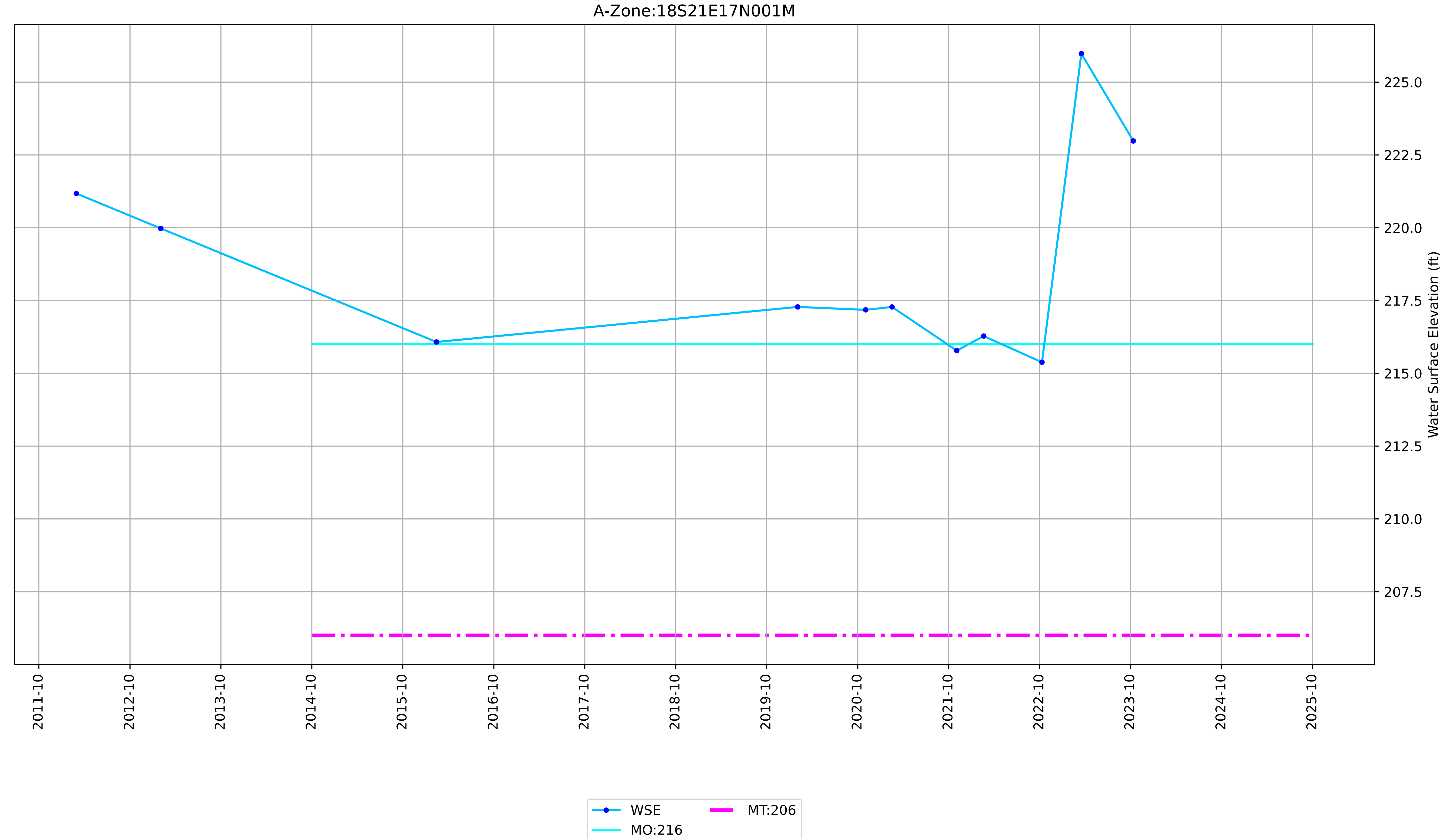
2027-10
2028-10
WSE
MO:211
MT:201



A-Zone:18S21E17N001M
225.0
222.5
220.0
217.5
215.0
212.5
210.0
207.5
Water Surface Elevation (ft)
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
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2020-10
2021-10
2022-10
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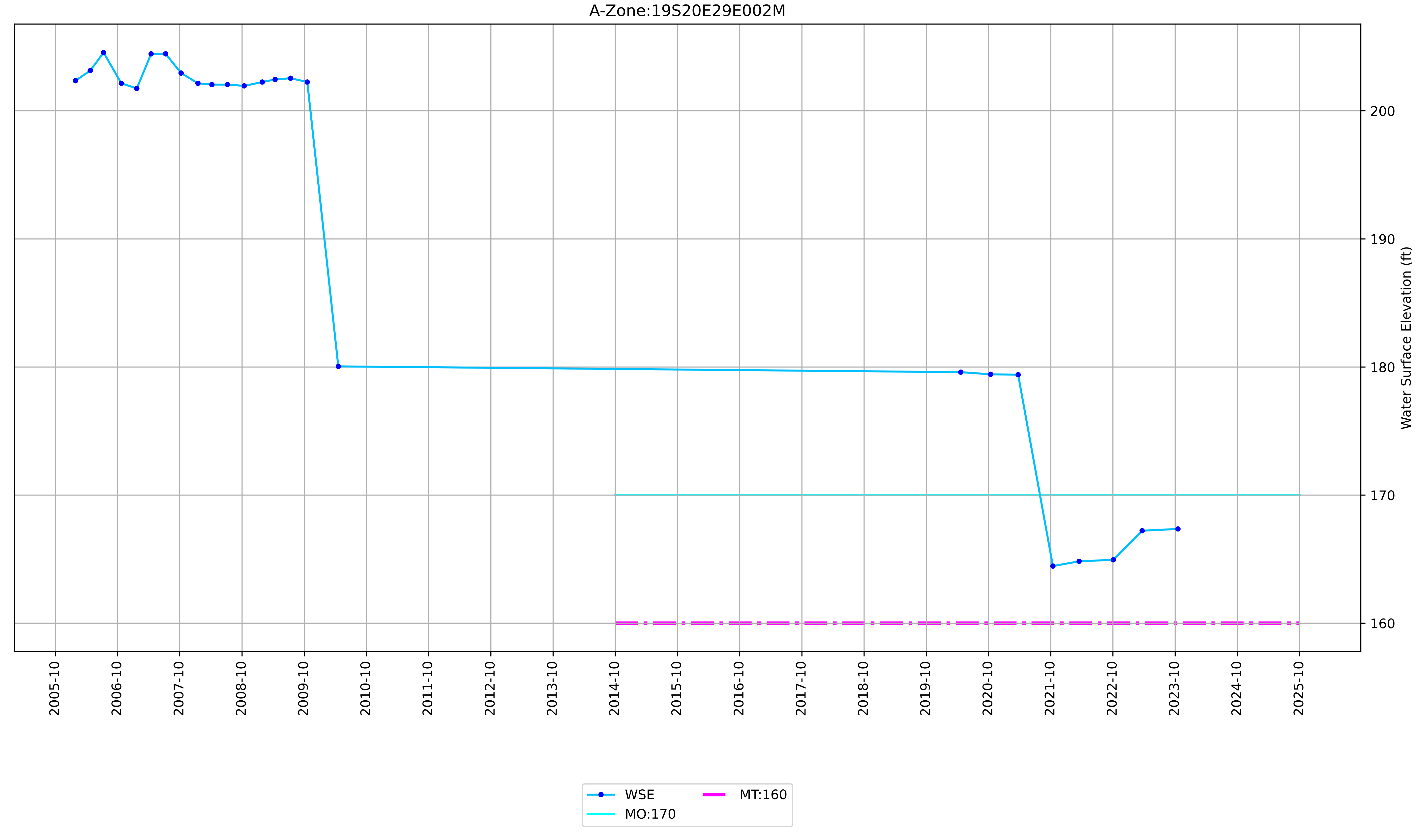
WSE
MT:206
MO:216



A-Zone:19S20E29E002M
Water Surface Elevation (ft)
200
190
180
170
160
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
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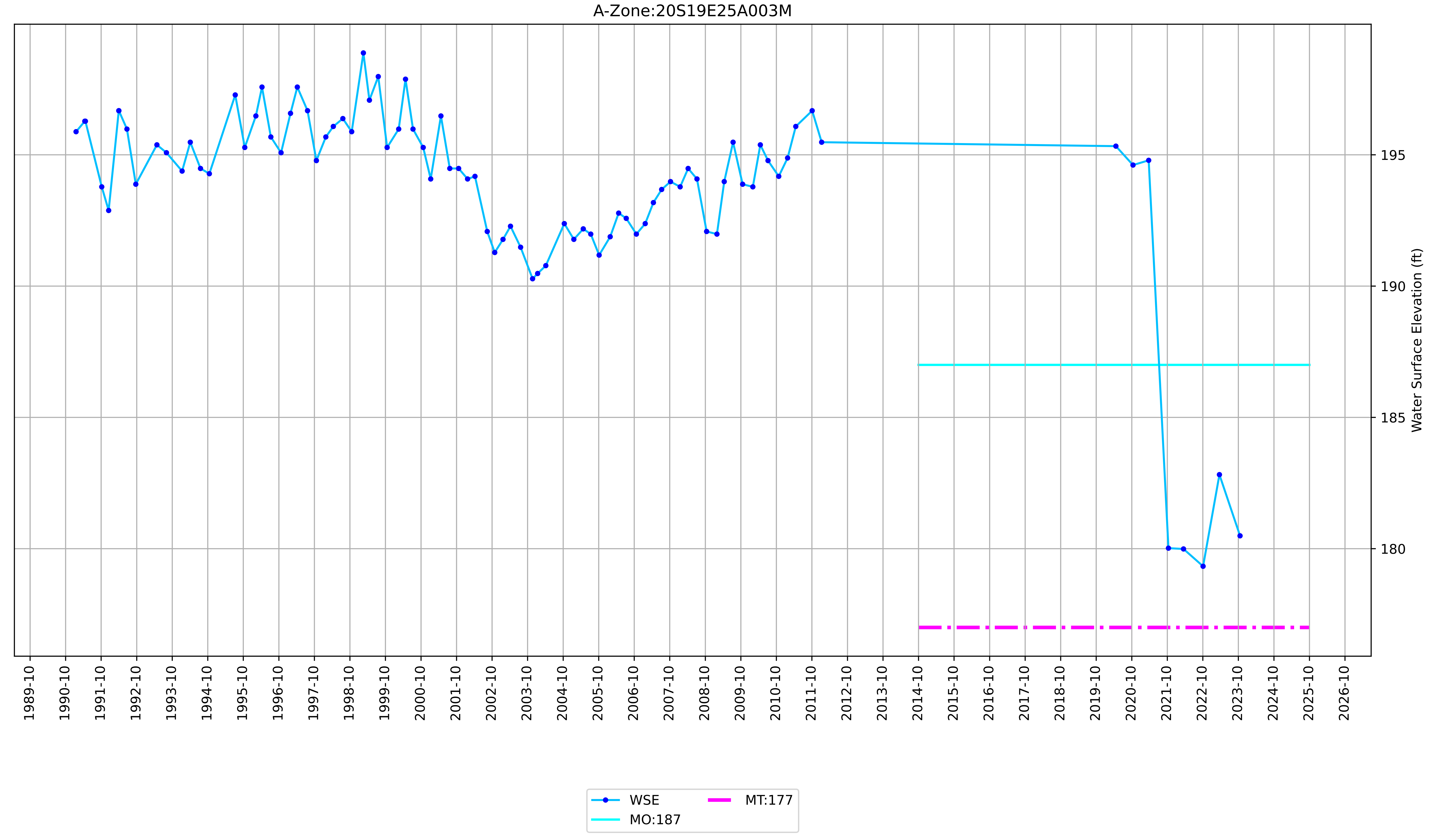
WSE
MO:170
MT:160


A-Zone:20S19E25A003M
Water Surface Elevation (ft)
195
190
185
180
1989-10
1990-10
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1995-10
1996-10
1997-10
1998-10
1999-10
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2014-10
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2017-10
2018-10
2019-10
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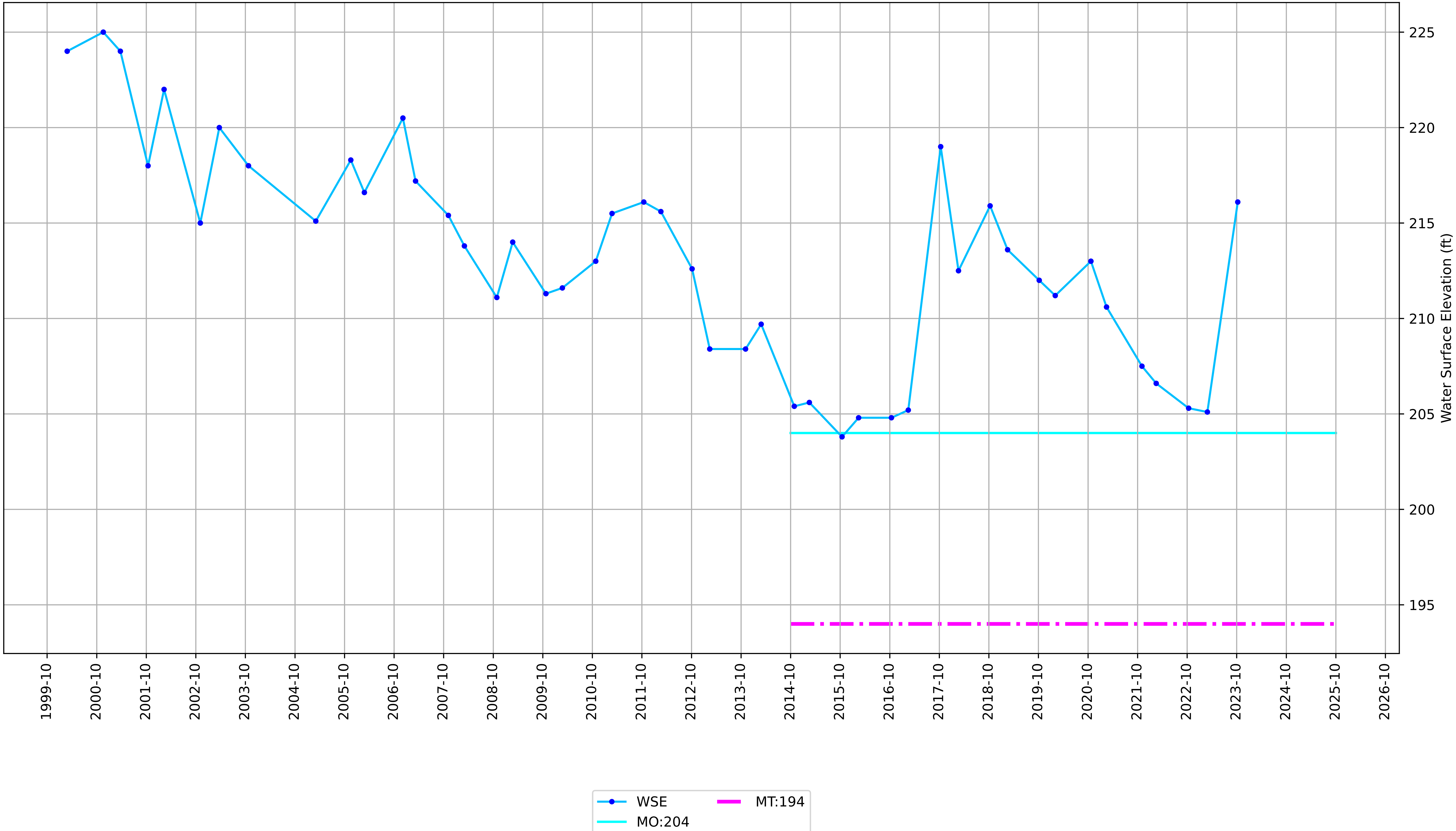
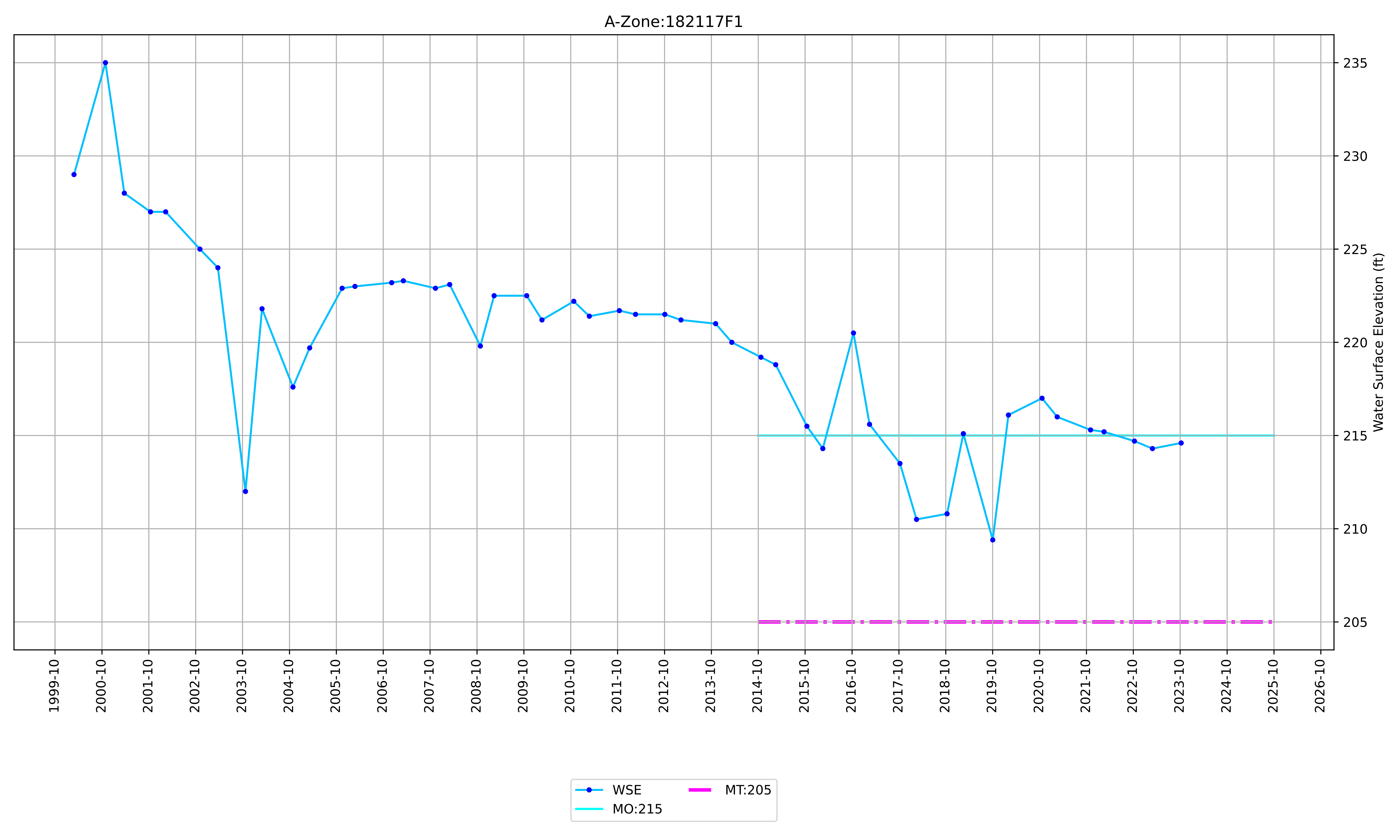
WSE
MO:187
MT:177

A-Zone:182036M1





A-Zone:182117F1
Water Surface Elevation (ft)
235
230
225
220
215
210
205
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
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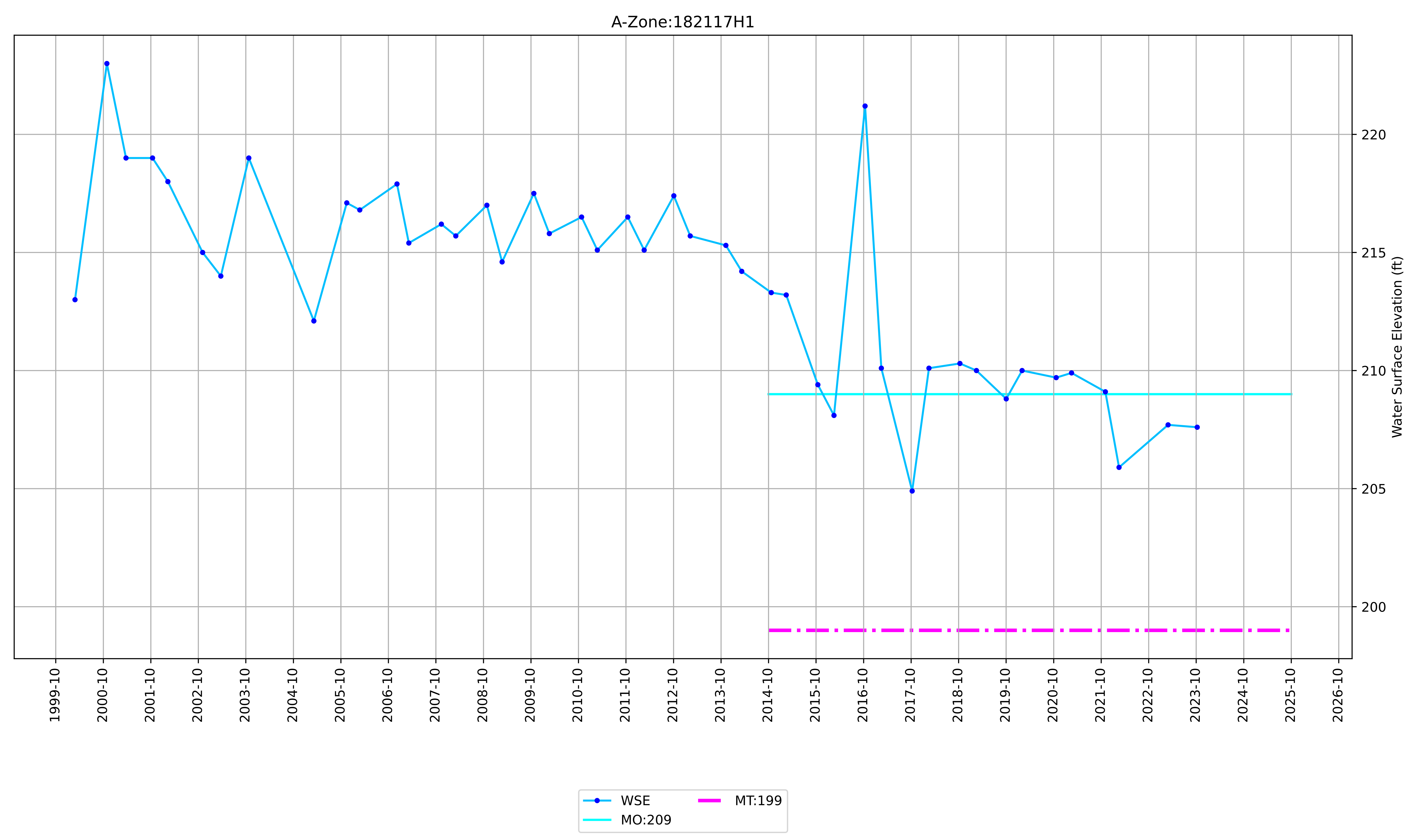
MO:215
MT:205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Water Surface Elevation (ft)
220
215
210
205
200
1999-10
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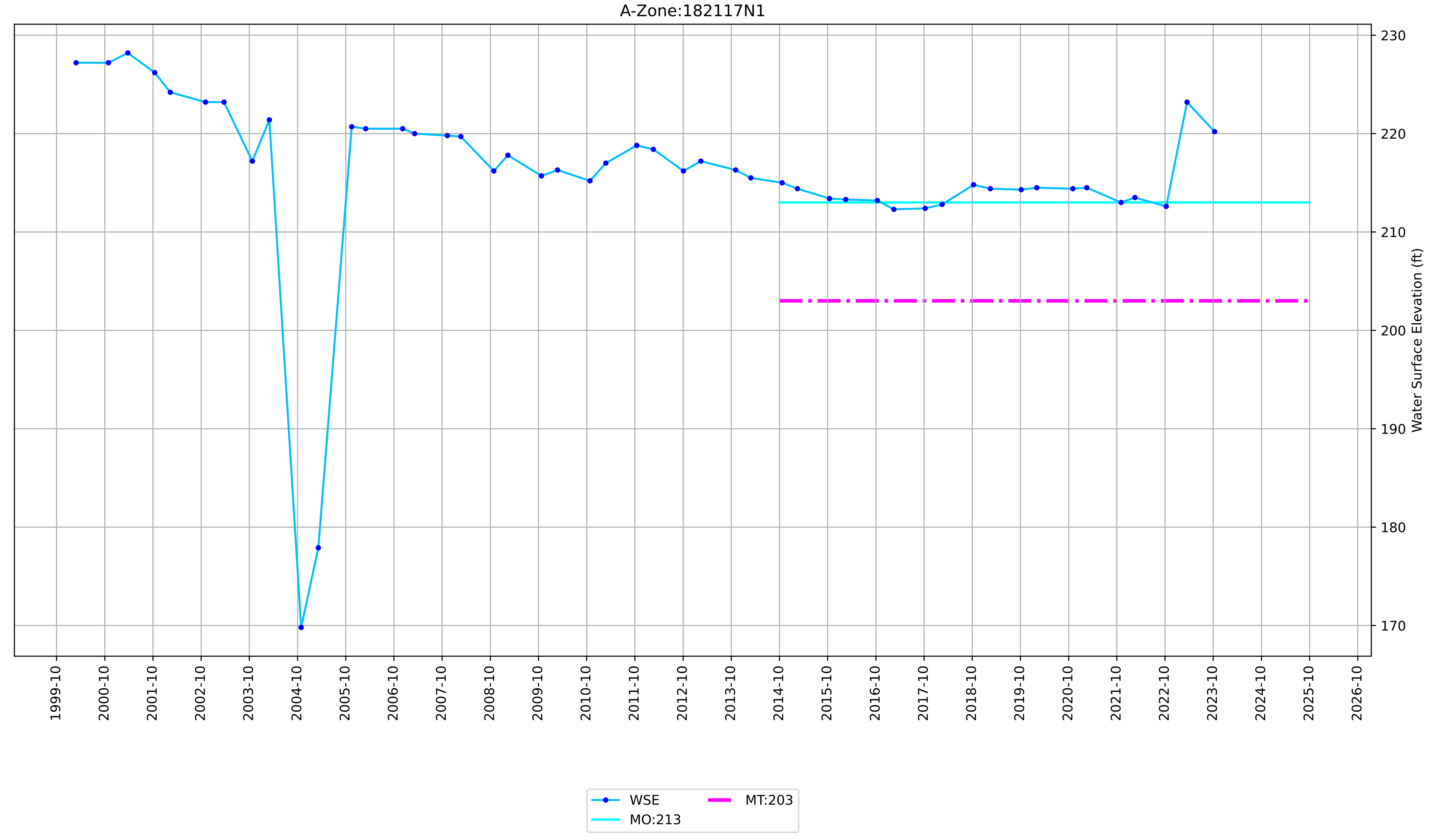
MO:209
MT:199



A-Zone:182117N1
Water Surface Elevation (ft)
230
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210
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190
180
170
1999-10
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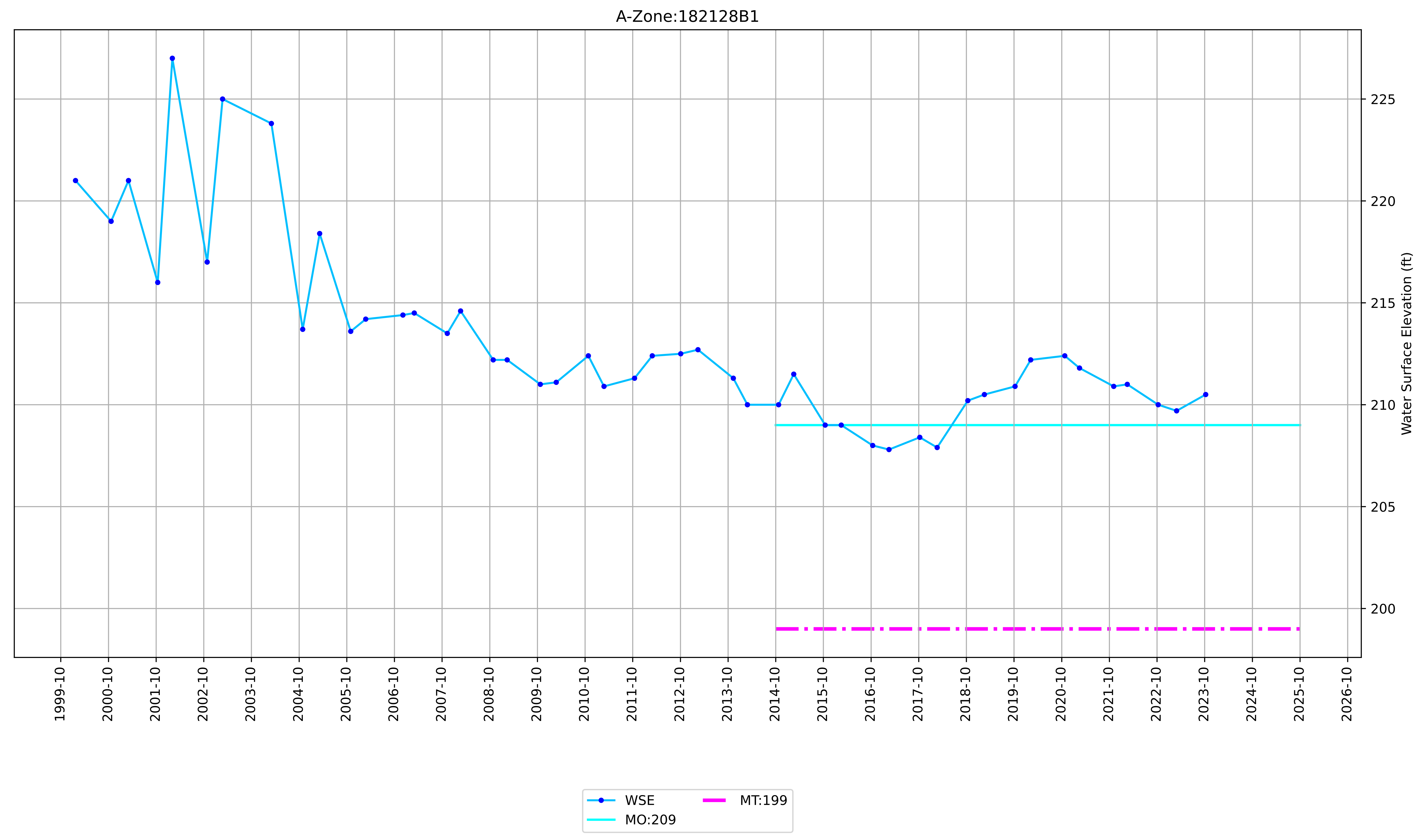
MT:203



A-Zone:182128B1
Water Surface Elevation (ft)
225
220
215
210
205
200
1999-10
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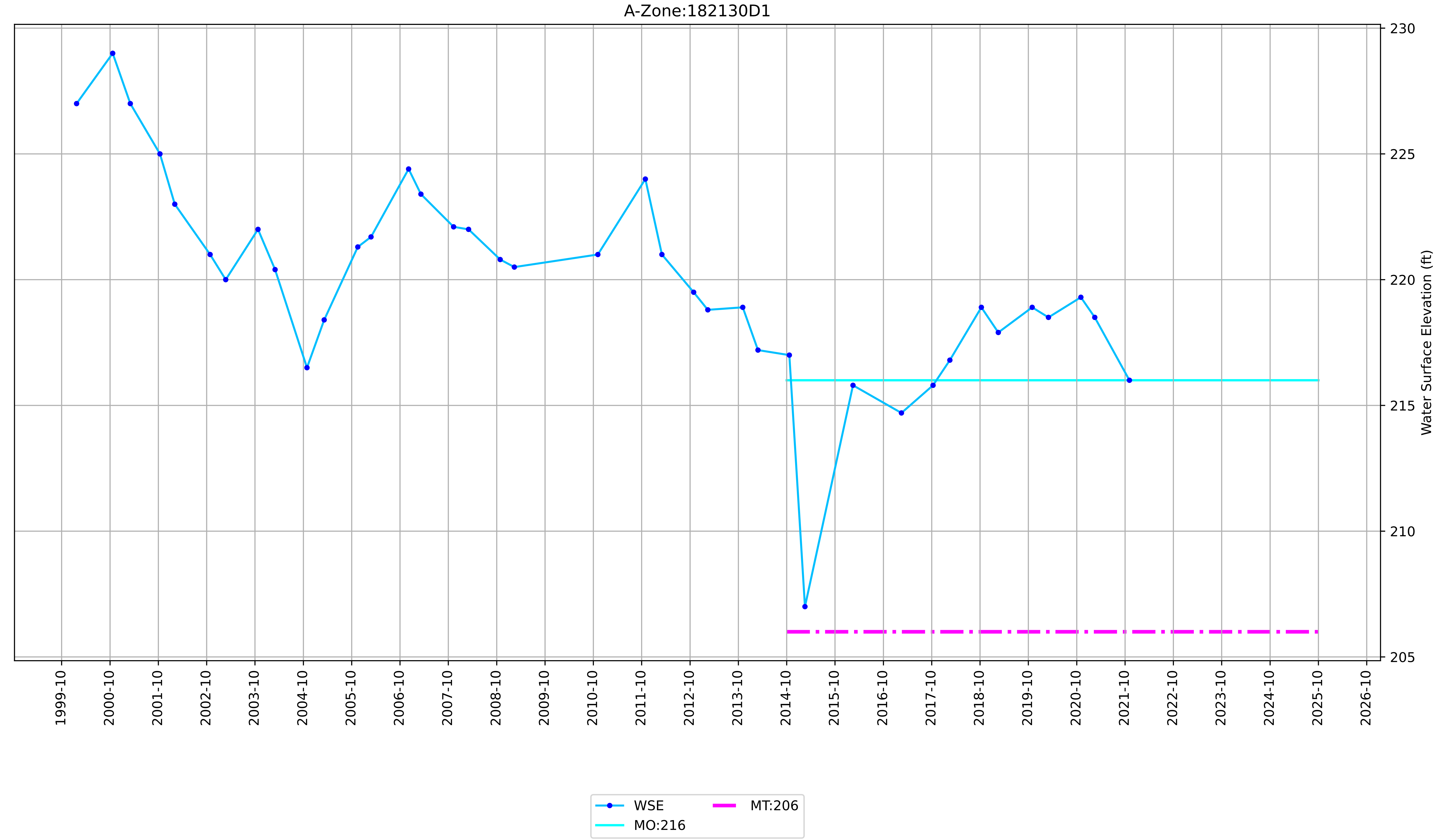
MT:199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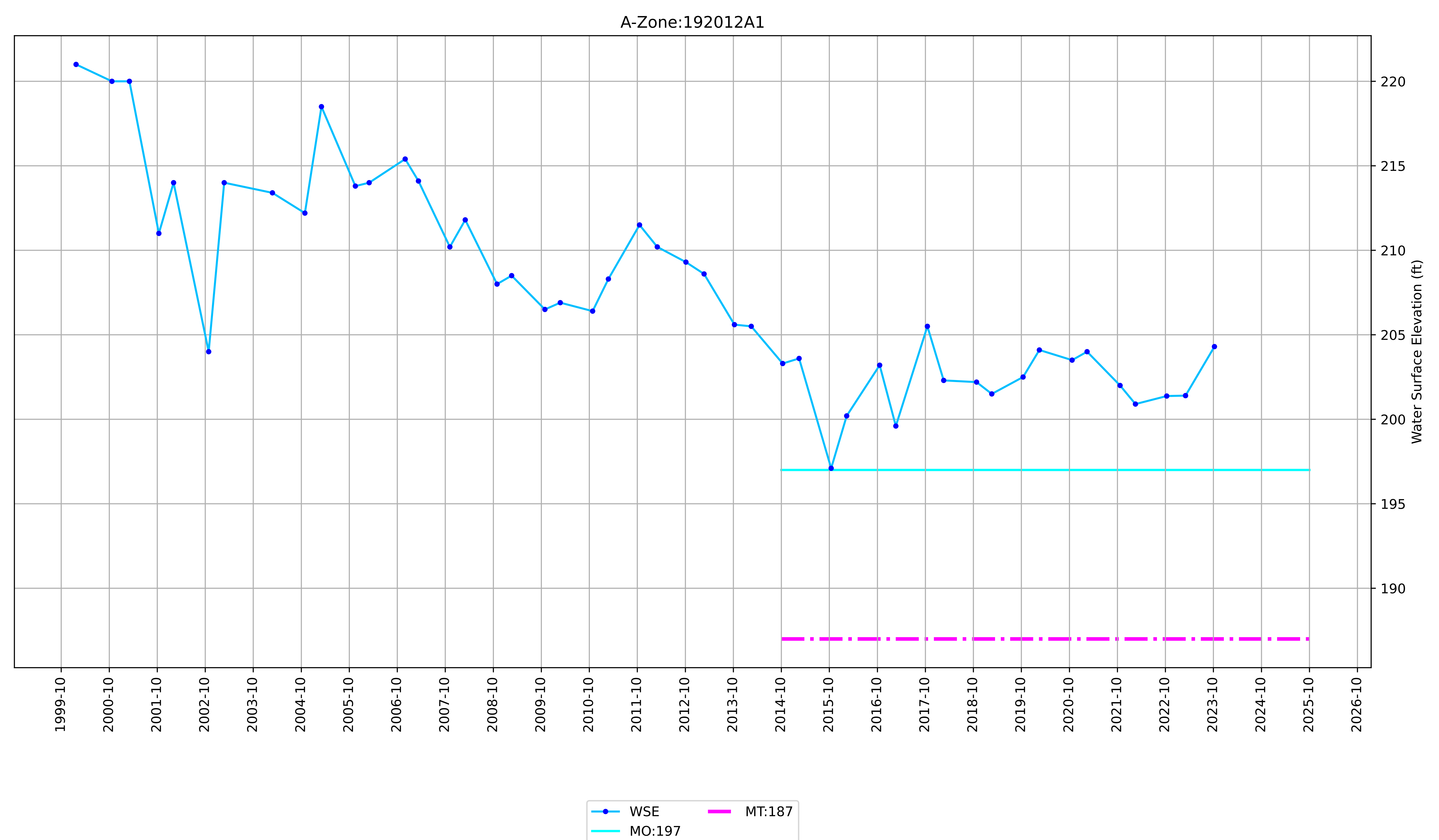

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Water Surface Elevation (ft)
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215
210
205
200
195
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2006-10
2007-10
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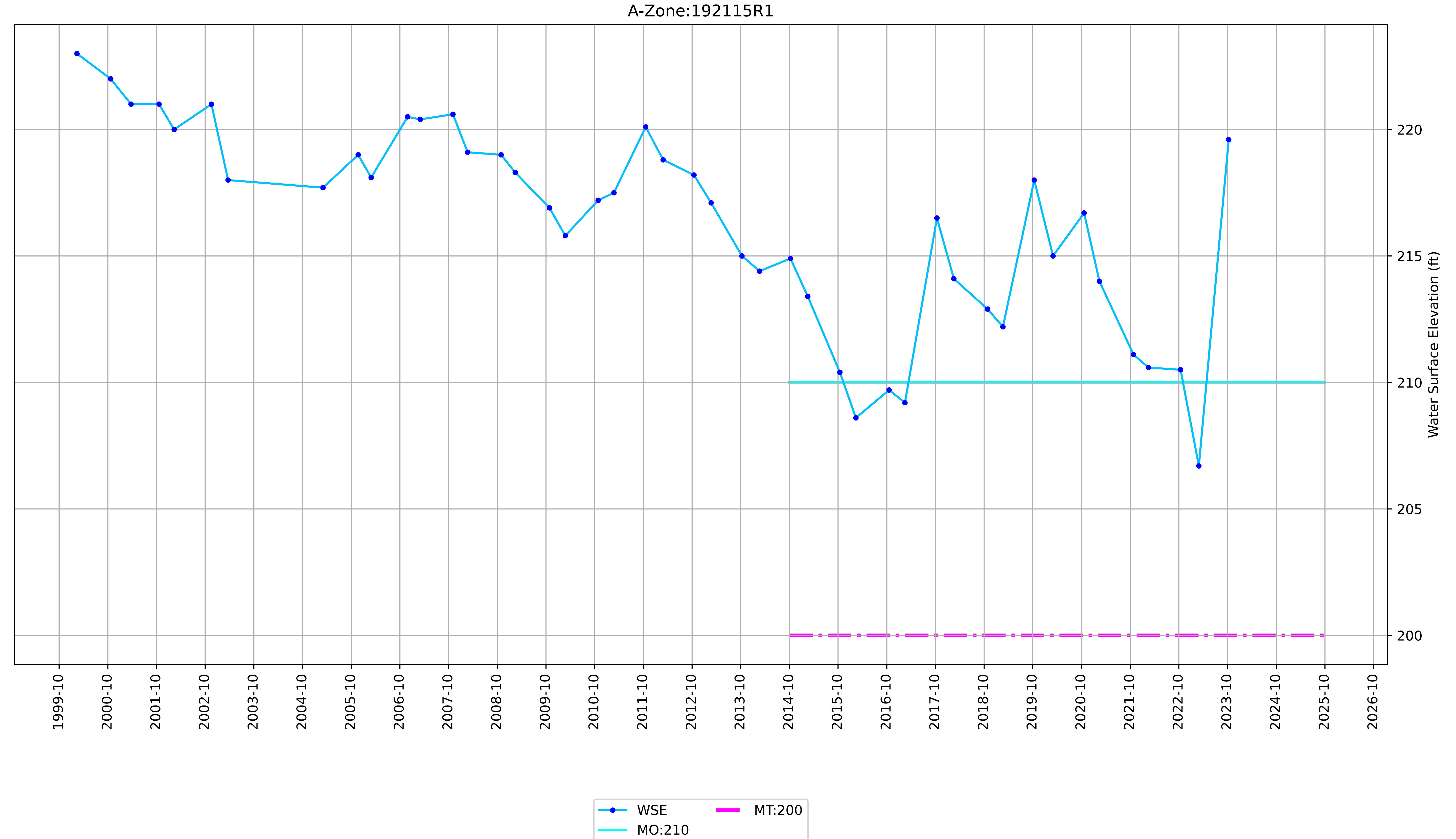

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Water Surface Elevation (ft)
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200
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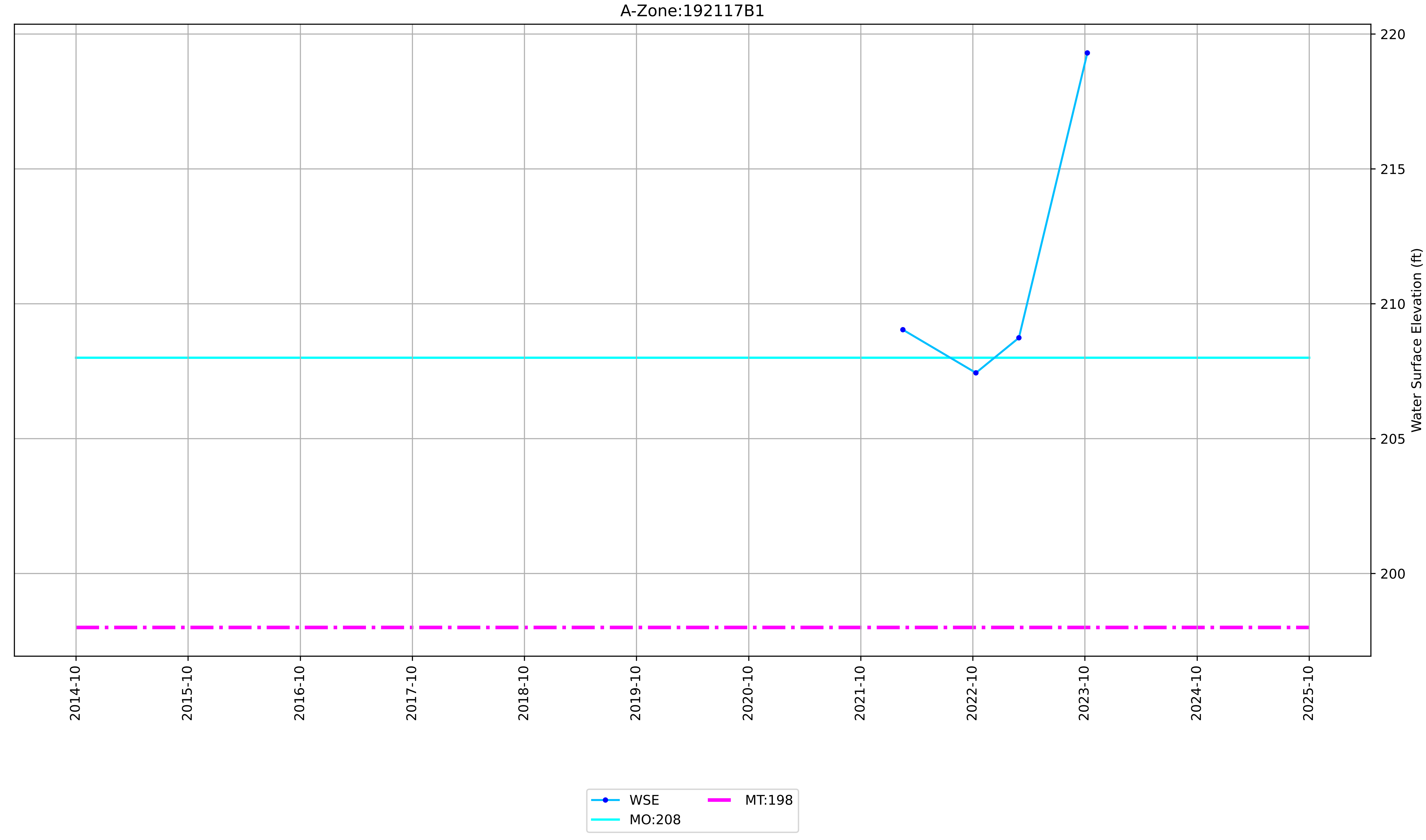
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Water Surface Elevation (ft)
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215
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205
200
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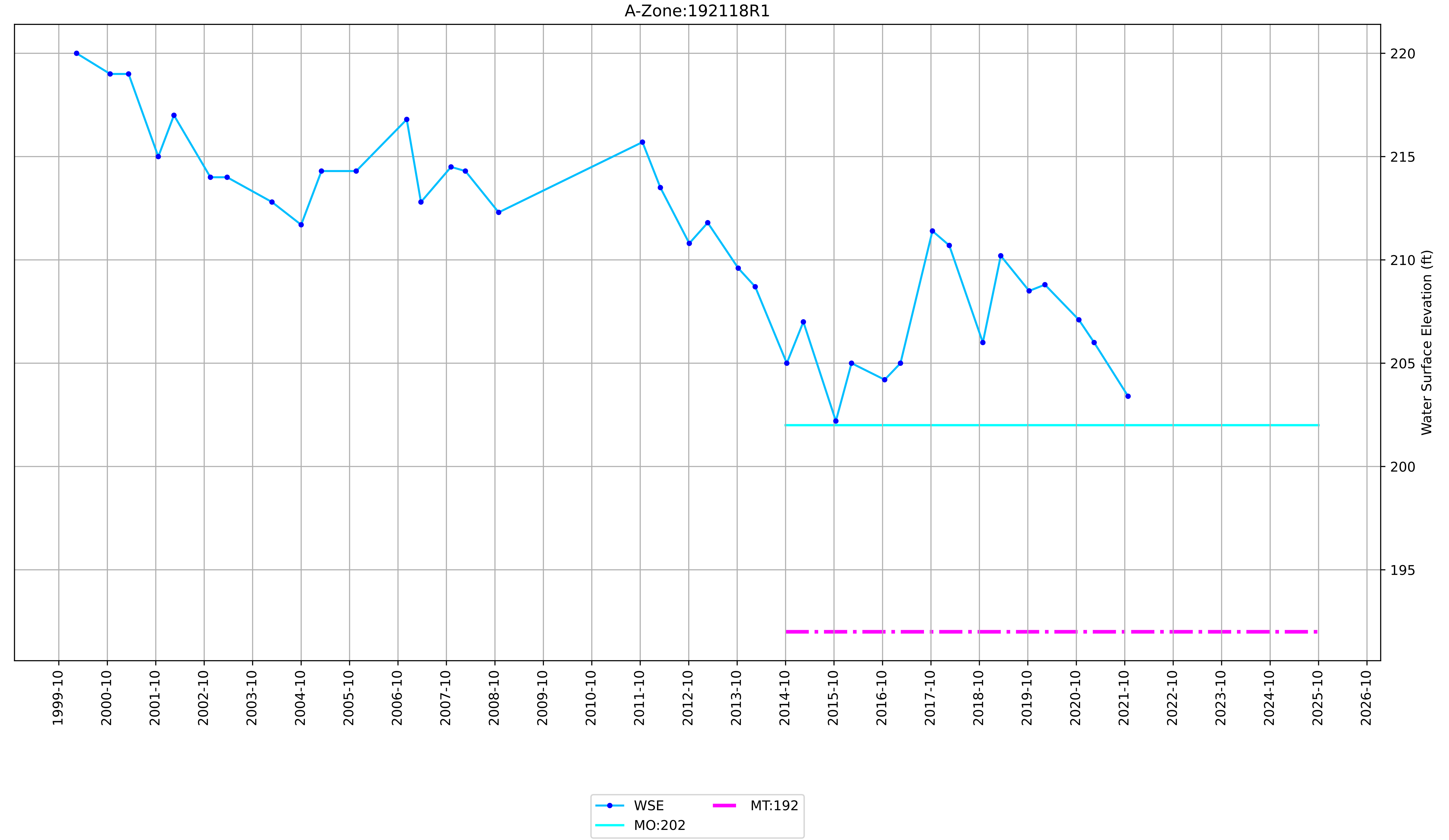

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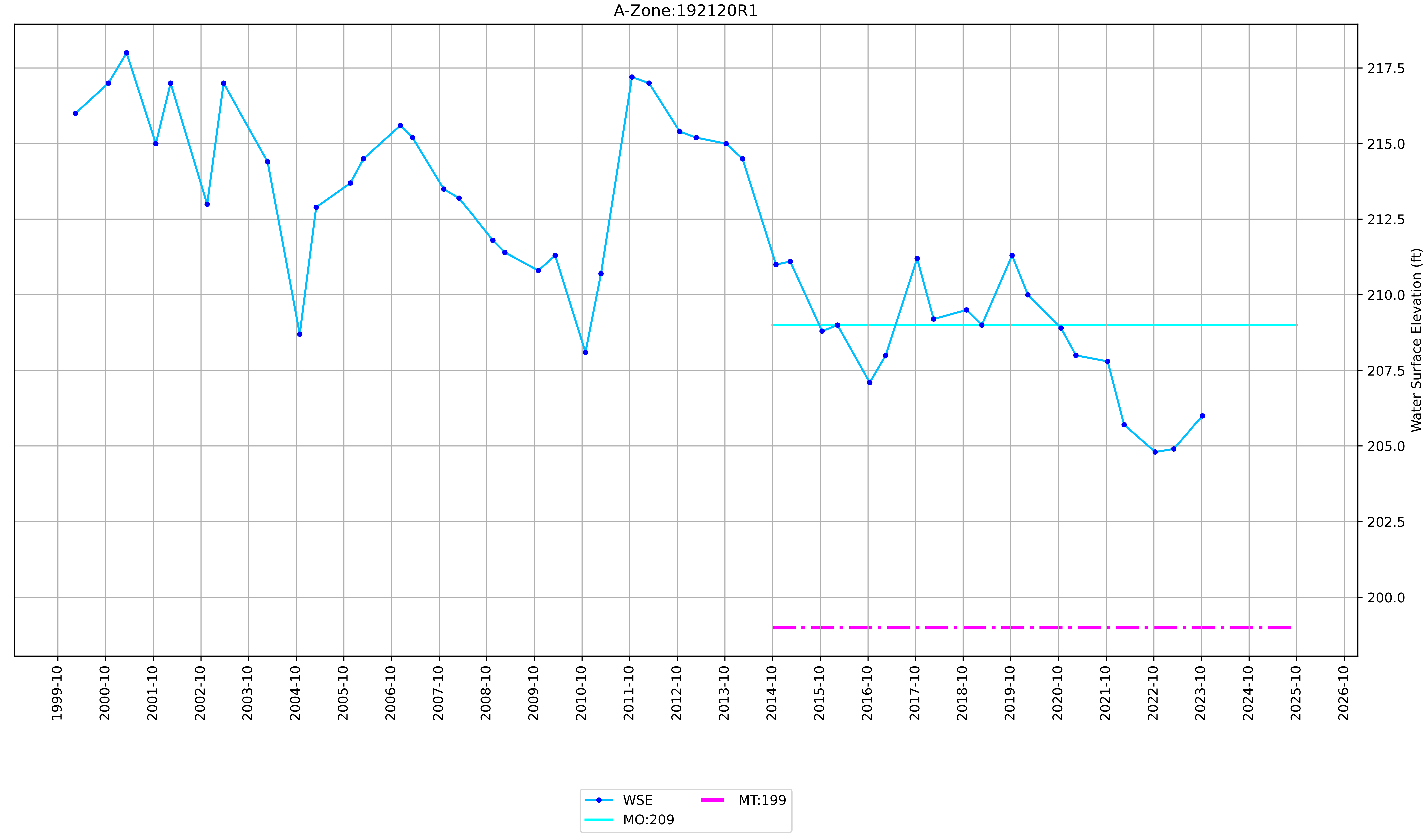

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Water Surface Elevation (ft)
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215.0
212.5
210.0
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200.0
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2000-10
2001-10
2002-10
2003-10
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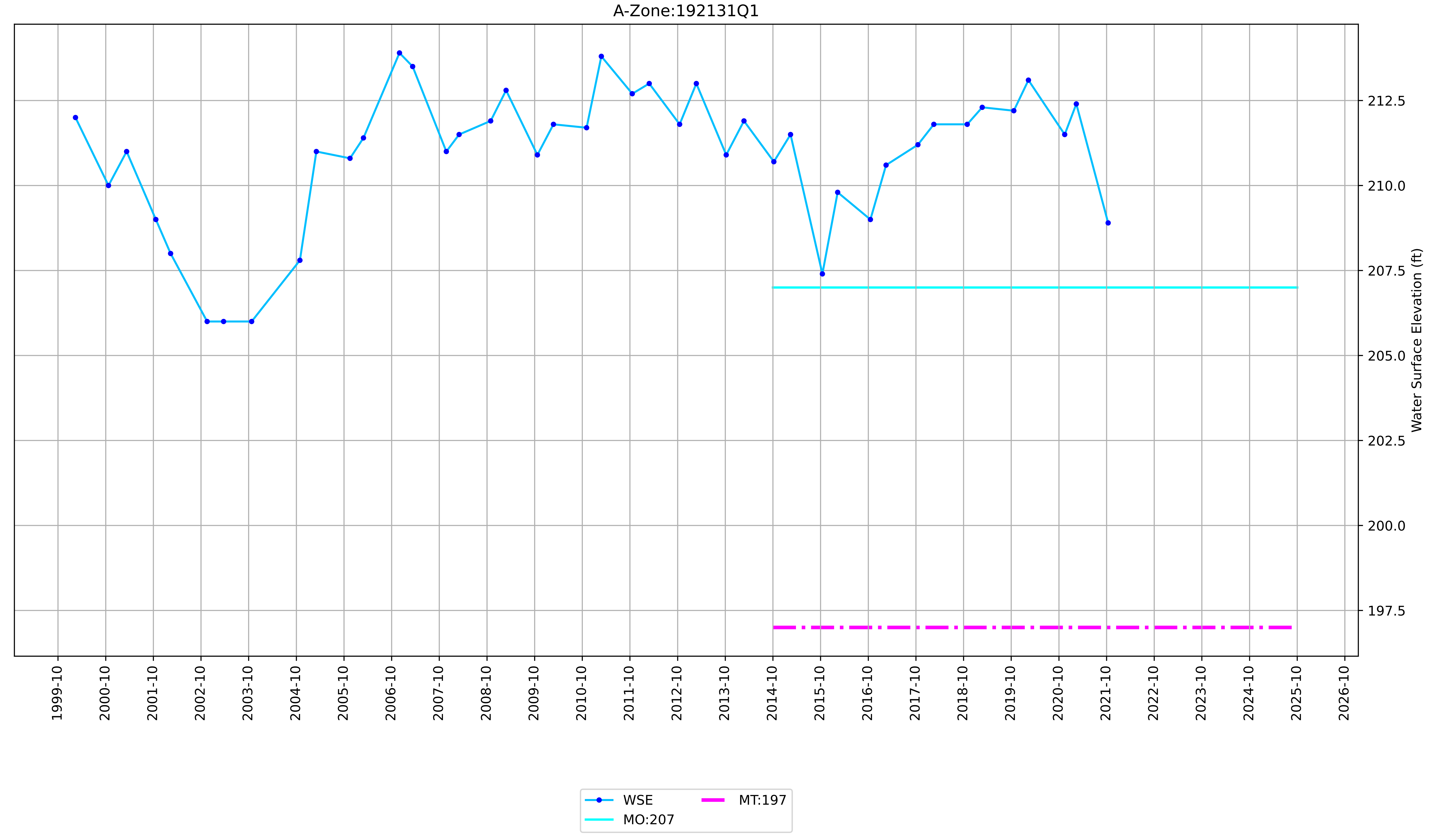

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Water Surface Elevation (ft)
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207.5
205.0
202.5
200.0
197.5
1999-10
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2001-10
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2003-10
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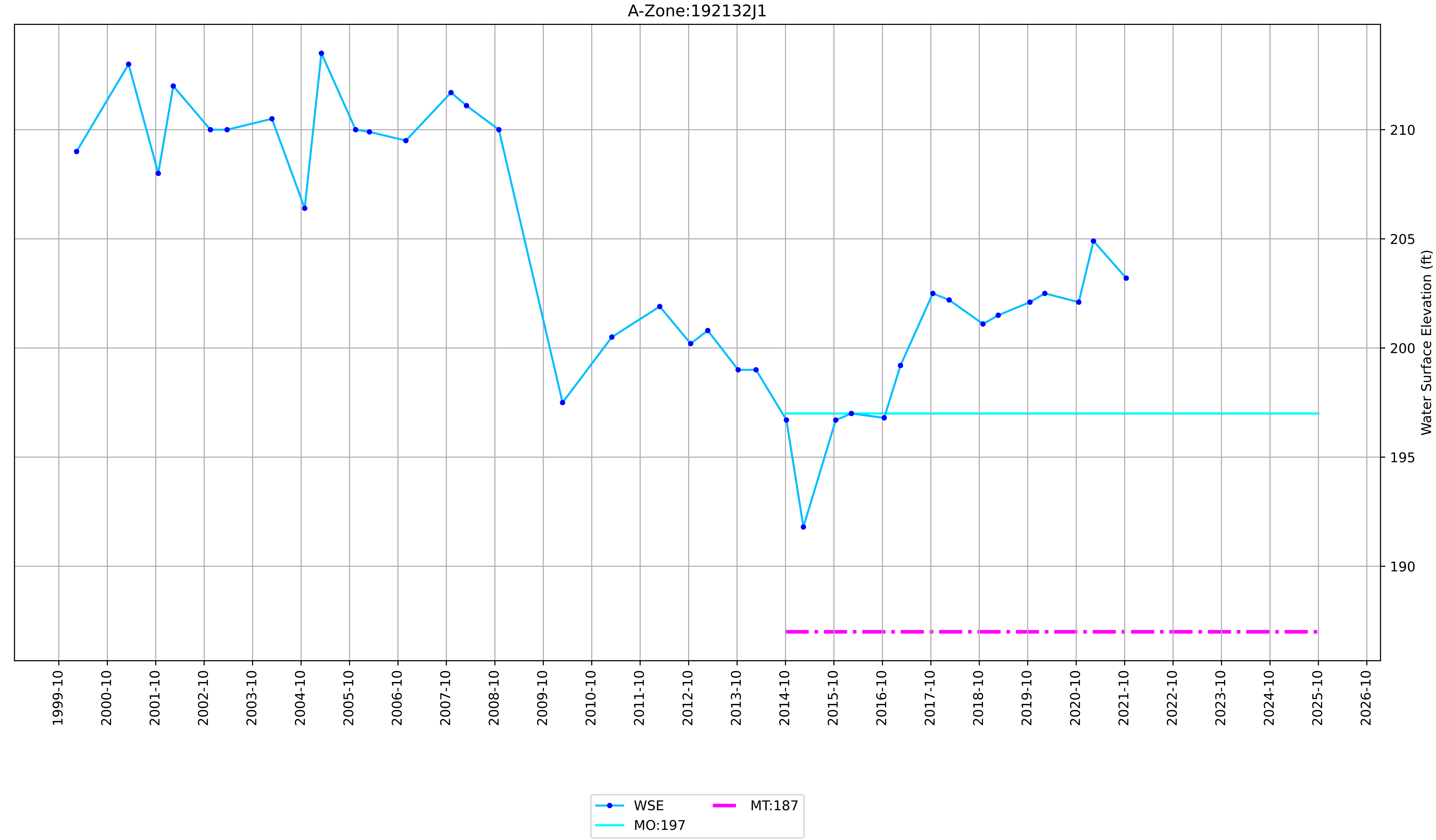

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Water Surface Elevation (ft)
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200
195
190
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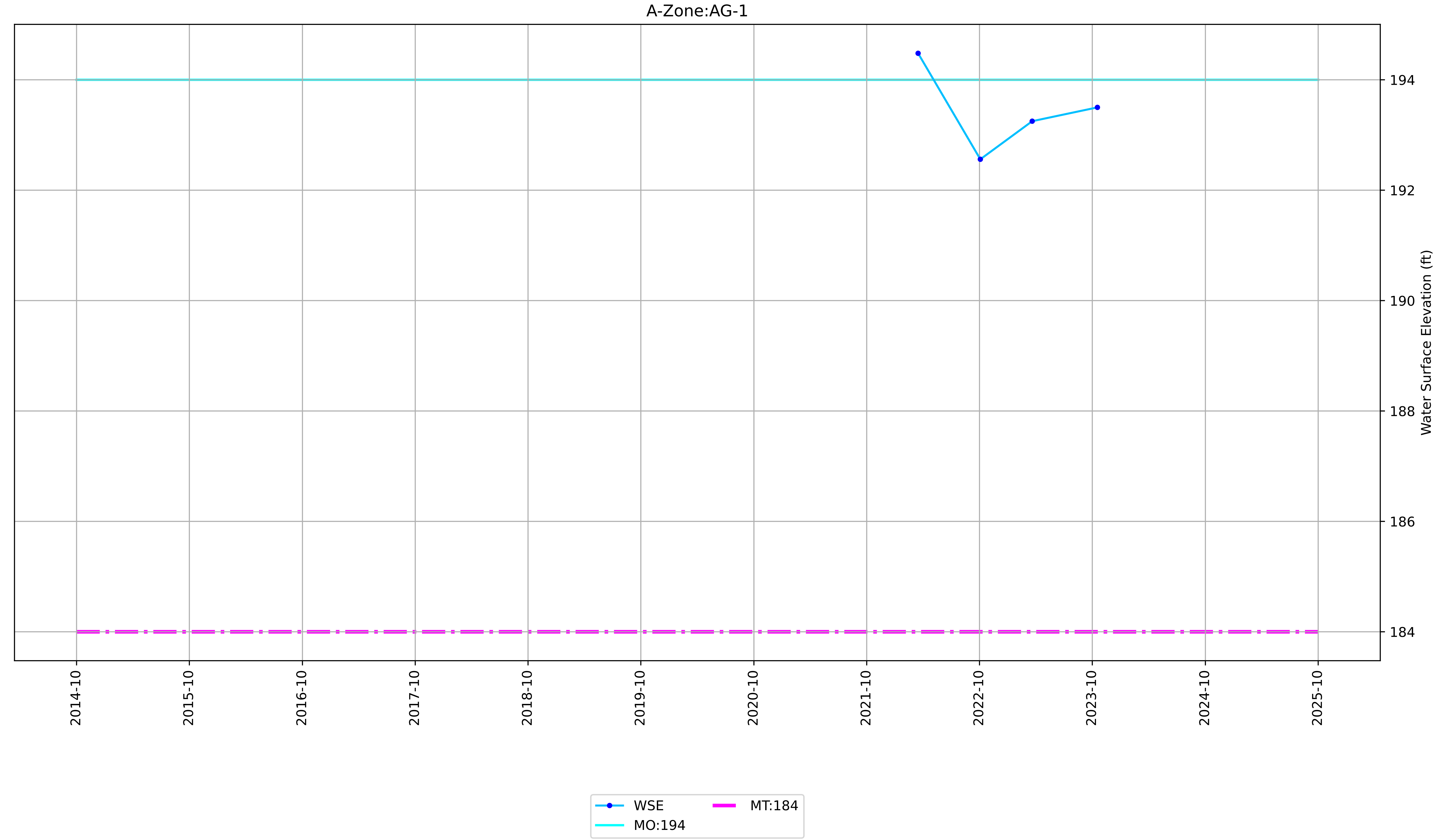

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Water Surface Elevation (ft)
194
192
190
188
186
184
2014-10
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2016-10
2017-10
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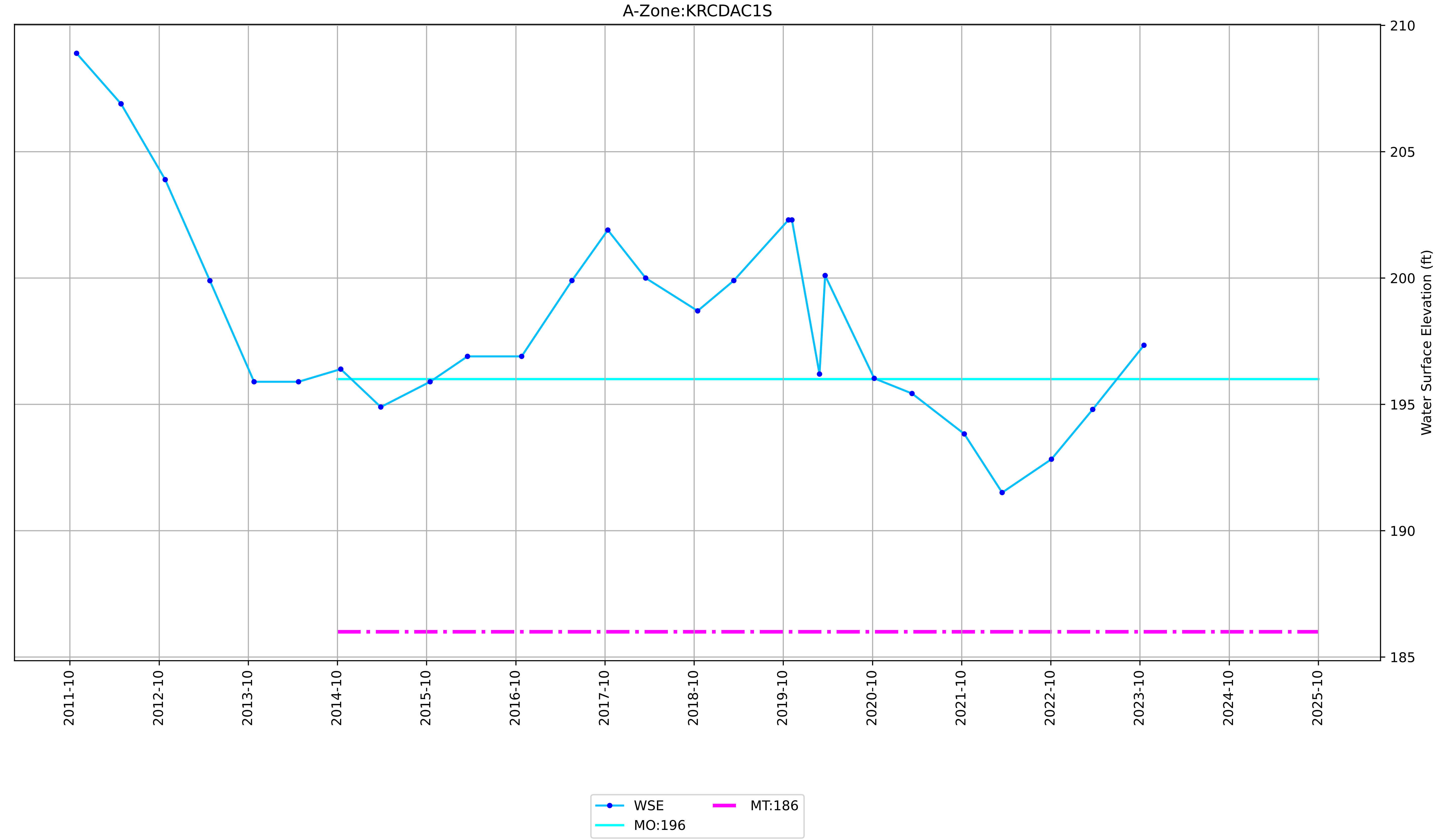
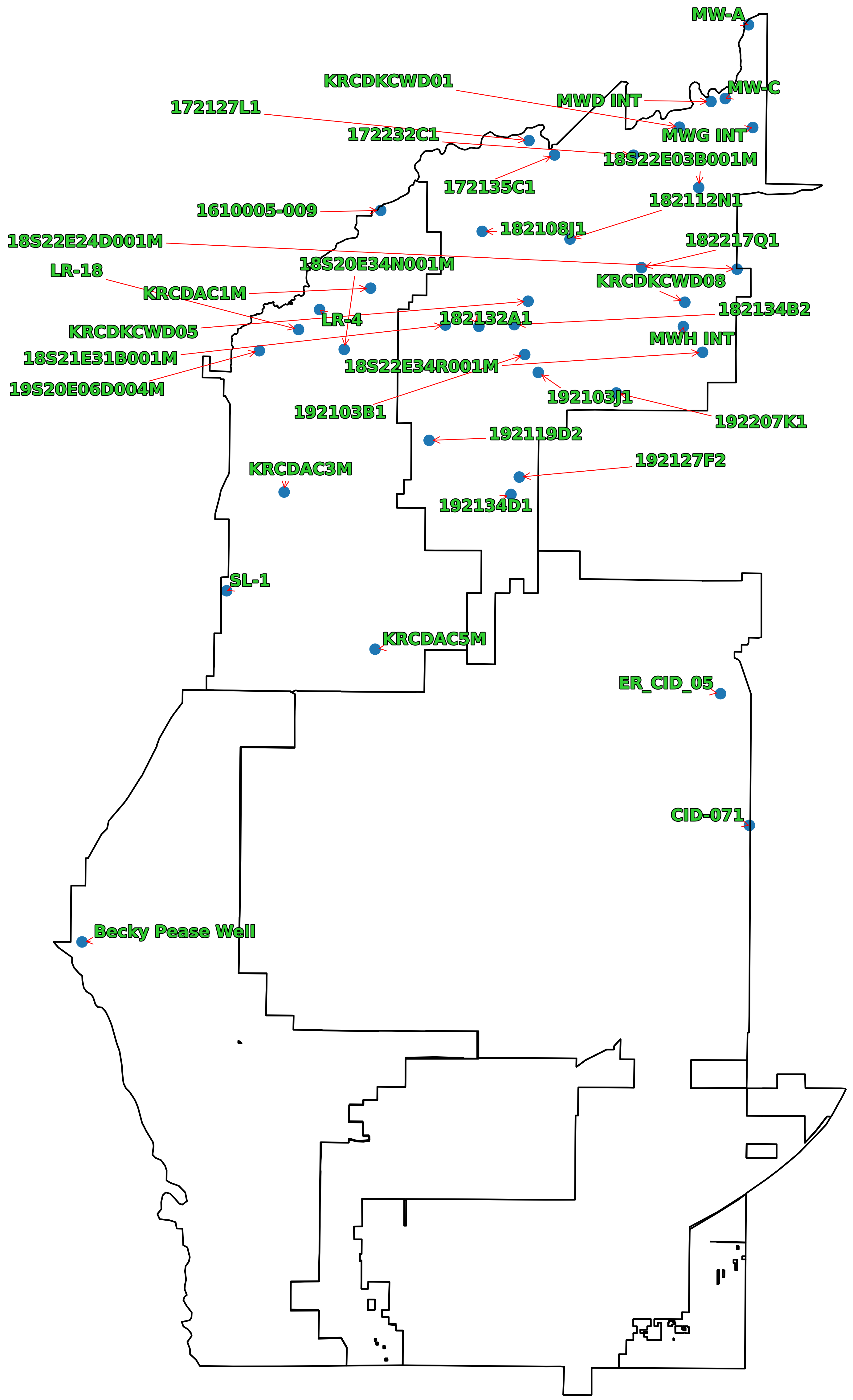
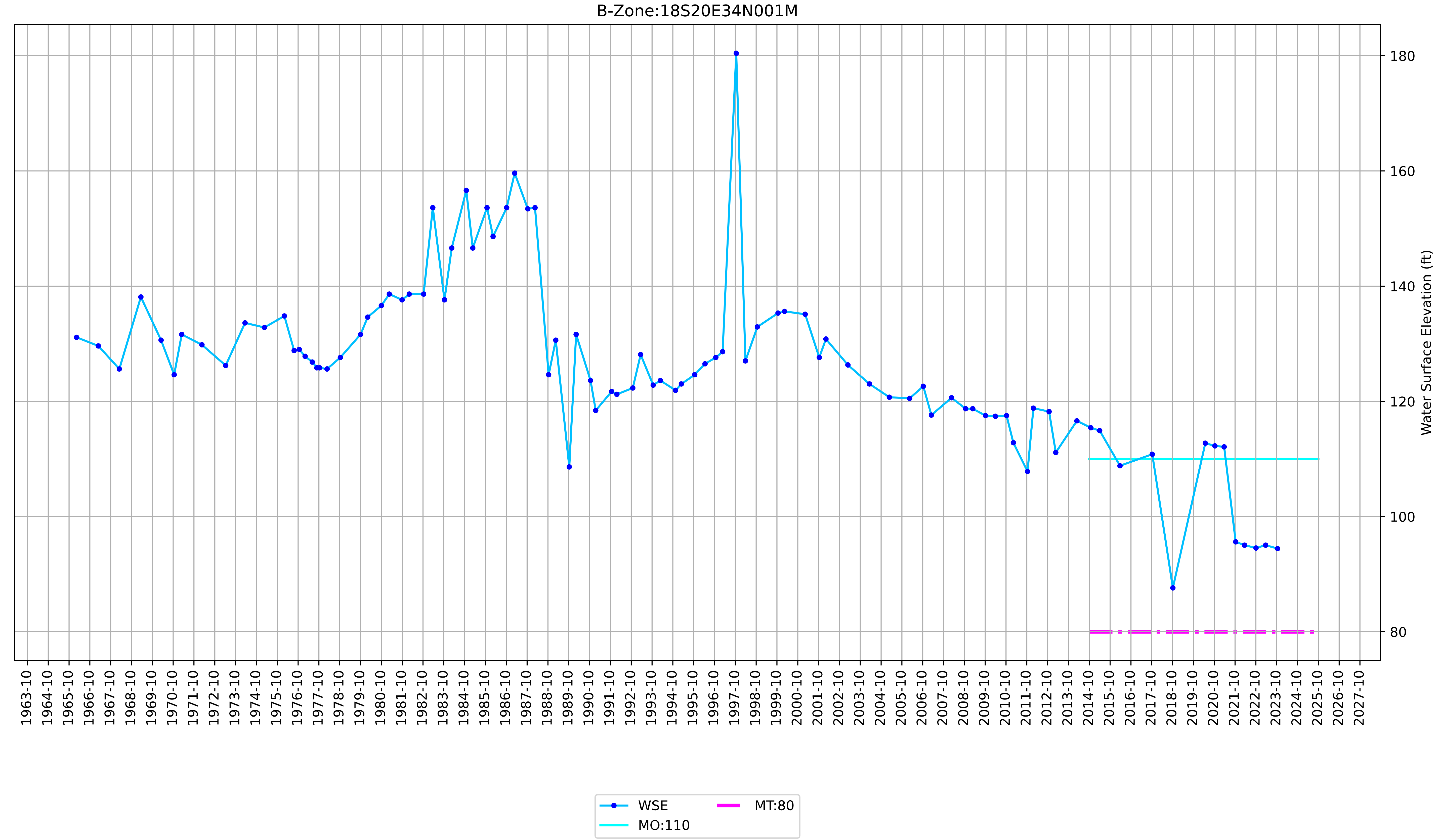
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:194
MT:184



A-Zone:KRCDAC1S
Water Surface Elevation (ft)
210
205
200
195
190
185
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:196
MT:186

B-Zone RMS Wells




B-Zone:18S20E34N001M
Water Surface Elevation (ft)
180
160
140
120
100
80
1963-10
1964-10
1965-10
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1968-10
1969-10
1970-10
1971-10
1972-10
1973-10
1974-10
1975-10
1976-10
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2016-10
2017-10
2018-10
2019-10
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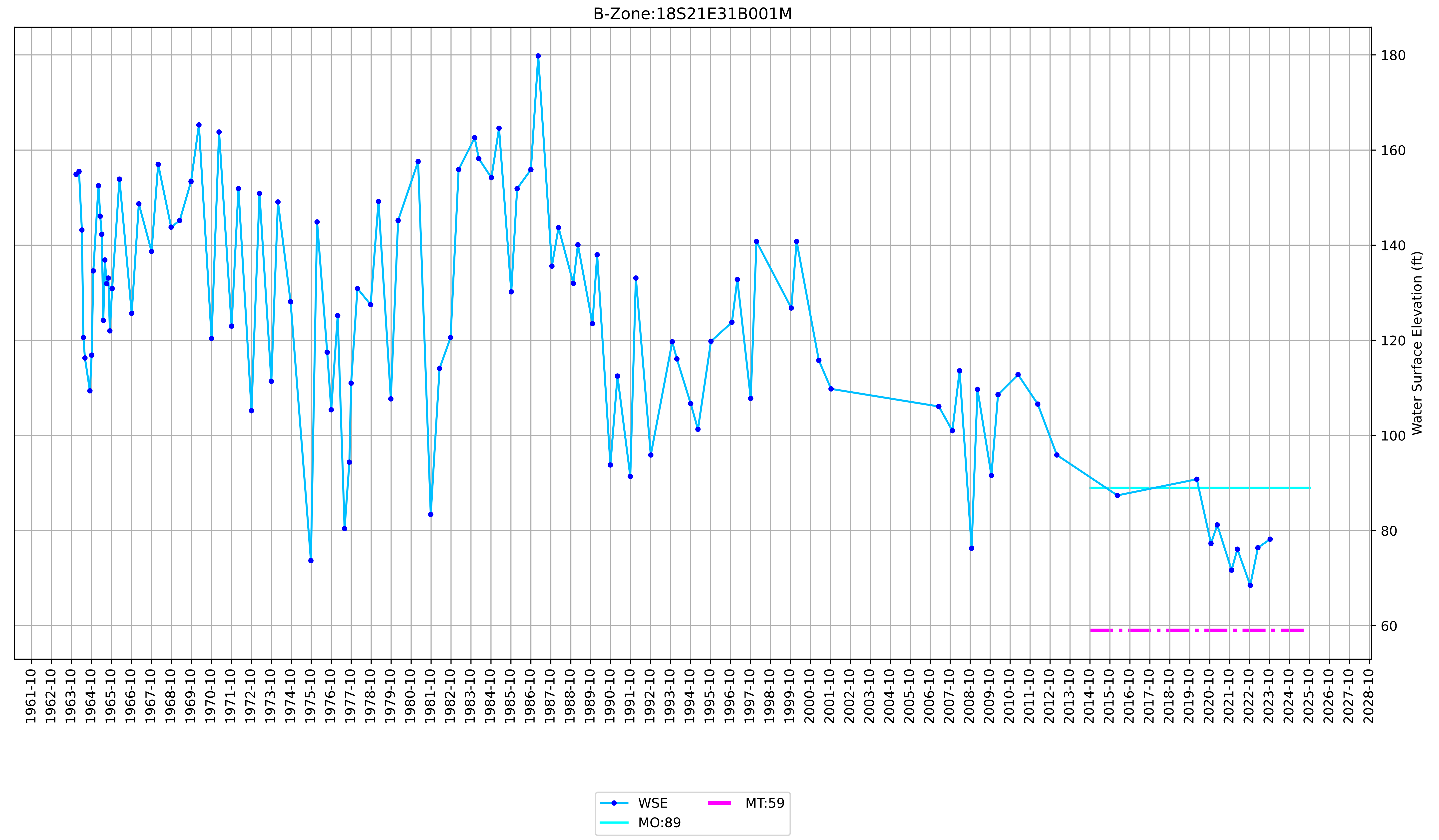
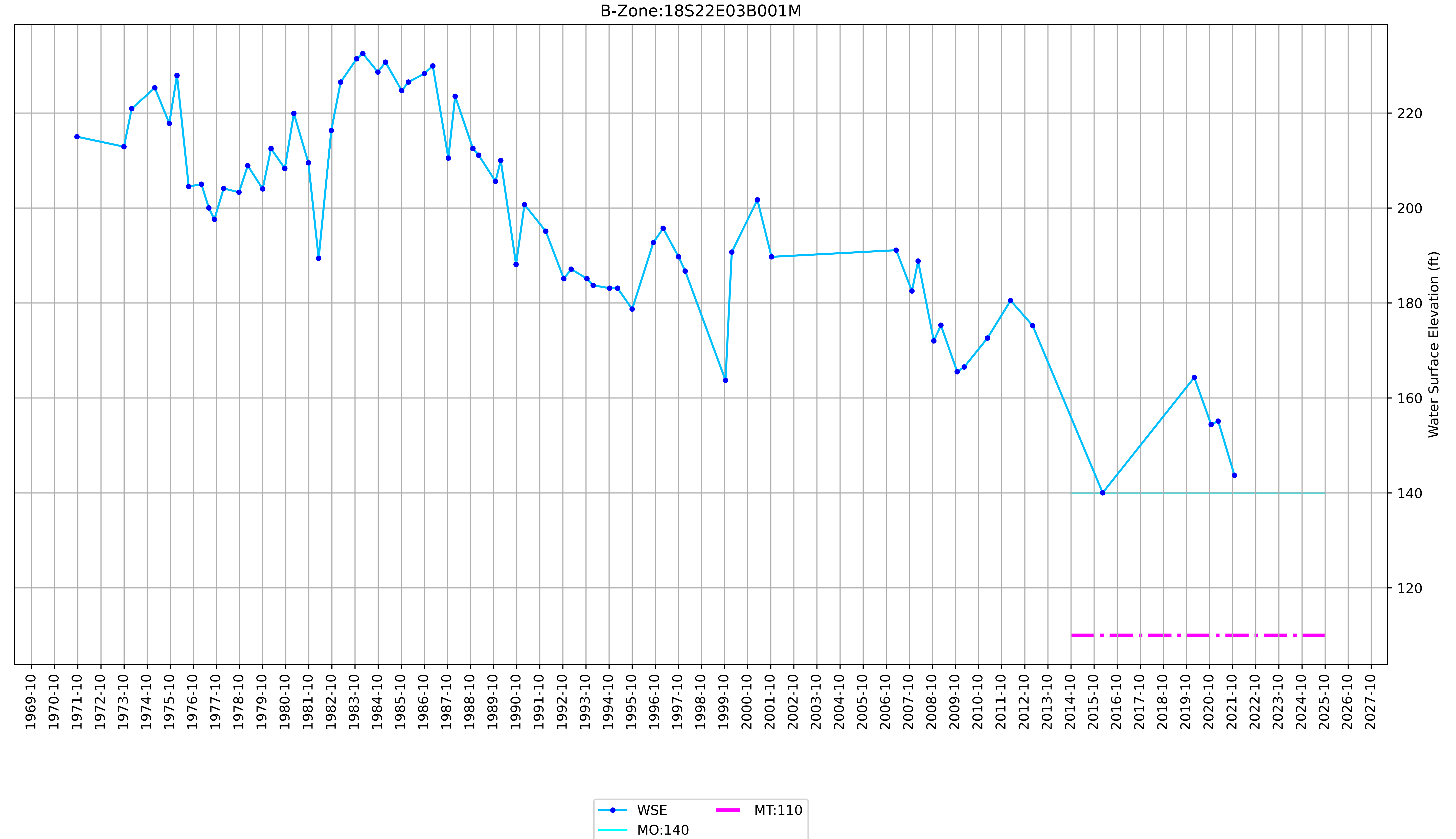
2027-10
WSE
MO:110
MT:80



B-Zone:18S21E31B001M
Water Surface Elevation (ft)
WSE
MO:89
MT:59


B-Zone:18S22E03B001M
Water Surface Elevation (ft)
220
200
180
160
140
120
1969-10
1970-10
1971-10
1972-10
1973-10
1974-10
1975-10
1976-10
1977-10
1978-10
1979-10
1980-10
1981-10
1982-10
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1997-10
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2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
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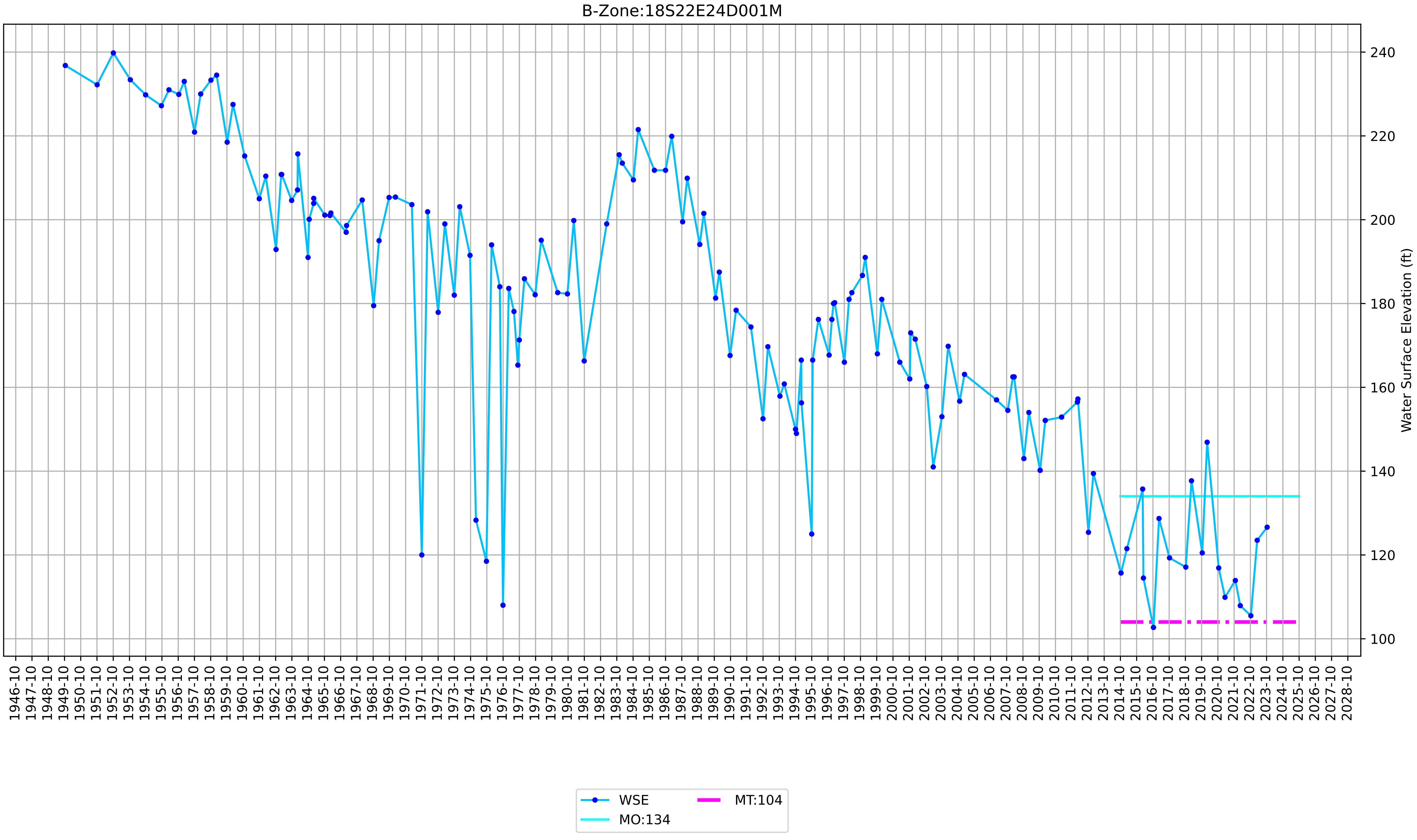
2026-10
2027-10
WSE
MO:140
MT:110



B-Zone:18S22E24D001M
Water Surface Elevation (ft)
240
220
200
180
160
140
120
100
1946-10
1947-10
1948-10
1949-10
1950-10
1951-10
1952-10
1953-10
1954-10
1955-10
1956-10
1957-10
1958-10
1959-10
1960-10
1961-10
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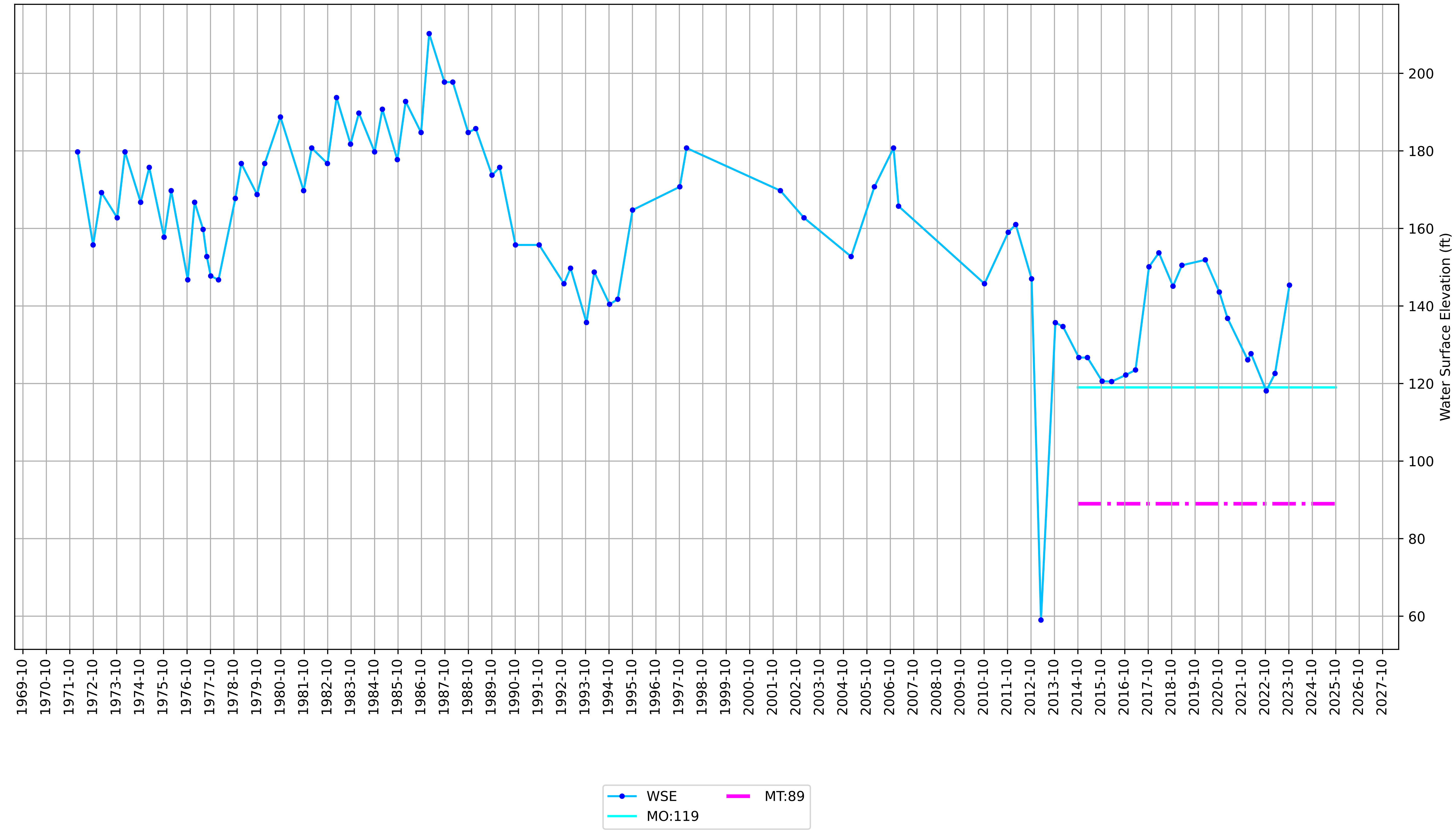
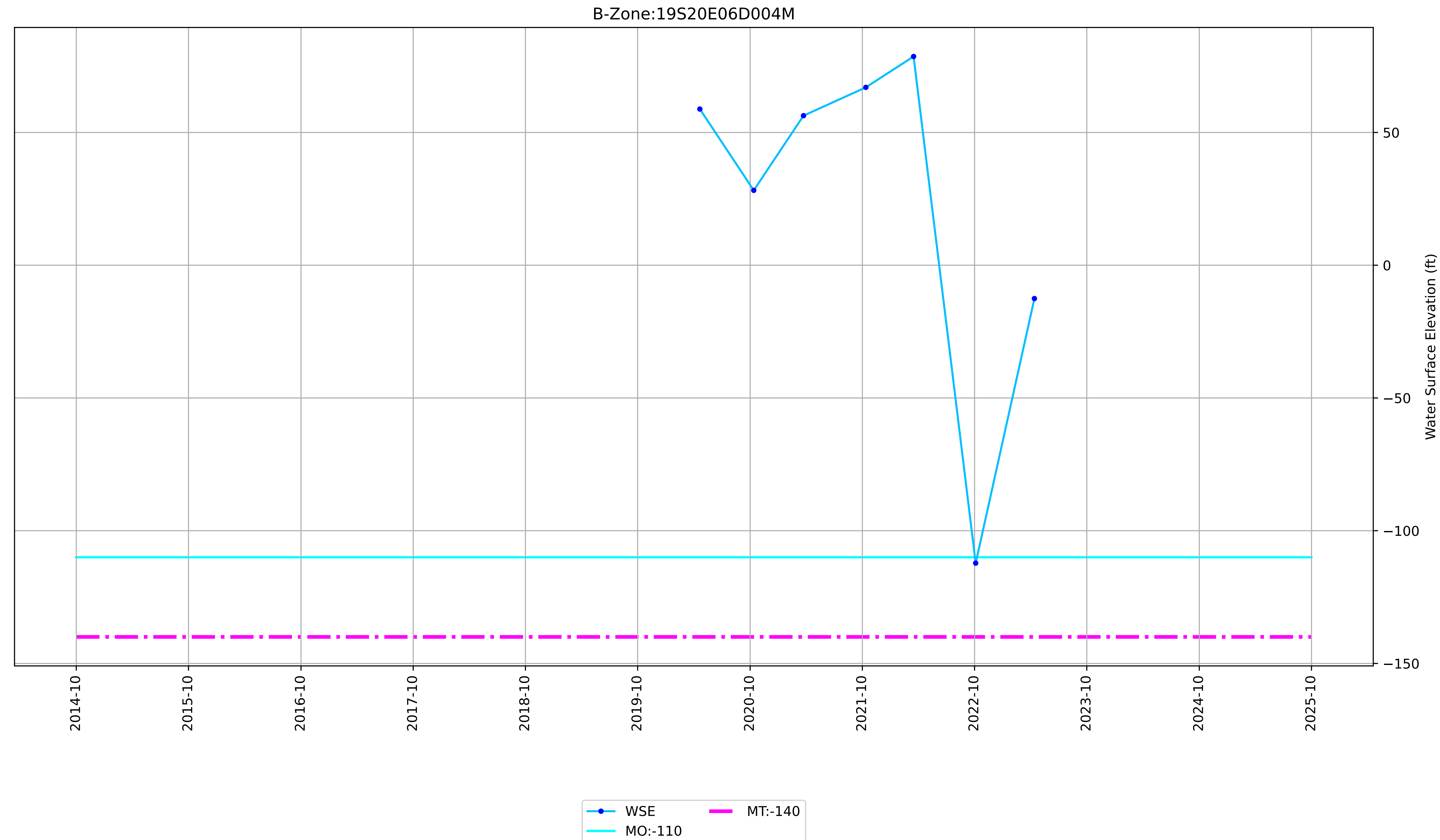
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
2027-10
2028-10
WSE
MO:134
MT:104

B-Zone:18S22E34R001M





B-Zone:19S20E06D004M
50
0
−50
−100
−150
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:-110
MT:-140

B-Zone:172127L1
Water Surface Elevation (ft)
220
200
180
160
140
120
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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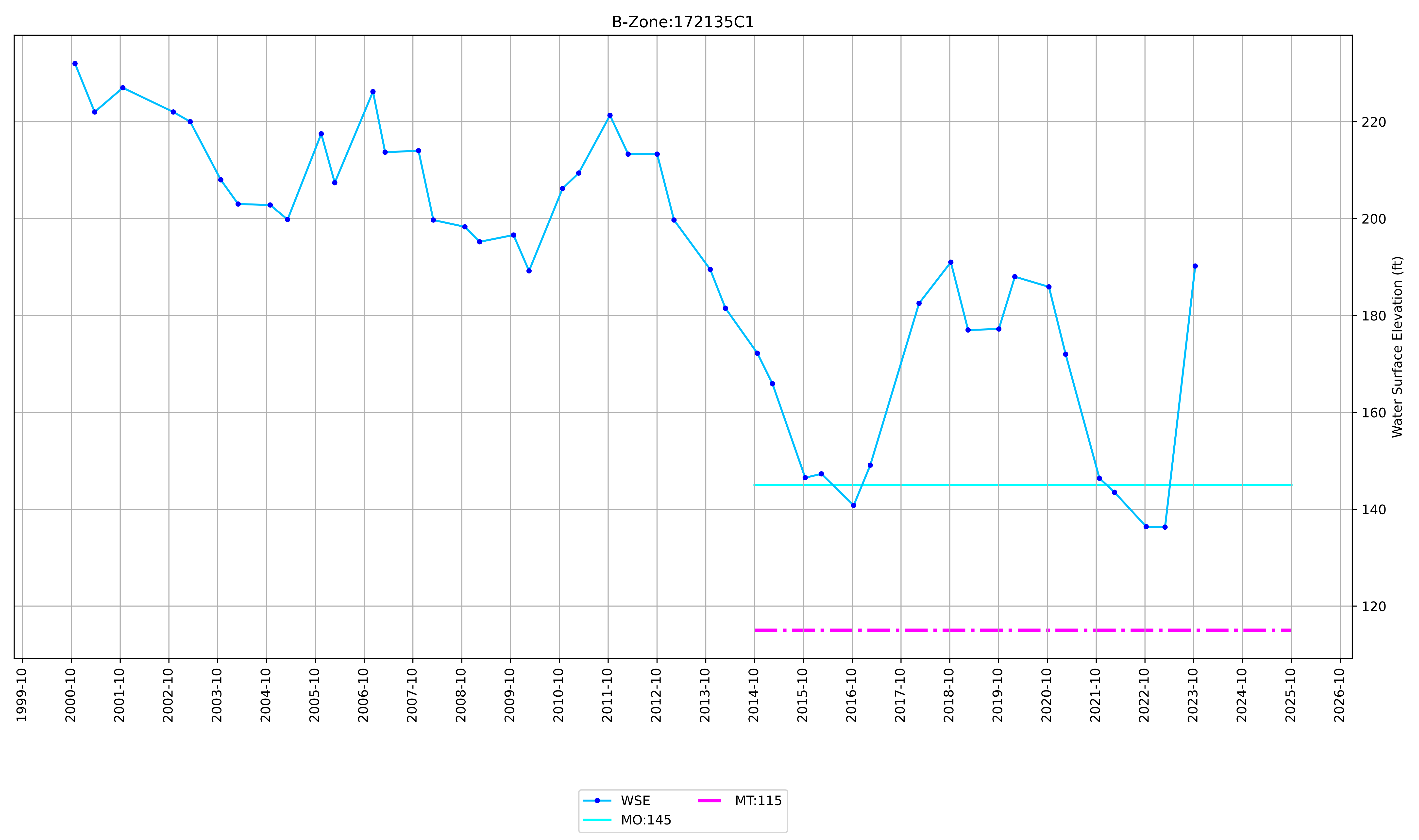
2026-10
WSE
MO:142
MT:112



B-Zone:172135C1
Water Surface Elevation (ft)
120
140
160
180
200
220
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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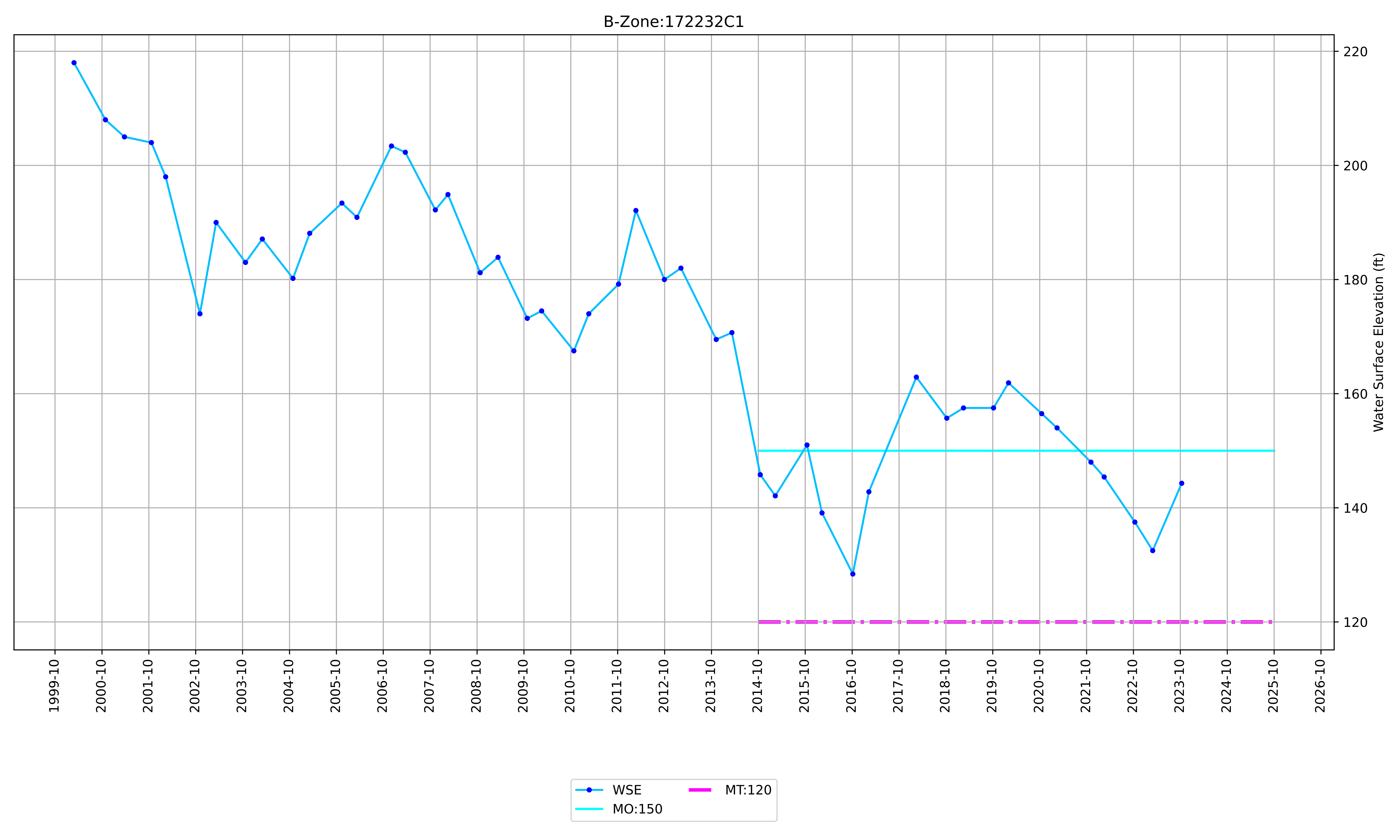
2026-10
WSE
MO:145
MT:115



B-Zone:172232C1
Water Surface Elevation (ft)
220
200
180
160
140
120
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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2022-10
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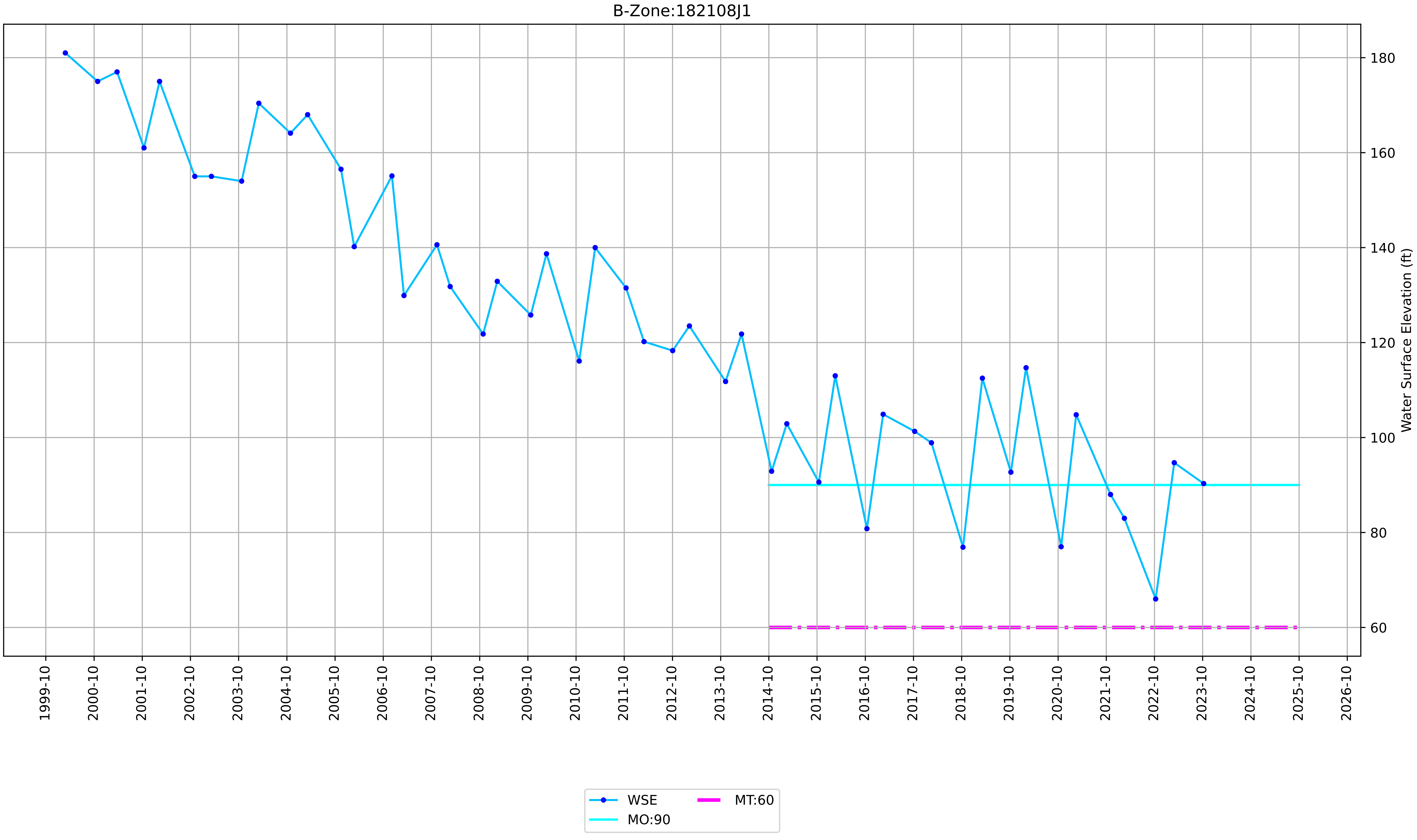
2024-10
2025-10
2026-10
WSE
MO:150
MT:120



B-Zone:182108J1
Water Surface Elevation (ft)
180
160
140
120
100
80
60
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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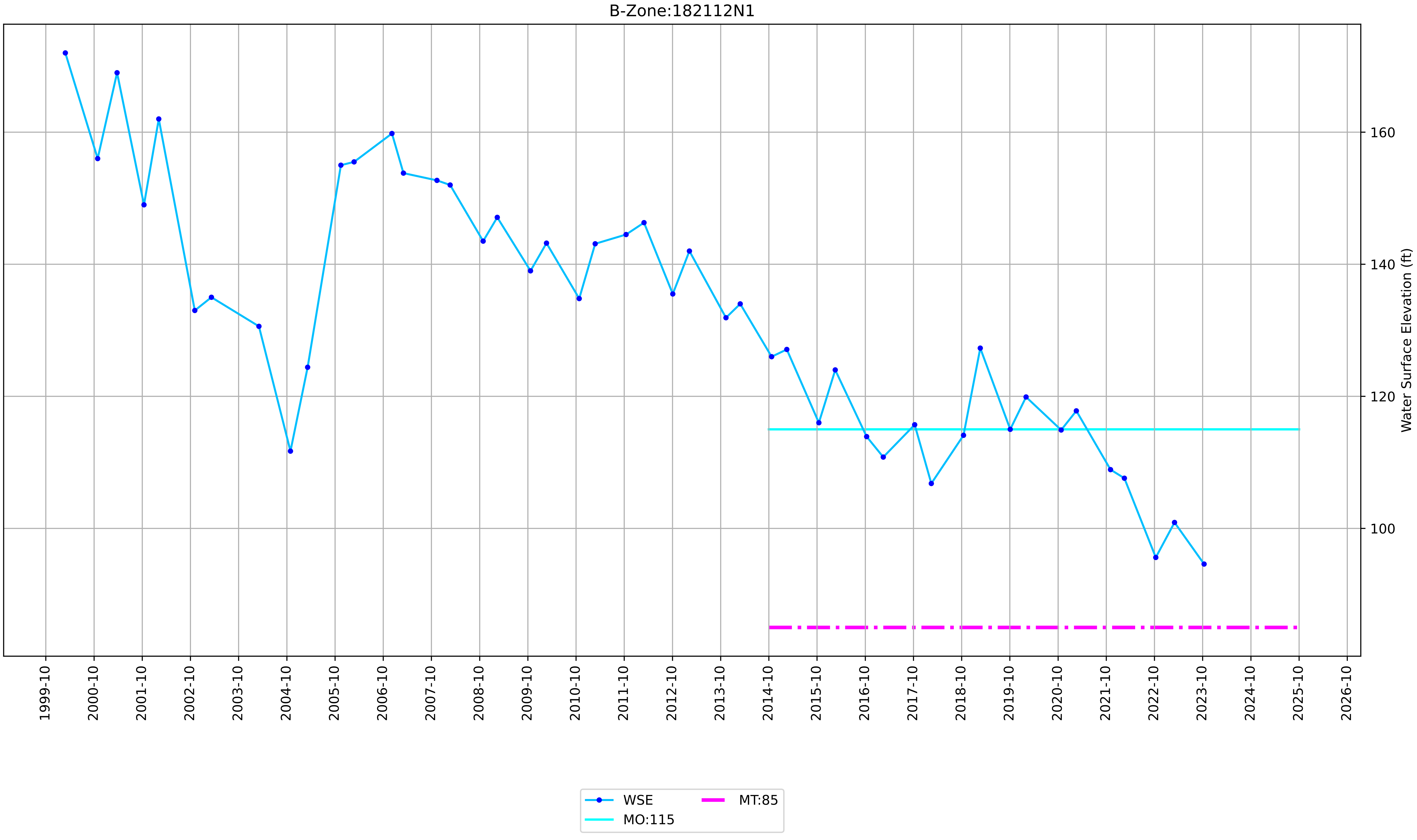
2026-10
WSE
MO:90
MT:60



B-Zone:182112N1
Water Surface Elevation (ft)
160
140
120
100
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
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2015-10
2016-10
2017-10
2018-10
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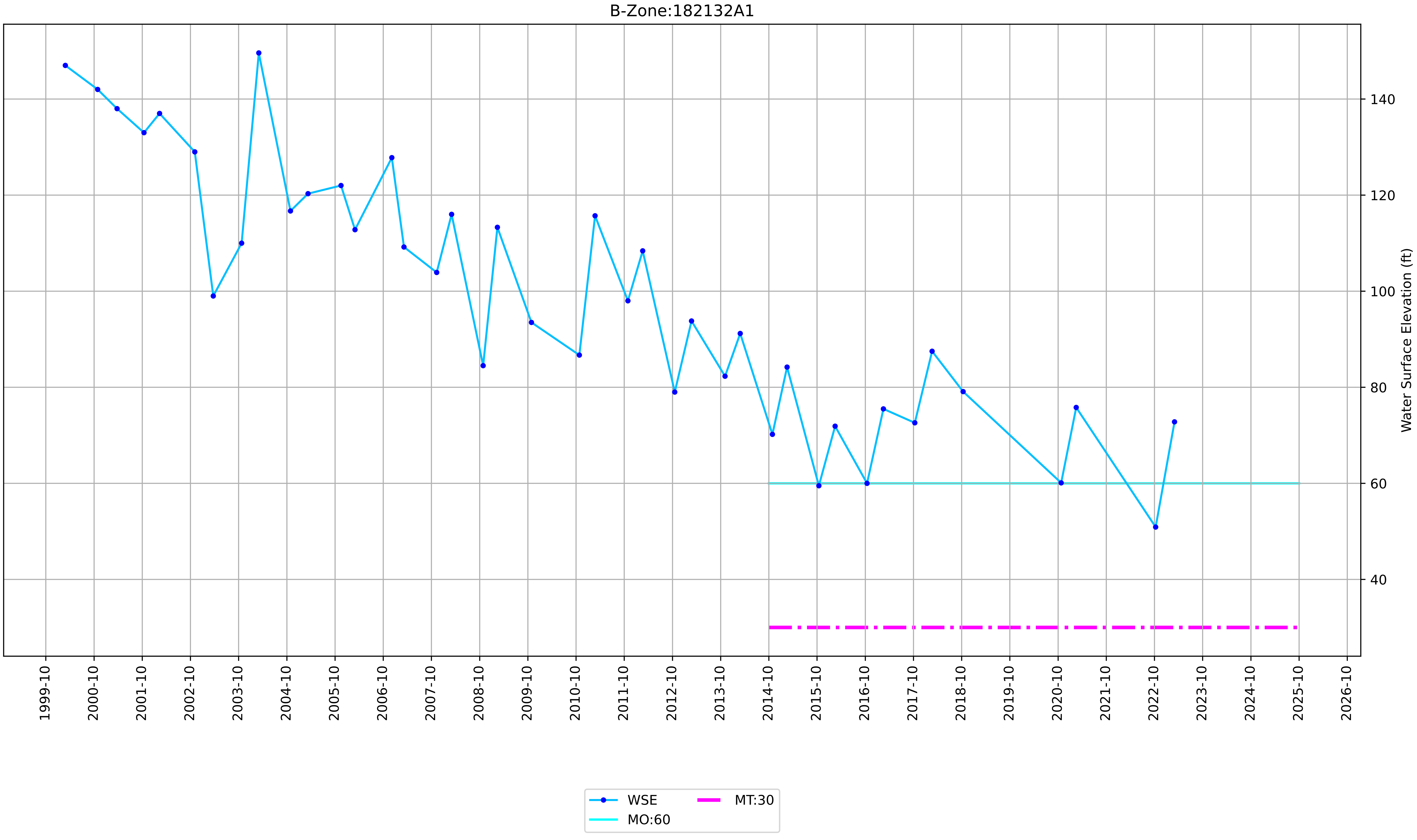
2024-10
2025-10
2026-10
WSE
MO:115
MT:85



B-Zone:182132A1
Water Surface Elevation (ft)
40
60
80
100
120
140
1999-10
2000-10
2001-10
2002-10
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2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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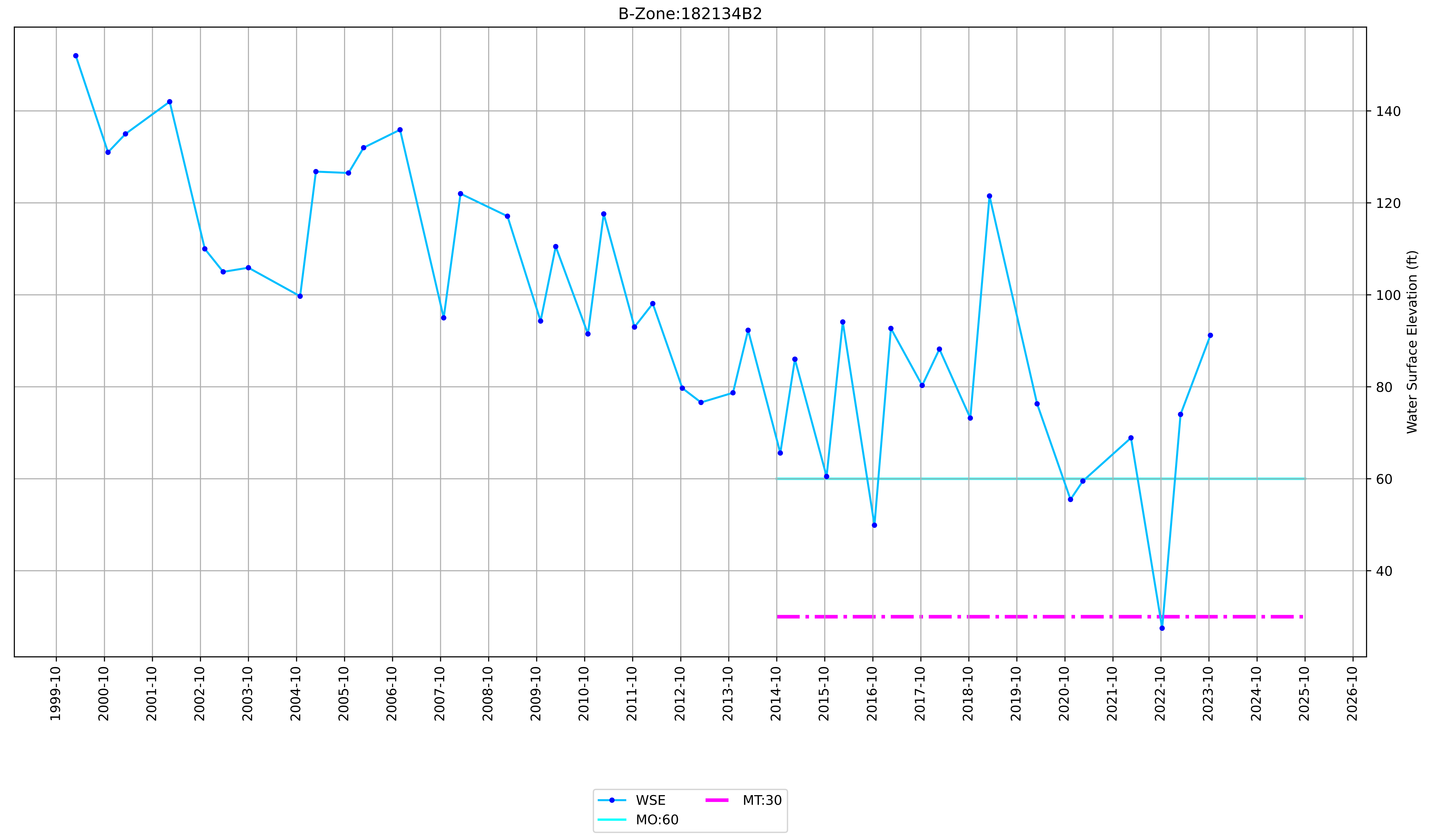
2022-10
2023-10
2024-10
2025-10
2026-10
WSE
MO:60
MT:30



B-Zone:182134B2
Water Surface Elevation (ft)
40
60
80
100
120
140
1999-10
2000-10
2001-10
2002-10
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2004-10
2005-10
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2007-10
2008-10
2009-10
2010-10
2011-10
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2013-10
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2016-10
2017-10
2018-10
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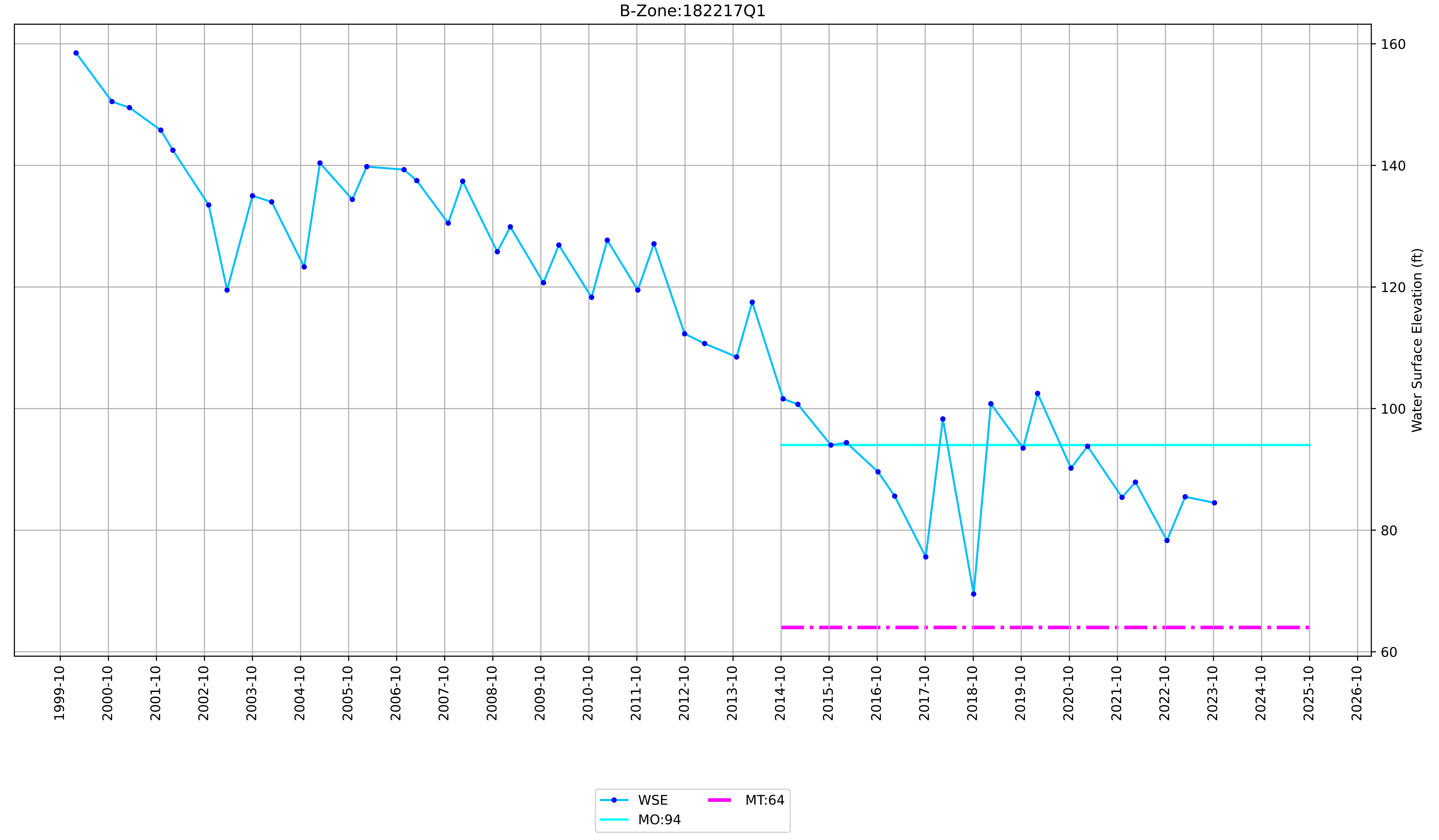
2025-10
2026-10
WSE
MO:60
MT:30



B-Zone:182217Q1
Water Surface Elevation (ft)
160
140
120
100
80
60
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
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2011-10
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2016-10
2017-10
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2024-10
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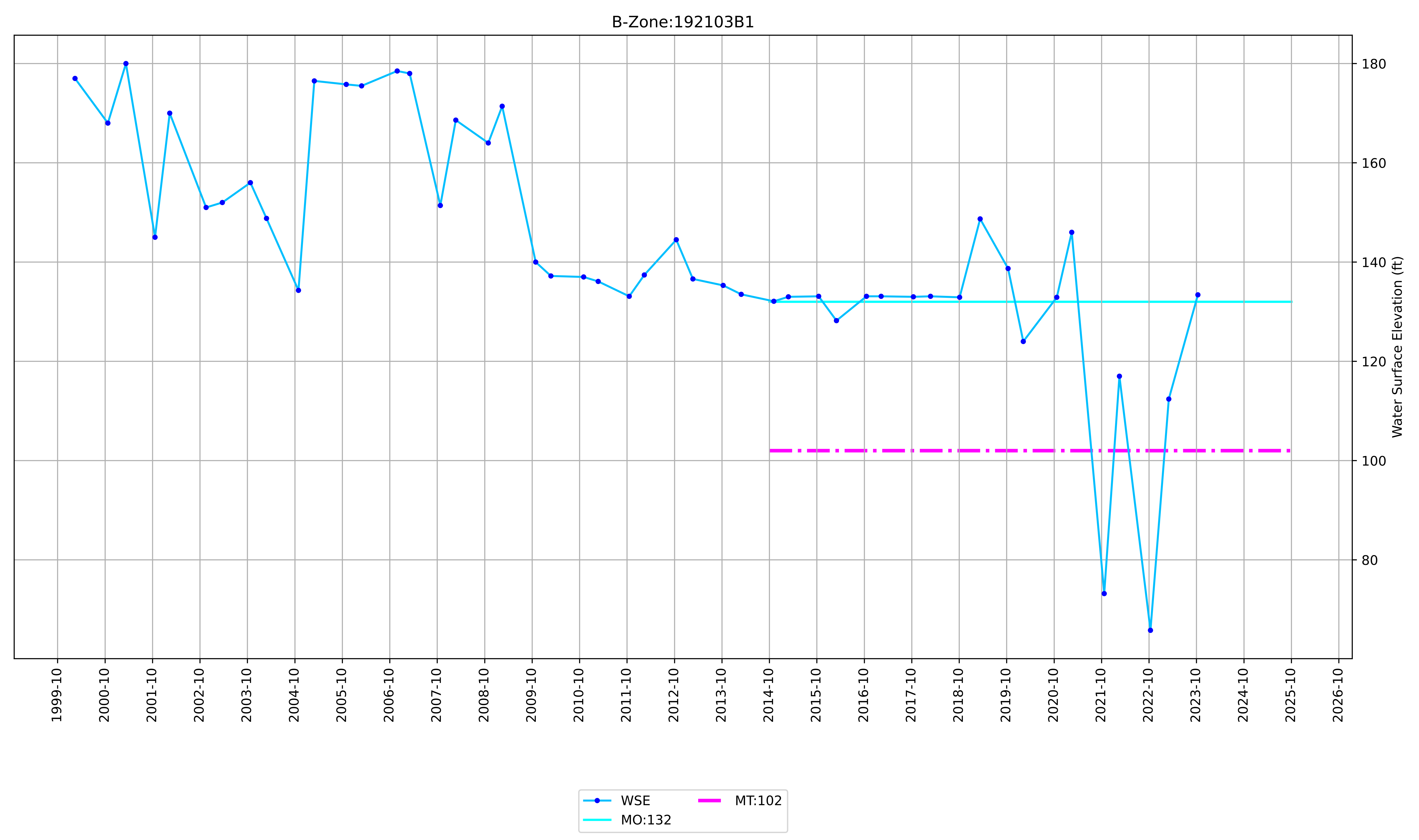
2026-10
WSE
MO:94
MT:64



B-Zone:192103B1
Water Surface Elevation (ft)
180
160
140
120
100
80
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
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2011-10
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2016-10
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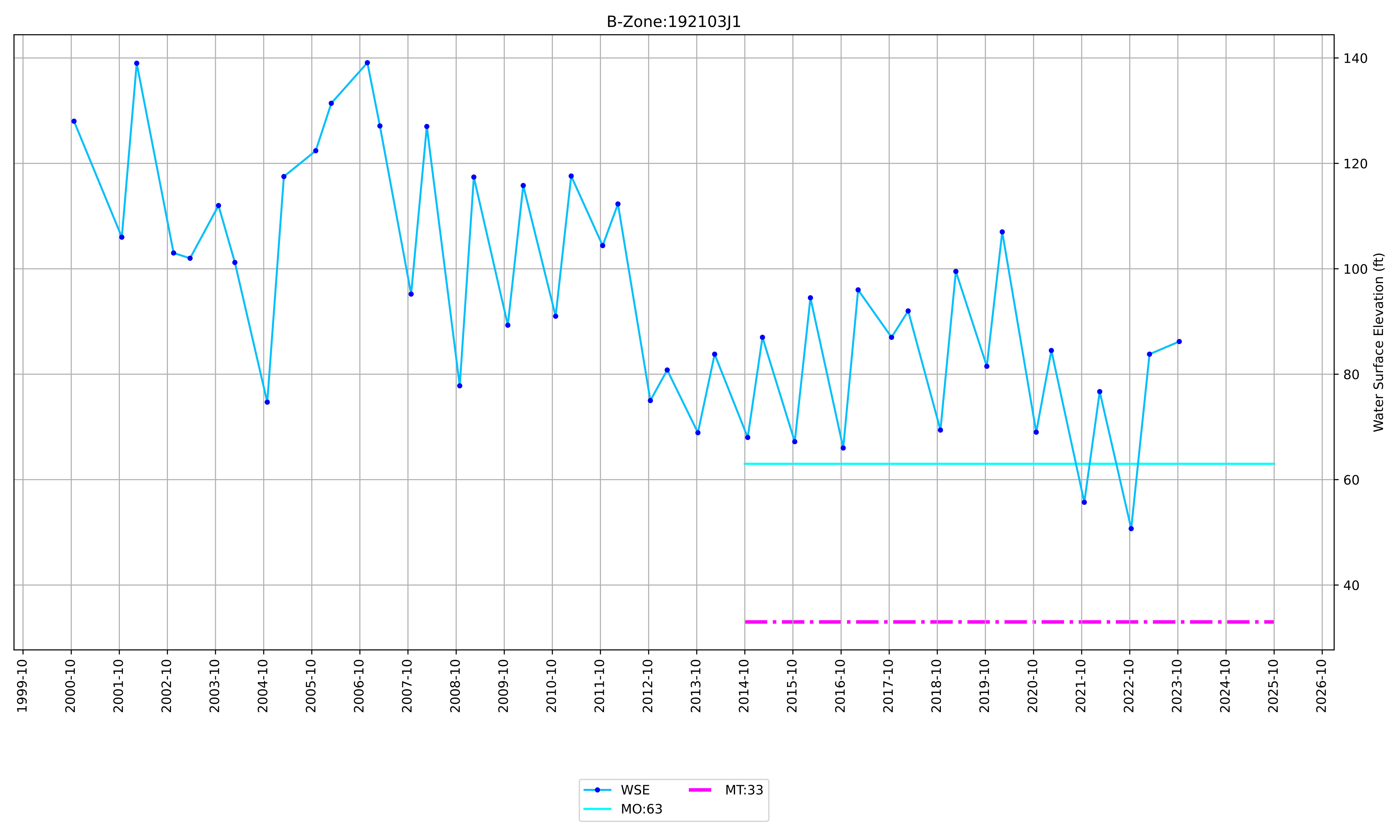
WSE
MO:132
MT:102



B-Zone:192103J1
Water Surface Elevation (ft)
140
120
100
80
60
40
1999-10
2000-10
2001-10
2002-10
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2005-10
2006-10
2007-10
2008-10
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2010-10
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2015-10
2016-10
2017-10
2018-10
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2022-10
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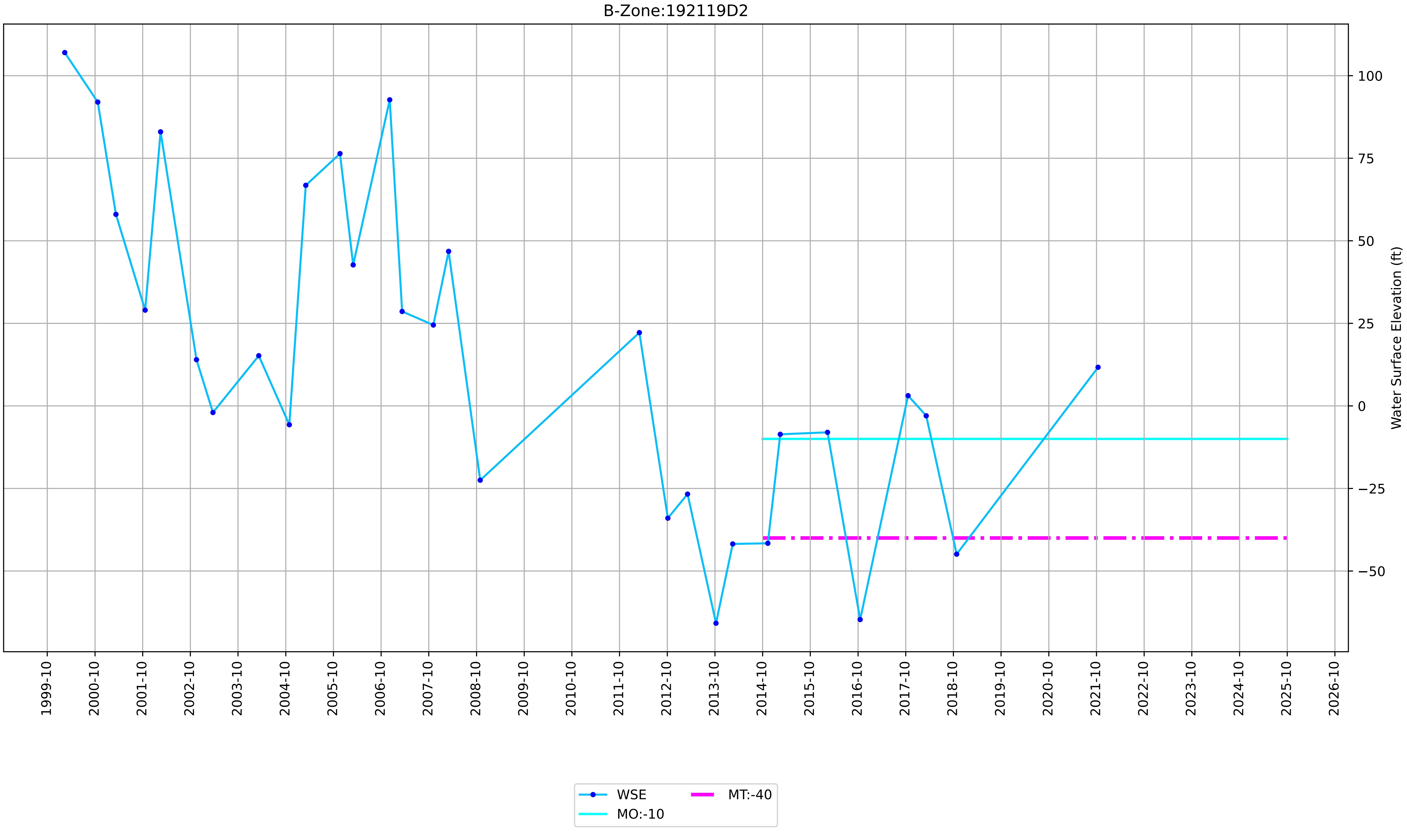
2024-10
2025-10
2026-10
WSE
MO:63
MT:33



B-Zone:192119D2
Water Surface Elevation (ft)
100
75
50
25
0
−25
−50
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
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2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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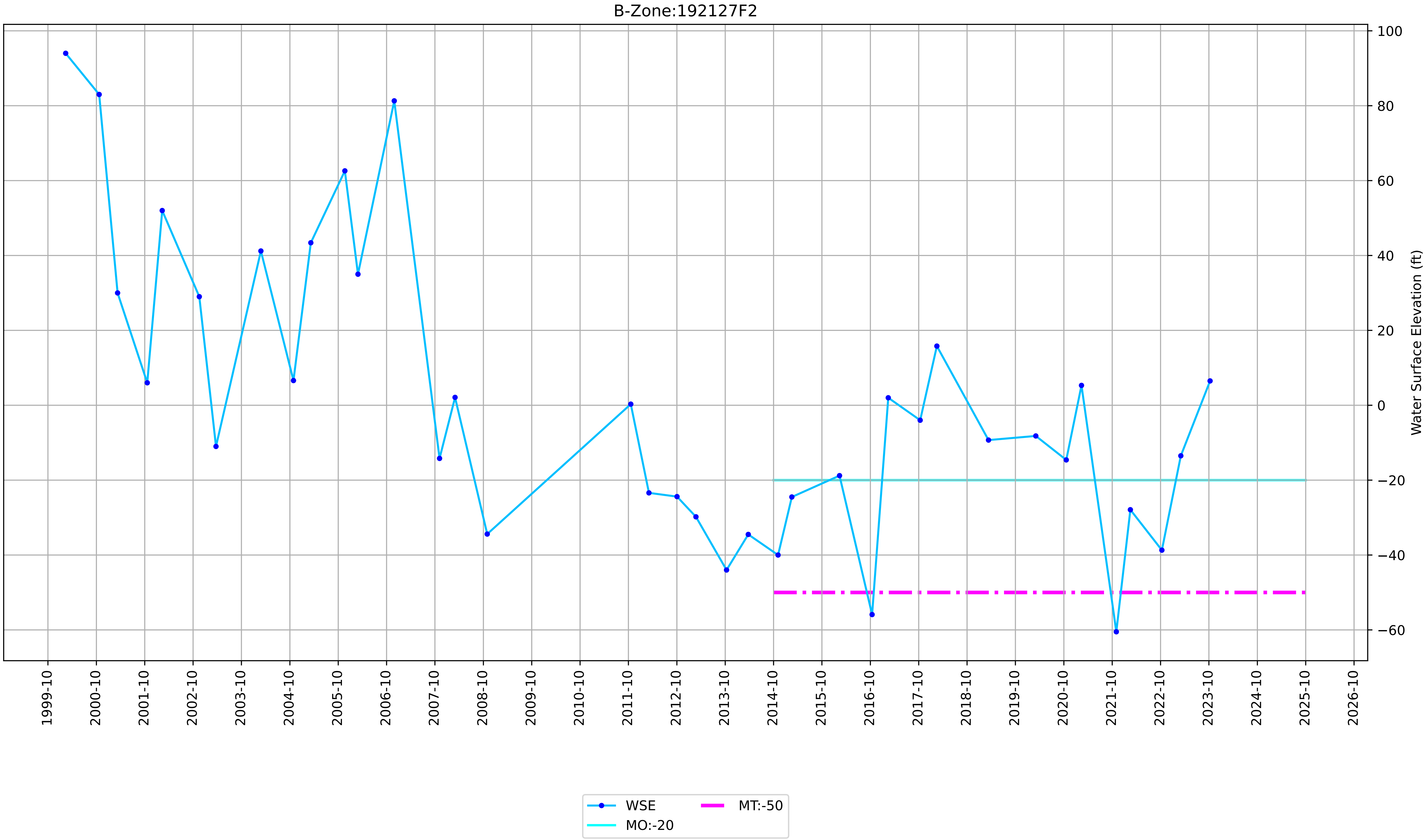
2026-10
WSE
MO:-10
MT:-40


B-Zone:192127F2
Water Surface Elevation (ft)
100
80
60
40
20
0
−20
−40
−60
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
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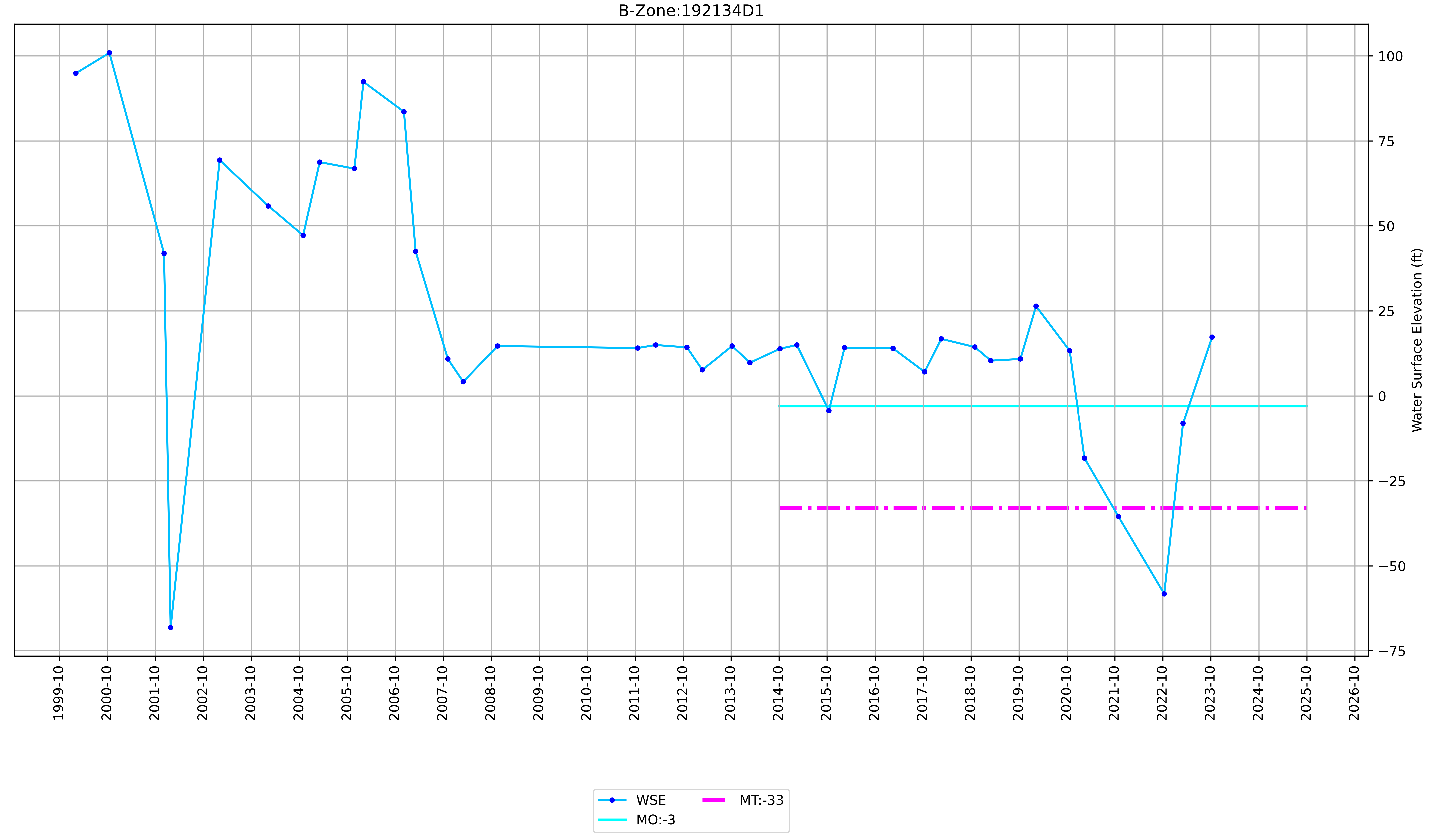
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
WSE
MO:-20
MT:-50


B-Zone:192134D1
Water Surface Elevation (ft)
100
75
50
25
0
−25
−50
−75
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
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2010-10
2011-10
2012-10
2013-10
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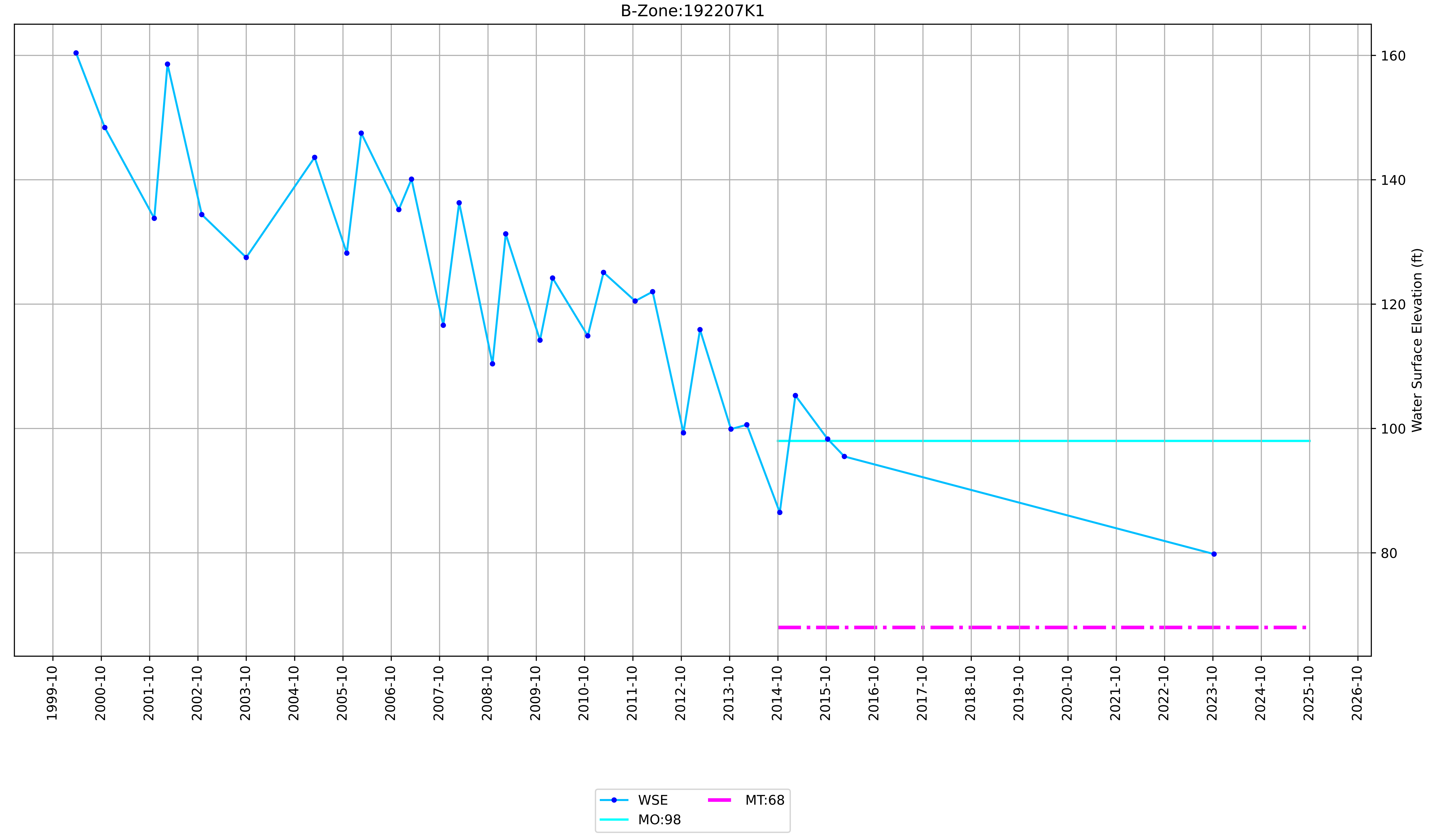
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
WSE
MO:-3
MT:-33



B-Zone:192207K1
Water Surface Elevation (ft)
160
140
120
100
80
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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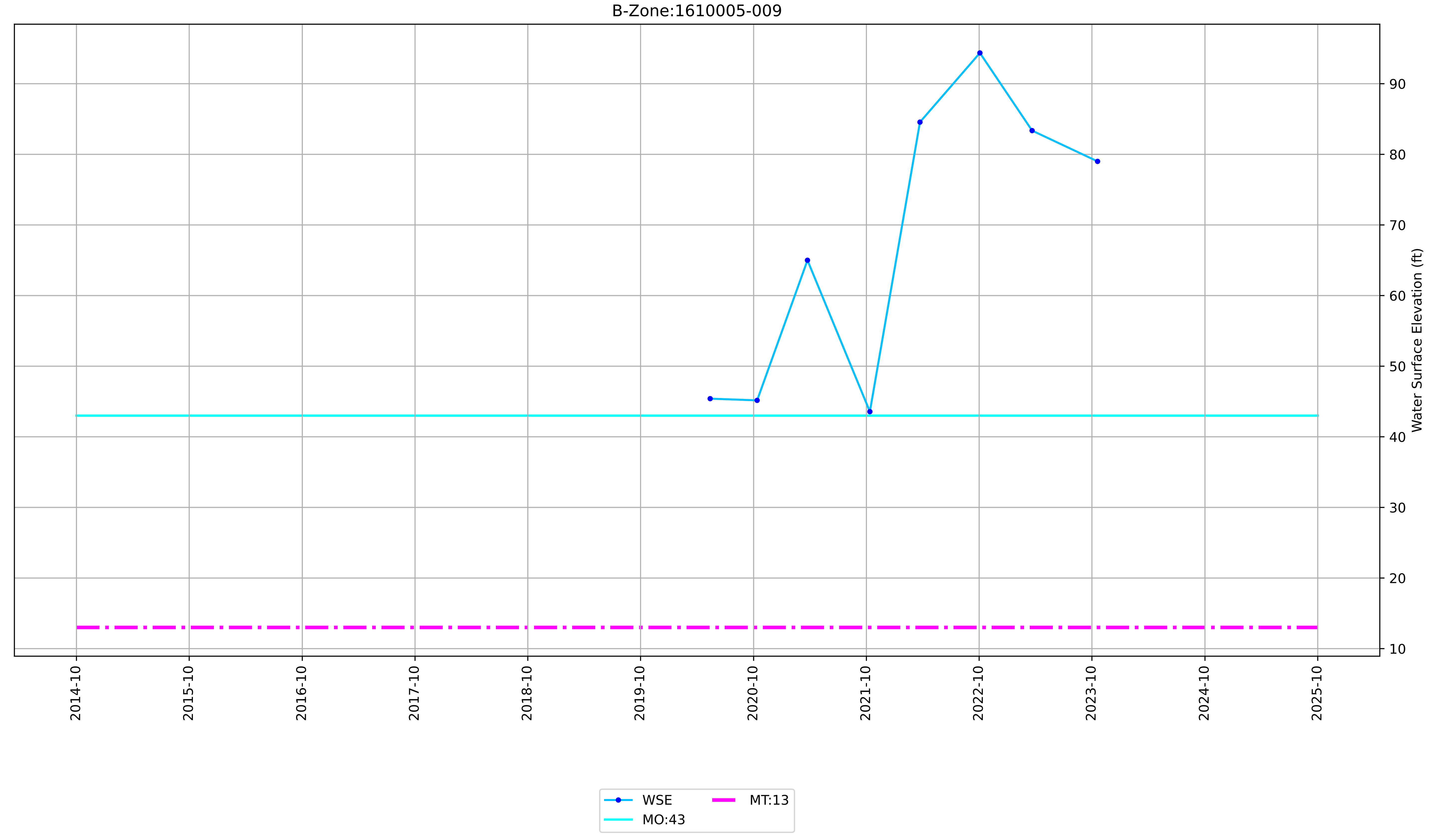
2025-10
2026-10
WSE
MO:98
MT:68



B-Zone:1610005-009
Water Surface Elevation (ft)
10
20
30
40
50
60
70
80
90
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
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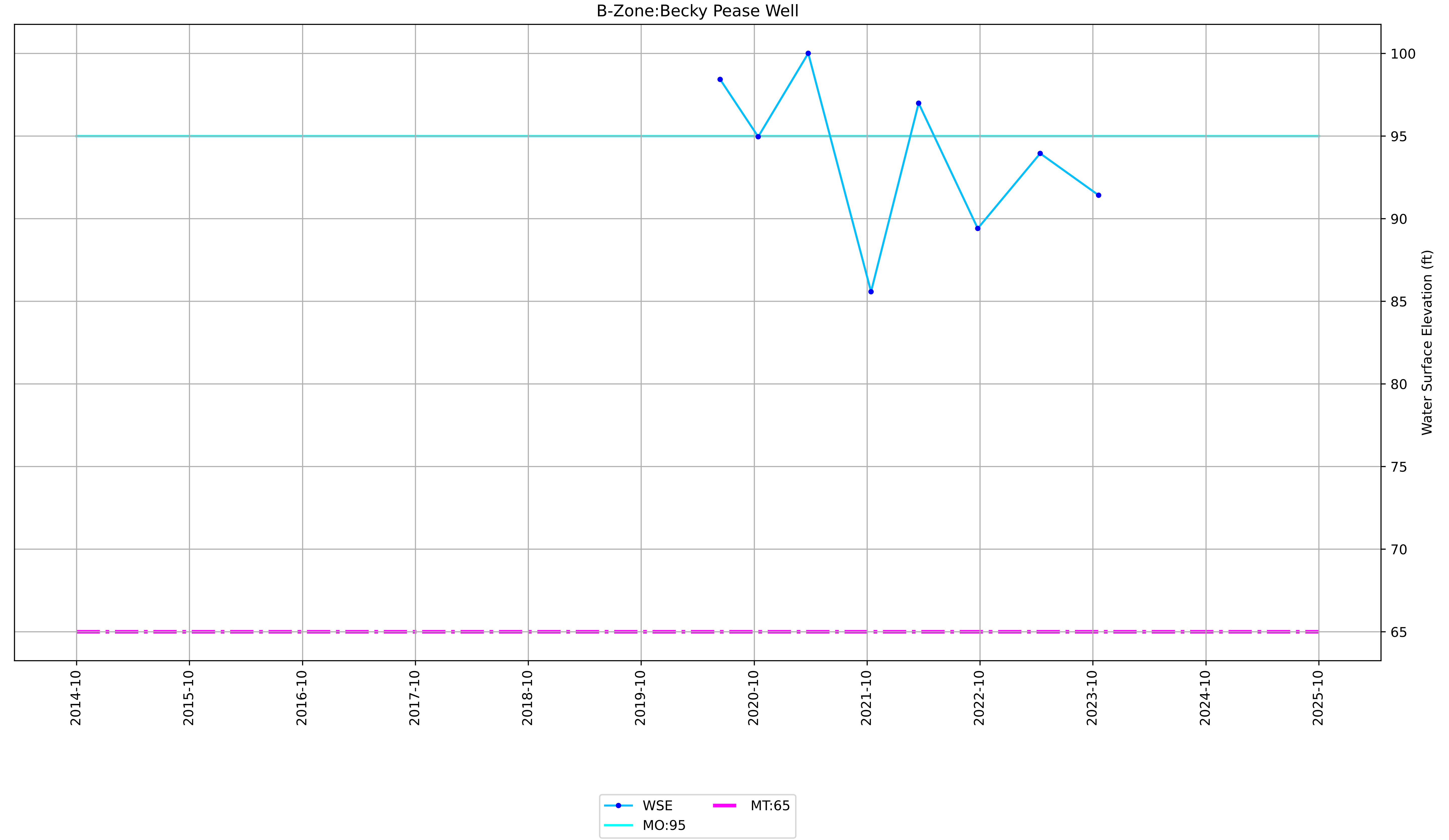
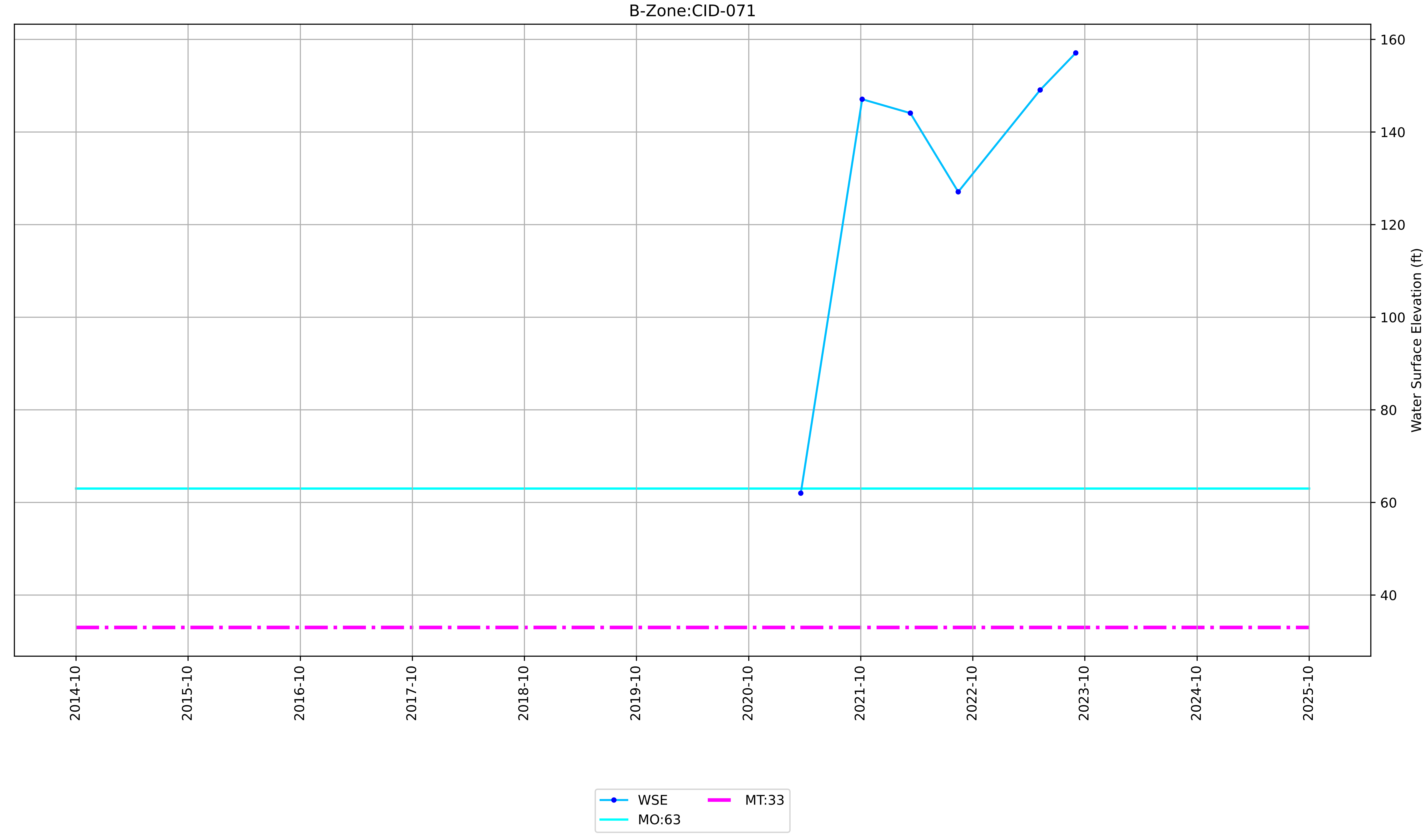
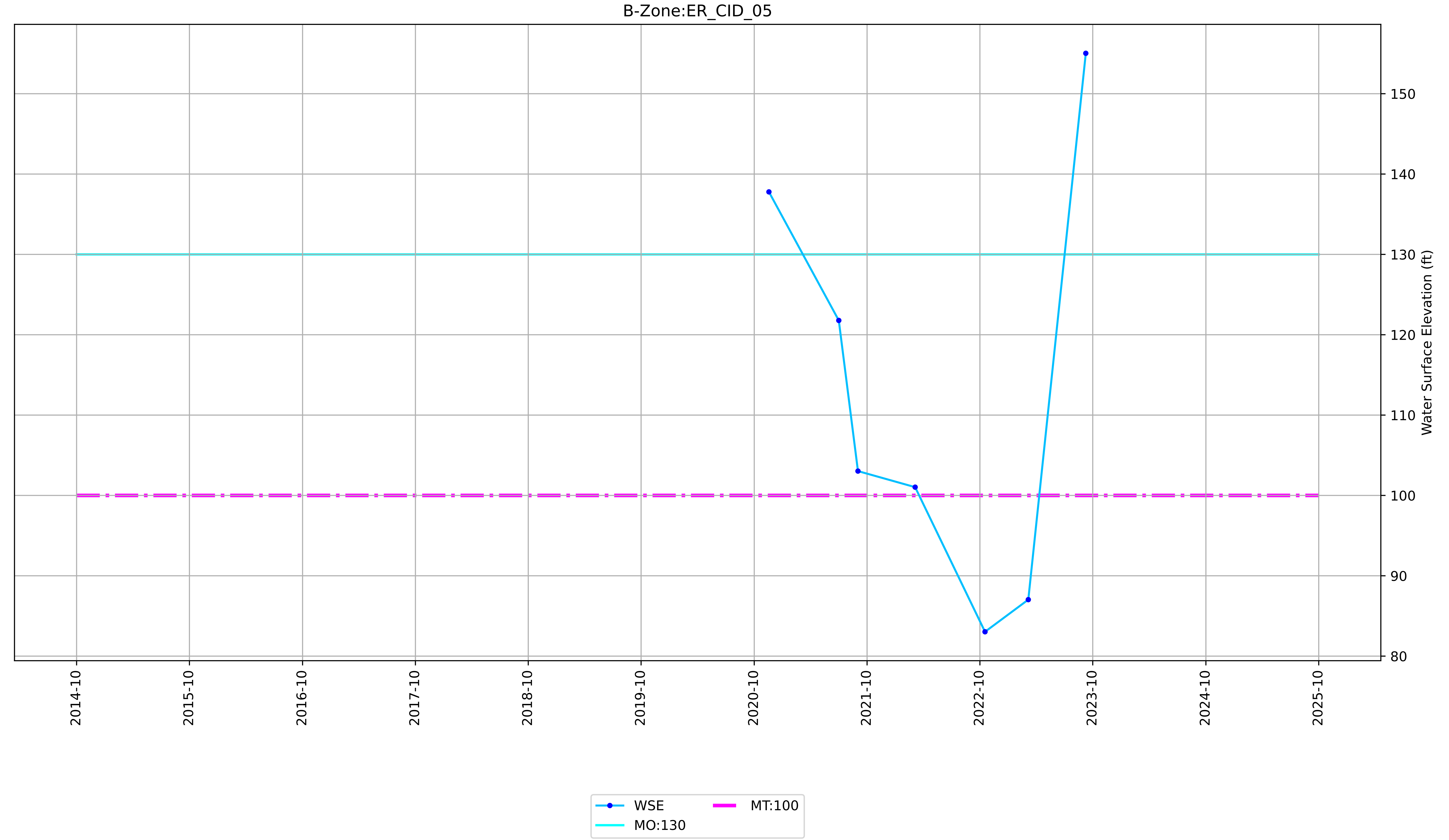
2023-10
2024-10
2025-10
WSE
MO:43
MT:13

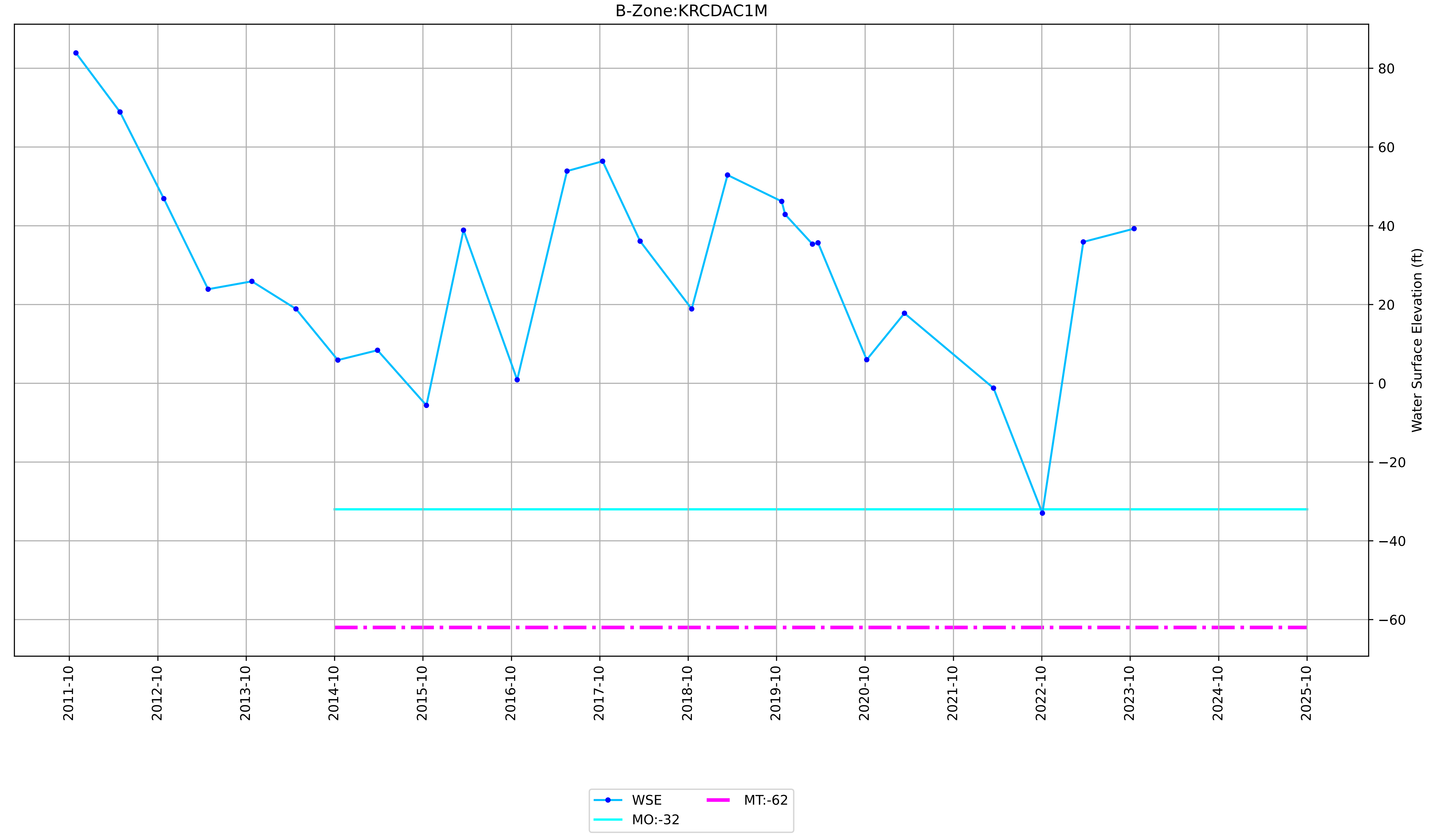


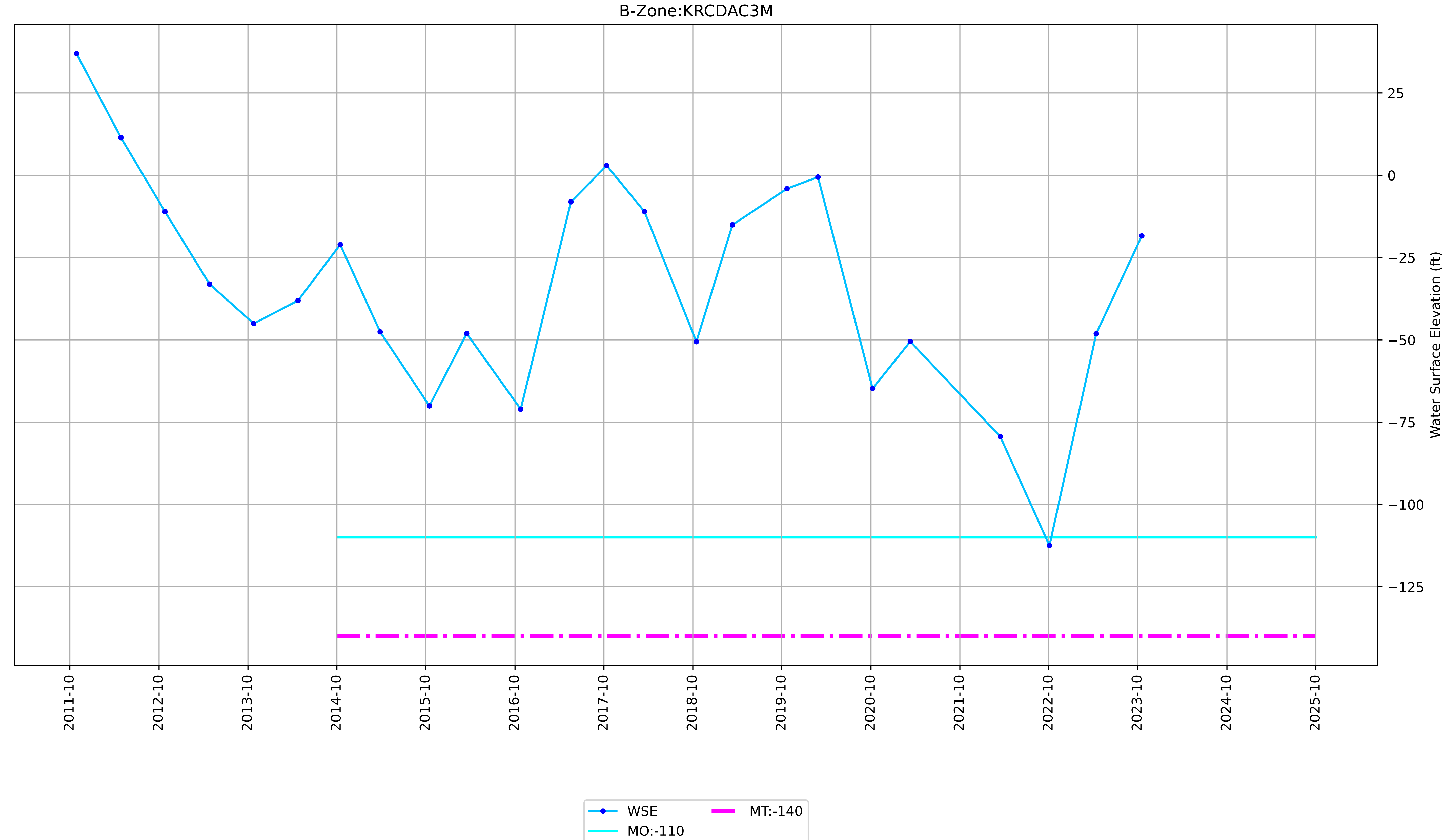
B-Zone:Becky Pease Well
Water Surface Elevation (ft)
100
95
90
85
80
75
70
65
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:95
MT:65

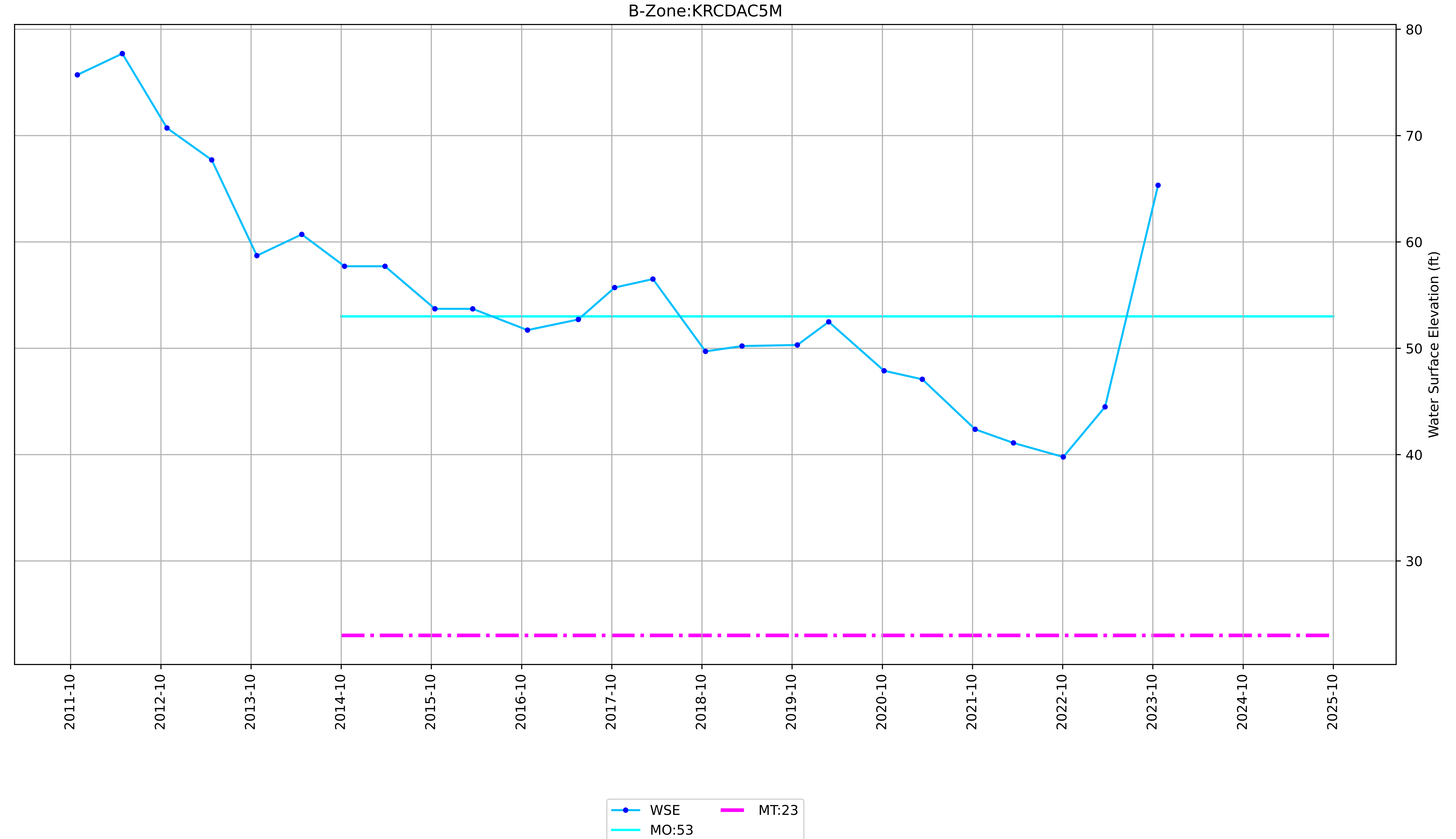


B-Zone:CID-071
160
140
120
100
80
60
40
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:63
MT:33

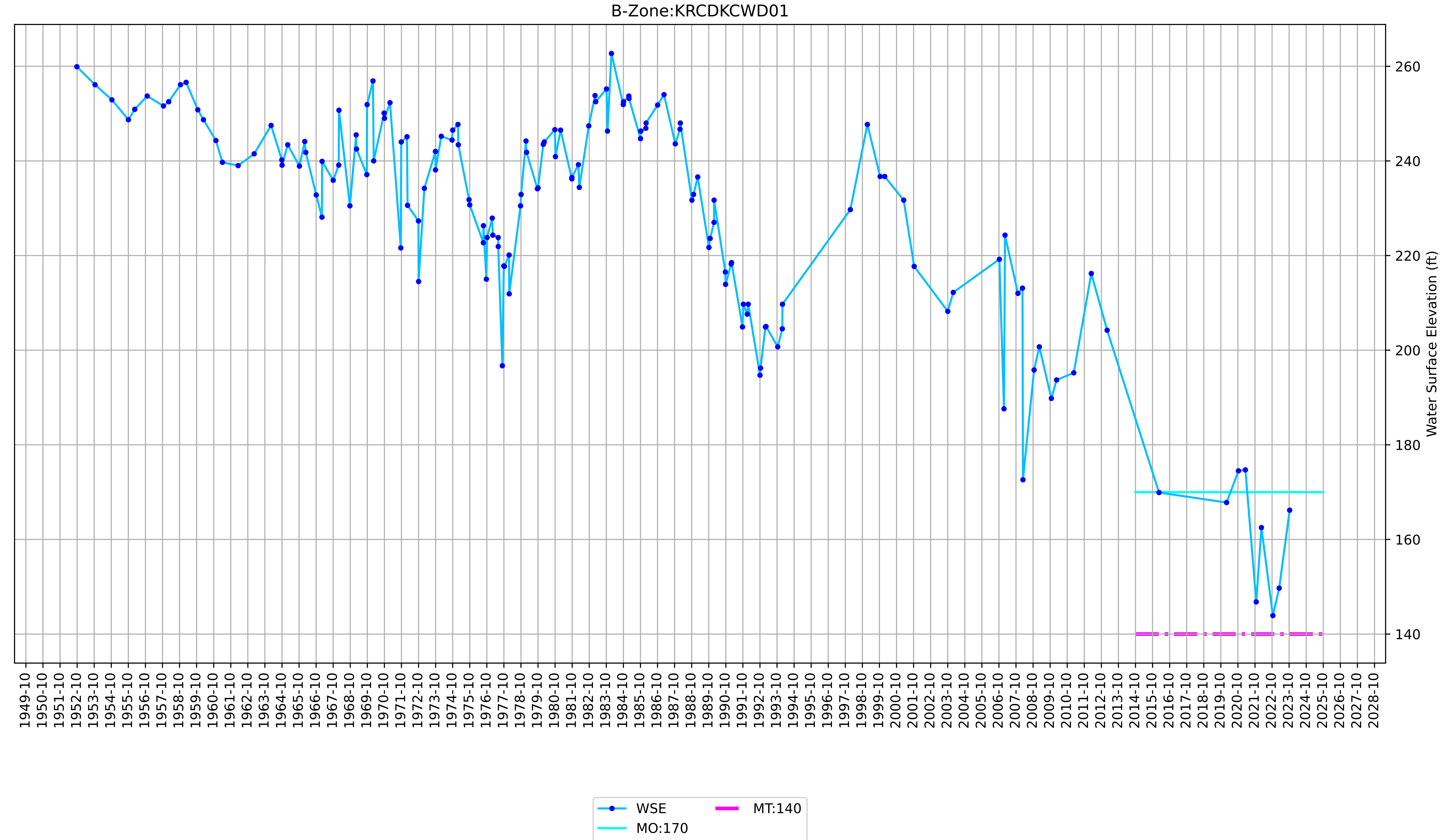

B-Zone:ER_CID_05
Water Surface Elevation (ft)
80
90
100
110
120
130
140
150
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:130
MT:100


B-Zone:KRCDAC1M
Water Surface Elevation (ft)
80
60
40
20
0
−20
−40
−60
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:-32
MT:-62


B-Zone:KRCDAC3M
Water Surface Elevation (ft)
25
0
−25
−50
−75
−100
−125
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:-110
MT:-140



B-Zone:KRCDAC5M
Water Surface Elevation (ft)
80
70
60
50
40
30
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:53
MT:23


B-Zone:KRCDKCWD01
Water Surface Elevation (ft)
260
240
220
200
180
160
140
1949-10
1950-10
1951-10
1952-10
1953-10
1954-10
1955-10
1956-10
1957-10
1958-10
1959-10
1960-10
1961-10
1962-10
1963-10
1964-10
1965-10
1966-10
1967-10
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1975-10
1976-10
1977-10
1978-10
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1981-10
1982-10
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1984-10
1985-10
1986-10
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2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
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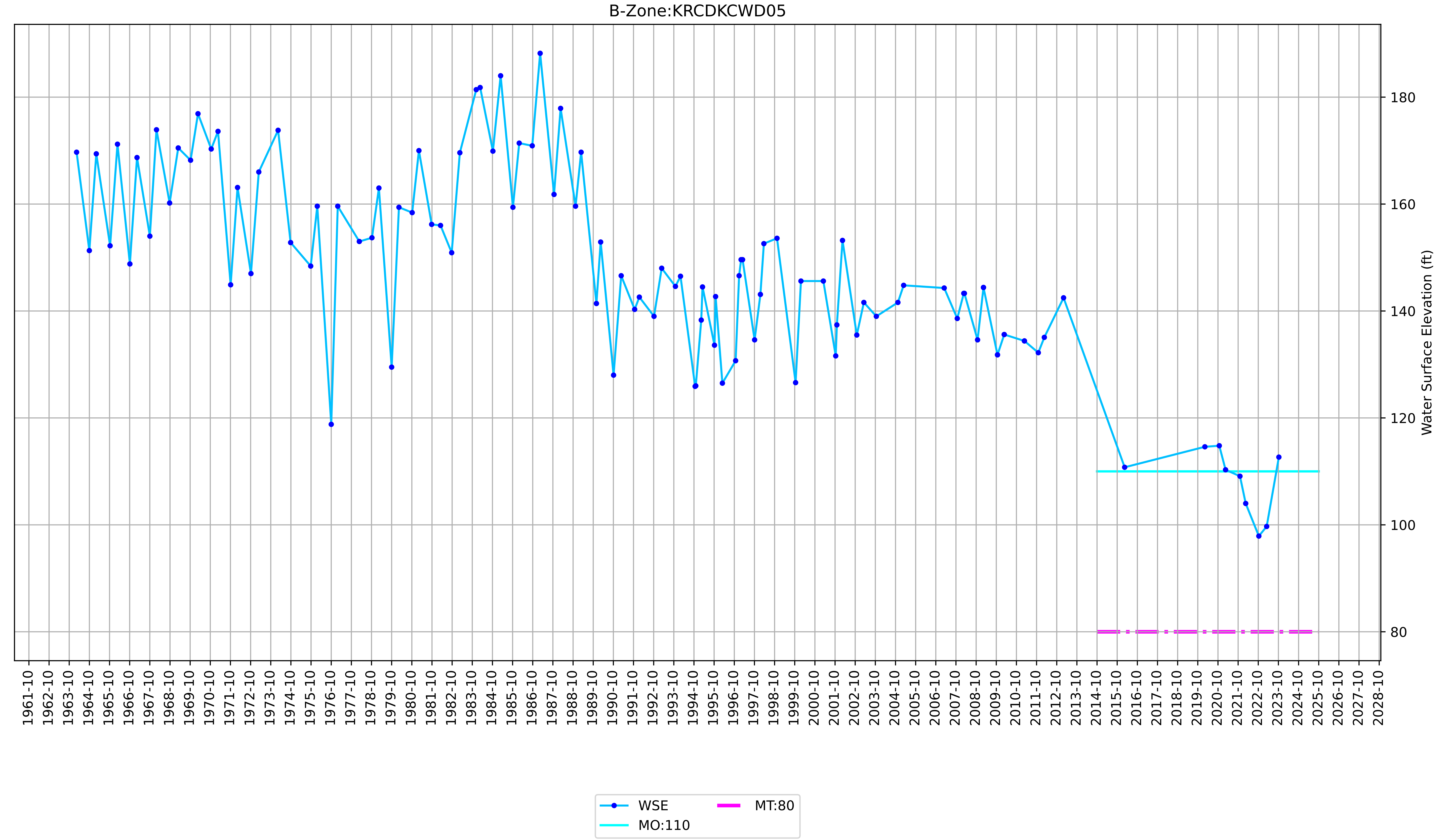
2023-10
2024-10
2025-10
2026-10
2027-10
2028-10
WSE
MO:170
MT:140


B-Zone:KRCDKCWD05
Water Surface Elevation (ft)
80
100
120
140
160
180
1961-10
1962-10
1963-10
1964-10
1965-10
1966-10
1967-10
1968-10
1969-10
1970-10
1971-10
1972-10
1973-10
1974-10
1975-10
1976-10
1977-10
1978-10
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1982-10
1983-10
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1992-10
1993-10
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1996-10
1997-10
1998-10
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2002-10
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2004-10
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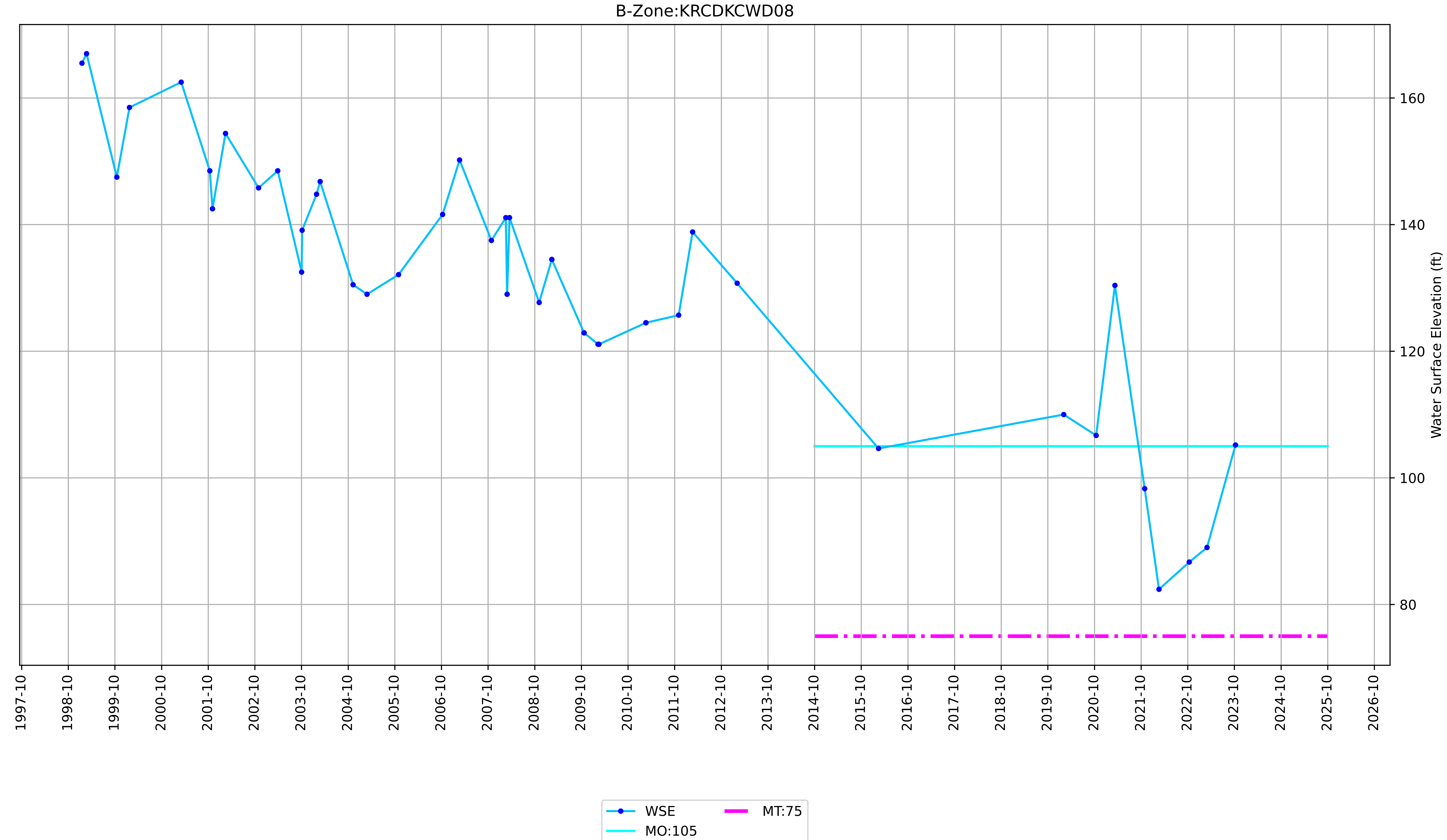
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
2027-10
2028-10
WSE
MO:110
MT:80



B-Zone:KRCDKCWD08
Water Surface Elevation (ft)
160
140
120
100
80
1997-10
1998-10
1999-10
2000-10
2001-10
2002-10
2003-10
2004-10
2005-10
2006-10
2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
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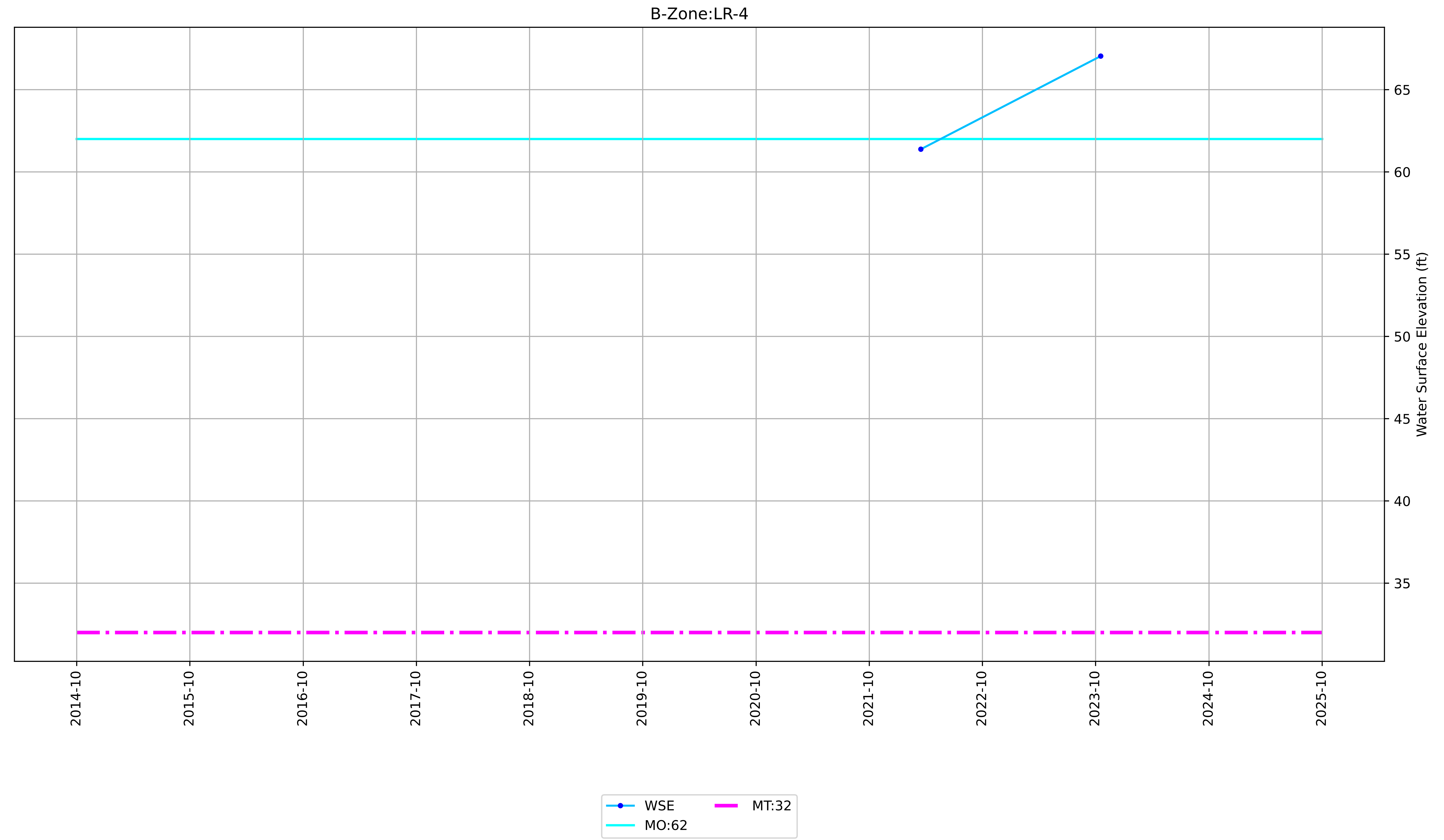
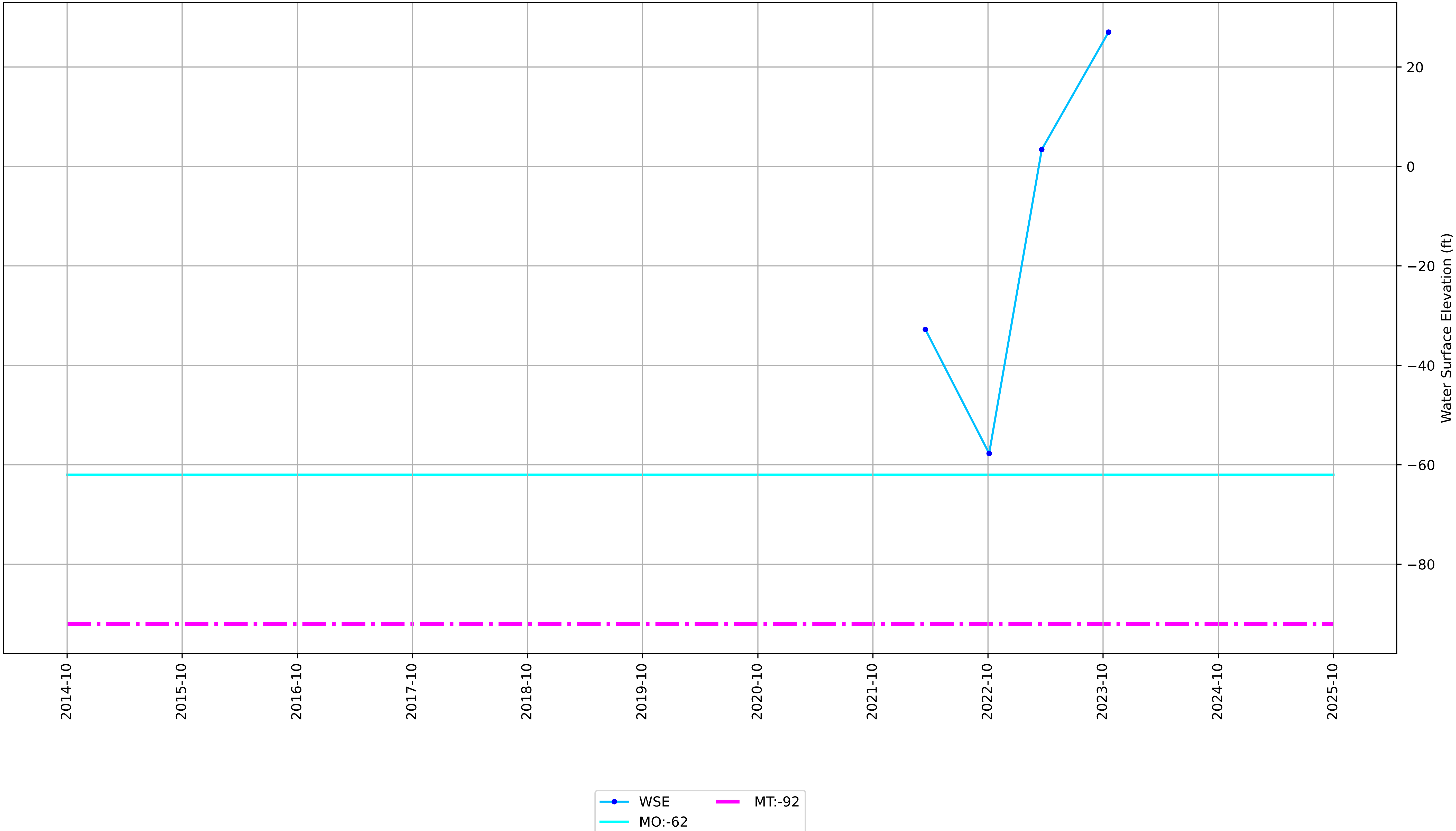
2025-10
2026-10
WSE
MO:105
MT:75

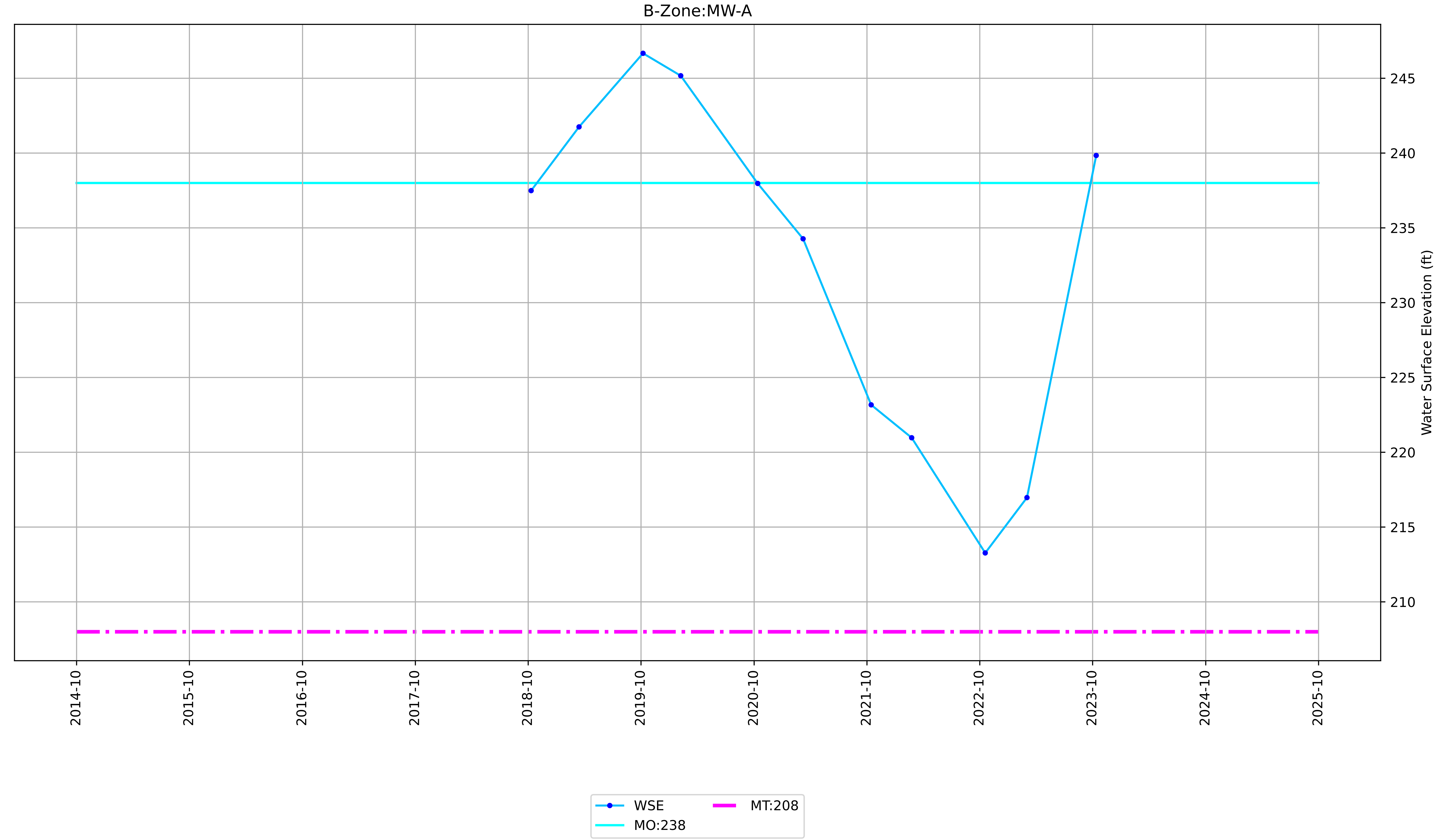


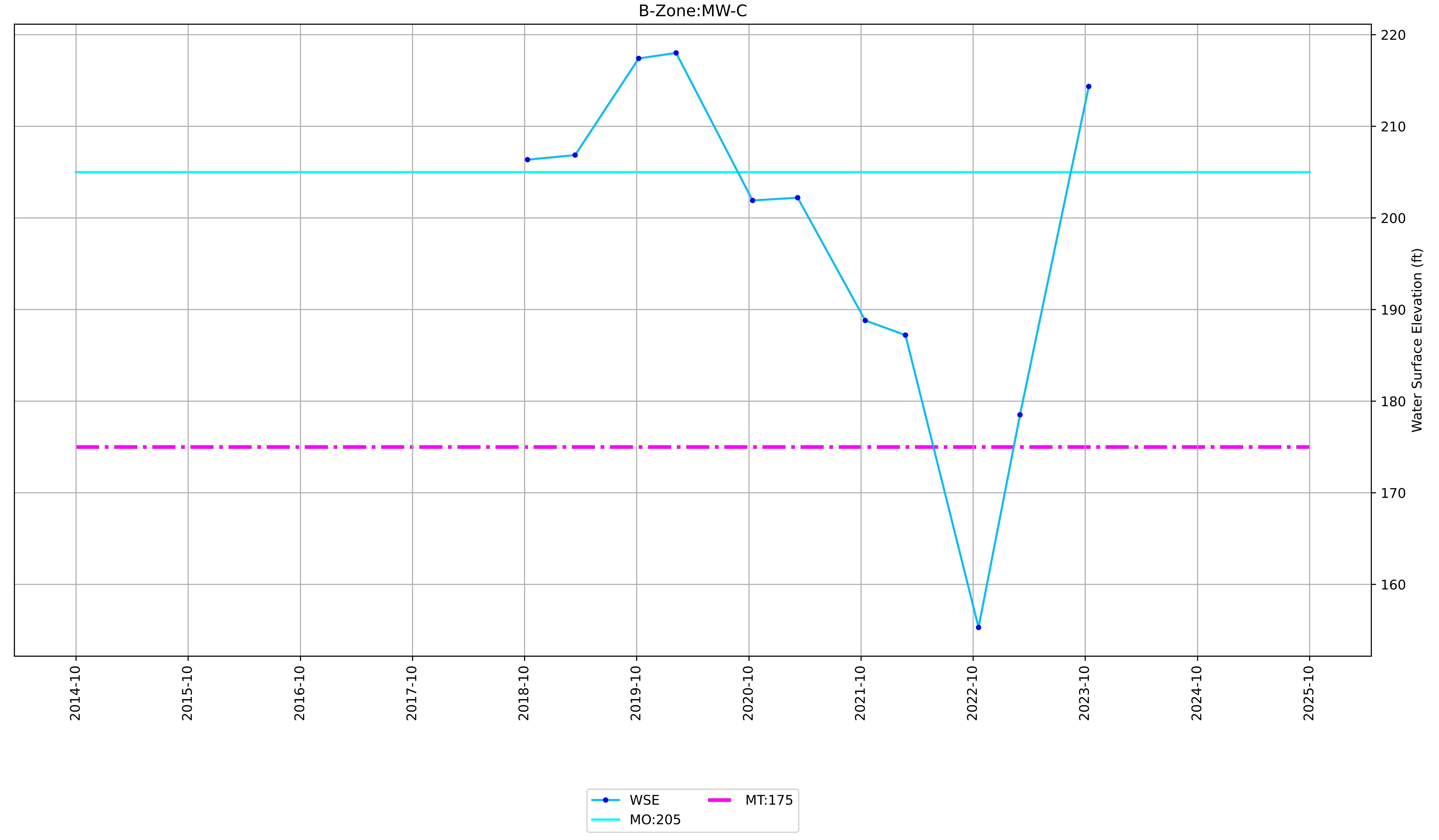
B-Zone:LR-4
Water Surface Elevation (ft)
65
60
55
50
45
40
35
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:62
MT:32

B-Zone:LR-18

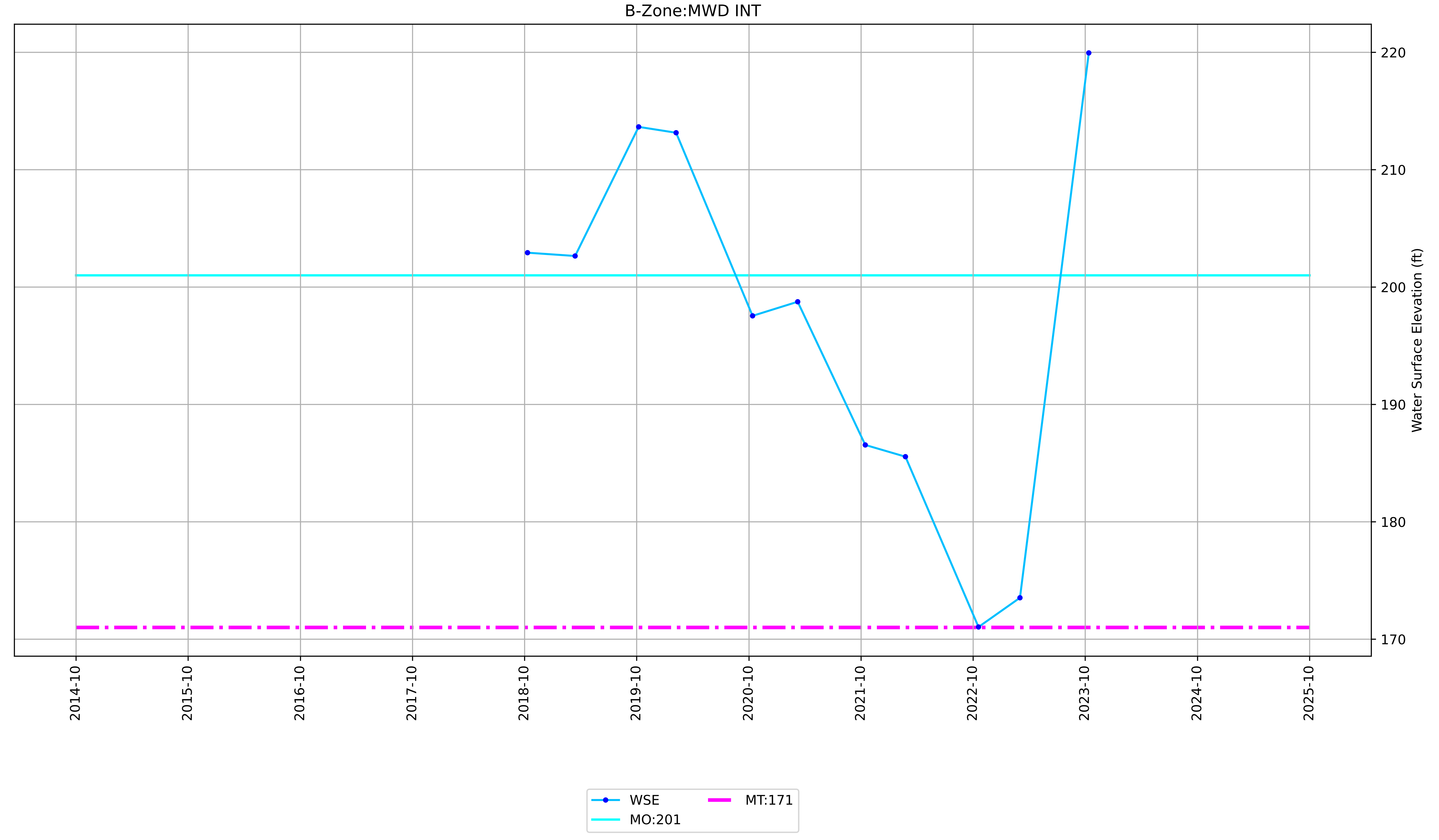


Water Surface Elevation (ft)
20
0
−20
−40
−60
−80
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:-62
MT:-92

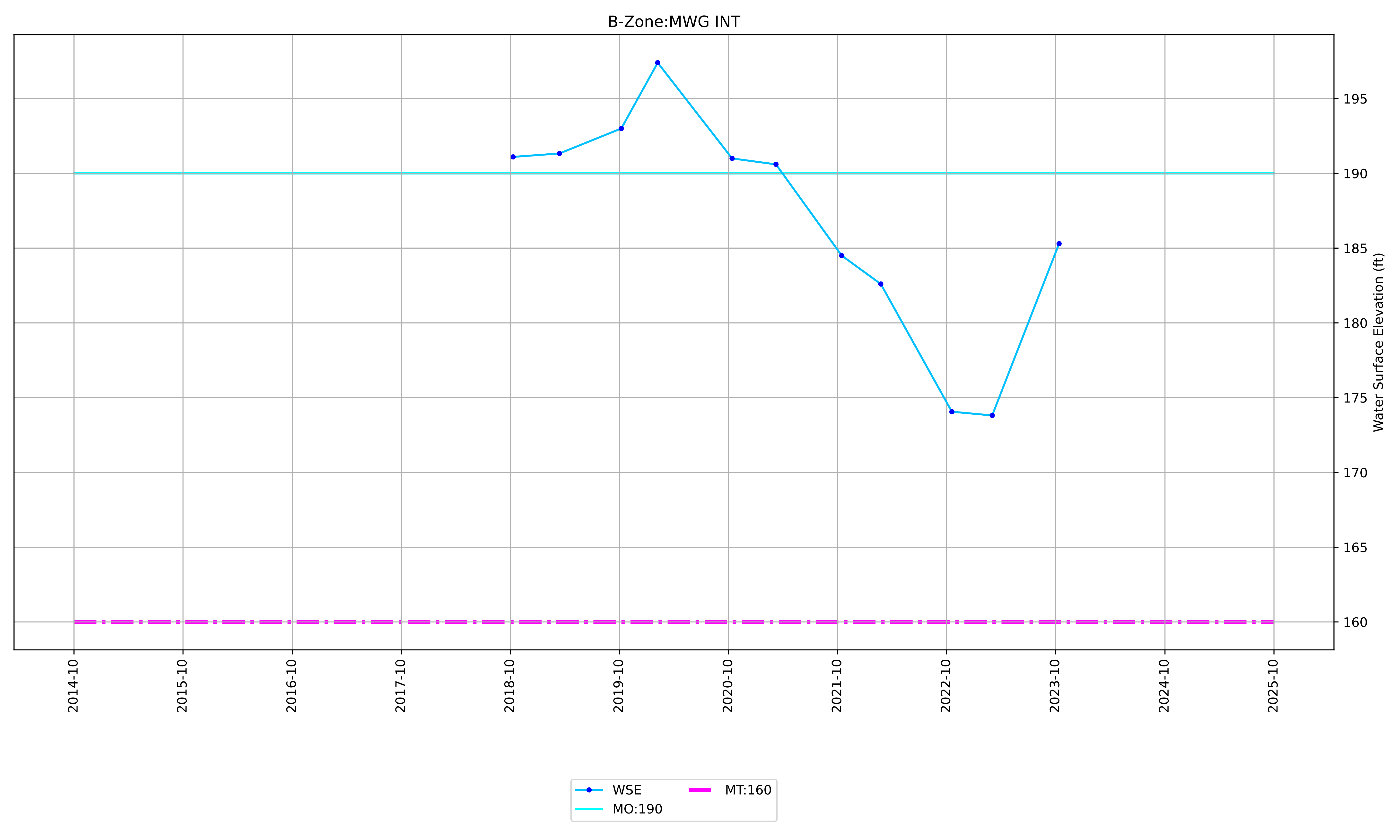

B-Zone:MW-A
Water Surface Elevation (ft)
245
240
235
230
225
220
215
210
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:238
MT:208



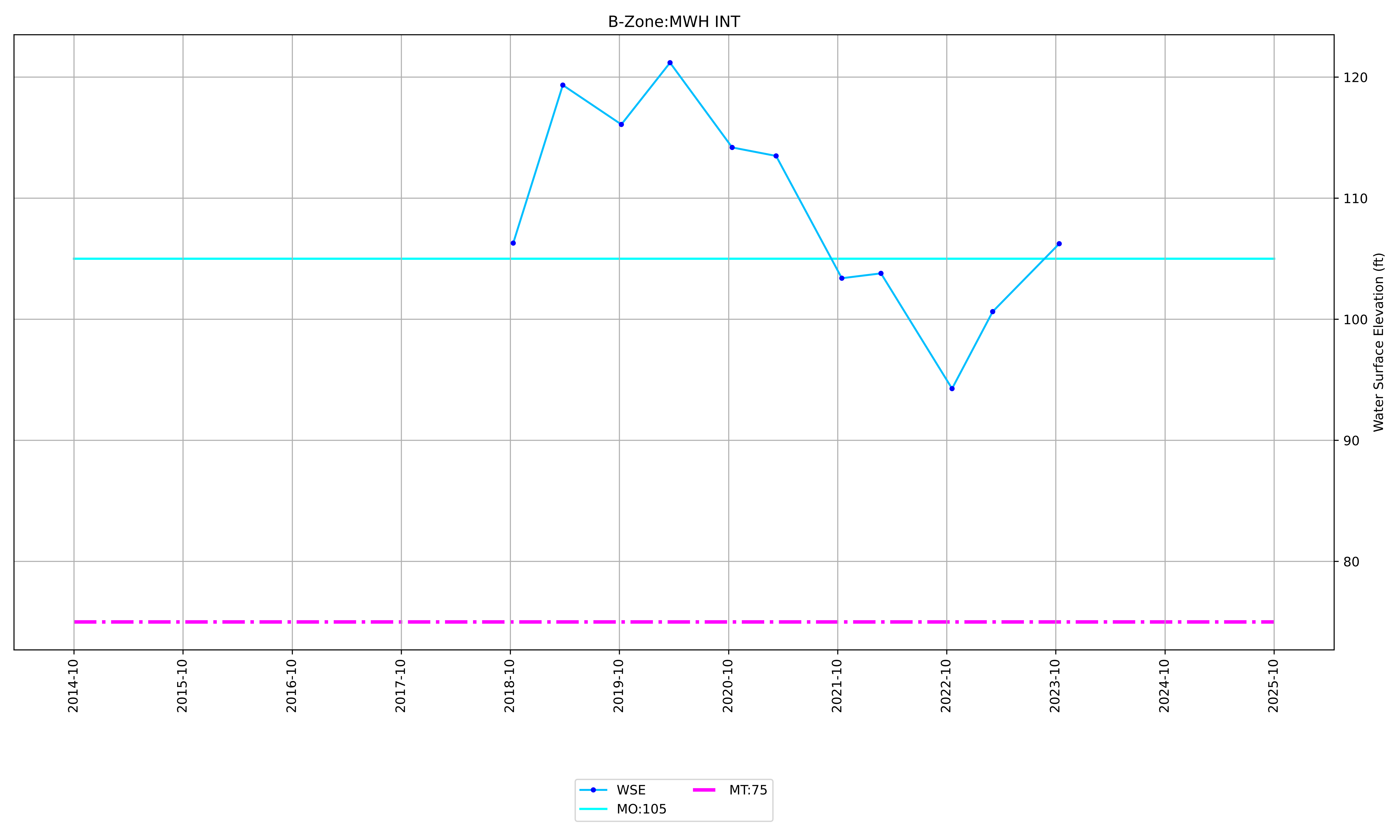
B-Zone:MW-C
Water Surface Elevation (ft)
220
210
200
190
180
170
160
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:205
MT:175



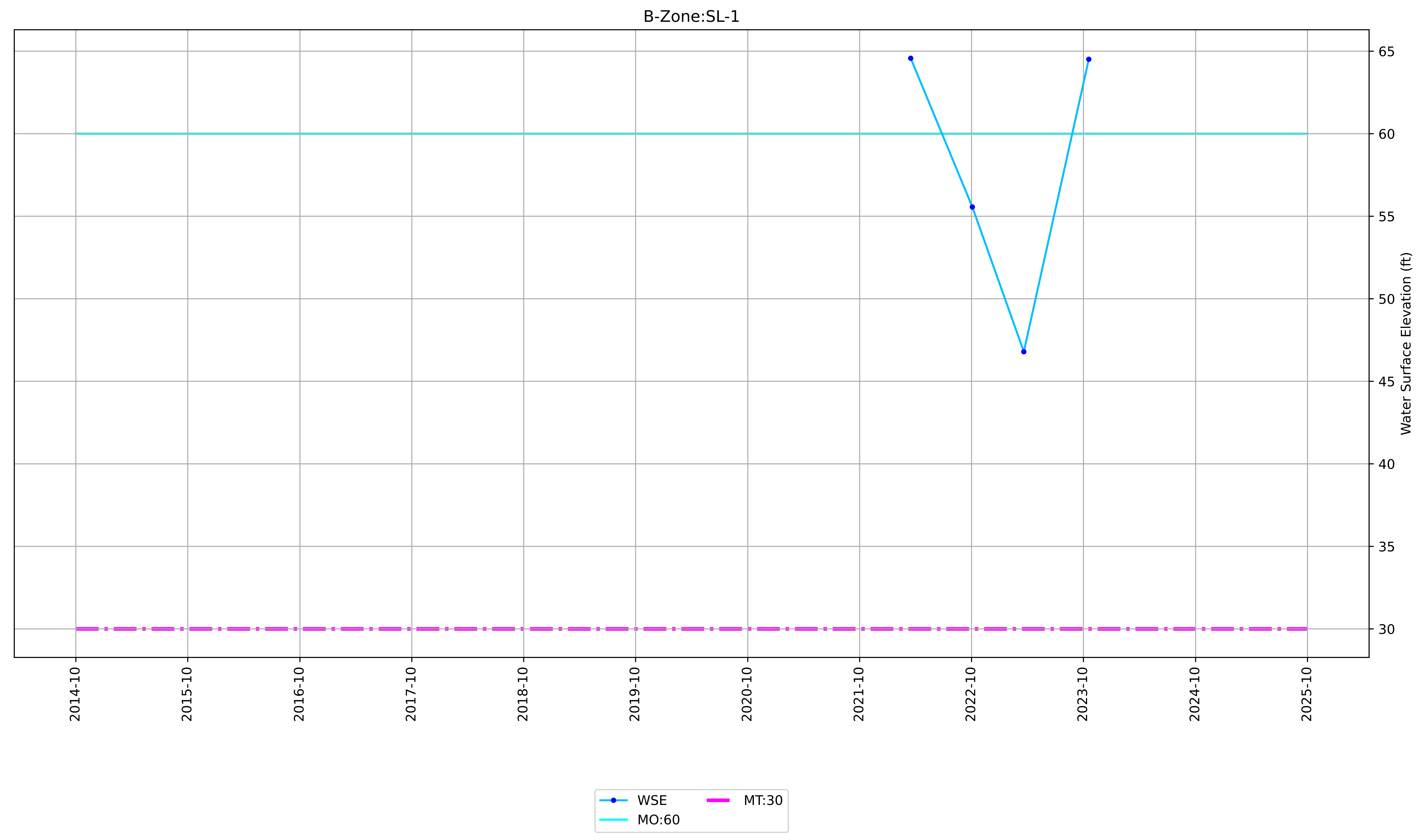
B-Zone:MWD INT
Water Surface Elevation (ft)
220
210
200
190
180
170
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:201
MT:171



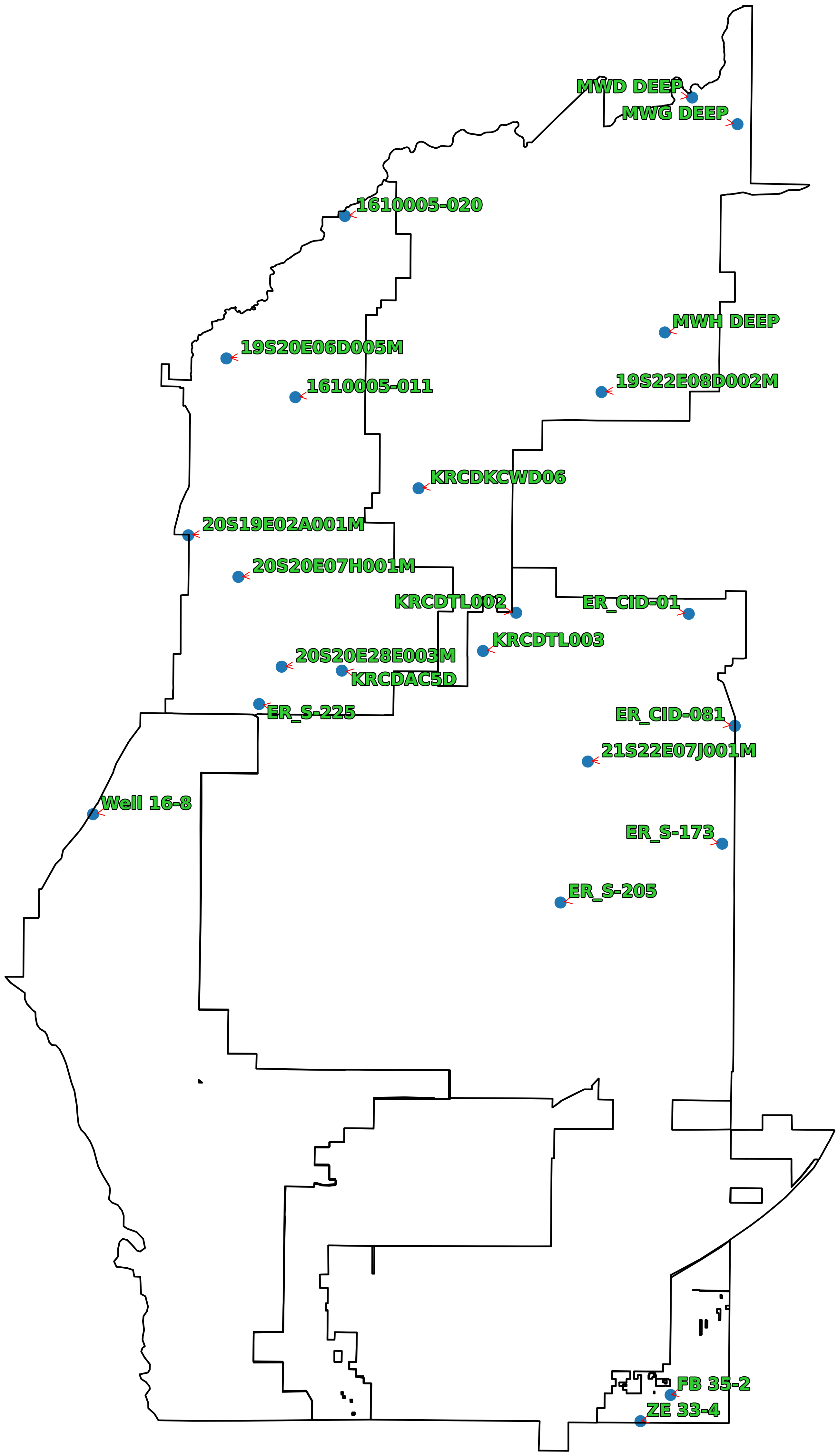
B-Zone:MWG INT
Water Surface Elevation (ft)
160
165
170
175
180
185
190
195
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:190
MT:160

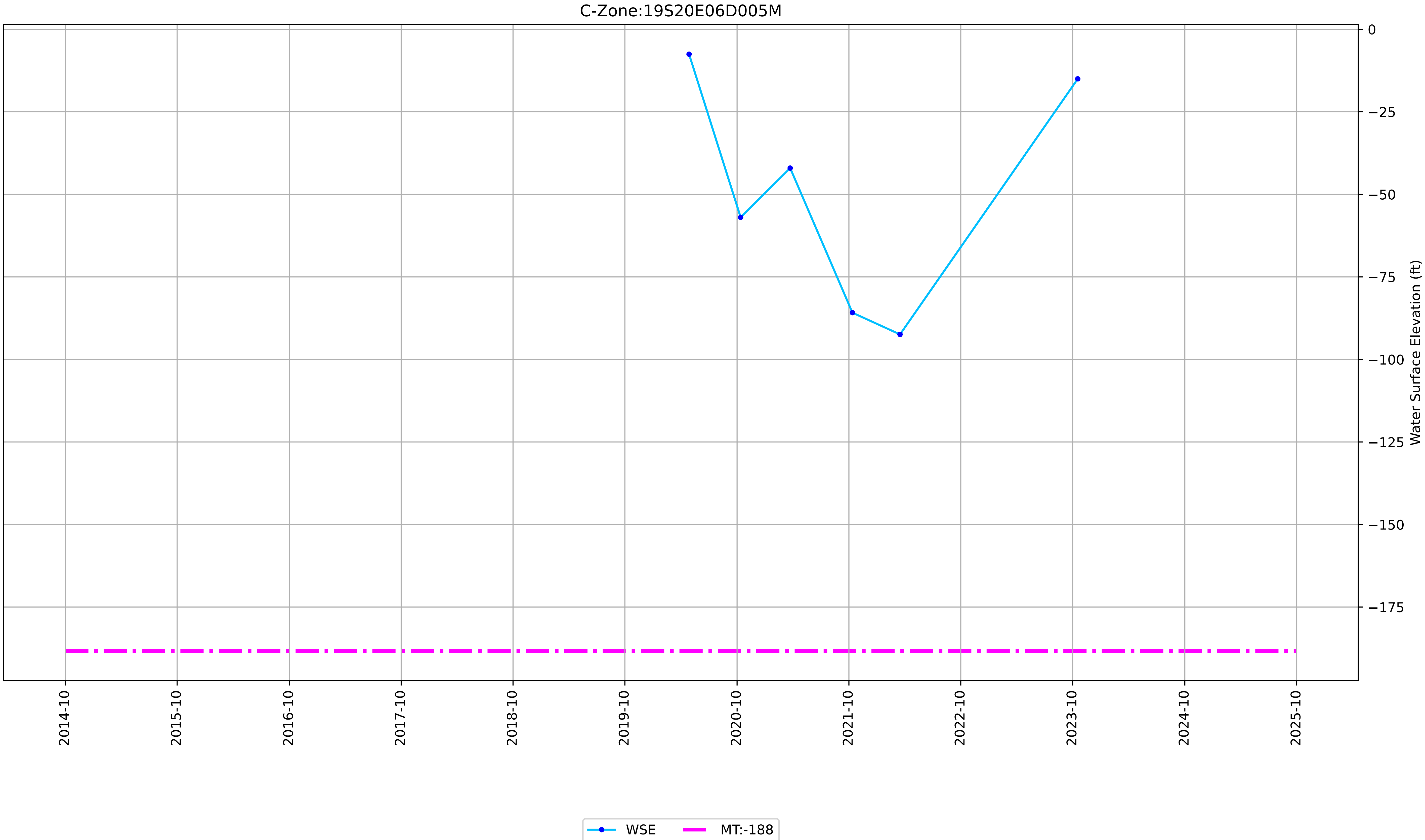


B-Zone:MWH INT
Water Surface Elevation (ft)
120
110
100
90
80
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:105
MT:75

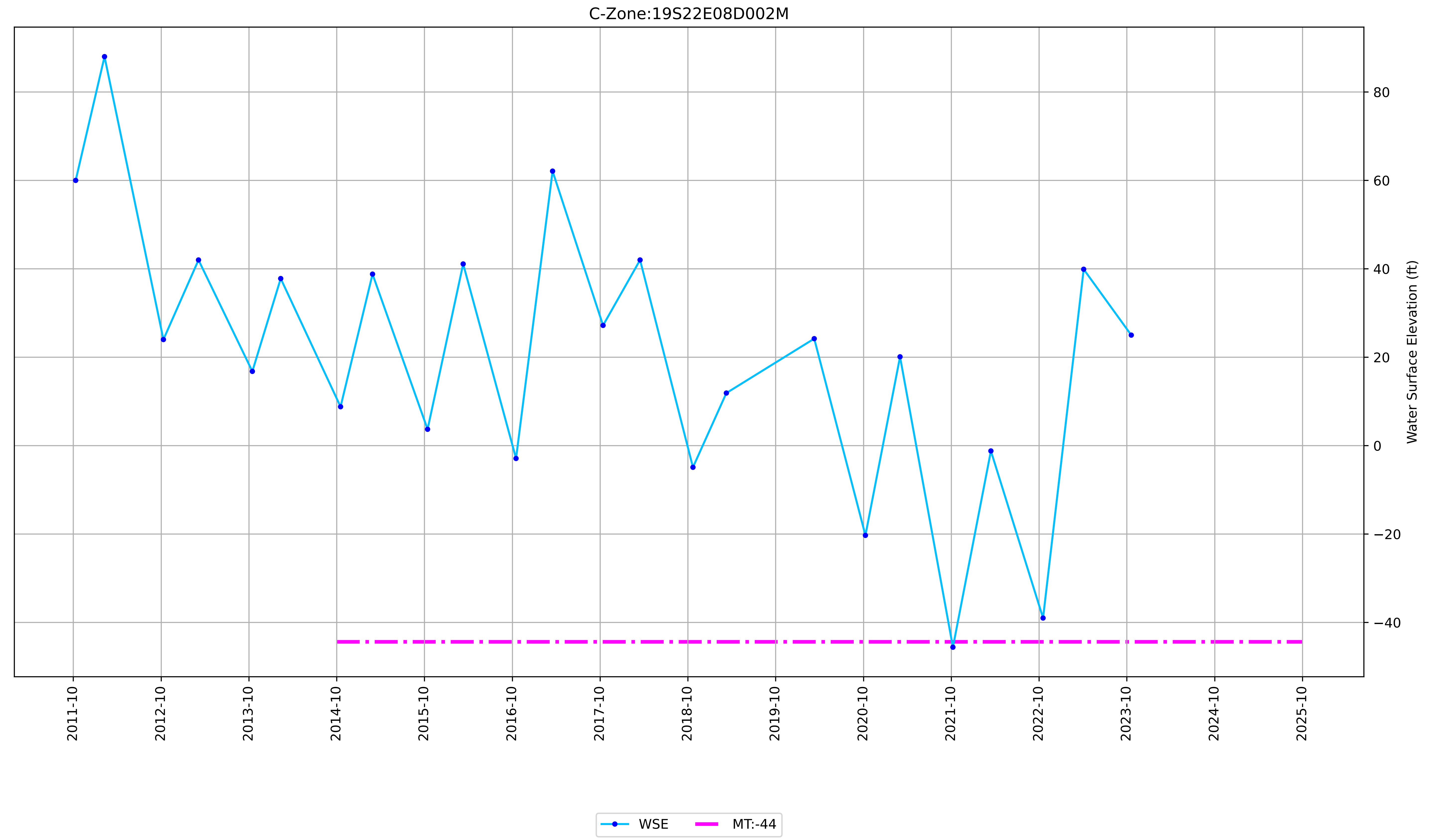

B-Zone:SL-1
Water Surface Elevation (ft)
65
60
55
50
45
40
35
30
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MO:60
MT:30

C-Zone RMS Wells





C-Zone:19S20E06D005M
Water Surface Elevation (ft)
0
−25
−50
−75
−100
−125
−150
−175
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-188



C-Zone:19S22E08D002M
Water Surface Elevation (ft)
80
60
40
20
0
−20
−40
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
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2019-10
2020-10
2021-10
2022-10
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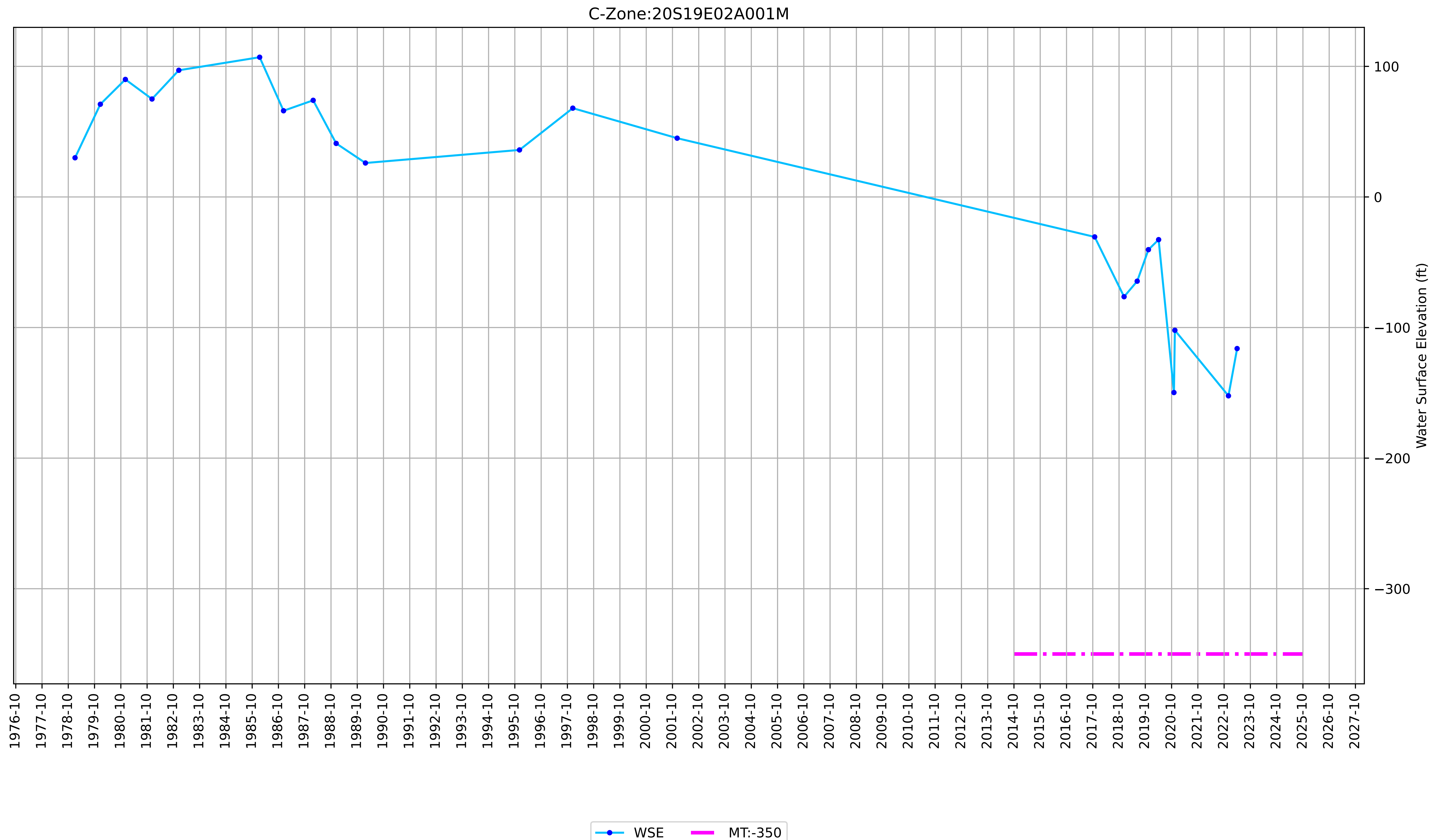
2025-10
WSE
MT:-44



C-Zone:20S19E02A001M
Water Surface Elevation (ft)
100
0
−100
−200
−300
1976-10
1977-10
1978-10
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1981-10
1982-10
1983-10
1984-10
1985-10
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2007-10
2008-10
2009-10
2010-10
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
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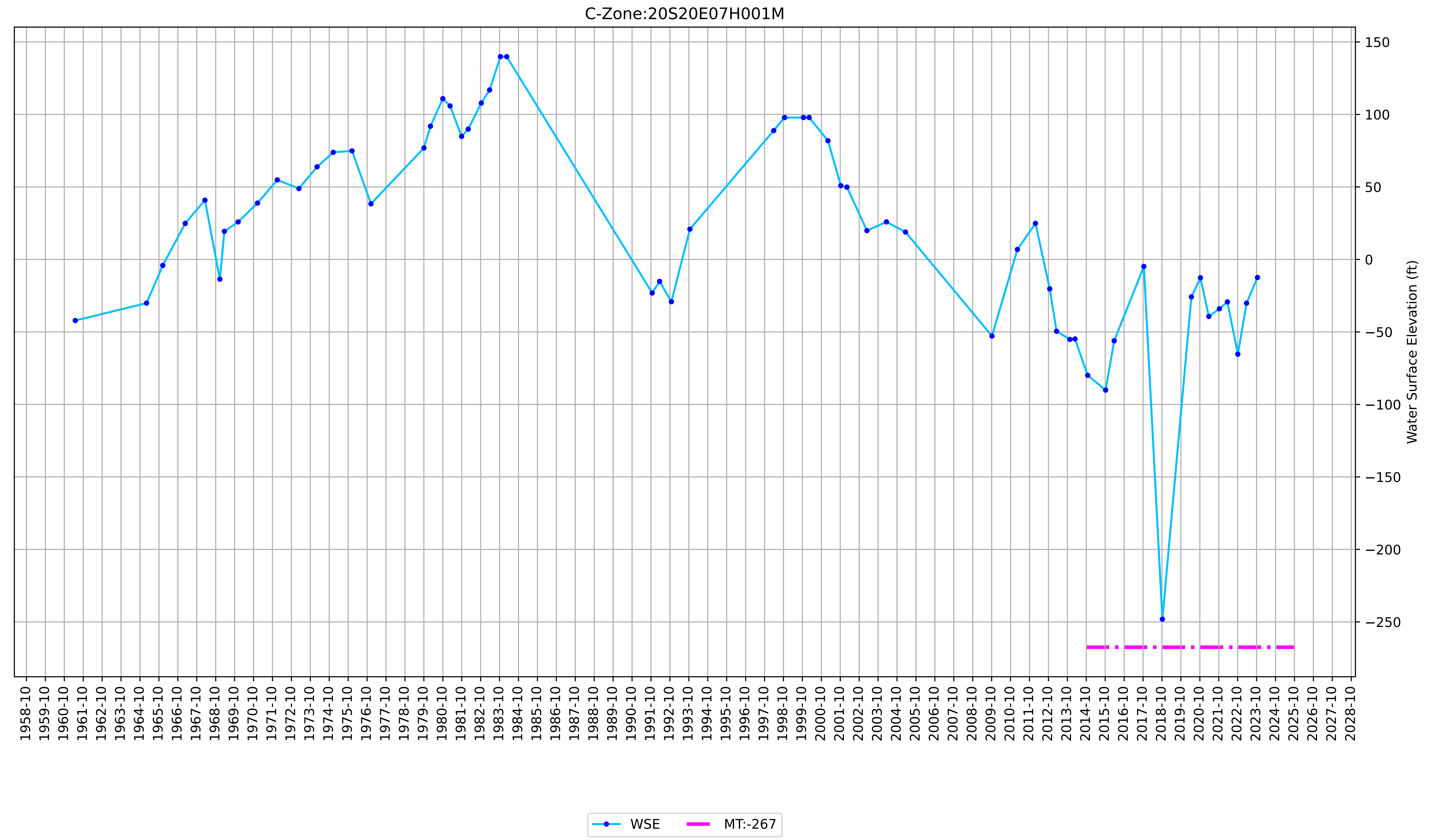
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
2027-10
WSE
MT:-350



C-Zone:20S20E07H001M
Water Surface Elevation (ft)
150
100
50
0
−50
−100
−150
−200
−250
1958-10
1959-10
1960-10
1961-10
1962-10
1963-10
1964-10
1965-10
1966-10
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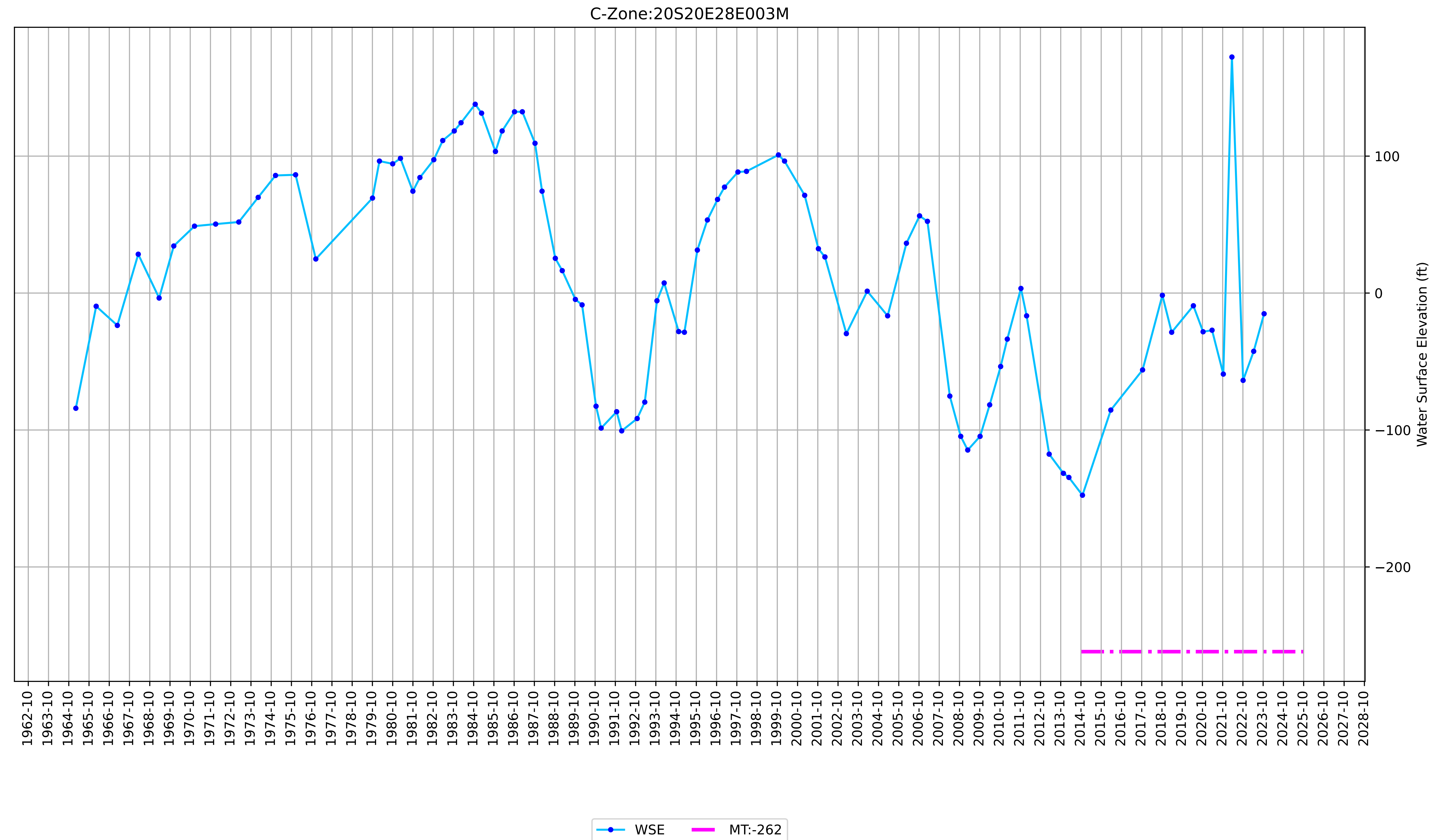
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
2027-10
2028-10
WSE
MT:-267



C-Zone:20S20E28E003M
Water Surface Elevation (ft)
100
0
−100
−200
1962-10
1963-10
1964-10
1965-10
1966-10
1967-10
1968-10
1969-10
1970-10
1971-10
1972-10
1973-10
1974-10
1975-10
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2016-10
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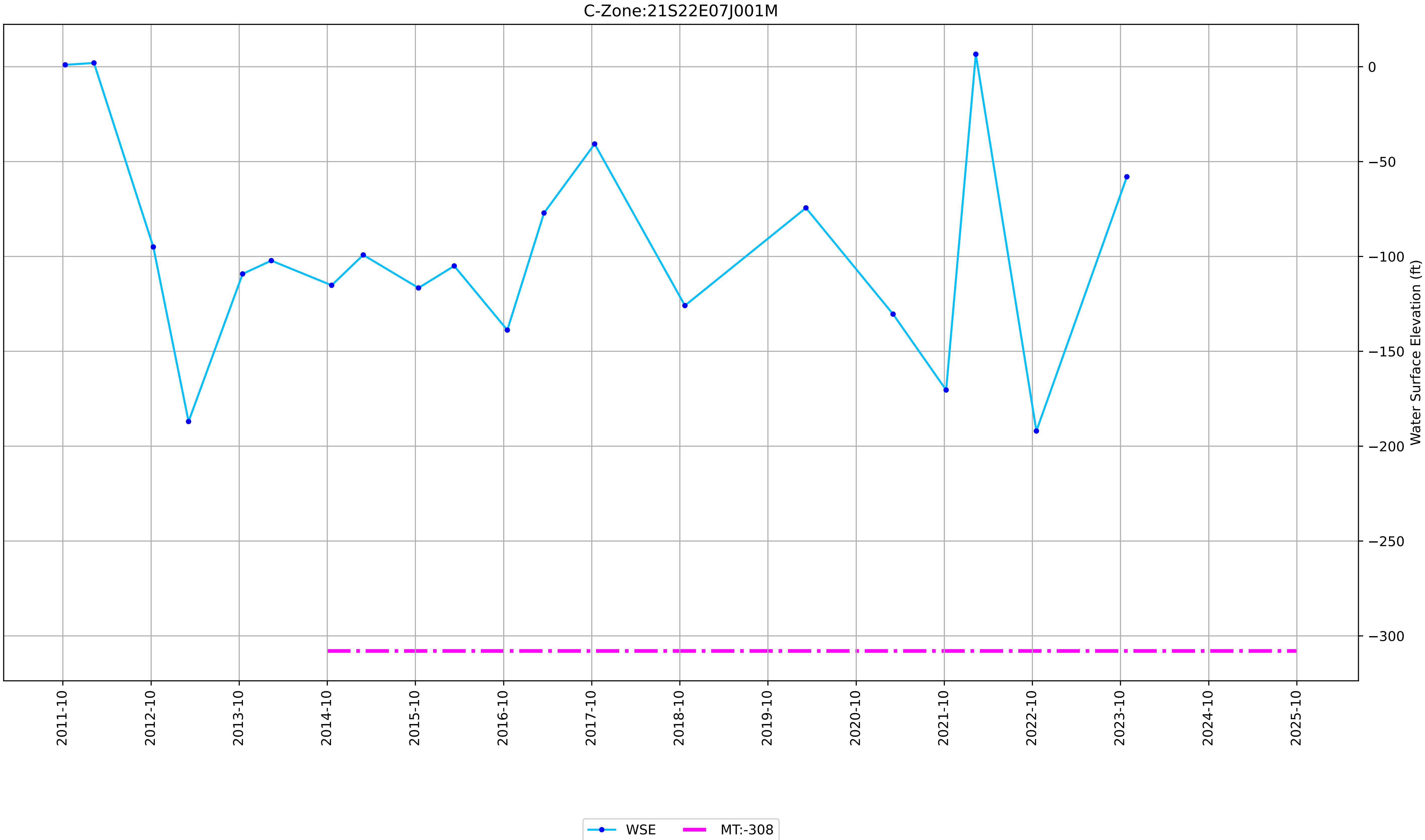
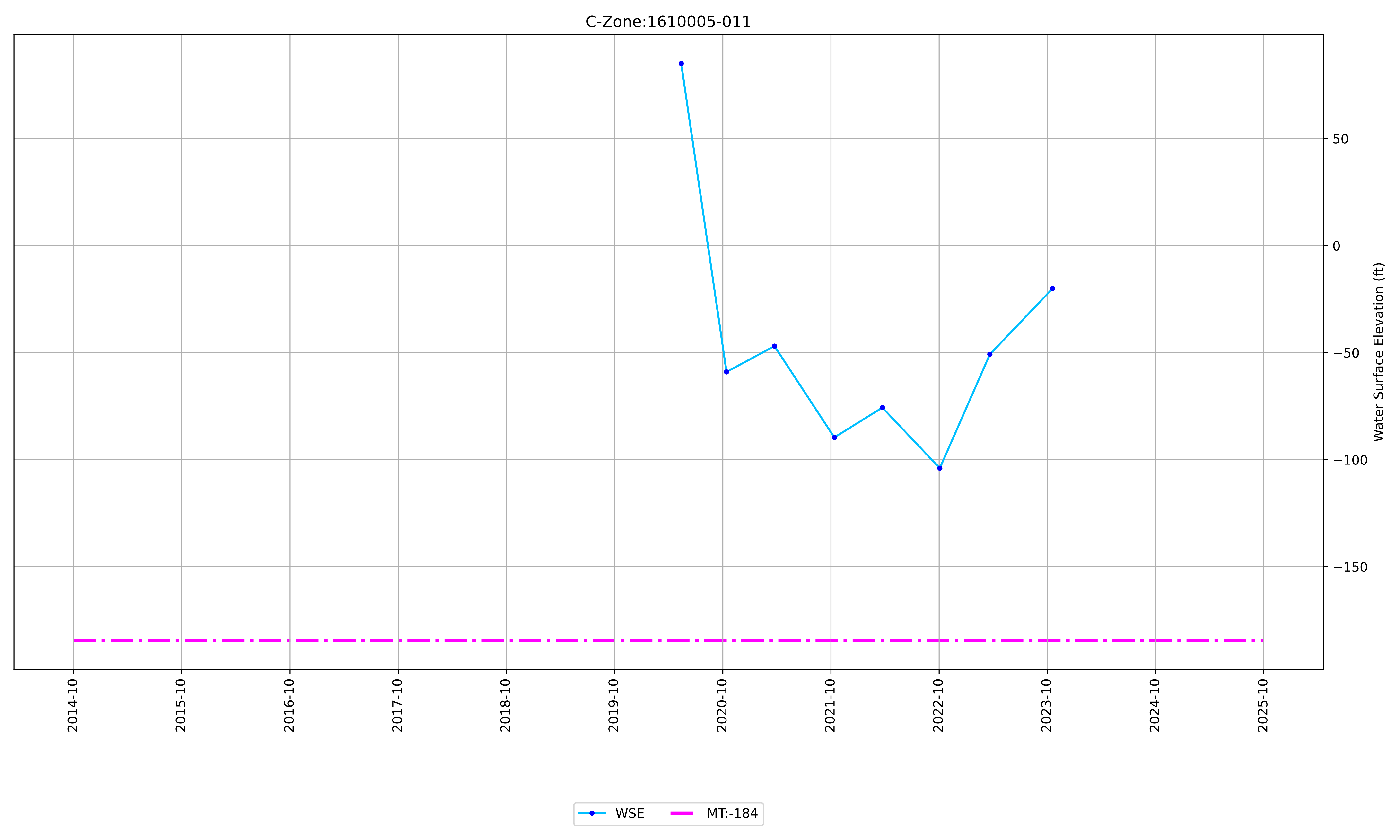
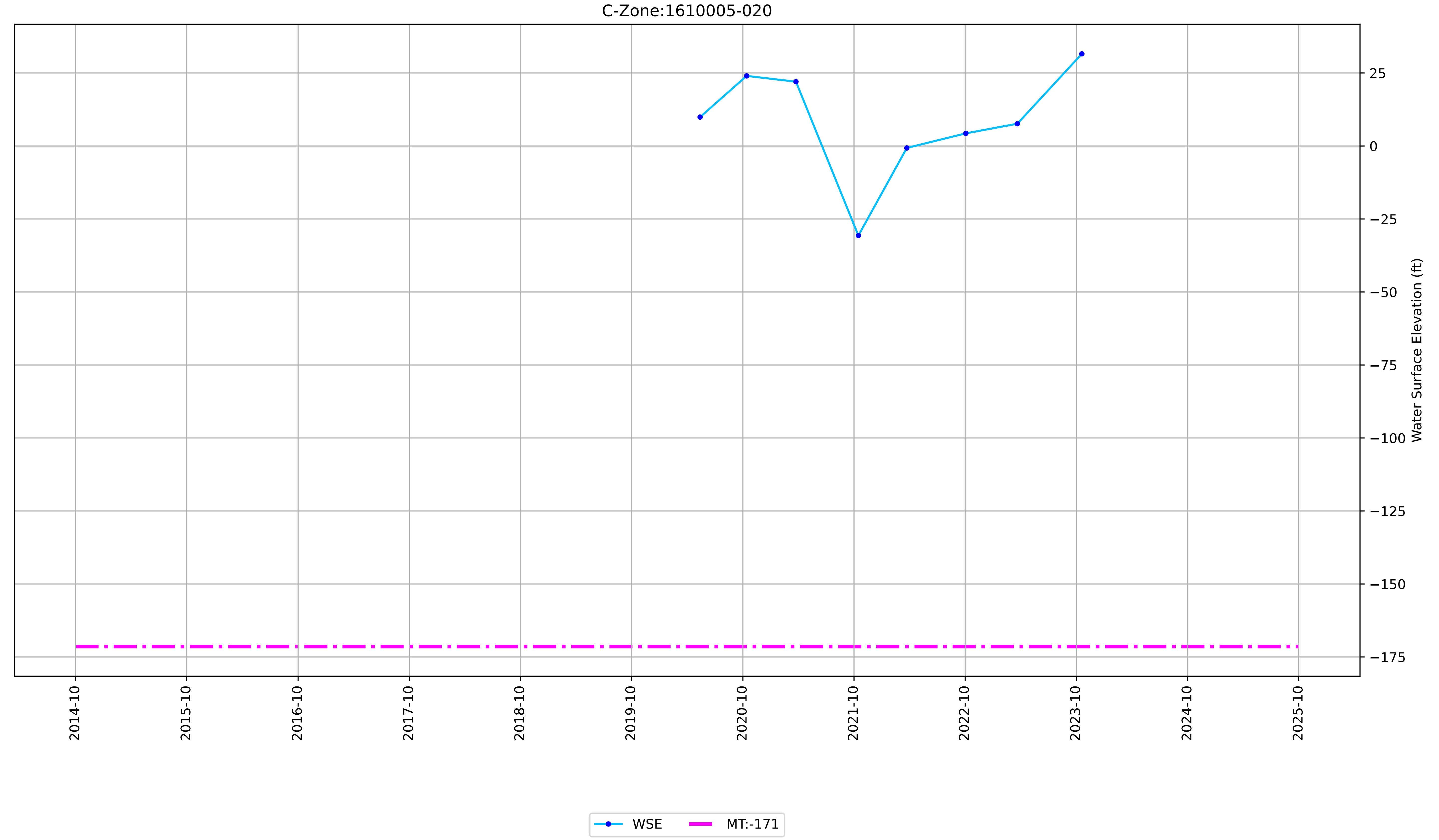
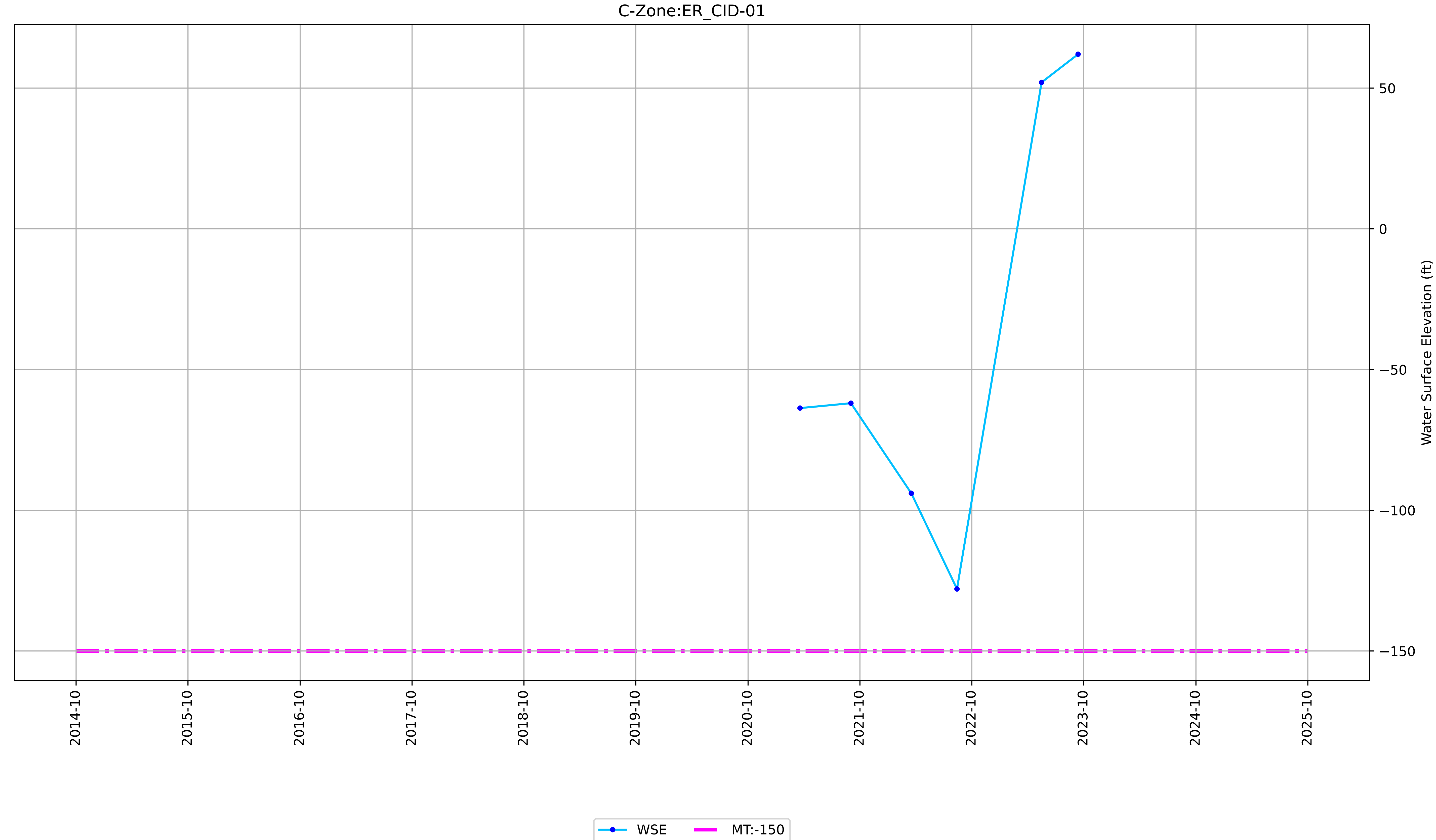
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
2026-10
2027-10
2028-10
WSE
MT:-262


C-Zone:21S22E07J001M
Water Surface Elevation (ft)
0
−50
−100
−150
−200
−250
−300
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-308

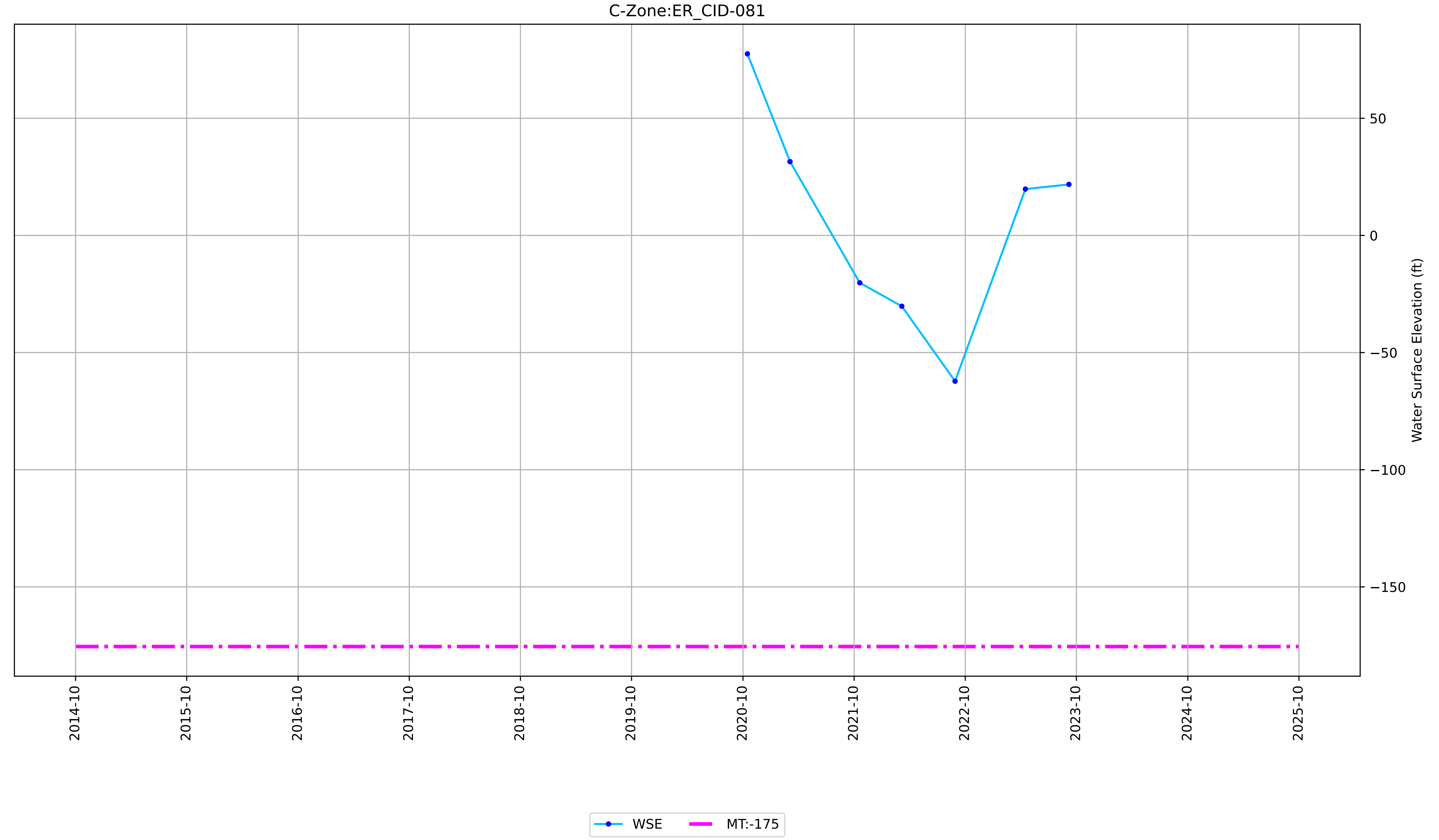

C-Zone:1610005-011
Water Surface Elevation (ft)
50
0
−50
−100
−150
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-184



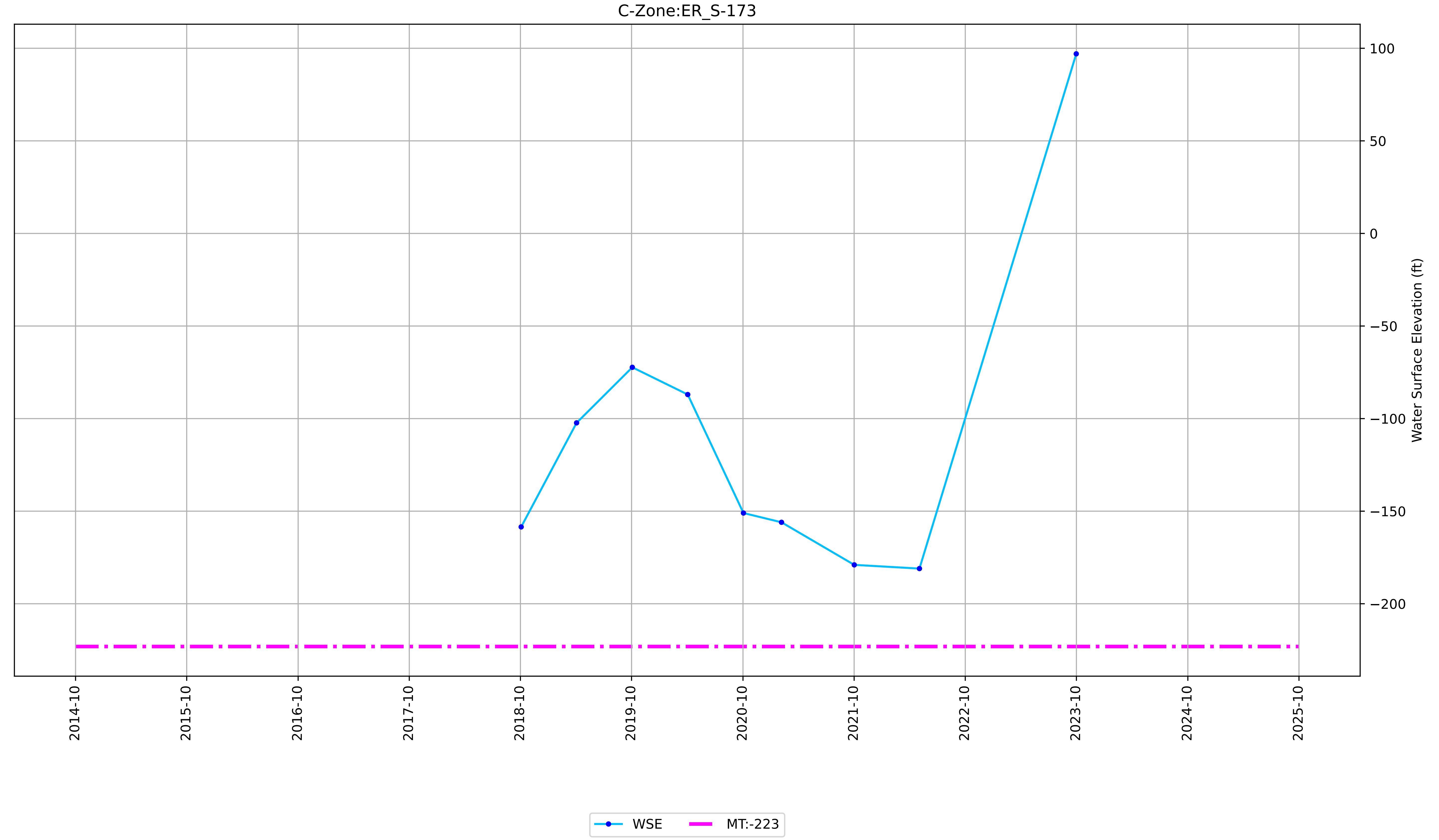
C-Zone:1610005-020
Water Surface Elevation (ft)
25
0
−25
−50
−75
−100
−125
−150
−175
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-171



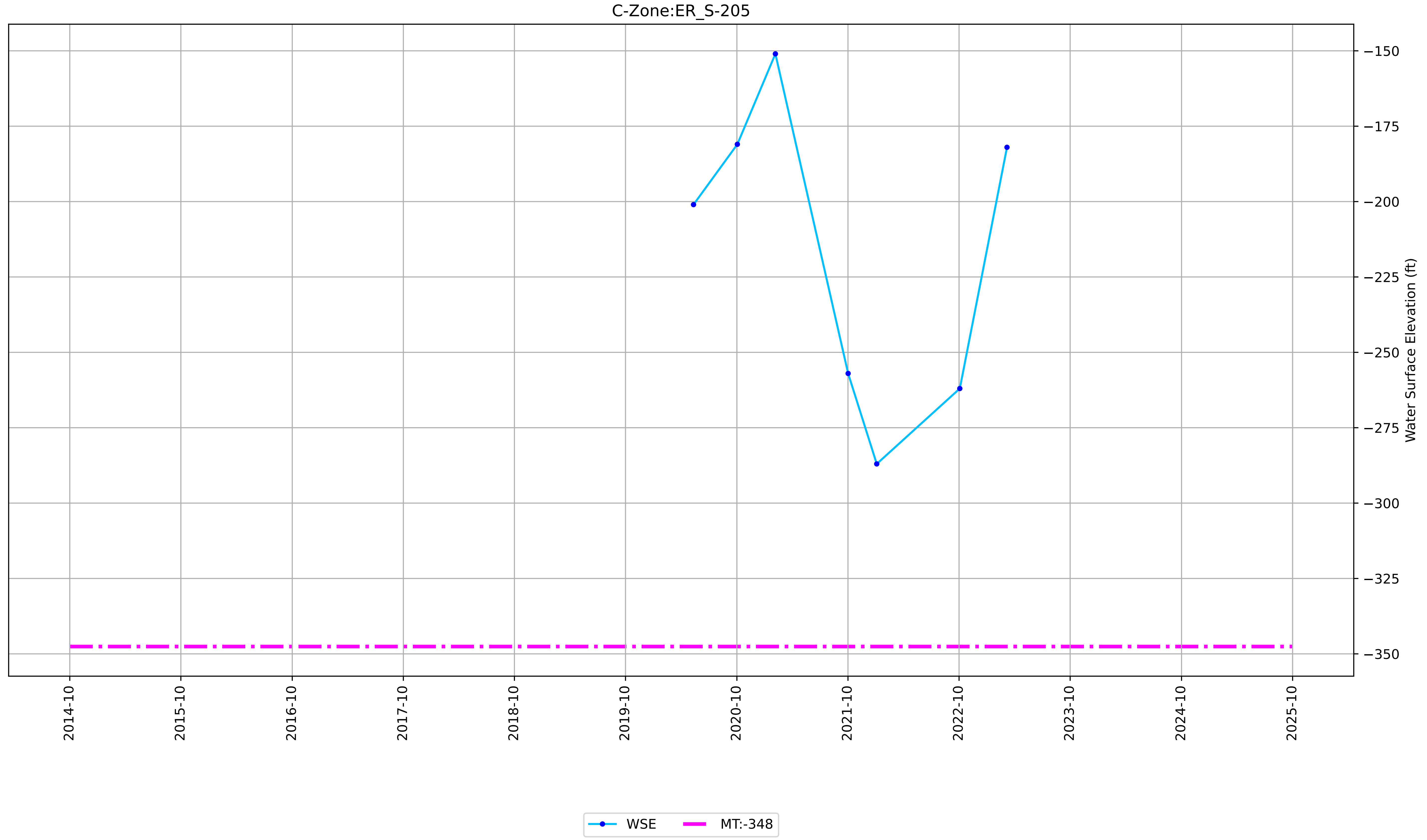
C-Zone:ER_CID-01
50
0
−50
−100
−150
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-150



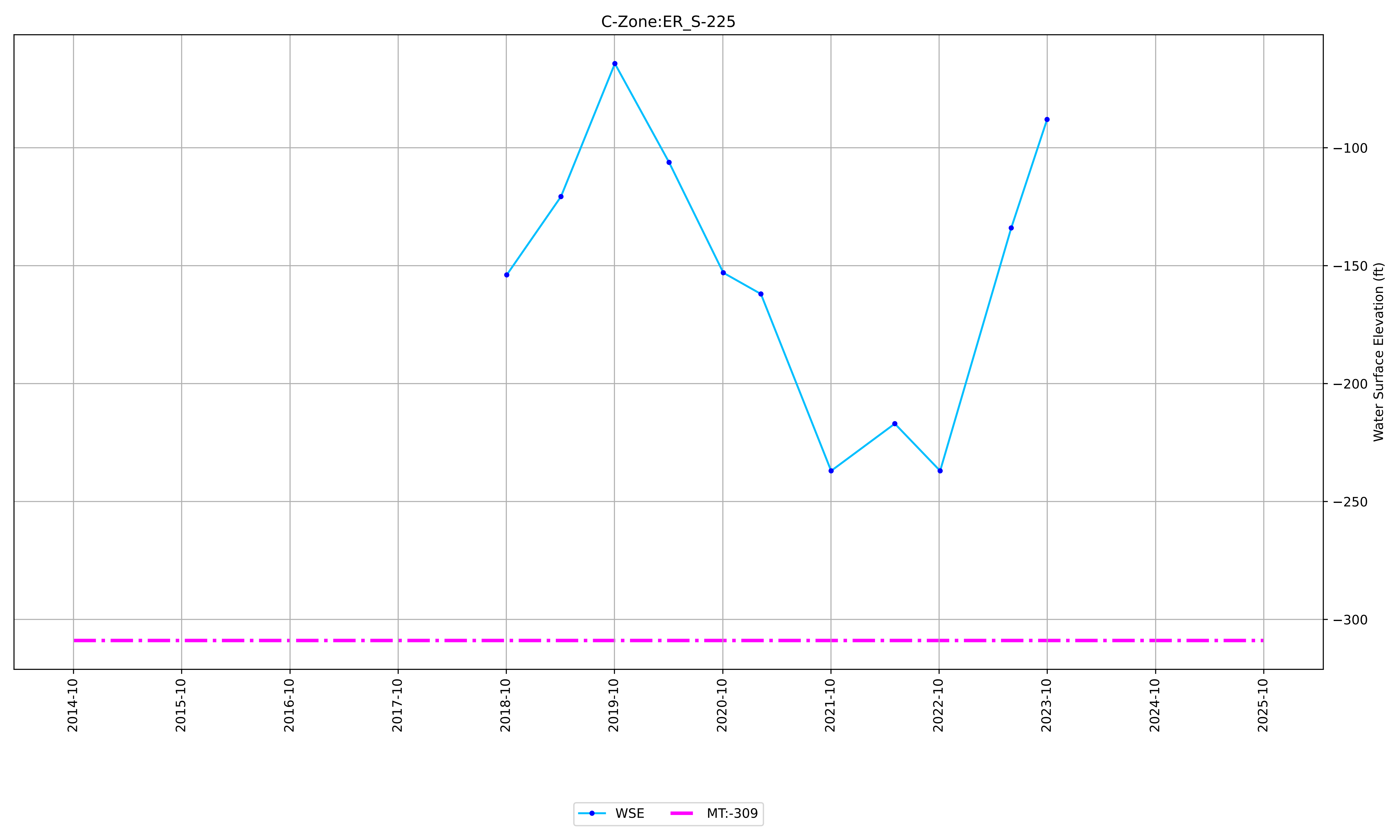
C-Zone:ER_CID-081
50
0
−50
−100
−150
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-175

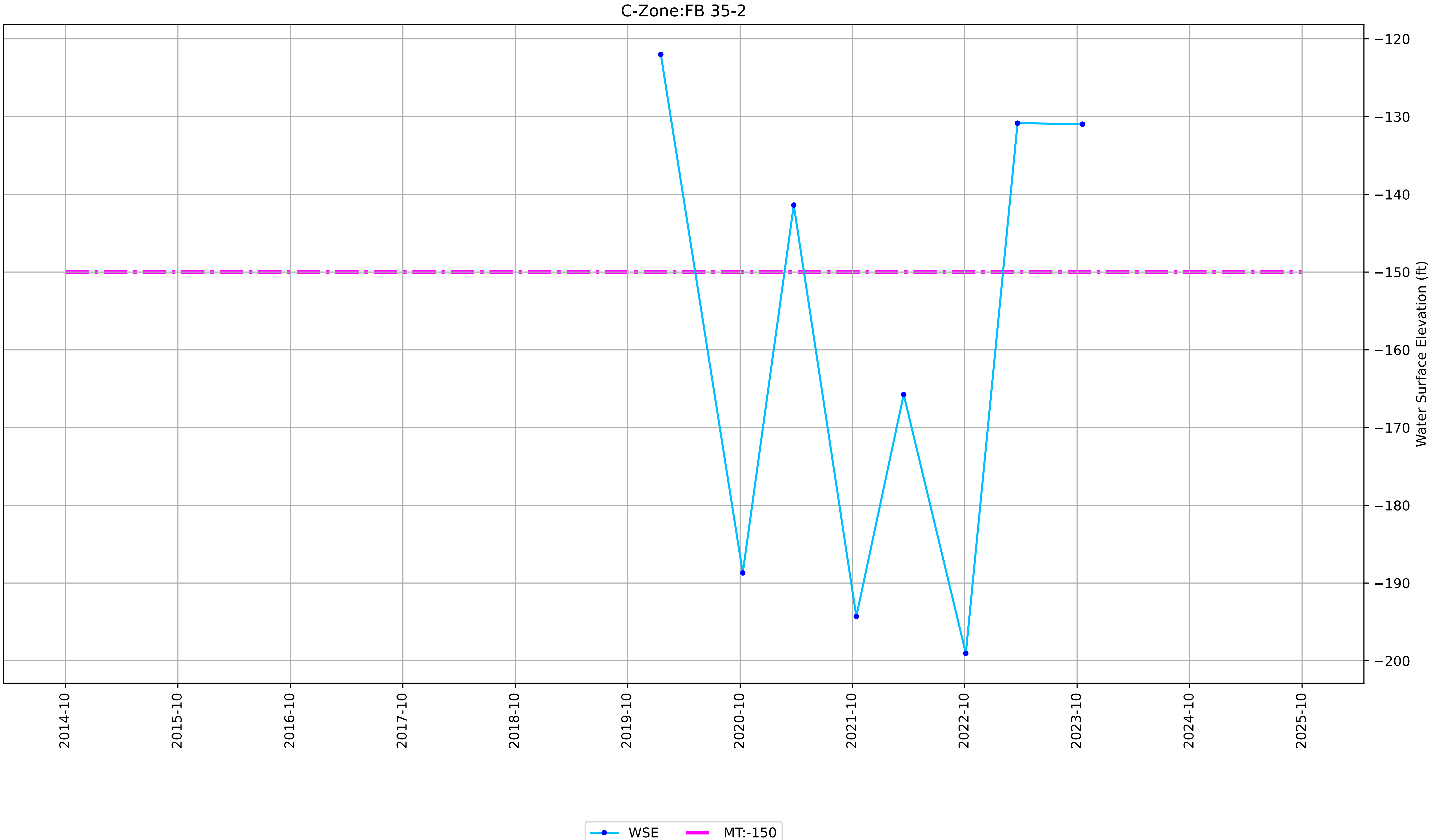


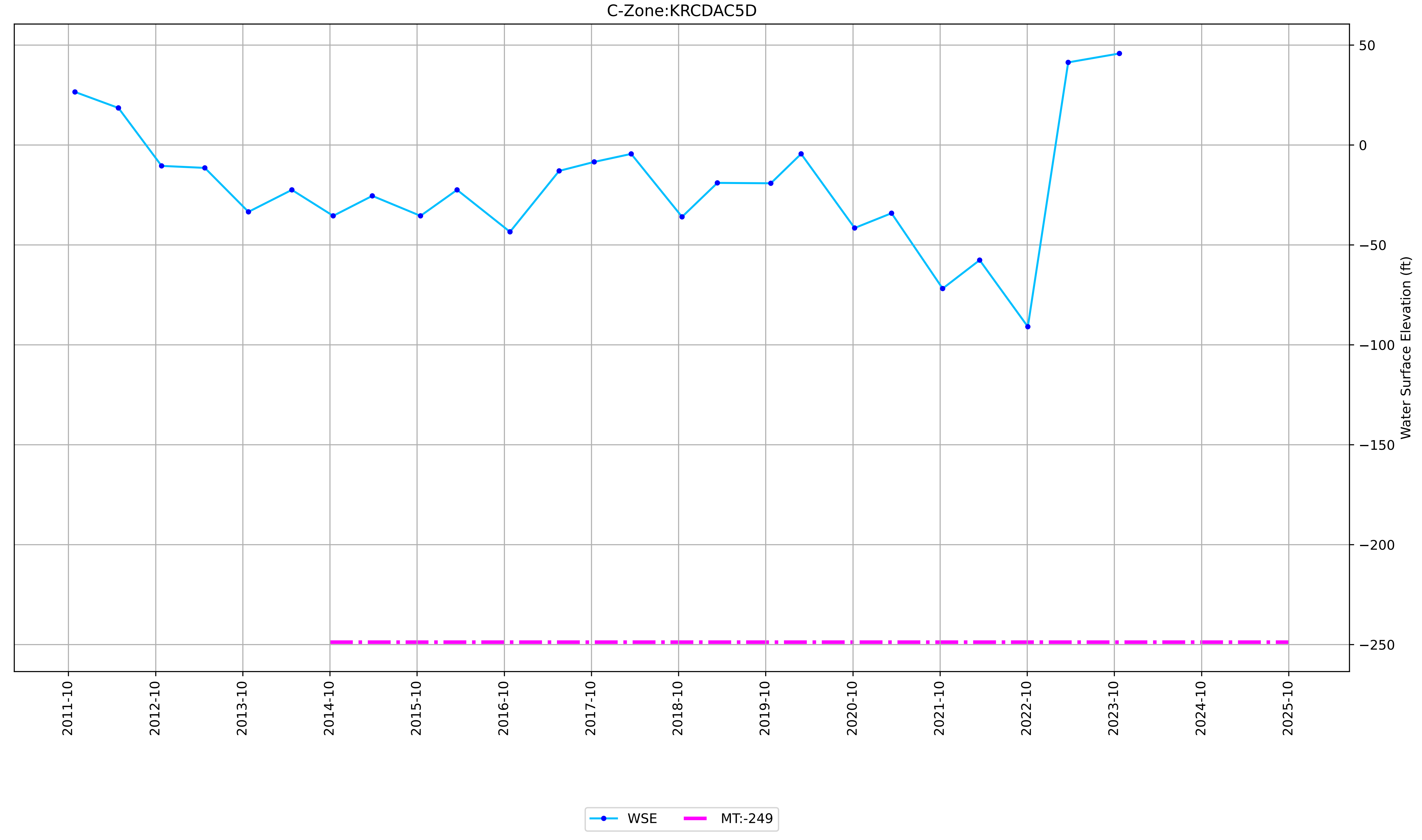
C-Zone:ER_S-173
100
50
0
−50
−100
−150
−200
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-223



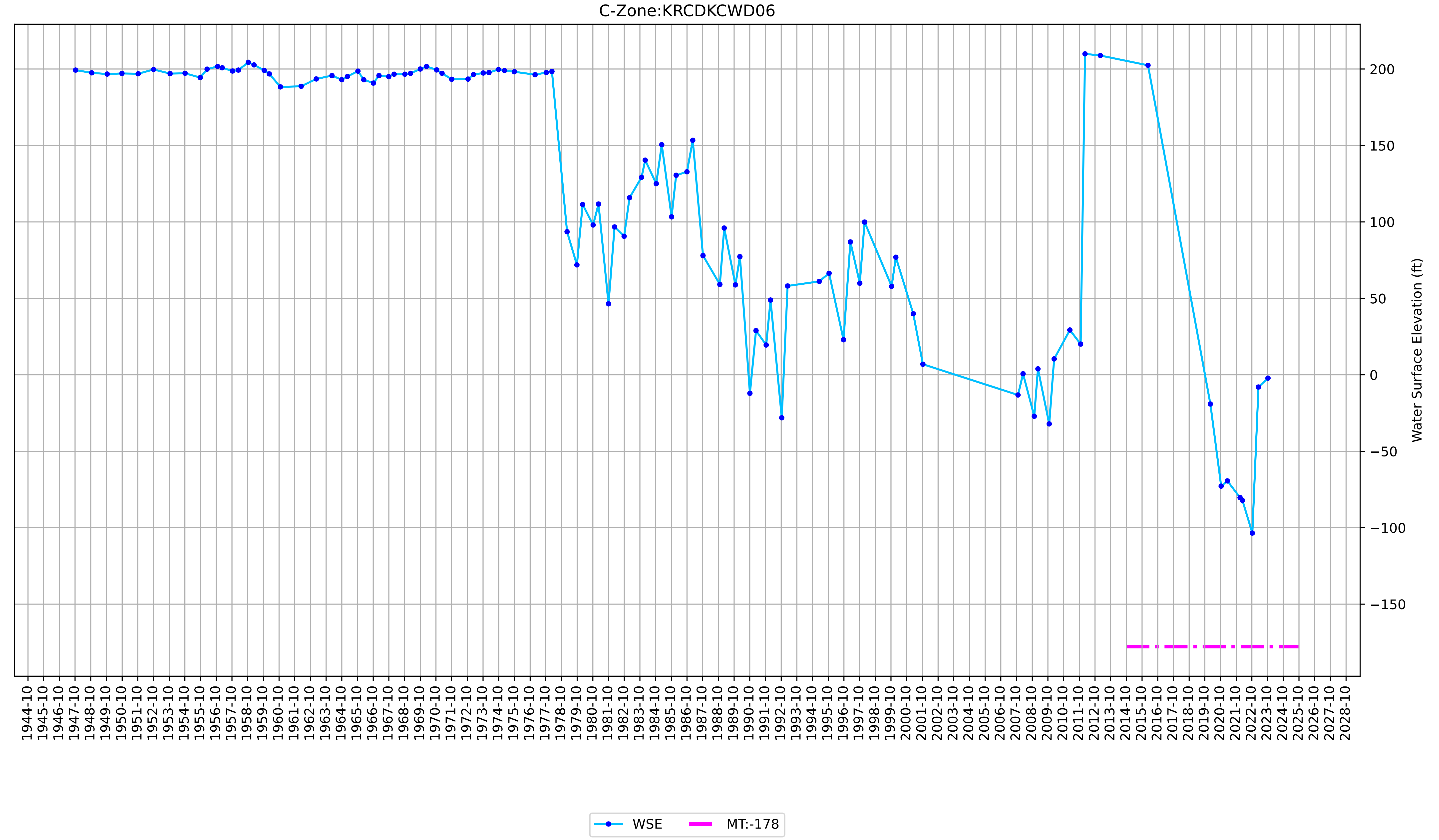
C-Zone:ER_S-205
−150
−175
−200
−225
−250
−275
−300
−325
−350
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-348


C-Zone:ER_S-225
−100
−150
−200
−250
−300
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-309


C-Zone:FB 35-2
−120
−130
−140
−150
−160
−170
−180
−190
−200
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-150



C-Zone:KRCDAC5D
Water Surface Elevation (ft)
50
0
−50
−100
−150
−200
−250
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-249



C-Zone:KRCDKCWD06
Water Surface Elevation (ft)
200
150
100
50
0
−50
−100
−150
1944-10
1945-10
1946-10
1947-10
1948-10
1949-10
1950-10
1951-10
1952-10
1953-10
1954-10
1955-10
1956-10
1957-10
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1962-10
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2016-10
2017-10
2018-10
2019-10
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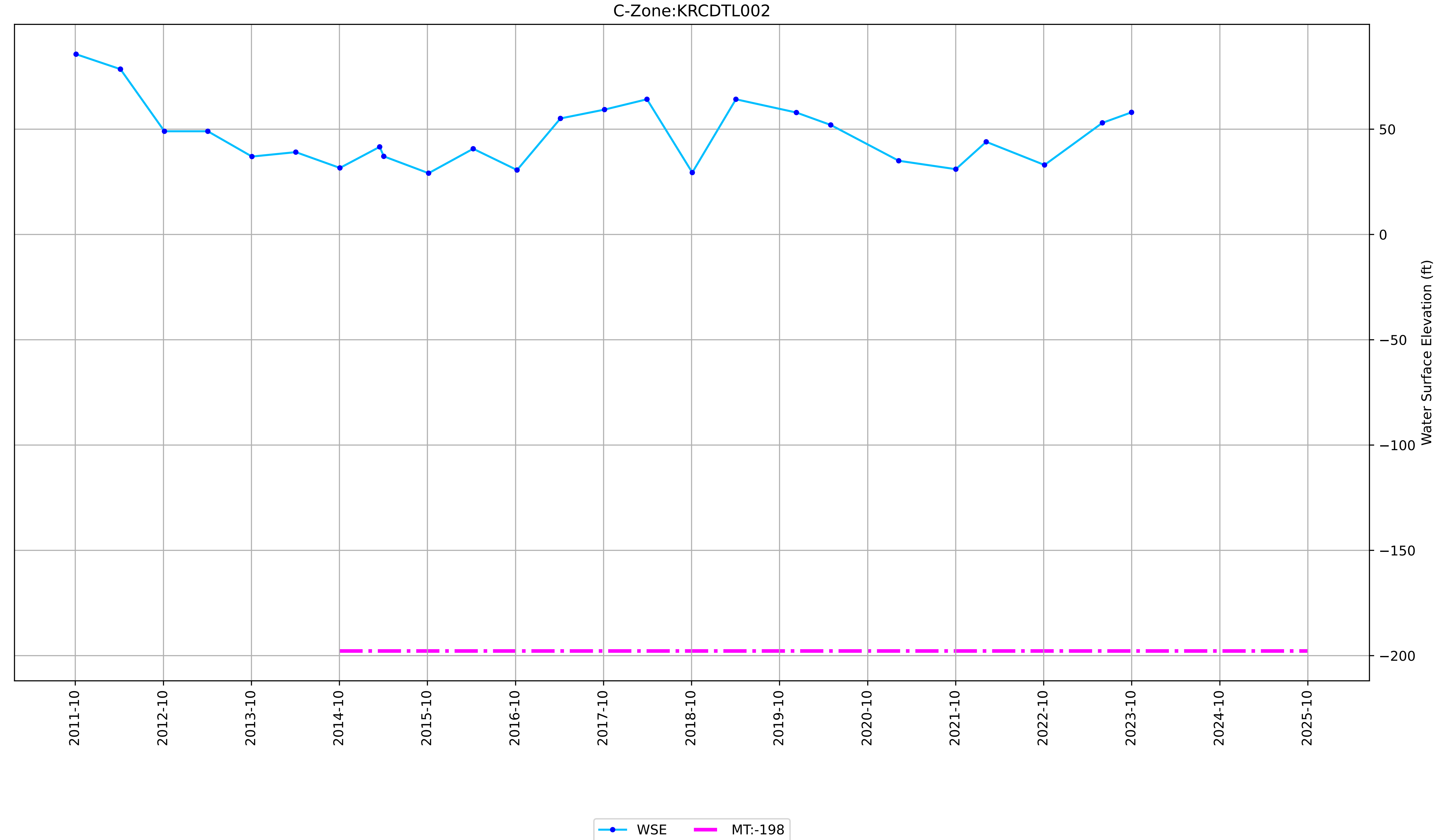
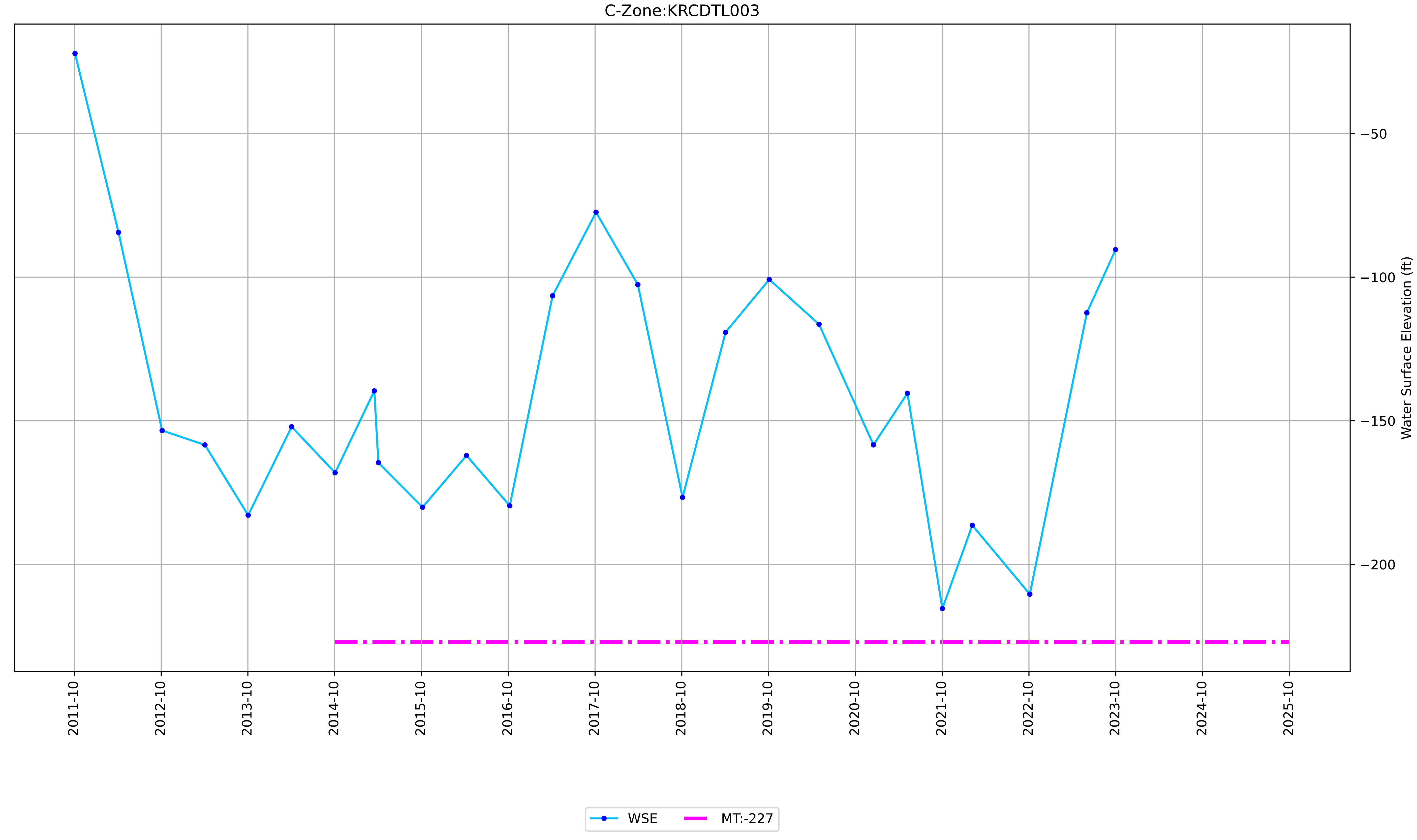
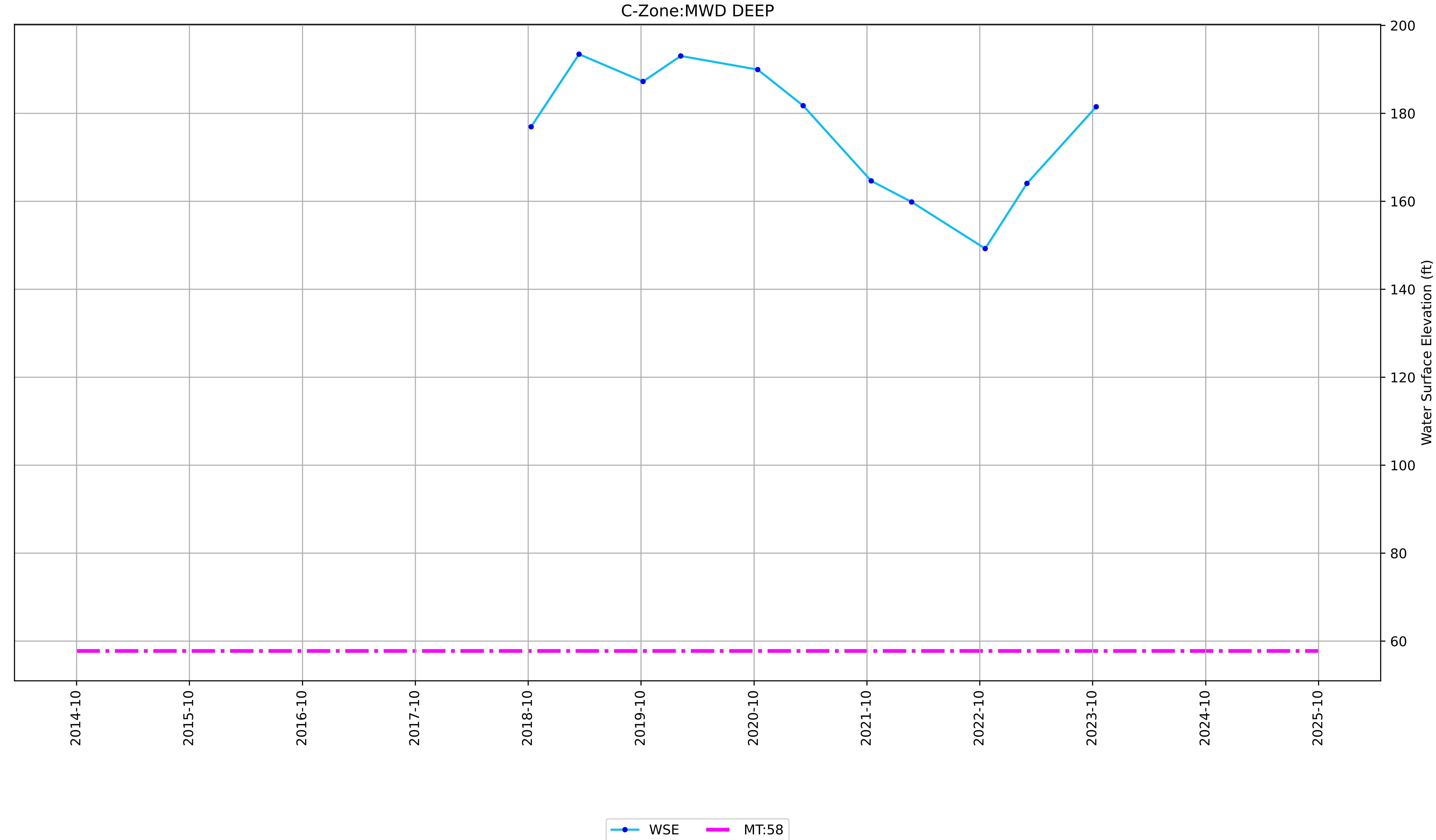
2028-10
WSE
MT:-178



C-Zone:KRCDTL002
Water Surface Elevation (ft)
50
0
−50
−100
−150
−200
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-198


C-Zone:KRCDTL003
−50
−100
−150
−200
Water Surface Elevation (ft)
2011-10
2012-10
2013-10
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-227



C-Zone:MWD DEEP
Water Surface Elevation (ft)
200
180
160
140
120
100
80
60
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
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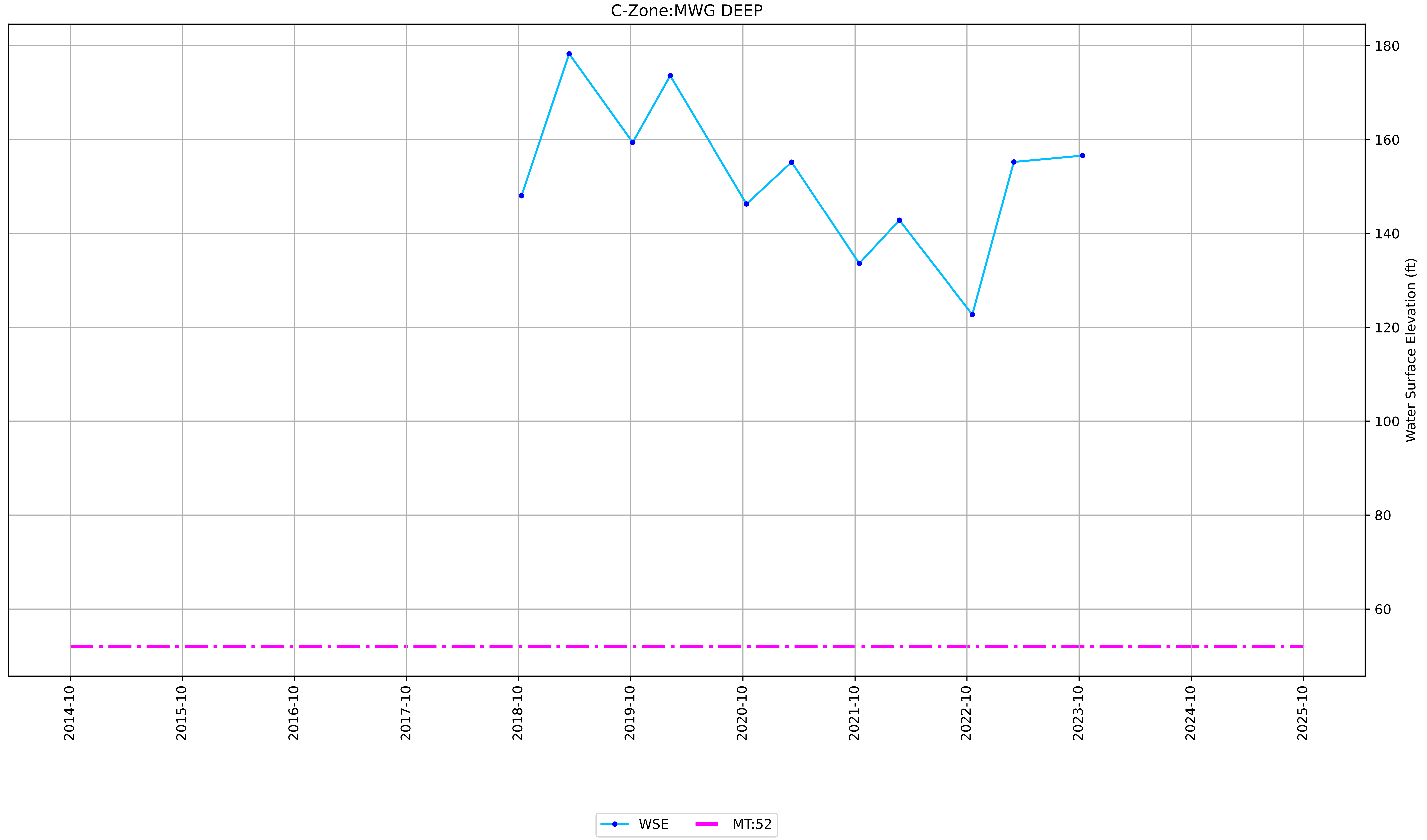
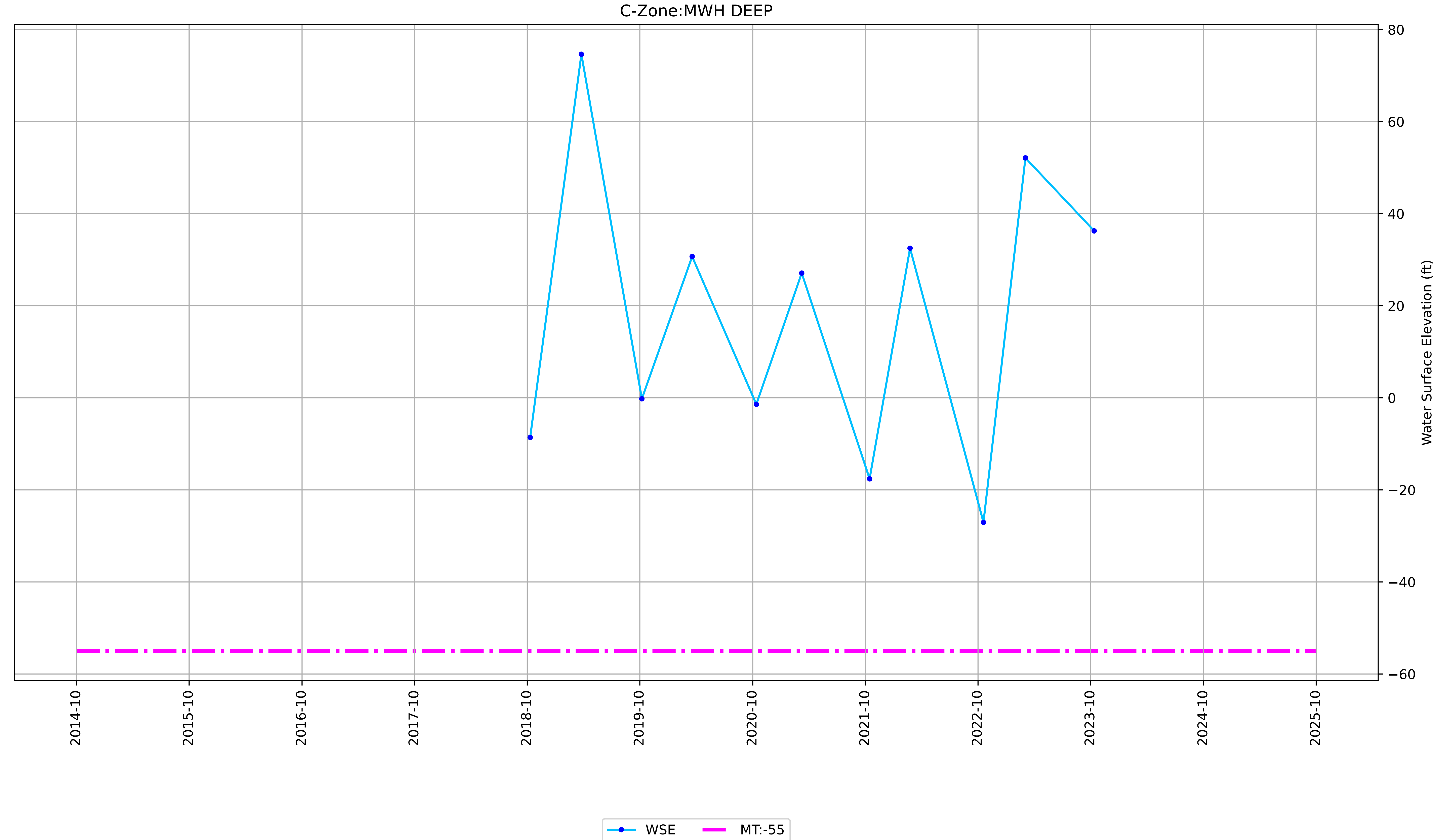
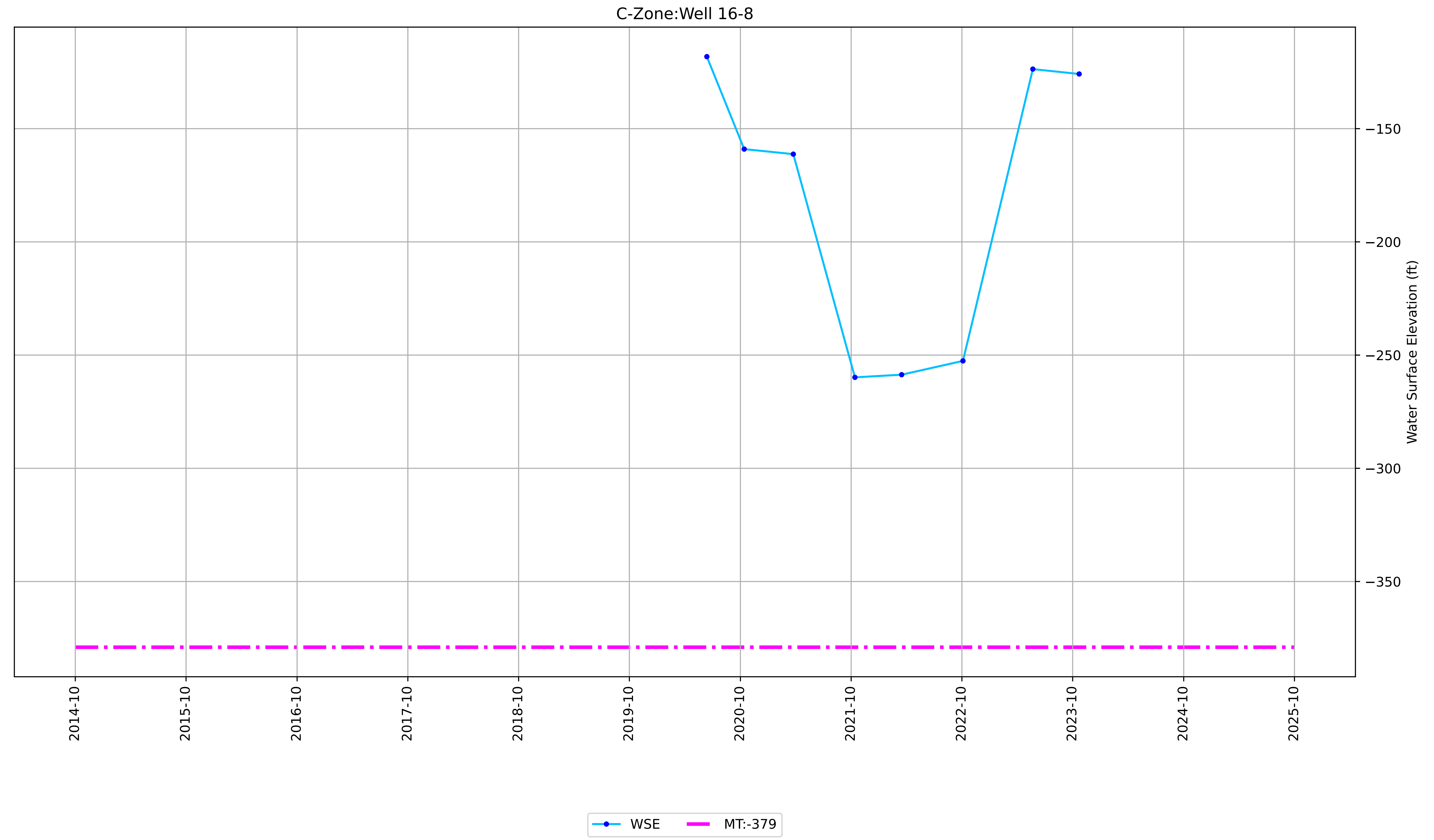
2025-10
WSE
MT:58


C-Zone:MWG DEEP
Water Surface Elevation (ft)
180
160
140
120
100
80
60
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:52



C-Zone:MWH DEEP
80
60
40
20
0
−20
−40
−60
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-55


C-Zone:Well 16-8
−150
−200
−250
−300
−350
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
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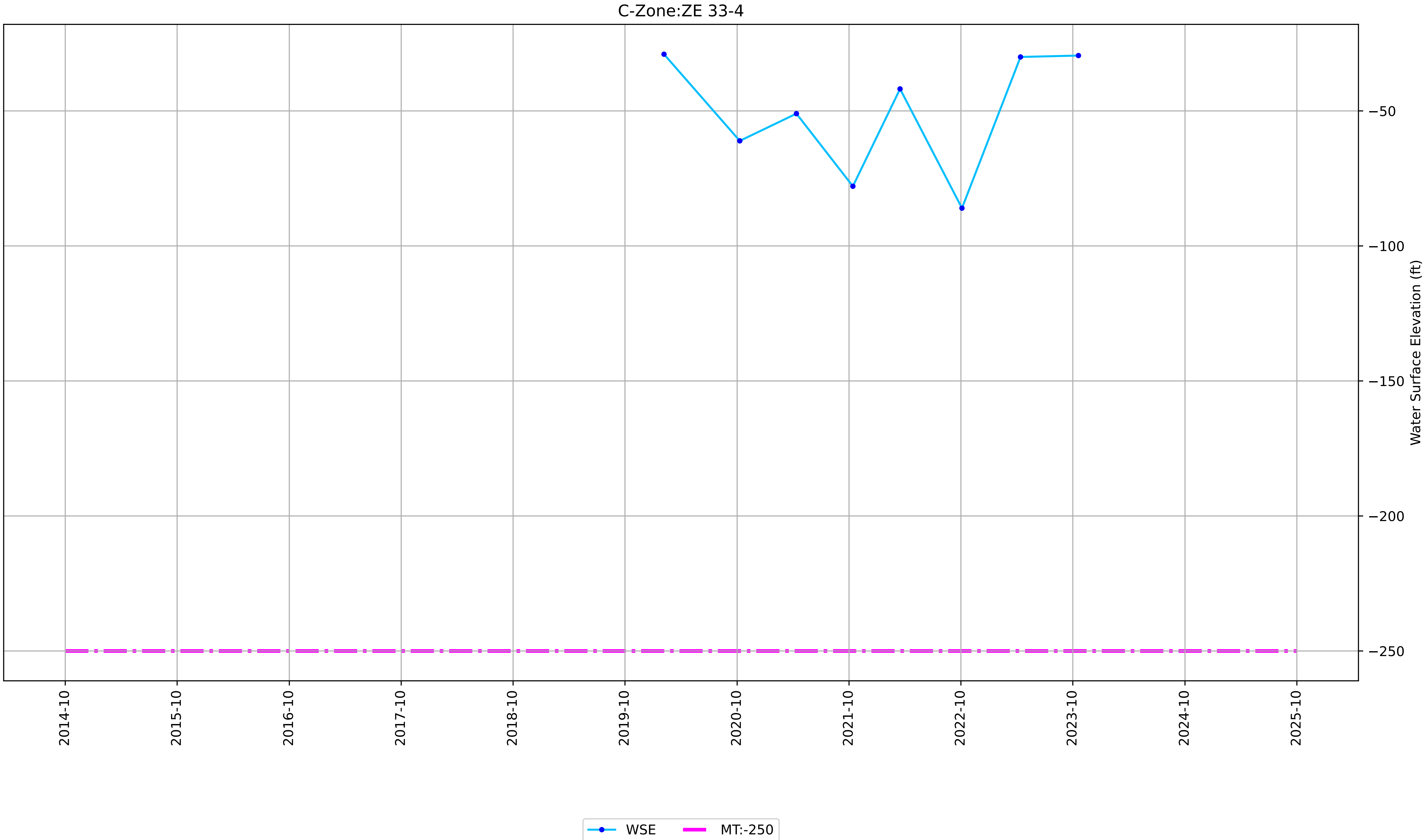
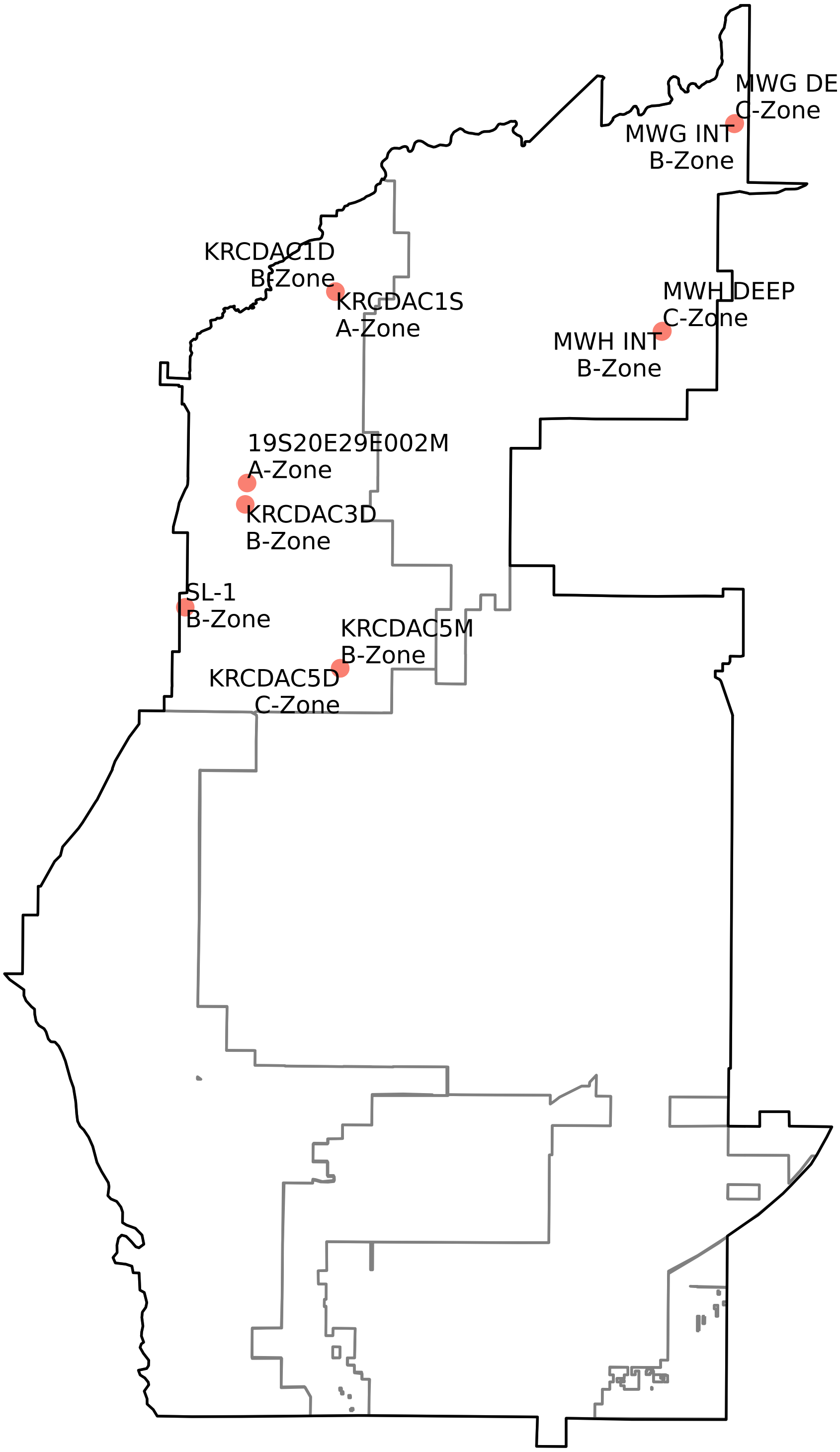
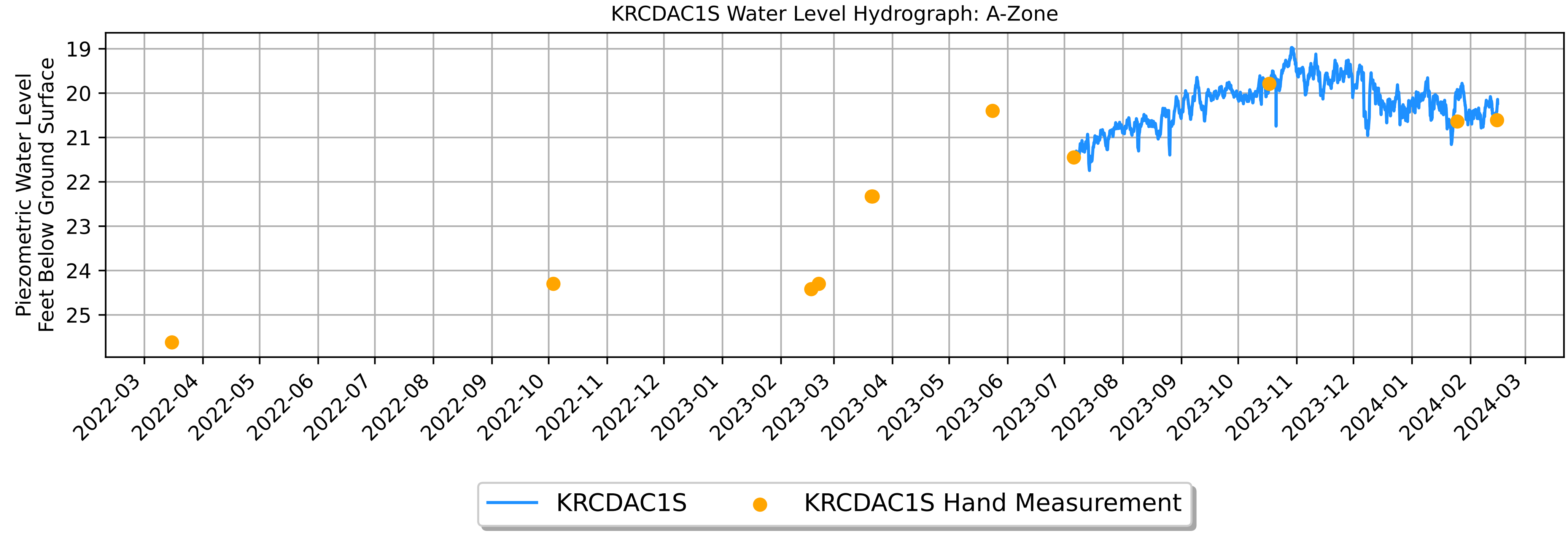
2025-10
WSE
MT:-379

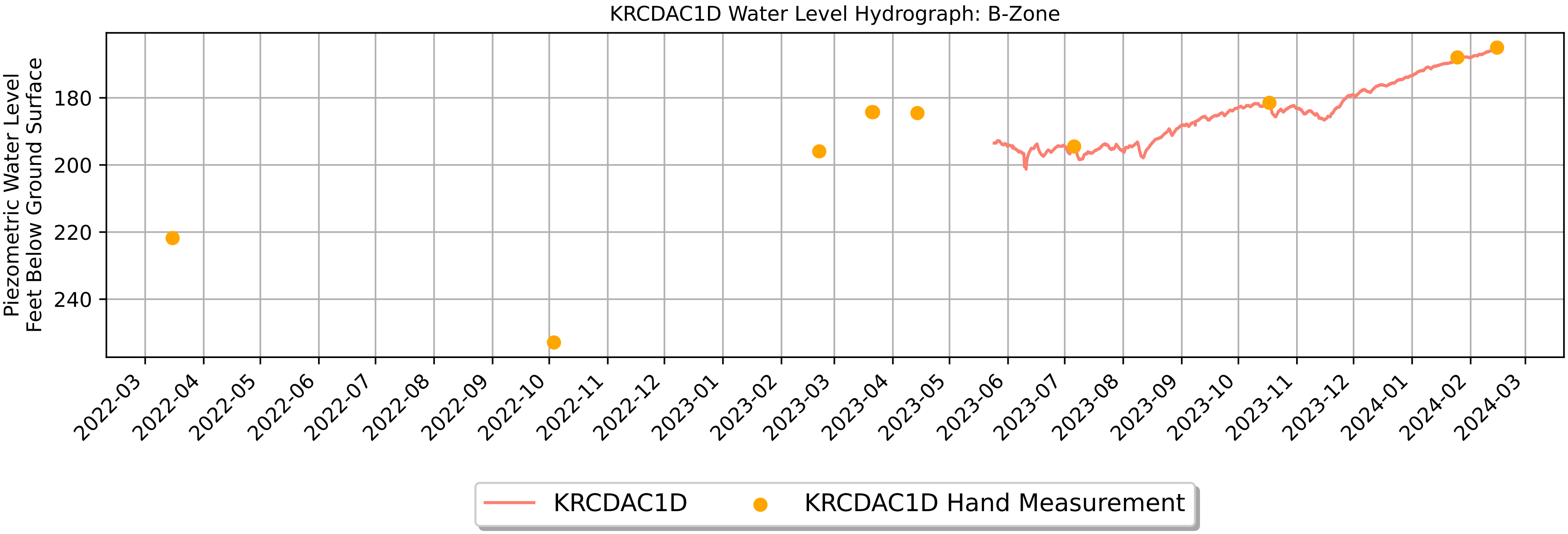


C-Zone:ZE 33-4
−50
−100
−150
−200
−250
Water Surface Elevation (ft)
2014-10
2015-10
2016-10
2017-10
2018-10
2019-10
2020-10
2021-10
2022-10
2023-10
2024-10
2025-10
WSE
MT:-250

Locations of RMS Wells with Water Level Transducers




KRCDAC1S Water Level Hydrograph: A-Zone
Piezometric Water Level
Feet Below Ground Surface
19
20
21
22
23
24
25
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
2023-09
2023-10
2023-11
2023-12
2024-01
2024-02
2024-03
KRCDAC1S
KRCDAC1S Hand Measurement


KRCDAC1D Water Level Hydrograph: B-Zone
Piezometric Water Level
Feet Below Ground Surface
180
200
220
240
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
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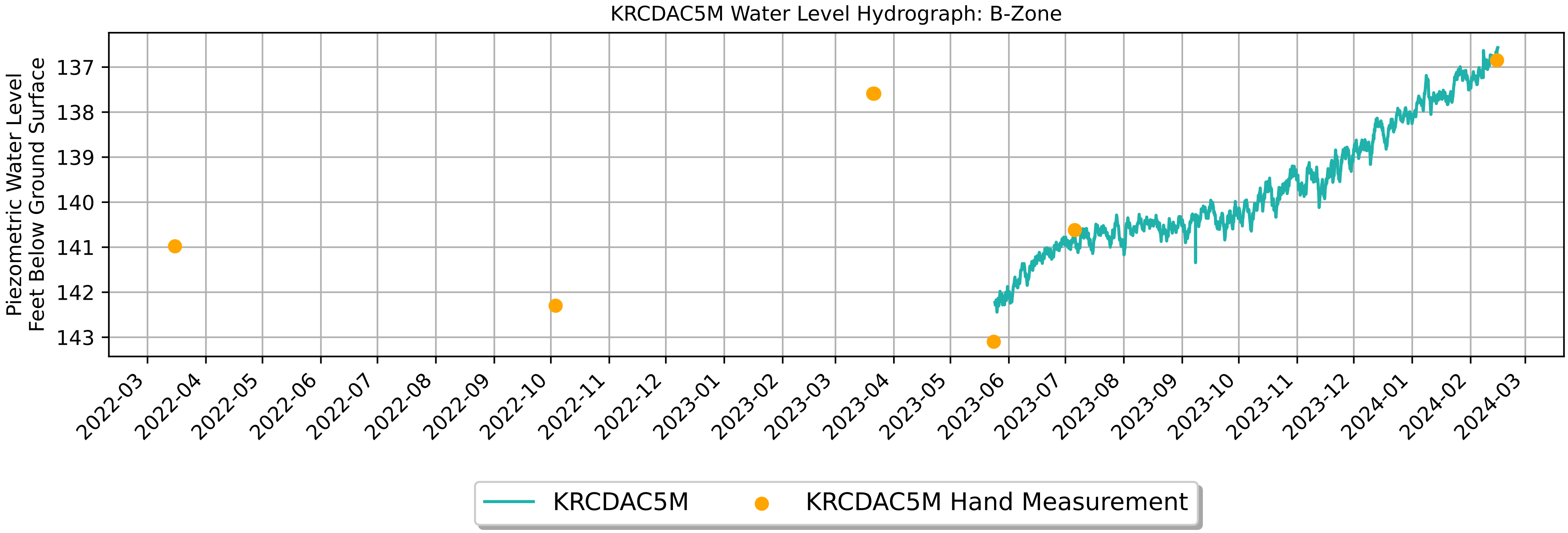
2023-10
2023-11
2023-12
2024-01
2024-02
2024-03
KRCDAC1D
KRCDAC1D Hand Measurement



KRCDAC5M Water Level Hydrograph: B-Zone
Piezometric Water Level
Feet Below Ground Surface
137
138
139
140
141
142
143
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
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2023-11
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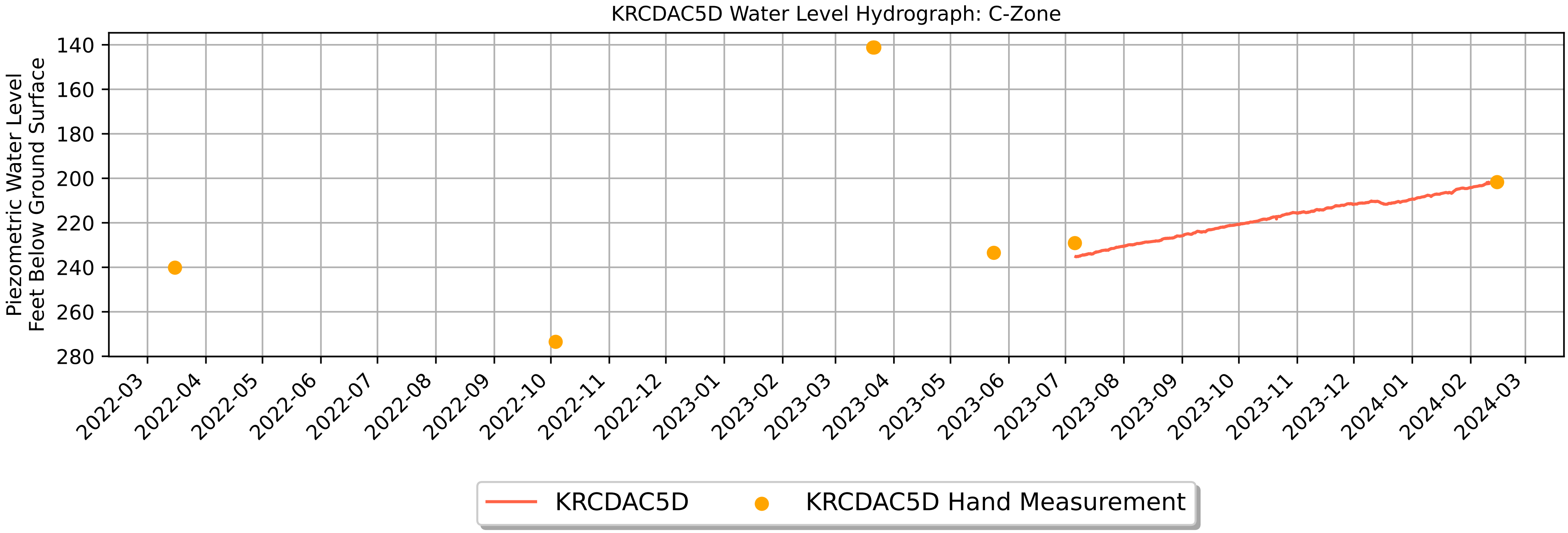
2024-03
KRCDAC5M
KRCDAC5M Hand Measurement



KRCDAC5D Water Level Hydrograph: C-Zone
Piezometric Water Level
Feet Below Ground Surface
140
160
180
200
220
240
260
280
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
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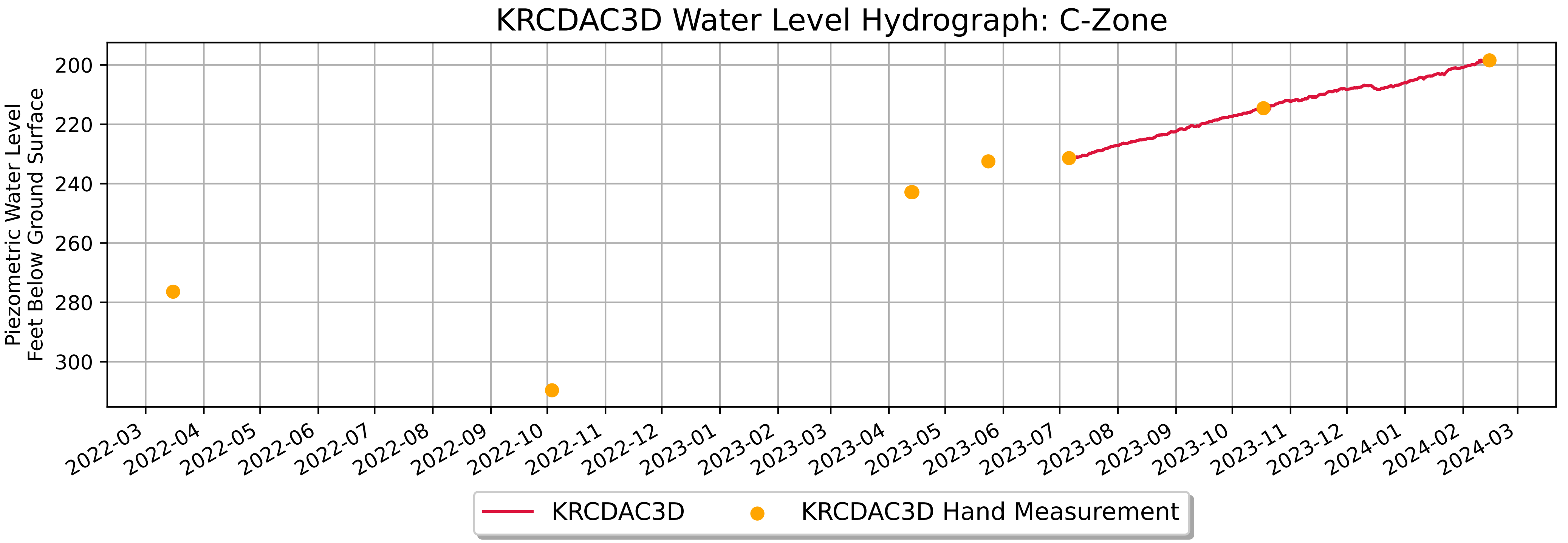
2024-02
2024-03
KRCDAC5D
KRCDAC5D Hand Measurement


KRCDAC3D Water Level Hydrograph: C-Zone
Piezometric Water Level
Feet Below Ground Surface
200
220
240
260
280
300
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
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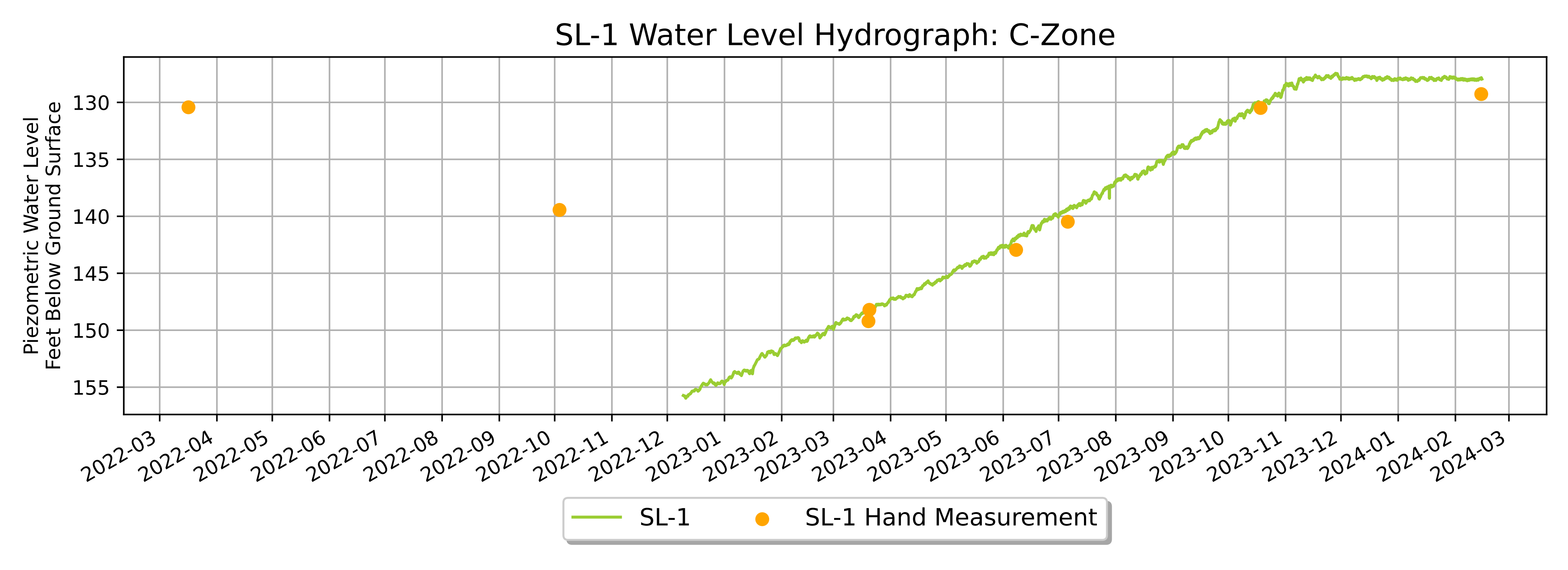
KRCDAC3D
KRCDAC3D Hand Measurement


SL-1 Water Level Hydrograph: C-Zone
Piezometric Water Level
Feet Below Ground Surface
130
135
140
145
150
155
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
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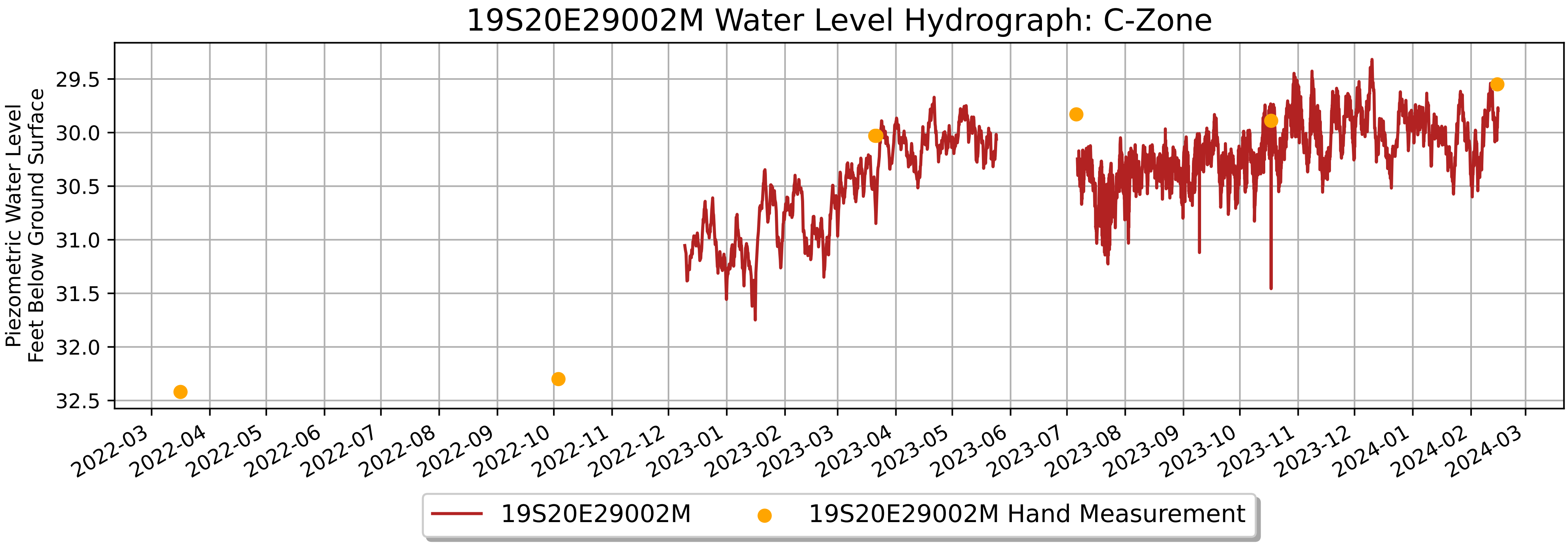
SL-1
SL-1 Hand Measurement



19S20E29002M Water Level Hydrograph: C-Zone
Piezometric Water Level
Feet Below Ground Surface
29.5
30.0
30.5
31.0
31.5
32.0
32.5
2022-03
2022-04
2022-05
2022-06
2022-07
2022-08
2022-09
2022-10
2022-11
2022-12
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
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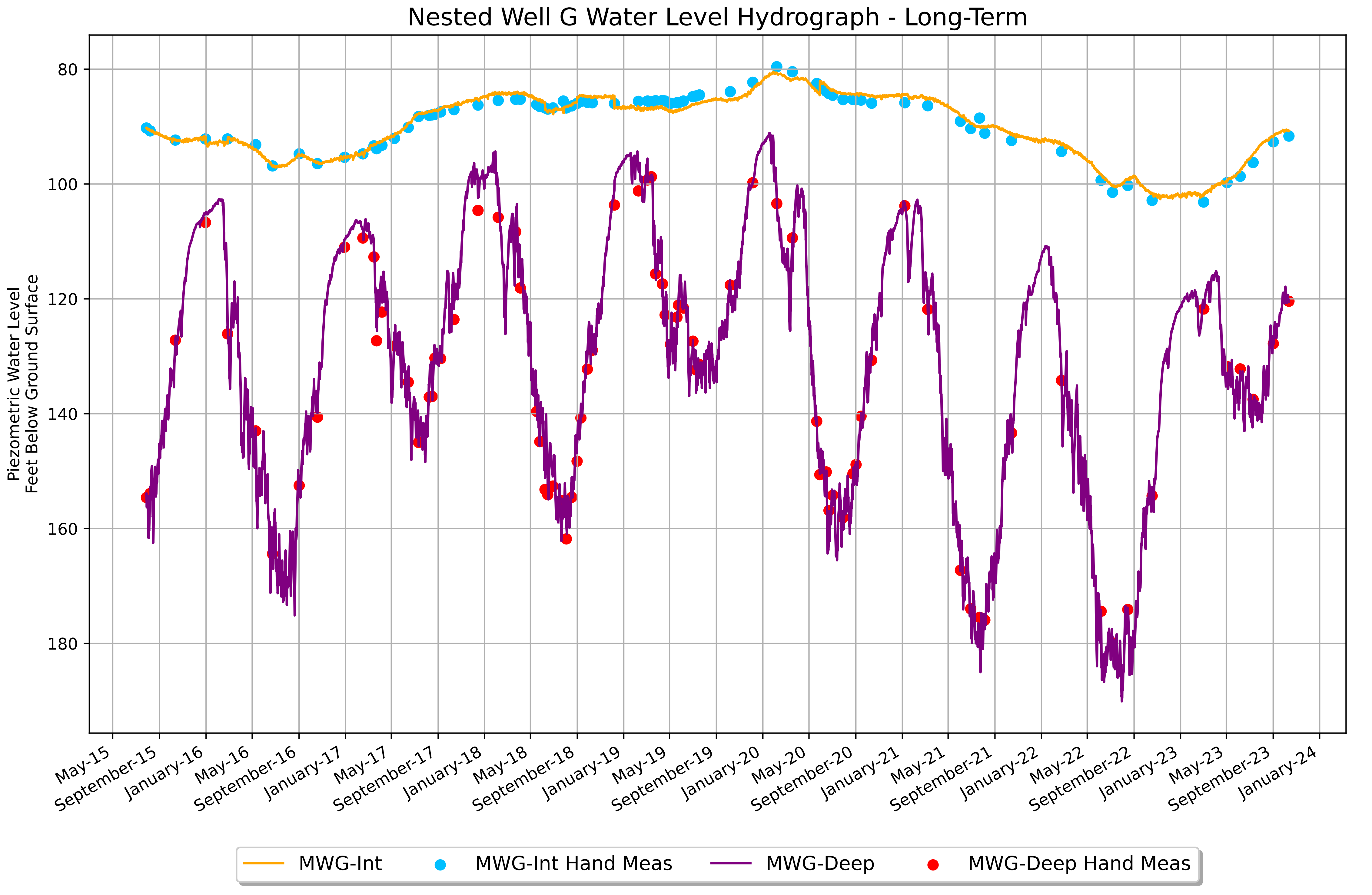
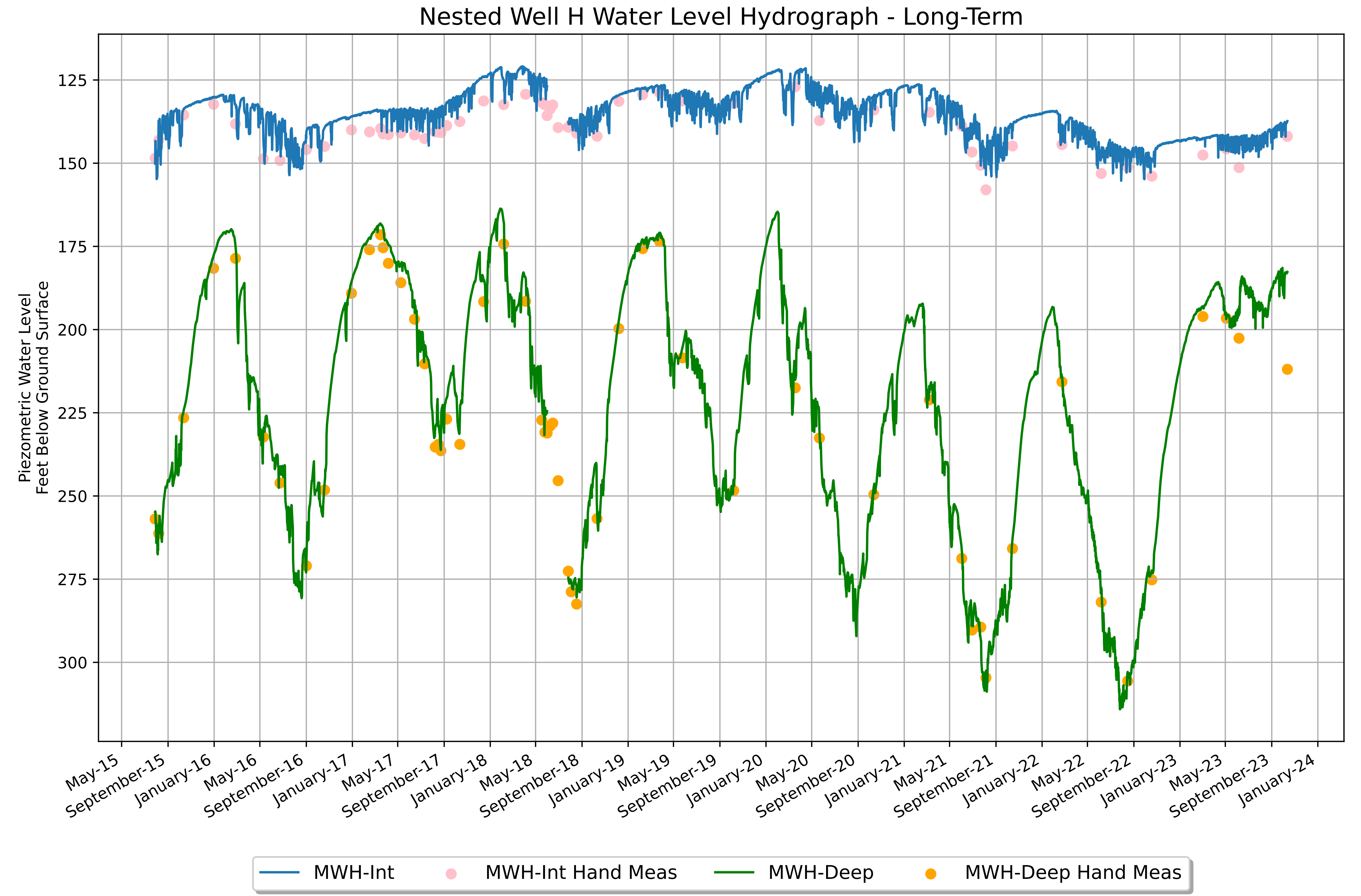
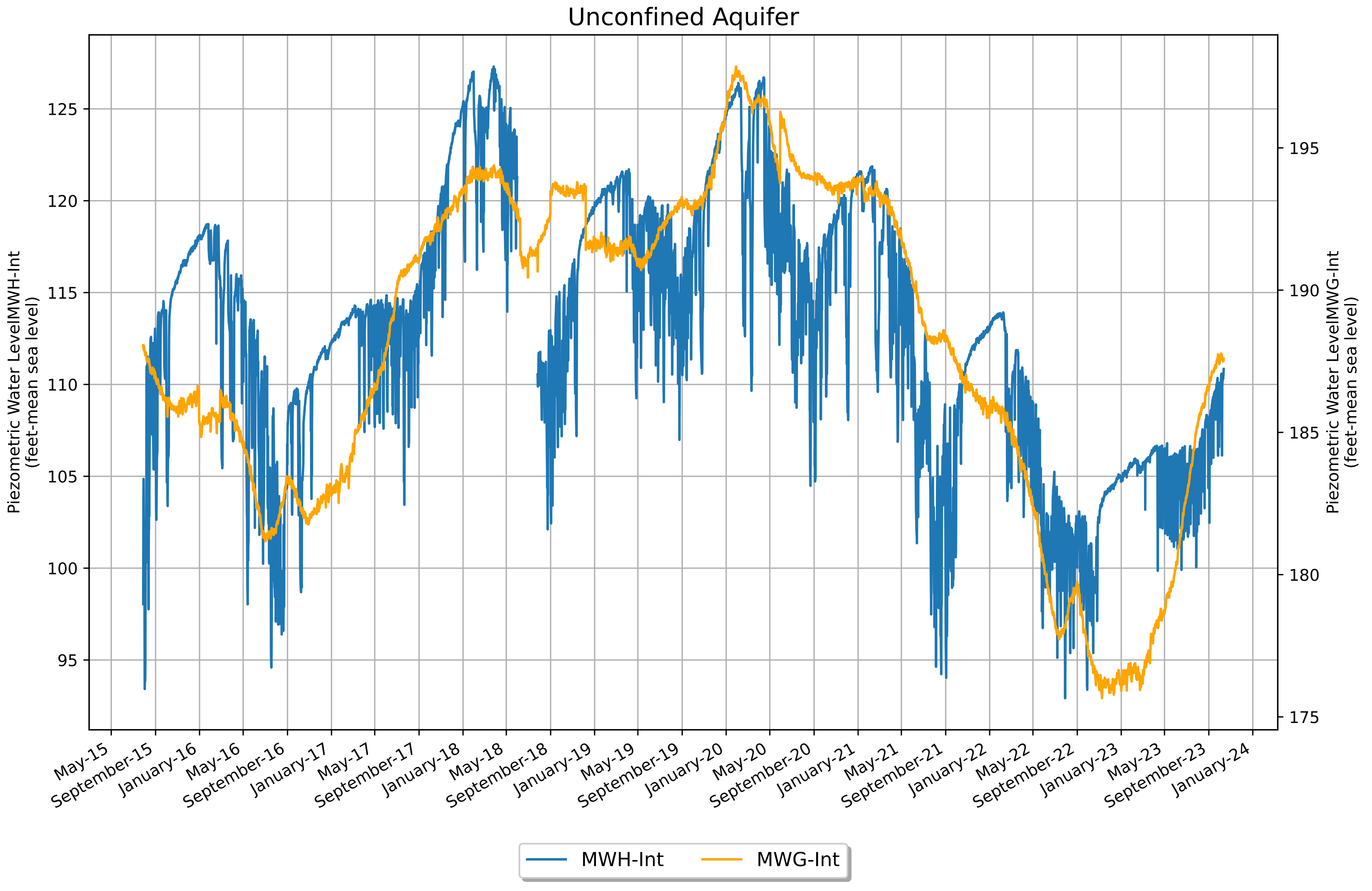
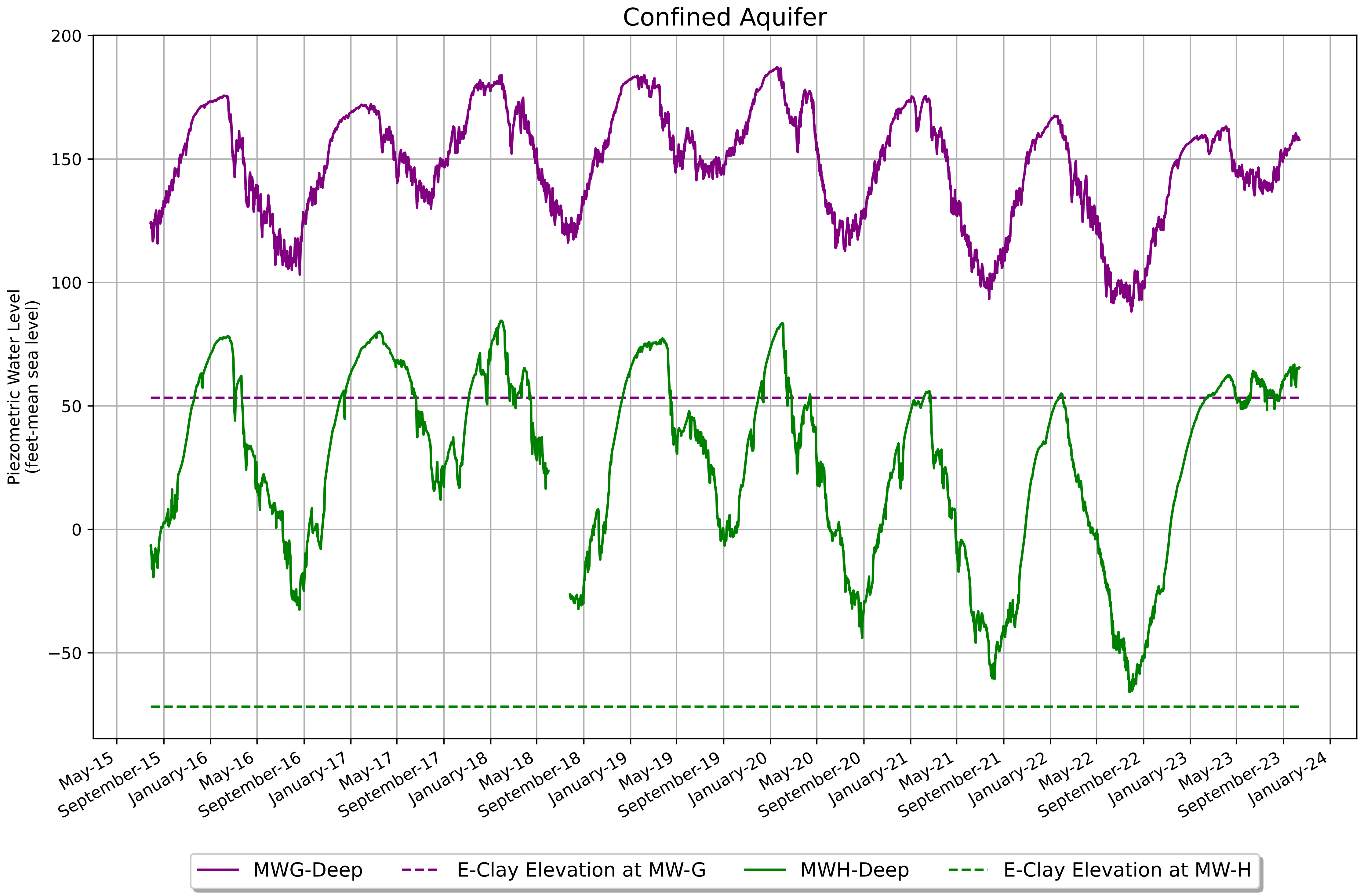
2024-02
2024-03
19S20E29002M
19S20E29002M Hand Measurement

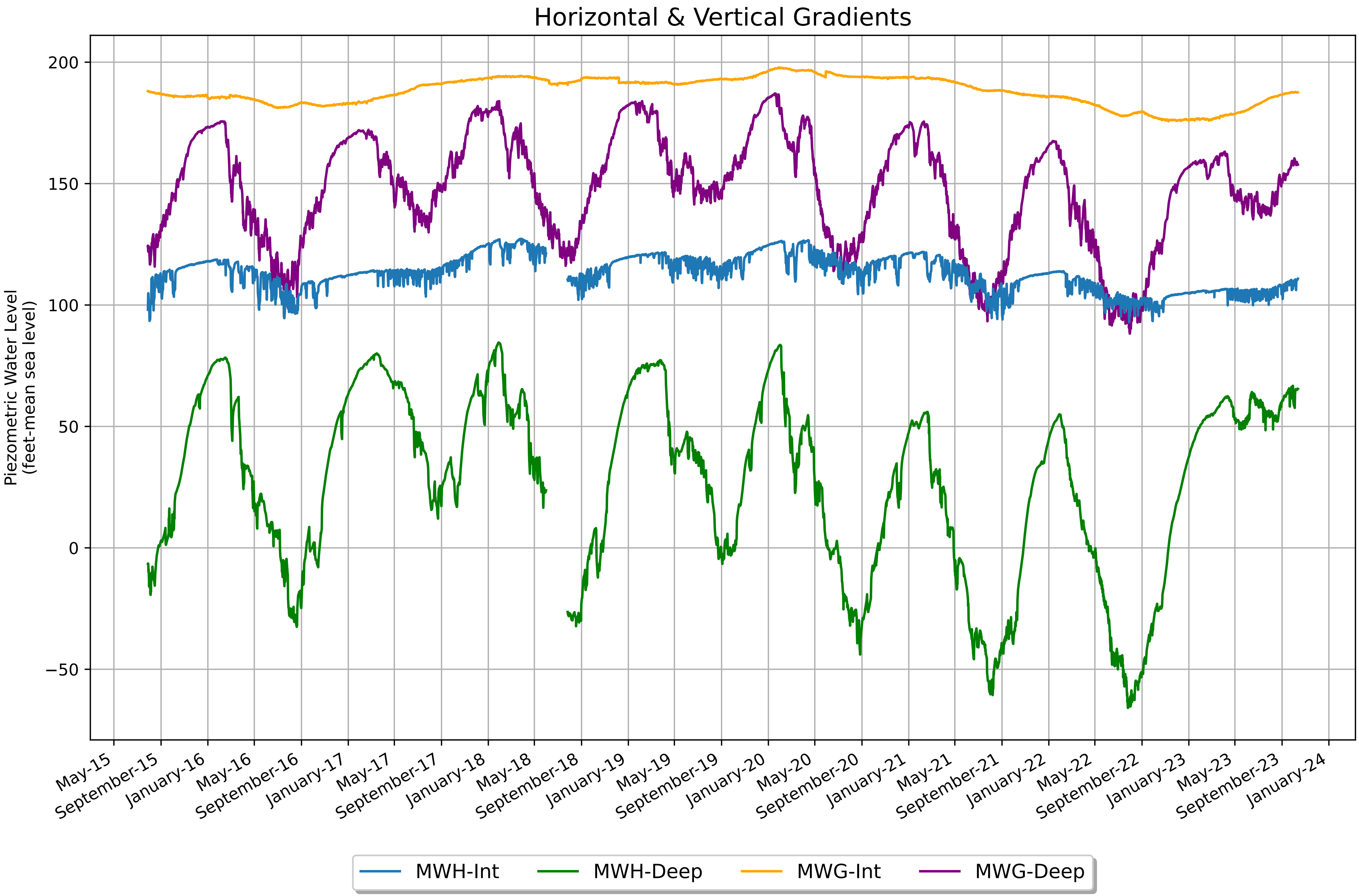

Nested Well G Water Level Hydrograph - Long-Term
Piezometric Water Level
Feet Below Ground Surface
80
100
120
140
160
180
May-15
September-15
January-16
May-16
September-16
January-17
May-17
September-17
January-18
May-18
September-18
January-19
May-19
September-19
January-20
May-20
September-20
January-21
May-21
September-21
January-22
May-22
September-22
January-23
May-23
September-23
January-24
MWG-Int
MWG-Int Hand Meas
MWG-Deep
MWG-Deep Hand Meas


Nested Well H Water Level Hydrograph - Long-Term
Piezometric Water Level
Feet Below Ground Surface
125
150
175
200
225
250
275
300
May-15
September-15
January-16
May-16
September-16
January-17
May-17
September-17
January-18
May-18
September-18
January-19
May-19
September-19
January-20
May-20
September-20
January-21
May-21
September-21
January-22
May-22
September-22
January-23
May-23
September-23
January-24
MWH-Int
MWH-Int Hand Meas
MWH-Deep
MWH-Deep Hand Meas


Unconfined Aquifer
Piezometric Water LevelMWH-Int
(feet-mean sea level)
Piezometric Water LevelMWG-Int
(feet-mean sea level)
125
120
115
110
105
100
95
195
190
185
180
175
May-15
September-15
January-16
May-16
September-16
January-17
May-17
September-17
January-18
May-18
September-18
January-19
May-19
September-19
January-20
May-20
September-20
January-21
May-21
September-21
January-22
May-22
September-22
January-23
May-23
September-23
January-24
MWH-Int
MWG-Int



Confined Aquifer
Piezometric Water Level
(feet-mean sea level)
200
150
100
50
0
−50
May-15
September-15
January-16
May-16
September-16
January-17
May-17
September-17
January-18
May-18
September-18
January-19
May-19
September-19
January-20
May-20
September-20
January-21
May-21
September-21
January-22
May-22
September-22
January-23
May-23
September-23
January-24
MWG-Deep
E-Clay Elevation at MW-G
MWH-Deep
E-Clay Elevation at MW-H


Horizontal & Vertical Gradients
Piezometric Water Level
(feet-mean sea level)
200
150
100
50
0
−50
May-15
September-15
January-16
May-16
September-16
January-17
May-17
September-17
January-18
May-18
September-18
January-19
May-19
September-19
January-20
May-20
September-20
January-21
May-21
September-21
January-22
May-22
September-22
January-23
May-23
September-23
January-24
MWH-Int
MWH-Deep
MWG-Int
MWG-Deep

Appendix H
Water Quality Sampling and Analysis Plan

Geosyntec consultants

engineers | scientists | innovators

APPENDIX – H

Tulare Lake Subbasin

Water Quality Sampling and Analysis Plan

Prepared for

Mid-Kings River GSA
South Fork Kings GSA
Southwest Kings GSA
El Rico GSA
Tri-County Water Authority GSA

Prepared by

Geosyntec Consultants, Inc.
1111 East Herndon Avenue, Suite 217
Fresno, CA 93720

Project SFO138B

April 12, 2024

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practices
CASGEM	California Statewide Groundwater Elevation Monitoring Program
CCR	California Code of Regulations
CFR	Code of Federal Regulations
COC	Constituents of concern
DDW	Division of Drinking Water
DQA	Data Quality Assessment
DQO	Data Quality Objective
DTW	Depth to Water
DWR	California Department of Water Resources
EB	Equipment Blank
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
FB	Field Blank
GAMA	Groundwater Ambient Monitoring and Assessment Program
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	2024 Revised Groundwater Sustainability Plan
HASP	Health and Safety Plan
KRWQC	Kings River Water Quality Coalition
LCS	Laboratory Control Samples
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MO	Measurable Objectives
MQO	Measurement quality Objectives
MSL	Mean Sea Level
MS	Matrix Spike
MSD	Matric Spike Duplicate
MT	Minimum Thresholds
PARCC	Precision, accuracy, representativeness, completeness, and comparability

PQL	Practical Quantitation Limit
QA	Data Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Data Quality Control
RMS	Representative Monitoring Sites
RP	Reference Point Elevation
RPD	Relative Percent Difference
SAP	Sampling and Analysis
SGMA	Sustainability Groundwater Management Act
SUM	Summation
SWN	State Well Number
SWRCB	State Water Resources Control Board
TB	Trip Blank
TD	Total Depth
TDS	Total Dissolved Solids
TFR	Total Filterable Residue
USGS	United States Geological Survey
VOCs	Volatile organic compounds
WLE	Groundwater Level Elevation

1. INTRODUCTION

Geosyntec Consultants, Inc. (Geosyntec) has prepared this Sampling and Analysis Plan (SAP) as supporting documentation to outline the sampling and analytical methods related to the 2024 Revised Groundwater Sustainability Plan (GSP) for the Tulare Lake Subbasin (Subbasin) (Figure 2.0.0-1 of GSP).

1.1 Purpose of SAP

The purpose of this SAP is to establish the Sustainable Groundwater Management Act (SGMA) compliant monitoring protocols and standard methods for water quality and groundwater level data collection in groundwater wells within the Subbasin. This SAP details:

- Water sample collection procedures
- Laboratory analytical methods
- Groundwater level measurement protocol in water wells
- Data Quality Assurance (QA) and Quality Control (QC) procedures

Serving as a companion document to the GSP, this SAP does not aim to impose specific schedules, monitoring wells, or sampling locations on the five member Groundwater Sustainability Agencies (GSAs) or other entities. Instead, it seeks to formalize the field techniques and procedures that these GSAs or other entities may already be using in their respective long-standing monitoring programs. A summary of these monitoring networks will be presented later in this SAP. SGMA mandates aquifer-specific evaluations (DWR, 2016b), which will pose a challenge within the Subbasin, as well as in many basins across the State. This challenge arises largely because many existing monitoring points utilize privately owned agricultural wells or municipal wells, which may be screened across multiple water-bearing units.

1.2 Technical and Regulatory Guidelines

This SAP has been developed in accordance with the Best Management Practices (BMP) for SGMA technical guidance documents provided by the California Department of Water Resources (DWR). These include:

- DWR SGMA BMP – Monitoring Protocols, Standards, and Sites (DWR, 2016a)
- DWR SGMA BMP – Monitoring Networks and Identification of Data Gaps (DWR, 2016b)
- DWR SGMA BMP – Sustainable Management Criteria (DWR, 2016c)

In addition, the following technical guidance documents were also considered in the preparation of this SAP:

- Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4 (EPA, 2006)
- Requirements for Quality Assurance Project Plans, EPA QA/R-5 (U.S. EPA, 2001)

- National Field Manual for the Collection of Water-Quality Data (USGS, individual Chapters published as separate documents)
- Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1 (USGS, 2011)

Much of the content contained in DWR's BMP technical guidance was directly applicable to the development of this SAP, and BMP content has been liberally reproduced in this SAP. Links to the complete documents, available online and cited in this SAP, are included in the References Section, where available.

This SAP has been prepared to satisfy criteria contained in Title 23 California Code of Regulations (CCR) § 352.2 (Monitoring Protocols), § 352.4 (Data and Reporting Standards), and § 352.6 (Data Management System). Monitoring protocols are to be reviewed and modified, as necessary, at least every five years as part of the periodic GSP evaluation (CCR § 352.2 Monitoring Protocols).

1.3 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 the success of GSP implementation.

Sustainable management criteria include:

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

These criteria for the Subbasin were developed through the assessment of sustainability indicators. These indicators are measured at Representative Monitoring Sites (RMSs) within each management area of the Subbasin. A detailed description of the sustainable management criteria is provided in Chapter 4 of the GSP.

1.4 Geographic Setting

The Subbasin is located primarily in Kings County in the Tulare Lake Hydrologic Region of the San Joaquin Valley, California (Figure 2.0.0-1 of GSP). The Subbasin covers an area of approximately 535,869 acres or about 837 square miles (DWR 2016c). It is bordered by the Kings Subbasin to the north, the Kaweah Subbasin to the northeast, the Tule Subbasin to the southeast, the Kern County Subbasin to the south, the Kettleman Plain Subbasin to the southwest, and the Westside Subbasin to the northwest.

The topography of the Subbasin is generally low sloping inward from all directions toward the center of Tulare Lake. Land use in the Subbasin and surrounding areas is predominately agricultural with three primary urban areas of the cities of Hanford, Lemoore, and Corcoran.

Stream flow in rivers, streams, and surface water conveyances (canals) is a significant source of groundwater recharge throughout the Subbasin by direct infiltration to the subsurface and from deep percolation where surface water is applied for agricultural irrigation. Major rivers supplying water to the Subbasin include the Kings, Kaweah, Tule, and Kern rivers. Streams emanating from the southern Sierra Nevada Mountains and the Coast Ranges are typically ephemeral and do not reach any major water course or surface impoundment in the Subbasin.

Currently, at least 34 conveyance systems (rivers, streams, canals, and diversions) are available to deliver surface water to the Subbasin. The only water generated within the Subbasin is from pumped groundwater. Pumped groundwater may be used for direct irrigation on nearby agricultural lands or piped into municipal or agricultural water delivery systems.

A detailed description of the Subbasin setting including the administrative, geographic, surface water conveyance, hydrogeologic framework, groundwater recharge & discharge, and groundwater conditions are included in the Chapters 1, 2, and 3 of the GSP.

1.4.1 Hydrogeologic Setting: Principal Groundwater Aquifers and Aquitards

Groundwater beneath the Subbasin occurs primarily in the coarser-grained Sierran sediment deposits of the alluvial fans of the Kings, Kaweah, and Tule rivers, as well as the fans of the lesser streams that drain from the Sierra Nevada Mountains into the southeastern portion of the Subbasin. On the west side of the Subbasin, some sediments may have Coast Ranges origin. The Corcoran Clay underlies most of the Subbasin, which essentially subdivides the Subbasin into two aquifer systems, an unconfined to semi-confined aquifer system above the Corcoran Clay and a confined aquifer system below the Corcoran Clay.

Fine-grained lacustrine, marsh and flood deposits underlie the valley trough and floor and were deposited in lacustrine or marsh environments (Croft 1972). These fine-grained units are critically important in the hydrology of the basin in that they restrict the downward movement of water and act as aquitards. The Corcoran Clay or E-Clay is the most extensive aquitard in the San Joaquin Valley. The low permeability of the Corcoran Clay makes it an effective aquitard. It has sharp vertical boundaries and shows up well on borehole geophysical electric logs.

For purposes of monitoring, as described in Chapter 3 of the GSP, the aquifers are divided into three aquifer zones:

- The A zone is the shallow portion of the aquifer above the A-Clay and in areas where shallow groundwater is present outside of the A-Clay,
- The B zone is the unconfined portion of the aquifer above the E-Clay or Corcoran Clay and below the A-Clay where the A-Clay is present, and
- The C zone is the confined portion of the aquifer below the E-Clay.

The three aquifer zones and aquitards are described in greater detail in the following sections.

1.4.1.1 Unconfined Aquifer (A and B Zone)

The unconfined and semi-confined upper portions of the regional freshwater aquifer are found above the Corcoran Clay. This upper portion of the regional freshwater aquifer is generally comprised of coarse- to medium-grained sediments (i.e., sand and gravel) with silt and clay interbeds. The depth to first groundwater beneath a large portion of the Subbasin is less than 15 feet below ground surface (bgs) in a zone situated above the A-Clay.

Groundwater within the rest of the Subbasin and surrounding areas are typically found between depths of 30 and 250 feet bgs, depending on location and the season or year when the water levels are measured. The shallow groundwater areas typically have poor water quality, and the shallow soils require drainage to grow crops (KDSA et al. 2015). In areas where groundwater is below 15 feet, the shallow unconfined aquifer is subject to large swings in water levels due to groundwater recharge, which occurs primarily along stream channels, unlined surface water conveyances, and artificial recharge basins. In thicker sections of the unconfined aquifer, pumping for agricultural uses may create significant drawdown of the water table during the irrigation season and under prolonged drought conditions. Nearer the Tulare Lake, where the upper aquifer is substantially interbedded with lacustrine deposits, the groundwater producing zones are thinner and become increasingly finer-grained limiting groundwater withdrawals to primarily relatively low demand domestic uses.

1.4.1.2 Confined Aquifer (C Zone)

The sediments below the Corcoran Clay comprise the lower confined portion of the regional freshwater aquifer. This lower portion of the regional freshwater aquifer is generally comprised of clay, silt, sand, and gravel (Page 1983).

Few maps are available showing groundwater elevations in the confined aquifer beneath the Subbasin and surrounding areas (Harder and Van de Water 2017). In fall 1998 and 1999, groundwater was at an elevation of about 100 feet below mean sea level (MSL) at a depth of about 300 feet bgs near Corcoran, decreasing in elevation to the south towards an apparent pumping center near Alpaugh. The coarser and thicker sections of sediments below the Corcoran Clay lend themselves to development of higher capacity wells that withdraw groundwater for municipal and agricultural uses. However, the limited extent of highly productive fresh groundwater aquifers within the boundary of the Subbasin, generally along the coarse-grained sediments within the alluvial fans (e.g., Kings River fan), concentrates these wells in the eastern portion of the Subbasin and in adjoining subbasins to the east, beyond the finer-grained deltaic and lacustrine deposits grading into the Tulare Lake. Because of the effectiveness of the Corcoran Clay as an aquitard, recharge to the confined aquifer likely occurs primarily in the upper portions of the alluvial fans beyond the Corcoran Clay's eastern extent.

The sediments within the southern portion of the Tulare Lake consist of a thick, continuous sequence of clays, forming a clay plug. There are no significant production wells within the clay plug due to the fine-grained nature of the sediments; however, there may be a few stock watering wells in this area.

1.4.1.3 Aquitards

Fine-grained lacustrine, marsh and flood deposits underlie the Valley trough and floor and were deposited in lacustrine or marsh environments (Croft 1972). These fine-grained units are critically important in the hydrology of the basin in that they restrict the downward movement of water and act as aquitards. These nearly impermeable gypsiferous fine sand, silt and organic clay deposits are more than 3,000 feet thick beneath parts of Tulare Lake and spread out laterally and interfinger with the coarser sediments found along the basin margins (Croft 1972; Page 1983). The clayey or silty clay units interbedded within the Tulare Formation are designated by letters A through F (Croft 1972). The A-, C- and E-Clay units are the primary fine-grained units underlying significant portions of the Subbasin and can isolate different waters and bounds the freshwater aquifers. However, beneath Tulare Lake, these individual clay units are not distinguishable from the other clay deposits that form the massive clay plug beneath the center of the lake (KDSA et al. 2015).

A-Clay

The A-Clay is a dark greenish gray or blue, organic clay found approximately 60 feet bgs in the Tulare Lake area (KDSA et al. 2015). A-Clay is approximately 10 to 60 feet in thickness and in some places a sand lens separates the A-Clay into an upper and lower unit (Croft 1972). However, due to similarities in the sedimentary deposits beneath Tulare Lake, A-Clay was not able to be positively identified in all areas (Page 1983). Outside of Tulare Lake area and near rivers and streams, groundwater above the A-Clay can be an important source of shallow groundwater for domestic and limited agricultural uses. In Tulare Lake area, groundwater above the A-Clay is typically too saline for municipal or agricultural usage and has been exempted from municipal and agricultural beneficial use (RWQCB 2017). The delineated lateral extent of the A-Clay is shown in Figure 1-2 delineated by Croft (1972).

C-Clay

The C-Clay consists of yellowish-brown to bluish-gray silty-clay and is found approximately 230 feet bgs in the Tulare Lake area (KDSA et al. 2015). The C-Clay is about 10 feet thick and is structurally warped and folded (Croft 1972). C-Clay could not be positively identified beneath Tulare Lake in previous studies (Page 1983). Outside of the Tulare Lake area, most of the groundwater production from public supply wells is from wells that tap water below the C-Clay (KDSA et al. 2015). In the Tulare Lake area, groundwater above the C-Clay is typically too saline for municipal or agricultural usage (RWQCB 2017) and has been exempted from municipal or agricultural beneficial use.

Corcoran Clay (E-Clay)

The Corcoran Clay is the most extensive aquitard in the San Joaquin Valley. The Corcoran Clay is composed of dark-greenish gray, mainly diatomaceous, silt, clay, silty clay, clayey silt and sand that was deposited in a lake that occupied the San Joaquin Valley (Croft 1972). The Corcoran Clay is warped into a major, asymmetric, northwest trending syncline that has been additionally deformed with smaller, subordinate folds.

Recently, a detailed evaluation of the presence of the Corcoran Clay beneath Tulare Lake area was undertaken in support of a de-designation of beneficial uses for groundwater beneath this lake area (KDSA et al. 2015). This study identified the Corcoran Clay as being present at depths of about 400 to more than 800 feet bgs throughout the Subbasin. Within the clay plug itself, due to the continuous fine-grained lacustrine nature of the sediments, like that of the Corcoran Clay, the Corcoran Clay cannot be delineated. The low permeability of the Corcoran Clay makes it an effective aquitard. It has sharp vertical boundaries and shows up well on borehole geophysical electric logs. The Corcoran Clay appears to extend out to the east of the Subbasin near SR 99. On the west, it rises sharply with the Tulare and underlying San Joaquin Formations. E-clay is more difficult to recognize as it approaches the west-side fold belts. Geophysical well logs indicate that the Corcoran Clay, although the largest single confining bed in the Subbasin, constitutes only a small percentage of the total cumulative thickness of clay layers in the unconsolidated sediments beneath the Tulare Lake clay plug.

1.4.2 Primary Use of Each Aquifer

The upper unconfined and semiconfined aquifer and the lower confined aquifer are sometimes used for different purposes based on economics and water quality. Primary groundwater uses within the Subbasin include domestic, municipal, agricultural, and industrial. Further description of the types of groundwater pumping are provided below.

1.4.2.1 Domestic Pumping

Domestic pumping is primarily from the upper unconfined and semiconfined aquifer because it is easier to access and typically has sufficient yield for domestic purposes.

1.4.2.2 Municipal Pumping

Municipal pumping of groundwater occurs in the Subbasin by the cities of Hanford, Lemoore, Stratford, and Corcoran. Wells for municipal purposes are typically in the deeper portions of the unconfined and semiconfined aquifer and sometimes reach into the confined aquifer. Municipal uses require larger sustained yields than domestic uses; therefore, municipal pumping looks to deeper zones with longer well screens than domestic wells. The municipal pumping demand varies seasonally, peaking in the summer months.

1.4.2.3 Agricultural Pumping

Agricultural pumping requires large quantities of water and water quality not impacted by elevated total dissolved solids (TDS), chloride, and boron concentrations. The requisite quantity and quality can be achieved by drilling into the deeper portions of the upper aquifer and below the Corcoran Clay into the lower confined aquifer. Thus, most of the agricultural pumping in the Subbasin and in adjoining subbasins is from deep wells.

1.4.2.4 Industrial Water Pumping

Industrial use depends on application. Groundwater used to provide steam for power generation or heating needs to contain low TDS and may require treatment. Some industrial use such as dust control may not be dependent on water quality.

1.5 Existing Groundwater Monitoring Programs

Groundwater conditions across the basin are diverse. The local member agencies and stakeholders of the five participating GSAs have implemented several monitoring programs to support various State agencies, local irrigation districts, conjunctive use programs, and General Plans. A summary of subbasin groundwater monitoring programs is described below.

1.5.1 Groundwater Quality

Groundwater contamination can be human-induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairy production, pesticide applications, septic tanks, industrial sources, stormwater runoff, disposal sites, and improperly constructed wells.

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 are maintained by the State Water Resources Control Board (SWRCB), Department of Toxic Substances Control, California Department of Pesticide Regulation, and the Groundwater Ambient Monitoring and Assessment Program (GAMA).

The SWRCB maintains a database of water quality data (GeoTracker) collected from various state regulatory programs, the USGS, and the University of California Davis Nitrate Study. These datasets were obtained for the Subbasin to gain a general overview of water quality. In general, chemicals of concern that generally affect water quality in the San Joaquin Valley were screened including naturally occurring and anthropomorphic. These included salinity (TDS), arsenic, nitrate, and volatile organic chemicals (VOCs) (RWQCB 2017).

South of Stratford and Corcoran, groundwater quality diminishes, and portions of the Tulare Lakebed have been de-designated as not suitable for municipal, domestic, agricultural irrigation, and stock watering supply (Secondary Management Area – Southwest Poor Quality Groundwater). The primary constituents of concern for the de-designated areas included boron, chloride, sodium, salinity, and TDS (RWQCB 2017).

1.5.2 Groundwater Level

The California Statewide Groundwater Elevation Monitoring (CASGEM) Program tracks long-term groundwater elevation trends throughout California. The Kings River Water Quality Coalition (KRWQC) ILRP is the local agency that monitors groundwater levels within the Plan area.

1.6 Principal Decision Makers

The SAP principal decision maker are the five participating GSAs. These decision makers will use data collected in accordance with this SAP in their basin management decision making process.

Each of the five GSAs within the Subbasin operate under an Interim Operating Agreement (effective September 1, 2017) to facilitate coordination and management actions. The Interim Operating Agreement is categorized as a legal agreement and ensures communication and coordination of the data and methodologies used by each GSA in developing the GSPs within the Subbasin for several factors, including groundwater elevation and extraction data, surface water supply, total water use, change in groundwater storage, water budget, total water use, and sustainable yield.

2. GENERAL INFORMATION

A primary objective of this SAP is to describe groundwater sample collection procedures that will produce reliable basin-specific water quality data that can be used to evaluate sustainability in the basin with respect to the sustainability indicators set forth in the SGMA legislation. This section details activities associated with data collection, including field methods to be implemented, analytical requirements of the SAP, and steps that should be undertaken to ensure the adequacy of the data collection activities.

The following excerpt is from DWR's SGMA BMP (DWR, 2016a):

Groundwater quality sampling protocols should ensure that:

- Groundwater quality data are taken from the correct location.
- Groundwater quality data are accurate and reproducible.
- Groundwater quality data represent conditions that inform appropriate basin management and are consistent with the Data Quality Objectives (DQO).
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity.

2.1 Monitoring Network

The monitoring network for the Subbasin comprises of existing and proposed RMS locations. The groundwater level RMS locations as discussed below are by aquifer zone. The groundwater quality RMS monitoring network is composed of wells currently sampled by the local cities/municipalities/small community systems and irrigated lands regulatory programs.

The aquifer system is divided into three aquifer zones for groundwater level monitoring:

1. The A zone is the shallow portion of the aquifer above the A-Clay and in areas where shallow groundwater is present outside of the A-Clay.
2. The B zone is the unconfined portion of the aquifer above the E-Clay or Corcoran Clay and below the A-Clay where the A-Clay is present.
3. The C zone is the confined portion of the aquifer below the E-Clay.

There are areas in the Subbasin where groundwater is not used due to poor water quality and/or, in the clay plug, non-productive strata. Portions of the Subbasin where groundwater pumping does not occur are not proposed to be actively monitored at this time. These areas overlay portions of El Rico, Tri-County Water Authority, and Southwest King GSAs.

The groundwater quality monitoring network will employ the same RMAs and associated RMS locations established for water levels, as depicted in Figures 5.2.1-1 through 5.2.1-3 of the GSP. An RMA will include at least one RMS well for groundwater quality. The purpose of the groundwater quality network will be to: 1) understand if groundwater pumping is causing or exacerbating groundwater quality concerns; and 2) if so, whether pumping restrictions would restore groundwater quality or whether other mitigation measures are necessary. Proposed monitoring for groundwater quality network includes 88 existing RMS locations with an additional 10 locations to be added for a total of 98 locations to monitor water levels across the Subbasin (Figures 5.2.1-1 to 5.2.1-3).

Groundwater level RMS (existing and proposed) locations are distributed across the Subbasin in areas where groundwater is used and by aquifer zone (discussed below). This vertical and horizontal distribution of groundwater level RMSs will allow the GSAs to develop the data needed to evaluate groundwater conditions in the various aquifer zones, discussed below, and will be used to inform the Subbasin GSAs as to plan progress in meeting measurable objectives, interim milestones, and minimum thresholds.

2.2 Representative Monitoring Points

DWR has referred to representative monitoring as utilizing a subset of sites in a management area. Development of the monitoring network of RMS wells where measurable objectives, minimum thresholds, and interim milestones are defined are presented in Section 4 of the GSP. Groundwater conditions can vary substantially across the Subbasin and the use of a small number of representative wells in the Subbasin is not practical to cover such a large area with varying conditions. The network will strive to fill data gaps with existing wells that have well construction information and historical groundwater level data. Proposed monitoring sites may include clustered wells, if existing wells cannot be identified and used, that will be able to provide data for different aquifer zones at a single location.

2.3 Well Types

The following well types are present in the Subbasin.

- Agricultural – Agricultural well means a non-potable well used for watering livestock, aquaculture, or watering household yards and gardens, or for other purposes related to farming but not for irrigating lands or crops.
- Domestic – well which is constructed for and serves domestic water to a single-family residence and, regardless of the size of the parcel on which the residence is located, water for the irrigation of not more than one acre.
- Irrigation – Irrigation Well means any well-constructed for the purpose of obtaining ground water to supply irrigation water for agriculture, silviculture, golf courses, fish farms, and land beautification, but excluding single-family irrigation of lawns or gardens.
- Monitoring – well intended for the purpose of determining groundwater quality or quantity.
- Municipal – water well that supplies water for use by a permitted Public Water System to supply water for human consumption.
- Piezometer – well that is drilled and designed to monitor water levels within a specific depth interval.
- Public – a water supply well that is a source of drinking water supply for a public water system.

- Unknown – wells that are of unknown specific location, unregistered ownership, and of unknown depth that penetrate the subject aquifers and aquitards.

2.4 Constituents of Concern

As outlined in the Chapter 3 Addendum, the constituents of concern (COCs) identified for water quality analysis in the monitoring program include the following:

- Salinity (measured as total dissolved solids [TDS])
- Nitrate (measured as Nitrogen[N])
- Arsenic
- Uranium
- Sulfate
- Chloride
- 1,2,3-Trichloropropane (TCP)

2.4.1 Regulatory Criteria to Define Undesirable Results

The criteria that determine whether water quality has degraded to an undesirable level are defined by several standards. These include the Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs) set by the Division of Drinking Water (DDW) of the California State Water Resources Control Board (SWRCB), along with Water Quality Objectives specific to agricultural uses in the Subbasin region. These standards serve as benchmarks to assess whether the activities of the GSA, such as groundwater extraction, lead to significant and unreasonable degradation of groundwater quality. Further details on the criteria used to measure degradation of water quality related to GSP activities can be found in Section 4.5.1.6 of the 2024 revised GSP.

Descriptions of the criteria for each constituent of concern are provided below.

- Salinity (measured as TDS) – TDS concentrations are compared to the SMCL upper limit of 1,000 milligrams per liter (mg/L).
- Nitrate (measured as N) – Nitrate concentrations are compared to the MCL of 10 mg/L for Nitrate as N. This level indicates high nitrate levels for potable water use.
- Arsenic – Arsenic concentrations, which are a public health concern in drinking water, are compared to the MCL of 0.0010 mg/L (10 micrograms per liter [µg/L]). A federal MCL for arsenic of 10 µg/L has been in effect since January 2006. Prior to these standards, both California and federal MCLs for arsenic were set at 50 µg/L.
- Uranium – Uranium in drinking water is compared to the MCL of 20 picocuries per liter (pCi/L). Notably, the USEPA has a different MCL for uranium, set at 30 µg/L. However, California follows its own standard of 20 pCi/L.
- Sulfate – Sulfate concentrations are compared to the upper limit of the SMCL, which is 500 mg/L.

- Chloride – Chloride concentrations, which are reported as the Cl^- ion, are evaluated against the upper limit of the SMCL, which is 500 mg/L.

- 1,2,3-TCP – Concentrations of 1,2,3-TCP are compared to the MCL of 0.005 µg/L.

2.5 Quality Objectives and Criteria

The following subsections present the DQOs and measurement quality objectives (MQOs) for the basin.

2.5.1 U.S EPA Data Quality Objectives

Data collected in accordance with this SAP will be of a standardized level of quality that provides decision makers with a sufficient level of confidence in the accuracy of the data on which they rely to inform their policy decisions. This SAP describes procedures to assure that the basin-specific Data Quality Objectives (DQOs) are met, and that the quality of data are known and documented.

The following excerpt from DWR's BMP (DWR, 2016a) recommends:

"Establishing data collection protocols that are based on best available scientific methods is essential. Protocols that can be applied consistently across all basins will likely yield comparable data. Consistency of data collection methods reduces uncertainty in the comparison of data and facilitates more accurate communication within basins as well as between basins.

Basic minimum technical standards of accuracy lead to quality data that will better support implementation of GSPs....

It is suggested that each GSP incorporate the Data Quality Objective (DQO) process following the U.S. Environmental Protection Agency (EPA) Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006). Although strict adherence to this method is not required, it does provide a robust approach to consider and assures that data is collected with a specific purpose in mind, and efforts for monitoring are as efficient as possible to achieve the objectives of the GSP and compliance with the GSP Regulations" (DWR, 2016a).

DQOs are qualitative and quantitative statements developed through the seven-step DQO process (U.S. EPA, 2006). The DQOs clarify the study objectives, define the most appropriate data to collect and the conditions under which to collect the data, and specify acceptance criteria that will be used to evaluate whether the quantity and quality of data collected are sufficient to support decision making. The DQOs are used to develop a scientific and resource-effective design for data collection.

2.5.2 QA/QC Objectives

The overall QA/QC objectives are as follows:

- Obtain data of known quality to support goals set forth in the GSP.

- Document all aspects of the quality program, including performance of the work and flexibility for changes to mitigate issues if they are discovered in the future.

- Attain QC requirements for field measurements and analyses specified in this SAP.

This SAP has been prepared with consideration of the EPA document, Requirements for Quality Assurance Project Plans, EPA QA/R-5 (U.S. EPA, 2001). Table H2-1 provides a link between the EPA's guidance and this SAP and identifies the sections of this SAP that address the elements of QA/R-5.

Table H2-1: Summary of SAP Section vs EPA QA/R-5 Requirements

EPA QA/R-5 QAPP Element		Tulare Lake Subbasin SAP	
A1	Title and Approval Sheet		Cover Letter and Title Page
A2	Table of Contents		Table of Contents
A3	Distribution List		Cover Letter
A4	Project/Task Organization	1.1	Purpose of SAP
A5	Problem Definition/Background	1.1 1.3	Purpose of SAP Sustainable Management Criteria
A6	Project/Task Description	2.1 2.2 2.3	Monitoring Network Representative Monitoring Points Well Types
A7	Quality Objectives and Criteria	2.5	Quality Objectives and Criteria
A8	Special Training/Certification	2.8	Training
A9	Documents and Records	3.1	Field Documentation
B1	Sampling Process Design	2.2	Representative Monitoring Points
B2	Sampling Methods	3.3	Sampling Methods
B3	Sampling Handling and Custody	3.4	Sampling Handling, Custody, and Laboratory Coordination
B4	Analytical Methods	3.6.2	Laboratory Analyses
B5	Quality Control	3.6.3	Water Quality Assurance and Quality Control
B6	Instrument/Equipment Testing, Inspection, and Maintenance	3.2	Groundwater Level Equipment Testing, Inspection, and Maintenance Requirements
B7	Instrument/Equipment Calibration and Frequency		
B8	Inspection/Acceptance of Supplies and Consumables	3.7	Requirements for Inspection and Acceptance of Supplies and Consumable
D2	Validation and Verification Methods	6.2	Verification Methods
B10	Data Management	4.0	Data Management
C1	Assessment and Response Actions	5.1	Assessment and Response Actions
C2	Reports to Management	5.2	Reporting to Management
D1	Data Review, Verification, and Validation	6.0	Data Evaluation and Usability
D3	Reconciliation with Data Quality Objectives	7.0	Reconciliation with DQOs

2.5.3 Data Quality Objectives

The seven steps of the DQO process for this SAP are presented in Table H1-2. Key to systematic planning is determining whether the problem to be solved requires a quantitative or qualitative answer (U.S. EPA, 2006).

Table H2-2: Data Quality Objectives

Step 1: State the Problem
• Multiple entities collect water quality and water level data in the basin and basic minimum technical standards of accuracy are needed to ensure quality data are collected that will better support GSP implementation and policy decisions. Data must be sufficient to limit uncertainty when used to assess the sustainability indicators.
Step 2: Identify the Goals
• Establish data collection protocols that are based on best available scientific methods. Protocols that can be applied consistently across the basin will likely yield comparable data. Consistency of data collection methods reduces uncertainty in the comparison of data and facilitates more accurate communication within as well as between basins.
Step 3: Identify the Inputs
• Groundwater Quality Sampling of Water Wells • Groundwater Level Measuring in Water Wells
Step 4: Define the Boundaries of Study
• The horizontal study boundaries are defined as the boundaries of the basin. • The vertical boundaries are defined as the base of groundwater below ground surface in the A-Zone, B-Zone, and C-Zone aquifers that is of a quality and quantity that it can be beneficially used. • There is no foreseeable temporal boundary as up-to-date water quality and water level data will continue to be necessary through GSP
Step 5: Develop an Analytical Approach
• Groundwater quality samples will be compared to the Subbasin GSP approved sustainable management criteria protective of water quality in the basin. • Groundwater levels will be compared to the Subbasin GSP approved sustainable management criteria protective of groundwater levels in the basin and any sustainability indicators in which water level is established as a viable proxy in the basins' GSP.
Step 6: Specify Performance or Acceptance Criteria
• Quality assurance samples will be collected during the sampling to evaluate sampling techniques and consistency. • Analytical results will be evaluated within their own tolerance limits and compared to appropriate screening levels. • Water quality samples will be analyzed using EPA methods that have been selected based on the reporting limits (RLs). RLs should be at a resolution that are sensitive enough to meet basins' DQOs.
Step 7: Develop a Plan for Obtaining Data

• It is not the purpose of this SAP to establish specific monitoring points but to equip the field data collecting entities active in the basins to collect data that is of a quality that will support sustainability monitoring in the basin. • The protocols established in this SAP will allow for consistency of data collection across the basin and will reduce uncertainty in data comparisons.

2.5.4 Measurement Quality Objectives

Analytical results of water quality samples should be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) and sensitivity parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the SAP objectives. Of these PARCC parameters, precision and accuracy should be evaluated quantitatively by collecting the QC samples listed in Table H2-3. The following subsections describe each of the PARCC parameters and how they will be assessed within this SAP.

Table H2-3: Data Quality Indicators for Water Quality Sample Laboratory Analysis

Data Quality Indicator	QC Sample Check	Acceptance Criteria
Precision (RPD)	MS/MSD Field duplicates	35% RPD 50% RPD
Accuracy (Percent recovery)	MS and MSD Blanks[a]	50 to 150% recovery Less than MDL
Representativeness	The sampling methods and the analytical methods described in this SAP are designed to provide data that are representative of site conditions.	
Completeness	The objective for data completeness is 90%.	
Comparability	he use of standard published sampling and analytical methods, and the use of QC samples, will ensure data of known quality. These data can be compared to any other data of known quality.	
Sensitivity	Not applicable	RLs and laboratory RLs sensitive to basins' DQOs.

[a] May include method blanks, reagent blanks, instrument blanks, calibration blanks, and other blanks collected in the field (such as field blanks)

QC = Quality Control
MS = Matrix spike
RPD = Relative percent difference
MSD = Matric spike duplicate
MDL = Method detection limit

2.5.4.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same chemical property under similar conditions. Usually, combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

RPD is calculated as follows:

$$RPD = \frac{|A - B|}{(A + B)/2} X100\%$$

where A = First duplicate concentration

B = Second duplicate concentration

Field sampling precision can be evaluated by analyzing field duplicate samples. It is recommended that for every 10 samples collected, 1 blind duplicate sample should be collected. However, this may not be necessary for inorganic analytes with low risk of contamination during sampling and are analyzed by straight forward standardized laboratory methods.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates or matrix spike (MS) and matrix spike duplicate (MSD) samples. For this SAP, MS/MSD samples should be generated for all analytes. The results of the analysis of each MS/MSD pair should be used to calculate the RPD as a measure of laboratory precision.

2.5.4.2 Accuracy

A program of sample spiking should be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, laboratory control samples (LCSs) or blank spikes, surrogate standards, and method blanks. MS and MSD samples should be prepared and analyzed at a frequency of 5 percent. LCSs or blank spikes are also analyzed at a frequency of 5 percent. Surrogate standards, where available, are added to every sample analyzed for organic constituents. The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$Percent\ Recovery = \frac{S - C}{T} X100\%$$

Where S = Measured spike sample concentration

C = Sample Concentration

T = True or actual concentration of the spike

2.5.4.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this SAP, representative data are anticipated to be obtained through careful selection of sampling locations and analytical parameters. Representative data will be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data can be ensured through the consistent application of established field and laboratory procedures. Field blanks (if appropriate) and laboratory blank samples should be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined by comparison with existing data to be non-representative should be used only if accompanied by appropriate qualifiers and limits of uncertainty. However, this may not be necessary for inorganic analytes with low risk of contamination during sampling and are analyzed by straight forward standardized laboratory methods.

2.5.4.4 Completeness

Completeness is a measure of the percentage of basin-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded.

When all data validation is completed, the percent completeness value should be calculated by dividing the number of usable sample results by the total number of sample results planned for this investigation.

Completeness should also be evaluated as part of the data quality assessment (DQA) process (U.S. EPA, 2000). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

2.5.4.5 Comparability

Comparability expresses the confidence with which one dataset can be compared with another. Comparability of data can be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

2.5.4.6 Detection and Quantitation Limits

The method detection limit (MDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The MDL for each analyte should be listed as the detection limit in the laboratory's electronic data deliverable (EDD). The practical quantitation limit (PQL) represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a sample matrix by a specific method. Reporting limits (RL or RDL) may vary from lab-to-lab and are the lowest detection of an analyte from a sample after any sample dilution adjustments have been accounted for. Analyte concentrations below the RL are reported as not detectable. Sometimes laboratory results can be obtained for analytes below the PQL, but these results should be reported as estimated values if concentrations are less than MDLs. For potable water samples, the U.S. EPA and many states have established water regulations for Maximum Contamination Levels (MCL) for primary and secondary contaminates. In California, state drinking water MCLs are often lower than the national regulations.

2.6 SAP Personnel Organization and Coordination

The following sections provide description of the SAP personnel organization and coordination for sampling.

2.6.1 GSA Organization Members

GSA member agencies involved in SAP implementation are listed below in Table H2-4.

Table H2-4: GSA Member Agencies

GSA	GSA Member Agencies
Mid-Kings River	Kings County Water District City of Hanford Kings County
El Rico	Alpaugh Irrigation District City of Corcoran Corcoran Irrigation District Kings County Lovelace Reclamation District No. 739 Melga Water District Salyer Water District Tulare Lake Basin Water Storage District Tulare Lake Drainage District
South Fork Kings	City of Lemoore Empire West Site Irrigation District Stratford Irrigation District Stratford Public Utility District Kings County
Southwest Kings	Dudley Ridge Water District Tulare Lake Reclamation District No. 761 Kettleman City Community Services District Tulare Lake Basin Water Storage District Kings County
Tri-County Water Authority	Angiola Water District Kings County Deer Creek Storm Water District Wilbur Reclamation District #825

2.6.2 Coordination and Scheduling

Groundwater levels in California basins are often at their highest annual levels during the spring of each year following winter precipitation. They are often at their lowest in the fall preceding the start of the winter rainy season with much of the annual precipitation falling from November through February in the basin. Temporal coordination of groundwater level collection activities across the State is important for comparison of water level measurements collected by different monitoring entities. DWR's BMP specifies that "Groundwater levels will be collected during the middle of October and March for comparative reporting purposes" (DWR, 2016b)

The following excerpt is from DWR SGMA BMP (2016a):

"Groundwater elevation data will form the basis of basin-wide water-table and piezometric maps and should approximate conditions at a discrete period. Therefore, all groundwater levels in a basin should be collected within as short a time as possible, preferably within a 1-to-2-week period" (DWR, 2016a).

Water levels will be collected by local and state agencies, as part of their established monitoring networks in the basin during other times of the year for various purposes, but as tight (small) a monitoring event window as reasonably possible should be scheduled around October and March of each year. These recommended spring-high water level measurement runs centering around April 1 and fall-low runs around October 1 are to conform to DWR's timing preference (mentioned above) for producing comparative state-wide record sets. Public water supply systems (e.g., City of Hanford) often have other sampling or measurement requirements (e.g., weekly water level measurements, quarterly or annual water quality sampling and analysis) as requirement of permits to serve potable water supplies.

2.6.3 Access Agreements

A signed access agreement should be procured prior to accessing all sites. The signed agreement should be on file and should be on hand in the field.

General agreement components should include, but are not necessarily limited to, the following:

- Monitoring site name (and any known alias), location and address
- Property owner's name
- Property contacts information including property representative primary point of contact.
- Names of field staff, agency affiliations and contractors (if any) accessing the site as part of the monitoring program
- Date and expiration (if any) of agreement
- Prior notification requirements of intent to access property
- Days of the week and time(s) of day property access is permitted
- Terms of agreement (e.g., liability considerations, data sharing considerations).

2.7 Standard Operating Procedures

It is recommended that individual monitoring entities develop and maintain Standard Operating Procedures for all field program activities. Table H2-5 lists recommended SOPs that should be developed (or updated as necessary) and implemented, if not currently in place, by monitoring entities in accordance with DWR's BMP Monitoring Protocols, Standards, and Sites (DWR, 2016a) and guidance from USGS reference documents cited in this SAP.

Table H2-5: List of Potential Standard Operating Procedures

SOP Title	
General Requirements	
	Equipment
	Field Notes
	Decontamination of Field Equipment
Water Sampling	
	Preparation for Water Sampling

	SOP Title
	Measurement of Field Parameters
	Collection of Groundwater Samples
	Collection of Surface Water Samples
	Sample Preservation
	Sample Filtration
	Quality Assurance/Quality Control (QA/QC) Samples
Water Levels	
	Measurement of Water Levels in Wells
	Pressure Transducer & Data Logger: Deployment, Download, Maintenance, and Troubleshooting
	Quality Assurance / Quality Control (QA/QC) Water Levels

2.8 Training

The following sections describe certification, license, and training requirements.

2.8.1 Equipment Operator Certifications and Licenses

Individual monitoring network managers and supervisors are responsible for ensuring that all field personnel are properly trained and certified in the activities they perform. Field sampling sometimes requires the use of specialized equipment that may require certification and training to safely operate.

2.8.2 Health and Safety Training

A basin-specific health and safety plan (HASP) is not included as part of this SAP. State and Local agencies should have in place HASPs and ongoing field staff training programs that are specific to the field conditions and safety hazards encountered in field data collection activities.

It is not anticipated that field personnel working in the Subbasin will necessitate access to sites that contain hazardous materials, but personnel should be aware that OSHA training requirements are defined in 29 Code of Federal Regulations (CFR) 1910.120(e). However, if necessary, these requirements include (1) 40 hours of formal off-site instruction, (2) a minimum of 3 days of actual on-site field experience under the supervision of a trained and experienced field supervisor, and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training.

Copies of the field team’s health and safety training records, including course completion certifications for the specialized supervisor training and the initial and refresher health and safety training, should be maintained, and kept with site-specific files.

3. WATER QUALITY DATA GENERATION AND AQUISTION

An objective of this SAP is to describe groundwater data collection procedures that will produce reliable basin-specific water level data that can be used to evaluate sustainability in the basin with respect to the SGMA legislation sustainability indicators. This section details activities associated with measuring water levels in wells, including field methods to be implemented and steps that should be undertaken to ensure the adequacy of the data collection activities.

DWR's BMP (DWR, 2016a) includes the following considerations for developing groundwater level protocols:

- Groundwater level data are taken from the correct location, well ID, and screen interval depth.
- Groundwater level data are accurate and reproducible.
- Groundwater level data represent conditions that inform appropriate basin management DQOs.
- All salient information is recorded to correct, if necessary, and compare data
- Data are handled in a way that ensures data integrity.

3.1 Field Documentation

This Section discusses the requirements for documenting water level measurement activities. Field personnel should follow the documentation guidelines outlined in DWR's BMP #1 - Monitoring Protocols, Standards, and Sites (DWR, 2016a).

Field personnel should use monitoring network specifically prepared forms ("run sheets") or permanently bound field logbooks with sequentially numbered pages to record and document field activities. Example water level data collection forms are included in Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1 (USGS, 2011). All paper field documentation should be scanned and archived by the monitoring entity.

General field-site documentation information should be on file with the monitoring agency that includes any access agreements (see Section 1.6) and associated property information. All field forms and logbooks should include and record at a minimum, the following information:

- Well identifier - CASGEM Well Identification Number and CA DWR SWN are recommended (see Section 2.3.1 for a description of DWR's well identification convention);
- Monitoring schedule event/list (e.g., fall water level run);
- Date and time (24-hour format) of measurement; and
- Comments/ Notes field
    - Discussions of problems encountered and their resolution

    - Discussions of deviations from the monitoring entity's water level measuring SOP or other governing documents
    - Factors that may influence the depth to water readings (see Section 3.4.1).

Documentation of water level measurements is essential to ensure data integrity. Field staff should adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent black or dark blue ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.
- Any serialized documents will be maintained by the monitoring entity and referenced in the site logbook.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

The monitoring entity's supervisor is responsible for ensuring that water level measurement activities are properly documented. The following subsections offer common "no measurement" obtained explanations and data qualifiers. It is important that monitoring entities maintain standardized lists of data qualifiers and all field staff understand the intended meaning (i.e., field conditions) of each qualifier so that they are applied in a standardized and consistent manner.

3.2 Groundwater Level Equipment Testing, Inspection, and Maintenance Requirements

This section outlines testing, inspection, and maintenance procedures for field equipment and water level measurement devices.

3.2.1 General Requirements

Testing, inspection, and maintenance methods and frequency should be based on the following:

- The type of water level measurement device.
- The instrument's stability characteristics.
- The required accuracy, sensitivity, and precision of the equipment.
- The equipment's intended use, considering basin-specific DQOs.
- Manufacturer's recommendations; and
- Other conditions that affect measurement or operational control.

For most equipment, preventive maintenance is performed in accordance with procedures and schedules recommended in (1) the manufacturer's literature or operating manual or (2) SOPs associated with applications of the measurement device.

3.2.2 Manual Water Level Measurement Equipment

After field equipment and measurement devices are transported to the field, they should be inspected for damage at the beginning and end of each day of use. Damaged equipment should be replaced or repaired immediately, if practicable. Battery-operated equipment (e.g., electric sounder) should be checked to ensure full operating capacity; if needed, batteries should be replaced.

Following use, field equipment should be properly decontaminated. Any equipment problems should be reported so that problems are not overlooked, and any necessary equipment repairs are performed before the next use of the equipment. Common water level measurement devices are listed below:

- Steel Surveyor's Measuring Tape.
- Electric Sounder (single wire and dual wire).
- Acoustic Sounder; and
- Permanently Installed Air Line.

For airline measurements, gauge reading is recorded after pressurizing with a pneumatic pump or compressed air tank. The depth of the bottom of the submerged tubing in the well open to the atmosphere must be known to calculate the water level in the well from the measured pressure.

3.2.3 Recording Water Level Devices – Pressure Transducer and Data Loggers

Pressure transducer and data logger monitoring networks are becoming commonplace in many groundwater basins. These devices can be used for recording water level measurements in wells on user defined or event-based schedules.

The electronics components of the device are sealed in a housing that is installed below the water level surface in the well. They measure pressure (commonly in psi) above the sensor. For every 1 psi of pressure recorded by the gauge, there are 2.31 feet of potentiometric head above the sensor. A simple linear correction (coefficient) can be applied to adjust output readings to depth-to-water in the well or water level elevation referenced to mean sea level (given a RP elevation has been surveyed for the site). The devices can be downloaded during well-site visits or can be connected to telemetry systems to transmit data remotely.

The following excerpt is from DWR's BMP #1 (DWR, 2016a) and provides guidance on the use of pressure transducers and data loggers as a component of the monitoring plan for a basin:

When installing pressure transducers, care must be exercised to ensure that the data recorded by the transducers is confirmed with hand measurements.

The following general protocols must be followed when installing a pressure transducer in a monitoring well:

- *The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended* *that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.*

- *The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.*
- *Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected is meeting the DQO and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.*
- *The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.*
- *Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.*
- *Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.*
- *The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.*
- *The data should be downloaded as necessary to ensure no data is lost and entered into the basin's DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.*

3.3 Sampling Methods

3.3.1 Groundwater Well Sampling Methodology

Groundwater samples should be collected from wells in the Subbasin in accordance with the monitoring entities' SOPs, if applicable. The specific sample collection procedure should reflect the type of analysis to be performed.

Before purging and sampling, groundwater level elevation should be measured in the well as described in the protocols in Section 3.3.2 of this SAP. The total depth of the well (TD), depth-to-water level measurement (DTW), and casing internal radius (in consistent units of feet) are needed to calculate the casing volume.

Casing volume in gallons is calculated as follows:

$$V = \pi r^2 h (7.48)$$

where V = casing volume (in gallons)

r = casing radius (feet)

h = TD – DTW (feet)

7.48 = 7.48 gallons/feet^3

Each well, not equipped with low-flow or passive sampling equipment, should be purged of a minimum of three casing volumes prior to sampling to ensure that a representative groundwater sample is obtained. When purging by use of a pump or airlifting, a discharge rate should be estimated (if a flow meter is unavailable) so that field staff can estimate the time required to complete the purging process before sample collection. In the case of sampling with bailers, the volume of water extracted before sampling should be estimated.

"Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected" (DWR, 2016a). If a well is purged dry, it should be documented and sampled when the well has recovered to within 90% of the original level prior to sampling. "Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary" (DWR, 2016a).

Means of extracting groundwater from a well for sampling include, but may not be limited to, the following industry standard methods:

- Dedicated pump – It is recommended that "samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment" (DWR, 2016a).
- Temporary pump – See Section 3.3.5 for decontamination considerations between monitoring sites.
- Bailer – Dedicated or disposable polyethylene bailers are recommended. Bottom-emptying devices are recommended to transfer groundwater samples from bailers to unpreserved containers, to minimize volatilization and ensure sample integrity.
- Airlifting - Method not recommended when collecting samples for determination of analytes that are volatile or otherwise are affected by exposure to oxygen (USGS, 2018).
- Low-Flow Sampling Equipment - Requires additional special protocols. "In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the following protocols derived from EPA's Low-flow (minimal drawdown) ground-water sampling procedures (Puls and Barcelona, 1996). These protocols apply to low-flow sampling equipment that generally pumps between 0.1 and 0.5 liters per minute.
- Passive Sampling Equipment - Requires additional special protocols. "In addition to the protocols listed above, passive diffusion samplers should follow protocols set forth in USGS Fact Sheet 088-00" (DWR, 2016a).

If a pressure transducer and data logger is installed in a dedicated monitoring well, it should be removed before bailing, airlifting, or installing any temporary sampling equipment (e.g., Grundfos Red-Flo2).

The following minimum field parameters should be collected at the time of sampling:

- Specific Conductivity or Electrical Conductivity (EC)
- Reduction-Oxidation Potential
- pH - "Measurements of pH should only be measured in the field, lab pH analysis are typically unachievable due to short hold times" (DWR, 2016a)
- Temperature

Additional field parameters "may also be useful for meeting DQOs of GSP and assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day" (DWR, 2106a). Additional field parameters may include, but are not limited to, the following:

- Dissolved Oxygen (DO) (in situ measurements preferable)
- Turbidity

Field parameters should be collected before, during and immediately after purging and should stabilize prior to sampling. "Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection" (DWR, 2016a).

Monitoring entities in the basin should have specific analytical programs adapted for their respective monitoring networks. Laboratory analytical methods are described in Section 3.6.2 of this SAP. Groundwater samples should be always accompanied by full chain of custody documentation (see Section 3.4.4).

3.3.2 Groundwater Levels Measurement Methodology

Depth to groundwater should be measured to a minimum accuracy of 0.1 feet (23 CCR § 352.4) with a desired accuracy of 0.01 feet relative to the RP. "Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions" (DWR, 2016a). Measurements must be in consistent units. Recommended units are feet, partitioned into tenths of feet, and hundredths of feet. The use of feet and inches is not recommended. "Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot" (DWR, 2016a).

Groundwater elevation is calculated as follows:

$$WLE = RP - DTW$$

Where:

WLE = Groundwater Level Elevation

RP = Reference Point Elevation

DTW = Depth to Water

"For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement" (DWR, 2016a).

3.3.3 Flowing Wells

A special condition associated with confined aquifer systems (see Section 1.1.8) are naturally flowing wells (artesian) wells where the potentiometric head in the well rises above the land surface. If a monitored well is found to be flowing (i.e., naturally without the aid of a pump) after removal of the well cap, the condition should be documented. If appropriate and safe, the well should be measured. "Site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration" (DWR, 2016a).

Two methods of measuring flowing wells are summarized below:

- Use of tubing or an extension pipe (appropriate for low artesian pressures). Water level under pressure from the flowing well rises in the tube/pipe to a height that is measured above the top of the well casing with respect to the established RP.
- Use of a pressure gauge (commonly applied where high artesian pressures make use of tubing/extension pipes impractical). For every 1 psi of pressure recorded by the gauge, there are 2.31 feet of potentiometric head above the gauge.

3.3.4 Periodically Dry Wells

If a well is dry, then document the total depth of the well (TD). If water level is measured near the TD of the well, professional judgment must be used to decide if the measurement is representative of the aquifer zone the well is completed in. Many wells have a sump (blank casing with a bottom cap) at the bottom of the well. Ten to 20-foot sumps are common in irrigation and production wells. Water level measurements that approach the TD of a well should be considered suspect unless the construction of the well is known, and it has been determined that the water is not evaporation (condensation) water in the bottom of the well with the actual water level of the aquifer some distance below the bottom of the well.

3.3.5 Equipment Decontamination

"The water level meter should be decontaminated after measuring each well" (DWR, 2016a). Equipment decontamination is especially important if a monitoring well-site is known to contain transferable contaminants. If a site is known to be contaminated, dedicated equipment or thorough decontamination after each use may be necessary. Disposable gloves should be properly discarded between sampling sites.

3.3.5.1 *Scheduling and Collection*

3.3.5.2 *No Measurement Documentation*

The following are common explanations for why a water level measurement was not obtained by field staff while accessing a well-site listed on a monitoring network schedule. Each of the bulleted explanations shown below can be assigned a unique number in a list maintained by a monitoring entity that allows field staff to quickly and efficiently document the field conditions that prohibited a water level measurement from being obtained. A list of commonly used qualifiers is included below. Documentation may include, but is not limited to, the following explanations:

- Measurement Discontinued
- Pumping
- Locked pump house
- Tape hung up.
- Can't get tape in casing.
- Unable to locate well.
- Well has been destroyed.
- Special/Other (requires explanation in comments field)
- Casing leaking or wet
- Temporarily inaccessible
- Well dry; and
- Unmeasured flowing well.

If a water level is not obtained, the minimum site visit information, outlined above, should still be collected. Documenting well-site conditions can help inform future data collection efforts in the basin. For example, if a well is pumping multiple site visits in a row, it may warrant contacting the well owner or operator to schedule a time to measure the well when it will be off.

3.3.5.3 *Water Level Measurement Qualifiers*

The following are common water level measurement qualifiers that that can be assigned a unique number in a list maintained by a monitoring entity that allows field staff to quickly and efficiently document ancillary information associated with a water level measurement. Commonly used by qualifiers are included below.

- Caved or deepened.
- Pumping
- Nearby pump operating
- Casing leaking or wet
- Pumped recently.

- Air or pressure gauge measurement.
- Special/Other (requires explanation in comments field);
- Recharge operation at or nearby well.
- Oil in Casing.
- Acoustic sounder.
- Measured flowing well.
- Does not match transducer record.

3.3.6 Well Site Condition Assessment

Upon arriving at a well-site, a basic site conditions assessment should be conducted. If the well being monitored is not a dedicated monitor well and is equipped with a pump, check to see if the pump is in operation or for other indicators that the pump was in operation recently (e.g., warm motor, wet adjacent irrigated fields or water around the well not associated with rain events). Do not measure the water level in the well if it is pumping unless instructed to do so by the monitoring entity's supervisor. Document "factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence [not applicable for the Owens Valley Groundwater Basin], or well condition" (DWR, 2016a). Document any site conditions findings that do not result in a water level measurement according to Section 3.1.1, and qualify water level measurements, as appropriate, with qualifiers listed in Section 3.1.2.

The sampler should remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure release. If a release is observed, the measurement should follow a period to allow the water level to equilibrate" (DWR, 2016a). "If agricultural or municipal wells are used for monitoring, the wells must be screened across a single water-bearing unit, and care must be taken to ensure that pumping drawdown has sufficiently recovered before collecting data from a well" (DWR, 2016b). After measuring the well, "The sampler should replace any well caps or plugs and lock any well buildings or covers" (DWR, 2016a).

3.3.7 Reference Point Surveying

If not previously measured and recorded for the site, or the former measurement is no longer valid (e.g., the surface casing was sheared off as the result of being run over by a truck), the reference point (RP) height in feet (above or below ground surface) should be measured. "Depth to groundwater must be measured relative to an established Reference Point (RP) on the well casing. The RP is usually identified with a permanent marker, paint spot, or a notch in the lip of the well casing. By convention in open casing monitoring wells, the RP reference point is located on the north side of the well casing. If no mark is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing" (DWR, 2016a).

Ground elevation and top of casing elevation reference points should be measured to North American Vertical Datum 1988 (NAVD88) within 0.5-foot accuracy (23 CCR § 352.4) and a higher level of accuracy of 0.1 foot or less is preferred.

The locations of the monitoring wells on the land surface should be surveyed to North American Datum 1983 (NAD83) to an accuracy of 0.1 foot. DWR's standard horizontal projected coordinate system is California Teale Albers, NAD83. Feature class (location) data uploaded through the SGMA portal is required to be converted to this projected coordinate system for consistency across data sets. The OVGA's online database (www.owens.gladata.com) uses NAD 1983.

"Survey grade global navigation satellite system (GNSS) global positioning system (GPS) equipment can achieve similar vertical accuracy when corrected. Guidance for use of GPS can be found at USGS http://water.usgs.gov/osw/gps/. Hand-held GPS units likely will not produce reliable vertical elevation measurement accurate enough for the casing elevation consistent with the DQOs and regulatory requirements" (DWR, 2016a).
"Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83" (23 CCR § 352.4).

3.4 Sampling Handling, Custody, and Laboratory Coordination

Each sample collected by the field staff should be traceable from the point of collection through analysis and final disposition to ensure sample integrity. Sample integrity helps to ensure the legal defensibility of the analytical data and subsequent conclusions.

The following bullets are general guidance and standardized protocols recommended by DWR in BMP #1 (DWR, 2016a):

- *Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.*
- *Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.*
- *Sample containers should be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.*
- *Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.*
- *Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.*
- *Instruct the laboratory to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels."*

3.4.1 Site and Sample Identification

Each sampling location (groundwater and surface water) should be identified as clearly as possible (e.g., Well #1 is not an acceptable site identifier). "Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion" (DWR 2016a). All monitoring entities operating within the basin should use the same unique identifier scheme but where not practical (e.g., for historical network or other reasons), cross-over tables should be developed to identify monitoring sites within the basin. Blind duplicates should be clearly documented, with the actual well location listed in the logbook.

California Code of Regulations (23 CCR § 352.4) requires that the CASGEM Well Identification Number be used, if available, for identifying site locations. In addition, DWR identifies wells by State Well Number (SWN). SWNs are in an alphanumeric form (e.g., 04N18W20P01S) based on the public land grid (Township, Range and Section) which indicates geographic location of the well. In the SWN naming scheme, Sections are further subdivided into 1/16ths in which individual wells are numbered sequentially. The final letter in a SWN is the baseline and meridian of the public land grid in which the well lies. The following recommends naming conventions appropriate for different kinds of samples:

- **Groundwater samples.** CASGEM Well Identification Number and DWR State Well Numbers (SWN) are recommended for identifying well sampling sites in the basin.
- **Surface water samples.** A modified SWN format is recommended for identifying surface water sampling sites in the basin in the form: Township, Range and Section followed by "SW" and ending with individual sites within the section numbered sequentially (e.g., 04N17W29SW1)
- **Trip blanks, field blanks, and equipment blanks.** Samples should be designated TB, FB, and EB respectively.

3.4.2 Sample Labeling

A sample label should be affixed to each sample container. The label should be completed with the following information written in indelible ink:

- Sample location and identification number.
- Date and time of sample collection.
- Sample collector's initials.
- Preservation required.
- Analysis required.

3.4.3 Sampling Documentation

Documentation during sampling is essential to ensure proper sample identification. Field staff should adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent black or dark blue ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.

- Any serialized documents will be maintained by the monitoring entity and referenced in the site logbook.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

The monitoring entity's supervisor is responsible for ensuring that sampling activities are properly documented.

3.4.4 Chain of Custody

Standard sample custody procedures should be used to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample should be in custody if one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Chain of custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The chain of custody record should be used to document all samples collected and the analysis requested. Information that the field personnel should record on the chain of custody record includes the following:

- Sample location and identification number.
- Name and signature of sampler.
- Destination of samples (laboratory name).
- Date and time of collection.
- Analysis requested.
- Signatures of individuals involved in custody transfer, including the date and time of transfer.
- Airbill number (if applicable); and
- Monitoring entity supervisor's contact and phone number.

Unused lines on the chain of custody record should be crossed out. Field personnel should sign chain of custody records that are initiated in the field, and the airbill number should be recorded. The record should be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed airbills serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the chain of custody record and the airbill should be retained and filed by field personnel before the containers are shipped.

3.4.5 Sample Shipment

The following procedures should be implemented if samples collected in accordance to this SAP are shipped:

- The shipping box should be filled with bubble wrap, sample bottles, and packing material. Sufficient packing material should be used to prevent sample containers from breaking during shipment.
- The chain of custody records should be placed inside a plastic bag. The bag should be sealed and taped to the inside of the cooler lid. The airbill, if required, should be filled out before the samples are handed over to the carrier. The laboratory should be notified if the sampler suspects that the sample contains any substance that would require laboratory personnel to take safety precautions.
- The shipping box should be closed and taped shut with strapping tape around both ends.
- Signed and dated custody seals should be placed on the front and side of each shipping box. Wide clear tape should be placed over the seals to prevent accidental breakage.
- The chain of custody record should be transported within the taped sealed shipping box. When the shipping box is received at the analytical laboratory, laboratory personnel should open the shipping box and sign the chain of custody record to document transfer of samples.

3.5 Sample Containers and Holding Times

Confer with the ELAP certified analytical lab that will be receiving the samples for required containers for required sample volume, container type, preservation technique, and holding time for each analysis that is to be conducted on the groundwater samples collected. Required containers, preservation techniques, and holding times for field QC samples, such as field duplicates and MS/MSD samples (Section 2.6), should be the same as for field samples.

3.6 Analytical Methods

The source of analytical services to be provided will be determined by the individual entities conducting monitoring in the Subbasin and should support DQOs presented in this SAP.

If an analytical system fails, the laboratory QA officer should be notified, and corrective action should be taken. In general, laboratory corrective actions should include stopping the analysis, examining instrument performance and sample preparation information, and determining the need to reprepare and/or reanalyze the samples.

TDS can be reported by either Total Filterable Residue (TFR) or by Summation (SUM), which is calculated by summing the mass of the major anions and cations in a water sample. TDS by Summation commonly yields a slightly higher value than the TDS by Total Filterable Residue. The wet chemistry evaporative method (TFR) is now the standard laboratory analysis for TDS and is recommended method for water sample analysis in the basin.

3.6.1 Laboratory Analyses

EPA-approved methods for laboratory analyses of the COC samples should be used. EPA-approved standard analytical methods are associated with each constituent listed in the table below.

Table H3-1: EPA Analytical Methods

COC	EPA Analytical Method
Salinity (measured as TDS)	EPA Method 200.7
Nitrate (measured as N)	EPA Methods 300.0
Arsenic	EPA Methods 200.8
Uranium	EPA Methods 908.0
Sulfate	EPA Methods, 300.0
Chloride	EPA 300.0
1,2,3-TCP	EPA 504.1

3.6.2 Water Quality Assurance and Quality Control

Various field and laboratory QC samples and measurements should be used to verify that analytical data meet the QA objectives. It is recommended that field QC samples and measurements be collected to assess the influence of sampling activities and measurements on data quality. Similarly, laboratory QC samples should be used to assess how the laboratory's analytical program influences data quality. This section describes the QC samples that are recommended to be analyzed during the site sampling activities. Table H3-2 specifies the recommended frequency of QC samples to be collected at the site.

All laboratories that perform analytical work under this SAP should adhere to a QA program that is used to monitor and control all laboratory QC activities. Each laboratory must have a written QA manual that describes the QA program in detail. The laboratory QA manager is responsible for ensuring that all laboratory internal QC checks are conducted in accordance with EPA methods and protocols, the laboratory's QA manual, and the requirements of this SAP.

Many of the laboratory QC procedures and requirements are described in EPA-approved analytical methods, laboratory method SOPs, and method guidance documents.

3.6.2.1 Field Quality Control Samples

Field QC samples should be collected and analyzed to assess the quality of data that are generated by sampling activities. These samples include laboratory QC samples collected in the field, field duplicates, equipment rinsates, MS/MSDs, and trip blanks. A temperature blank should be included. QC samples collected in the field for fixed laboratory analysis are presented in Table H3-2.

Field duplicates are independent samples that are collected as close as possible, in space and time, to the original investigative sample. Field duplicates can measure the influence of sampling and field procedures on the precision of an environmental measurement. They can also provide information on the heterogeneity of a sampling location. Field duplicates should be collected as listed in Table H3-2.

Equipment rinsate blanks are collected when non-dedicated or non-disposable sampling equipment is used to collect samples and put the samples into containers. One equipment blank should be collected per sampling event (run).

MS/MSDs are laboratory QC samples that are associated with analytical methods for organics. MSs are typically associated with analytical methods for inorganics. In the laboratory, MS/MSDs and MSs are split and spiked with known amounts of analytes. Analytical results for MS/MSDs and MSs and laboratory duplicate samples are used to measure the precision and accuracy of the laboratory's organic and inorganic analytical programs, respectively. Each of these QC samples should be collected and analyzed at a frequency of 1 for every 20 investigative samples or 1 method blank per batch if the batches consist of fewer than 20 samples.

Temperature blanks are containers of deionized or distilled water that are placed in each cooler shipped to the laboratory. Their purpose is to provide a container to test the temperature of the samples in the respective cooler.

Table H3-2: Frequency of Field QC Samples

Field Quality Control Sample	Frequency of QC Sample Collection
Field Duplicate	1 per 10 samples, rounded up
Equipment Rinsate Sample	1 per sampling event
Matrix spike/matrix spike duplicate (organics and inorganics) [a]	1 per 20 samples
Trip Blank	1 with each cooler containing aqueous samples for VOC analysis
Temperature Blank	1 per cooler

[a] Matrix spike, matrix spike duplicate, and matrix duplicate analyses are technically not field quality control samples; however, they generally require that the field personnel collect additional volume of sample and are therefore included on this table for easy reference.

3.6.2.2 Laboratory Quality Control Samples

EPA methods specify the preparation and analysis of QC samples. These samples may include, but are not limited to, the following types: (1) LCSs, (2) method blanks, (3) MS and MSD samples, (4) matrix duplicate (MD) samples, (5) surrogate spikes, and (6) standard reference materials or independent check standards. The following subsections discuss the QC checks that should be implemented.

Laboratory Control Samples

LCSs are thoroughly characterized, laboratory-generated samples that are used to monitor the laboratory's day-to-day performance of analytical methods. The results of LCS analyses are compared to well-defined laboratory control limits to determine whether the laboratory system is in control for the method. If the system is not in control, corrective action should be implemented. Appropriate laboratory corrective actions include (1) stopping the analysis, (2) examining instrument performance or sample preparation and analysis information, and (3) determining whether samples should be reprepared or reanalyzed.

Method Blanks

Method blanks, which are also known as preparation blanks, are analyzed to assess the level of background interference or contamination in the analytical system and the level that may lead to elevated concentration levels or false positive data. Method blanks should be required for all laboratory analyses and should be prepared and analyzed at a frequency of 1 method blank for every 20 samples, or 1 method blank per batch if the batch consists of fewer than 20 samples.

A method blank consists of reagents that are specific to the analytical method and are carried through every aspect of the analytical procedure, including sample preparation, cleanup, and analysis. The results of the method blank analysis should be evaluated in conjunction with other QC information to determine the acceptability of the data generated for that batch of samples. Ideally, the concentration of a target analyte in the method blank should be below the reporting limit for that analyte. For some common laboratory contaminants, a higher concentration may be allowed.

If the method blank for any analysis is beyond control limits, the source of contamination should be investigated, and appropriate corrective action should be taken and documented. This investigation includes an evaluation of the data to determine the extent of the contamination and its effect on sampling results. If a method blank is within control limits but analysis indicates a concentration of analytes that is above the reporting limit, an investigation should be conducted to determine whether any corrective action could eliminate an ongoing source of target analytes.

For organic and inorganic analyses, the concentration of target analytes in the method blank must be below the reporting limit for that analyte for the blank to be considered acceptable. An exception may be made for common laboratory contaminants (such as methylene chloride, acetone, 2-butanone, and phthalate esters) that may be present in the blank at up to five times the reporting limit. These compounds are frequently detected at low levels in method blanks from materials that are used to collect, prepare, and analyze samples for organic parameters.

Matrix Spikes and Matrix Spike Duplicates

MSs and MSDs are aliquots of an environmental sample to which known concentrations of target analytes and compounds have been added. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis. If there are many target analytes, they should be divided into two to three spike standard solutions. Each spike standard solution should be used alternately. The MS, in addition to an unspiked aliquot, should be taken through the entire analytical procedure, and the recovery of the analytes should be calculated. Results should be expressed in terms of percent recoveries and RPD. The percent recoveries of the target analytes and compounds are calculated and used to determine the effects of the matrix on the precision and accuracy of the method. The RPD between the MS and MSD results is used to evaluate method precision.

The MS/MSD is divided into three separate aliquots, two of which are spiked with known concentrations of target analytes. The two spiked aliquots, in addition to an unspiked sample aliquot, are analyzed separately, and the results are compared to determine the effects of the matrix on the precision and accuracy of the analysis. Results should be expressed as RPD and percent recovery and compared to control limits that have been established for each analyte. If results fall outside control limits, corrective action should be performed.

Laboratory (Matrix) Duplicates

MDs, which are also called laboratory duplicates, are prepared and analyzed for inorganic analyses to assess method precision. Two aliquots of sample material are taken from the sample and processed simultaneously without adding spiking compounds. The MD and the original sample aliquot are taken through the entire analytical procedure, and the RPD of the duplicate result is calculated. Results are expressed as RPD and are compared to control limits that have been established for each analyte.

Surrogate Spikes

Surrogates are organic compounds that are like the analytes of interest in chemical properties but are not normally found in environmental samples. Surrogates are added to field and QC samples before the samples are extracted to assess the efficacy of the extraction procedure and to assess the bias that is introduced by the sample matrix. Results are reported in terms of percent recovery. Individual analytical methods may require sample reanalysis based on surrogate criteria.

The laboratory should use surrogate recoveries mainly to assess matrix effects on sample analysis. Obvious problems with sample preparation and analysis (such as evaporation to dryness or a leaking septum) that can lead to poor surrogate spike recoveries must be eliminated before low surrogate recoveries can be attributed to matrix effects.

3.7 Requirements for Inspection and Acceptance of Supplies and Consumables

Individual monitoring network managers and supervisors are responsible for identifying the types and quantities of supplies and consumables that are needed for collecting the samples and groundwater level measurements described in this SAP. When supplies are received, field personnel should inspect the condition of all supplies before the supplies are accepted for use. If the supplies do not meet the monitoring entities acceptance criteria (e.g., non-expired field meter calibration standards), the supplies should be rejected.

4. DATA MANAGEMENT

"Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin" (23 CCR § 352.6).

4.1 Water Quality Data

When appropriate, the data should be obtained from the analytical service provider in the form of an electronic data deliverable (EDD), in addition to the required digital PDF analytical data package. Formal verification of data should be conducted before associated results are presented or are used in subsequent activities.

Data tracking is essential to ensure timely, cost-effective, and high-quality results. Data tracking begins with sample chain of custody. When the analytical service provider receives custody of the samples, the provider should send a sample acknowledgment to the supervisor of the monitoring network entity. The sample acknowledgment confirms sample receipt, condition, and required analyses. The chain of custody forms should contain all pertinent information about each sample and can track the data at each phase of the process.

Data should be imported into the monitoring entities electronic database and shared with the GSA's clearing house for the agency's use annually at a minimum.

4.2 Water Level Data

Data should be imported into the monitoring entities electronic database and shared with the GSA's clearing house on a minimum frequency of once a year. Water level elevation data appropriately and all data qualifiers and associated water level measurements should be entered into the database along with any no measurement explanations documented in the field collection effort should be entered into the database along with the measured water levels.

5. ASSESSMENT AND RESPONSE ACTIONS

The following sections describe the assessment and response actions for reporting.

5.1 Assessment and Response Actions

The SAP QA Officer should conduct a readiness review immediately prior to major data collection tasks in the basin. The QA Officer should report findings to the GSA's Executive Manager, who should take corrective action (if necessary) before the data collection task begins. The GSA's Executive Manager and QA Officer should thoroughly debrief field staff a short time after beginning their respective implementation tasks if any emerging/unanticipated problems are reported and take corrective action, if necessary.

5.2 Reporting to Management

An annual report, after submittal of the basins' GSP, is required as a component of the SGMA legislation. The annual reports are intended to document monitoring and water use data to the California Department of Water Resources to gauge performance of the groundwater basin relative to the sustainability goal(s) identified in the subbasins' GSP. A component of the annual report could include SAP performance in meeting the sustainability monitoring requirements in the basin. Any limitations in the way the data can be reliably used should be described.

The GSA's Executive Manager could present an annual oral report to the GSA's Board of Directors during a regular monthly board meeting. The oral report should include:

- Readiness review findings (described above).
- Status of SAP related activities in the basin; and
- Identify whether any major QA problems were encountered (and if so, how they were handled).

6. DATA EVALUATION AND USABILITY

This section describes the procedures that are planned to review and verify field and laboratory data, as well as procedures for verifying that the data are sufficient to meet DQOs and MQOs for the basin.

6.1 Data Review and Reduction Requirements

Data reduction (i.e., processing) and review are essential functions for preparing data that can be used effectively to support basin-specific policy decisions and DQOs. Data review includes all procedures that field or laboratory personnel conduct to ensure that measurement results are correct and acceptable in accordance with the QA objectives that are stated in this SAP. Field and laboratory measurement data reduction and review procedures and requirements are specified in previously discussed field and laboratory methods, and guidance documents.

Field personnel should record, in a field logbook and/or on the appropriate field form, all raw data from chemical and physical field measurements. Field staff should have the primary responsibility for (1) verifying that field measurements were made correctly, (2) confirming that sample collection and handling procedures specified in this basin-specific SAP were followed, and (3) ensuring that all field data reduction and review procedures requirements are followed. Field staff are also responsible for assessing preliminary data quality and for advising the data user of any potential QA/QC problems with field data. If field data are used in required basin reporting, data reduction methods should be fully documented.

The laboratory should complete data reduction for chemical and physical laboratory measurements and should complete an in-house review of all laboratories analytical results. The laboratory QA manager is responsible for ensuring that all laboratory data reduction and review procedures follow State and Federal requirements. The GSA's SAP QA manger is responsible for ensuring that these laboratory procedures are consistent with the requirements that are stated in this SAP. The laboratory QA manager should also be responsible for assessing data quality and for advising the GSA's SAP QA manager of possible QA/QC problems with laboratory data.

6.2 Verification Methods

All data that are used to support decision making must be adequate for their intended purposes. This section outlines the basic data verification procedures that should be followed for all field and laboratory measurements.

The usability of a dataset is determined by comparing the data with a predetermined set of QC limits. GSA's data reviewers should conduct a systematic review of the data for compliance with established QC limits (such as sensitivity, precision, and accuracy) based on spike, duplicate, and blank sampling results that are provided by the laboratory. Data reviewers should evaluate laboratory data for compliance with the following information:

- Method- and basin-specific analytical service requests
- Holding times
- Initial and continuing calibration acceptance criteria
- Field, trip, and method blank acceptance criteria

- Surrogate recovery
- Field duplicates and MS and MSD acceptance criteria
- MD precision
- LCS accuracy
- Other laboratory QC criteria specified by the method or on the basin-specific analytical service request form
- Compound identification and quantitation
- Overall assessment of data, in accordance with basin-specific objectives

The most current EPA guidelines should be followed for completing data verification for all applicable test methods (U.S. EPA, 2002).

7. RECONCILIATION WITH DQOS

After data have been collected, reviewed, and validated, the data should undergo a final evaluation to determine whether the DQOs specified in this SAP have been met. EPA's DQA process should be followed to verify that the type, quality, and quantity of data that are collected are appropriate for their intended use (U.S. EPA, 2000).

The DQA process involves (1) verifying that the data have met the assumptions under which the data collection design and DQOs were developed, (2) taking appropriate corrective action if the assumptions have not been met, and (3) evaluating the extent to which the data support the decision that must be made so that scientifically valid and meaningful conclusions can be drawn from the data. To the extent possible, DQA methods and procedures should be followed that have been outlined by the U.S. EPA (2000).

To the extent possible, DQA process should be followed to verify that the type, quality, and quantity of data collected are appropriate for their intended use (U.S. EPA, 2000). This assessment should include the following:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support basins' objectives.
- A review of basin-specific data quality indicators for PARCC and quantitation limits to determine whether acceptance criteria have been met.
- A review of basin specific DQOs to determine whether they have been achieved by the data collected.
- An evaluation of any limitations associated with the decisions to be made based on the data collected. For example, if data completeness is only 90 percent compared to a basin-specific completeness objective of 95 percent, the data may still be usable to support a decision, but at a lower level of confidence.

7.1 Sustainability Indicators, Minimum Thresholds, and Undesirable Results

Sustainability indicators are the six effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, are undesirable results. For example, surface water depletion due to groundwater pumping is a sustainability indicator because it is an effect that must be monitored to determine whether it has become significant and unreasonable.

Sustainability indicators become undesirable results when a GSA-defined combination of minimum thresholds is exceeded. Those combinations of minimum threshold exceedances define when a basin condition becomes significant and unreasonable.

The methods detailed in this SAP are designed to establish monitoring protocols and standard methods compliant with SGMA for collecting water quality and groundwater level data from wells within the Subbasin. This includes procedures for water sample collection, laboratory analytical methods, groundwater level measurement protocols in water wells, and data QA/QC) procedures. These protocols aim to bolster confidence in the data collected during Subbasin sampling activities, ensuring the data's validity in measuring sustainable management criteria.

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Appendix I
Well Database

Geosyntec consultants

engineers | scientists | innovators

APPENDIX – I

Well Database

Prepared for

Mid-Kings River GSA
South Fork Kings GSA
Southwest Kings GSA
El Rico GSA
Tri-County Water Authority GSA

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Project SFO138B

April 13, 2024

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ABBREVIATIONS AND ACRONYMS

bgs	below ground surface
DEM	Digital Elevation Model
DMS	Data Management System
DWR	Department of Water Resources
ft	feet
GAMA	Groundwater Ambient Monitoring and Assessment
GIS	Geographic Information System
GSA	Groundwater Sustainability Agency
MO	measurable objectives
MT	minimum thresholds
OSWCR	Online System of Well Completion Reports
PLSS	Public Land Survey System
RMA	Representative Monitoring Area
RMS	Representative Monitoring Wells
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
TLS	Tulare Lake Subbasin
TRS	Township-Range-Section
USGS	United States Geological Survey

1. TULARE LAKE SUBBASIN WELL RECORDS DATABASE

1.1 Introduction

The Tulare Lake Subbasin (TLS, or Subbasin) spans 535,680 acres that are mostly rural domestic farmland used for growing crops and raising livestock. Within the Subbasin, there are six localized urban areas, including the communities of Armona, Home Garden, Stratford, and Kettleman City. Beneficial uses of groundwater include drinking water, agriculture, and industrial supply. To support these beneficial uses, there exists a vast infrastructure of groundwater extraction wells that produce water from the three main aquifer zones that underly the Subbasin (the A-Zone, B-Zone, and C-Zone). To track the well infrastructure and facilitate informed decision-making in the management of the Subbasin's groundwater resources, the Groundwater Sustainability Agencies (GSAs) developed a database of well completion reports. The database serves as a tool for assessing the impact of groundwater levels on the various groundwater infrastructure across the three aquifer zones. The information in the database was used to define the undesirable result and establish minimum thresholds (MTs) and measurable objectives (MOs) for the chronic lowering of groundwater levels. This appendix reviews the available records, the process for assigning the three aquifer zones to well records and provides a discussion on the number of wells that are estimated to be impacted if water levels reach the minimum thresholds set at the representative monitoring site wells (RMS wells).

1.2 Available Well Records

The existing groundwater infrastructure defines the locations where potential impacts to beneficial uses and users could occur if groundwater levels decline. Therefore, it is important to establish a well database that is representative of current conditions in the subbasin. A key part of the effort included evaluating existing databases that contain information regarding the location, depth, completion interval, and stratigraphy associated with the well infrastructure in the Subbasin. Four databases containing well infrastructure information are available in the Subbasin as described below.

1.2.1 DWR OSCWR Database

The California Department of Water Resources (DWR) hosts an Online System of Well Completion Reports (DWR OSWCR) which serves as a tool for the State's water resource management and environmental stewardship. Within the boundaries of the Subbasin, the DWR OSWCR database contains wells dating back to the 1940s. An analysis of DWR OSWCR indicates several significant issues with the database including missing or duplicated records, missing or incorrectly entered values from the original reports, and incorrect data such as latitude, longitude, record type, planned use, ownership, address, screen interval and total completed depth. Additionally, the system has limited spatial resolution, with most well reports spatially registered to the center of a section of the Public Land Survey System. Based on the identified concerns noted and discussions with SWRCB staff, the decision was made not to utilize the DWR OSWCR database but to review other available information from the United States Geologic Survey (USGS), Kings County, and the GAMA water quality databases.

1.2.2 USGS Attributed Well Completion Data

The USGS geospatial dataset *Attributed California Well Supply Well Completion Report Data for Selected Areas* serves as a subset of records derived from DWR OSWCR Data. To differentiate the databases, the USGS data set will be referred to as “USGS OSWCR". The USGS has updated the DWR OSWCR database with well completion depths or screen intervals and location information. What makes this dataset distinct from DWR OSWCR is its additional fields and improved accuracy in locating the wells. It offers more complete details about the wells' open or perforated intervals, various identification numbers, addresses, owner information, and a general description of the geological material (lithology) encountered during drilling. Efforts were made to verify and update some of the information previously available in DWR OSWCR, leading to more accurate data for some fields. Moreover, the locations of the wells have been determined with higher accuracy. This improvement in detail and enhanced accuracy makes it a valuable resource for making better-informed management decisions.

1.2.3 Kings County Well Permit Database

Kings County has developed a well completion report database based on well permits. This database consists of records for wells completed since the year 2000. It functions as an extensive well registry, incorporating records for all wells in Kings County, which accounts for more than ninety percent of the Subbasin. This database distinguishes itself from the USGS OSWCR by providing additional well location data, detailed construction information, and information on changes in status (e.g., abandoned or destroyed wells). The Kings County database is expected to be the most accurate dataset of wells that are currently operational.

1.2.4 DWR GAMA Database

The DWR Groundwater Ambient Monitoring and Assessment (GAMA) program provides an extensive evaluation of groundwater quality across the state, capturing detailed data on the construction of groundwater wells that are regularly monitored through various reporting programs. This includes sampling initiatives such as the Priority Basin Project and the Domestic Well Testing Project. The distribution of records indicating beneficial use is divided, with half attributed to domestic and municipal purposes, while the remainder are classified as either irrigation or water supply wells. These wells are subject to regular monitoring efforts, which include information on well location, comprehensive construction details, and clarification of their beneficial uses.

1.3 Review of the Available Well Records

To create the best available dataset, the Kings County's records, known for their recent and accurate local information, were matched and verified against the USGS OSWCR records utilizing the following process:

Step 1: Kings County and USGS OSWCR records were matched using permit numbers and verified with well construction details and GAMA records were appended resulting in a refined database of 4,671 beneficial use wells after excluding well destruction records.

Step 2: Well completion records indicating that a well was permanently retired from service were excluded from consideration. This includes instances where the well was destroyed or redrilled to a new depth, rendering the original completion report obsolete. Consequently, such wells no longer represent a beneficial use and were not included in the analysis.

Step 3: Records that matched between the different well databases, information considered the most accurate was used first followed by the next available data. The Kings County Well Permit Database was considered the most accurate followed by GAMA and USGS OSWCR databases.

An analysis of the TLS database has indicated that not all wells listed are likely to be active. Some wells in the database are old enough that their usable lifespan has likely been exceeded, and the depths of certain wells suggest that they had been dewatered prior to the implementation of the Sustainable Groundwater Management Act (SGMA) in January 2015. Two previous studies estimated the average retirement ages of wells at 28 years in the Central Valley (Pauloo et al., 2020) and 33 years in Tulare County (Gailey et al., 2019). The GSAs understand that the database needs further refinement and will be updated through an ongoing well registration program discussed in Chapter 6. The expectation is that, as the well database is refined, the number of wells will remain the same, but they are likely to be deeper to account for historical drought periods.

Of the 4,671 records in the database, 3,554 have undergone extensive review, including direct verification and, in some instances, remote sensing verification performed separately by the USGS and Kings County. This level of verification has resulted in a higher level of confidence in the information attributed to these records. Utilizing the subset of 3,554 high-quality records, the analysis of the well infrastructure, including estimates of the number of well impacts at the minimum threshold (MT) presented in the following sections, was performed.

Figure I1-1 shows the Public Land Survey System (PLSS) Township-Range-Section (TRS) within the TLS area labeled with the number of high-quality records counted at each section. Based on the distribution of well records shown on Figure I1-1, the highest concentration of wells is located west of Hanford, where smaller communities such as Grangeville are located. Southward, beyond the City of Lemoore, the well record counts per section decrease to single digits until reaching the lake bottom region. In this area, there are few to no well records located between Kettleman City and the southeastern portion of the Subbasin.

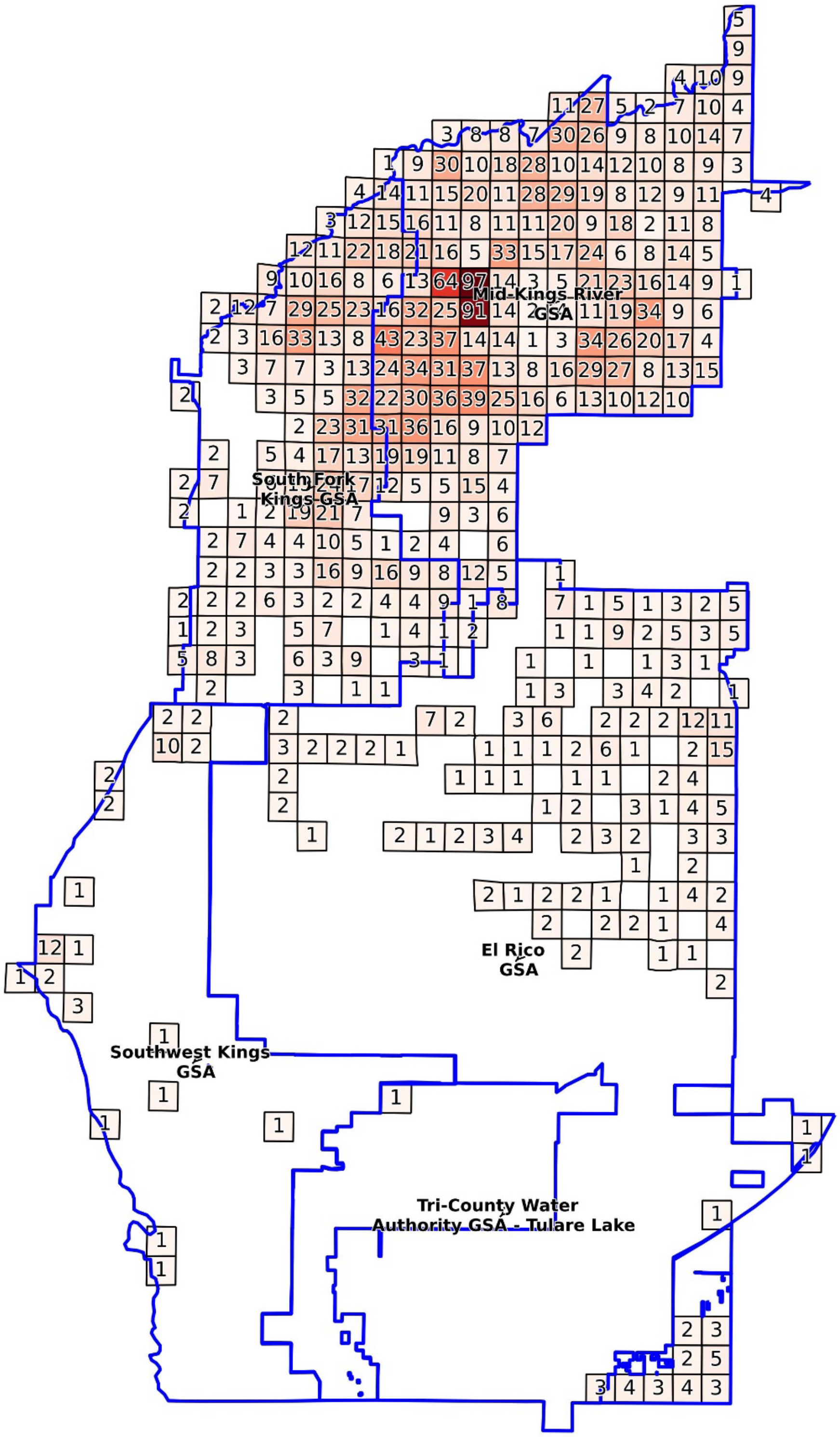
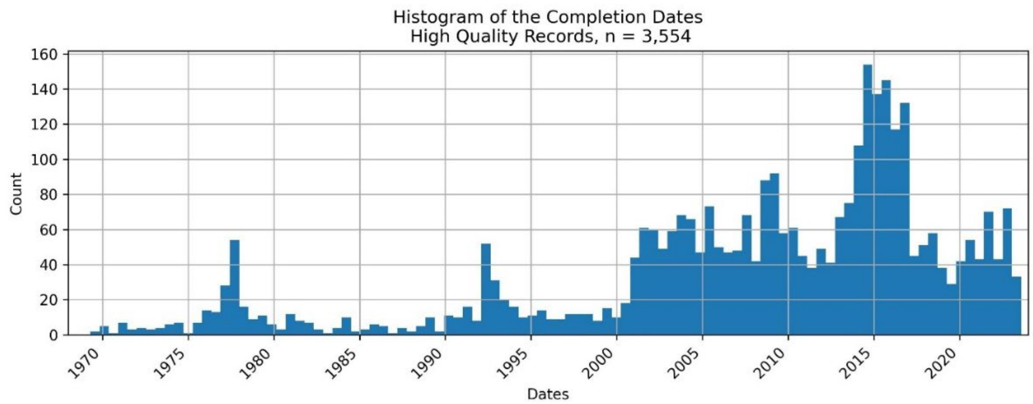


Figure I1-1: The Tulare Lake Subbasin PLSS TRS Labeled with the Number of Well Records The map displayed above, oriented with north at the top, shows the boundary of the TLS (blue) with sections labeled with the number of high-quality well records within in each section.

Figure I1-2 presents histograms of well completion dates and completion depths for the high-quality records. Peaks in well completions occur during drought years of 1976-1977, 1987-1992, 2007-2009, 2011-2017. The bottom histogram shows the distribution of well completion depths. Wells are commonly completed at five different intervals: less than 50 feet, 200 feet, 250 feet, 300 feet, 400 feet and at 500 feet.



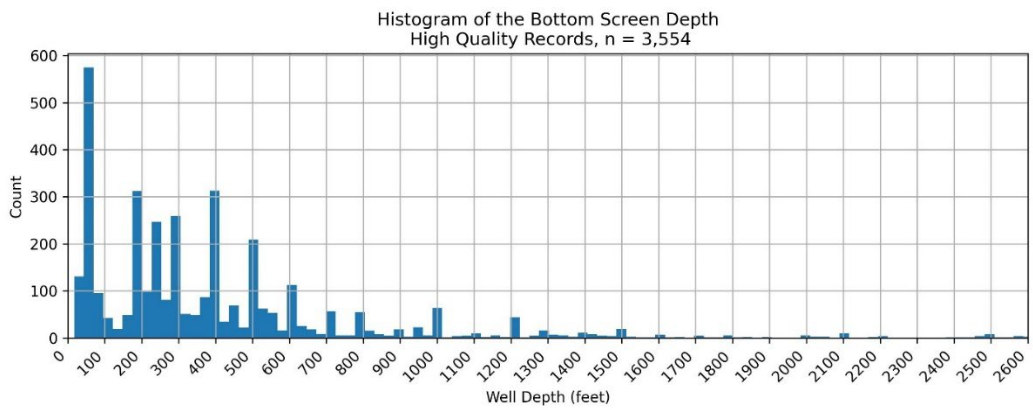


Figure I1-2: Histograms of Well Completion Dates and Depths for High Quality Well Records The top histogram shows temporal variation in the number of well completions since 1968. The bottom histogram shows the distribution of the well completion depths in units of feet below ground surface (bgs).

1.3.1 Future Handling of the Reviewed Records

A total of 1,117 well records, identified as low-quality due to a lack of verified information, were excluded from further analysis. This exclusion applies to the development of the Chapter 4 SMC for the Chronic Lowering of Water Levels. Future efforts will be made to confirm the beneficial-use of these records. Should these records be confirmed to still exist, their information will be updated in the database.

Figure I1-3 shows the distribution of completion dates and completion depths for the subset of records identified as low-quality. Completion dates of the low-quality records follow similar trends to the high-quality records. There are noticeably fewer records after 2000 in the low-quality subset likely because the majority of well records recorded after 2000 have been verified, as discussed in Sections 1.2.3 and 1.3.

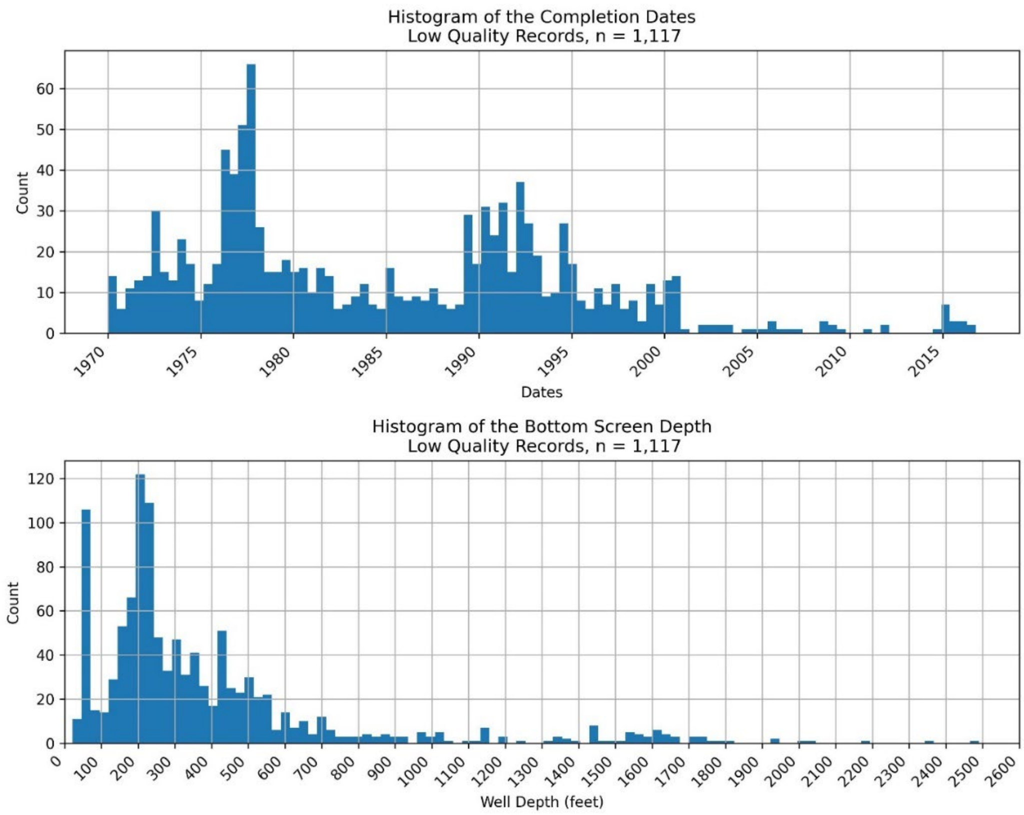


Figure I1-3: Histograms of Well Completion Dates and Depths for Low-Quality Records The top histogram shows the distribution of the low-quality well records' completion dates. The bottom histogram shows the distribution of the low-quality well record's well completion depths in units of feet below ground surface (bgs).

1.3.2 Examination of the High Quality/Relied-Upon Well Records

The 3,554 records that have undergone extensive review are classified into six beneficial-use categories: agriculture, domestic, municipal, industrial, water supply, and unknown. Table I-1 summarizes the distribution of wells by type. Agriculture and Domestic wells are the dominant beneficial-uses while municipal, industrial, water supply, and unknown beneficial uses comprise approximately 5% of the total well records. It's important to note that these classifications were determined at the time each well was drilled, and their uses may have since changed. As implementation of the GSP progresses, the accuracy of these database records will be verified through public outreach as part of the Subbasin's ongoing project and management actions.

Table I1-1: Well Records Counted by Well Type

Planned Use	Count
Agriculture	1,793
Domestic	1,573
Municipal	89
Industrial	54
Water Supply	16
Unknown	30

Table I1-2 provides the number of well types within the five GSAs. Table I1-2 shows that the Mid-Kings River GSA encompasses the greatest number of well records, followed by the South Fork Kings GSA and the El Rico GSA. Collectively, the Southwest Kings GSA and the Tri-County Water Authority (TCWA) have fewer than 10 domestic wells.

Table I1-2: Well Record Counted by GSA and Well Type

GSA	Planned Use	Count
El Rico GSA	Agriculture	218
	Domestic	37
	Industrial	1
	Irrigation / Industrial	5
	Municipal	2
	Unknown	1
	Water Supply, Other	2
Mid-Kings River GSA	Agriculture	1066
	Dairy	4
	Domestic	1170
	Industrial	10
	Irrigation / Industrial	8
	Livestock	2
	Municipal	41
	Public	8
	Stock Or Animal Watering	5
	Unknown	21
	Water Supply, Other	3
South Fork Kings GSA	Agriculture	462
	Dairy	1
	Domestic	359
	Industrial	1
	Irrigation – Landscape	1
	Irrigation / Industrial	10
	Livestock	1
	Municipal	20
	Public	4
	Stock Or Animal Watering	2
	Unknown	8
	Water Supply	1
	Water Supply, Other	5
Southwest Kings GSA	Agriculture	22
	Domestic	6
	Industrial	1
	Irrigation / Industrial	2
	Municipal	10
	Public	1
	Water Supply, Other	5
Tri-County Water Authority	Agriculture	29
	Domestic	2

The spatial distribution of agricultural, domestic and Municipal wells is shown on Figure I1-4. Agricultural wells, which outnumber domestic wells, are concentrated in similar areas between Lemoore and Hanford, which suggests some beneficial users have access to multiple well types. Municipal wells are concentrated in the northern half of the Subbasin. In the southern portion of the Subbasin, the majority of wells serve an agricultural beneficial use.

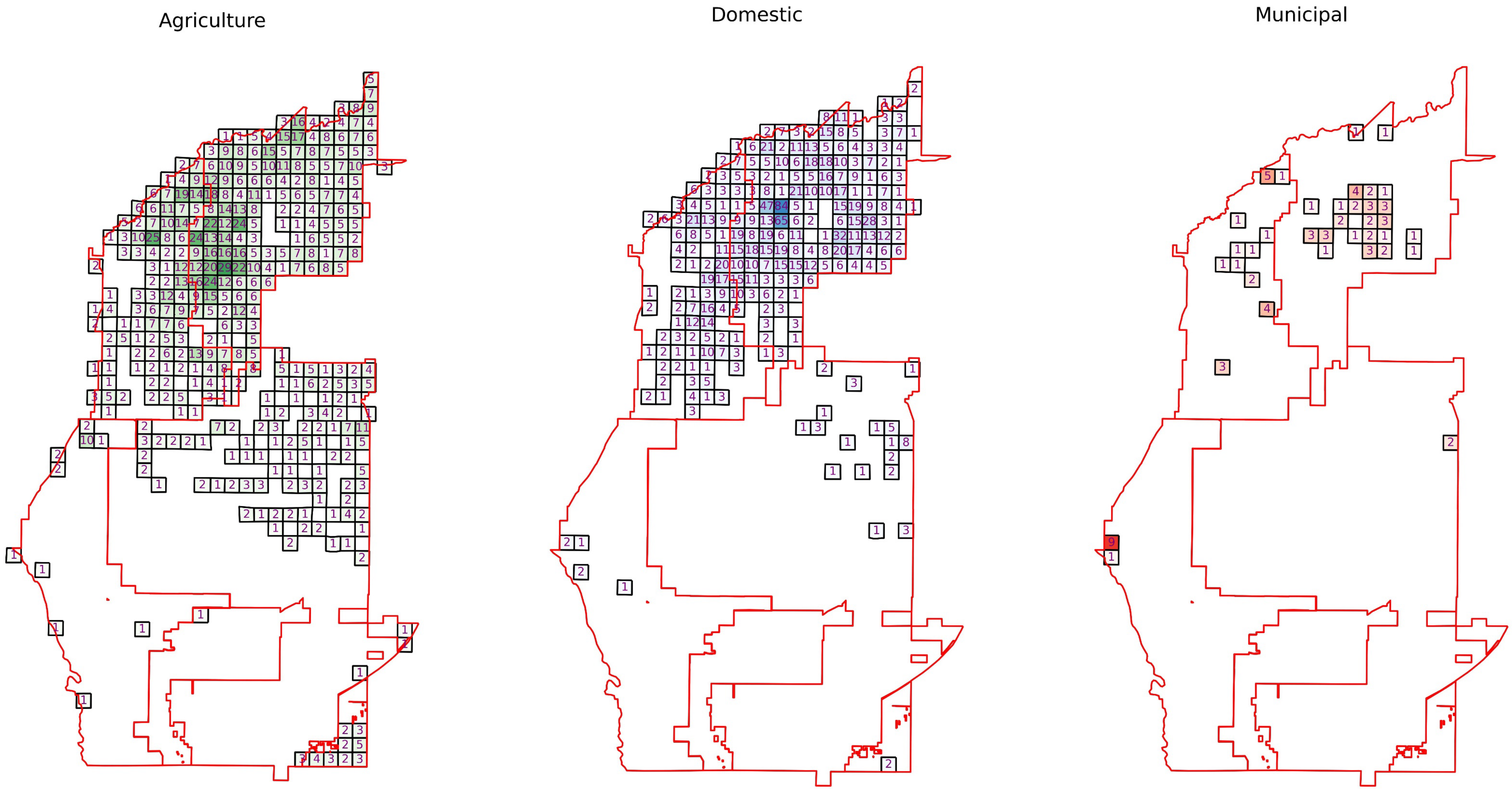


Figure I1-4: Spatial Distribution of the Most Common Beneficial-use Well Types The GSA boundary maps show the PLSS TRS section counts for the most common beneficial-use well types. Maps are labeled by number of wells counted at each TRS. Left map shows the agricultural wells, the center map shows the domestic wells and the right map shows the municipal wells. Sections are shaded from light to dark corresponding to the number of wells labeled in each section.

Figure I1-5 shows the locations of the older wells. The well locations are colored shades of red to correspond with older well completion ages. Based on Figure I1-5, the majority of these older wells are located within the Mid-Kings River GSA, specifically between Lemoore and Hanford, and to the north and east of Hanford. The areas where the oldest wells are concentrated coincides with areas where domestic and agricultural wells are densely located as observed in Figure I1-4.

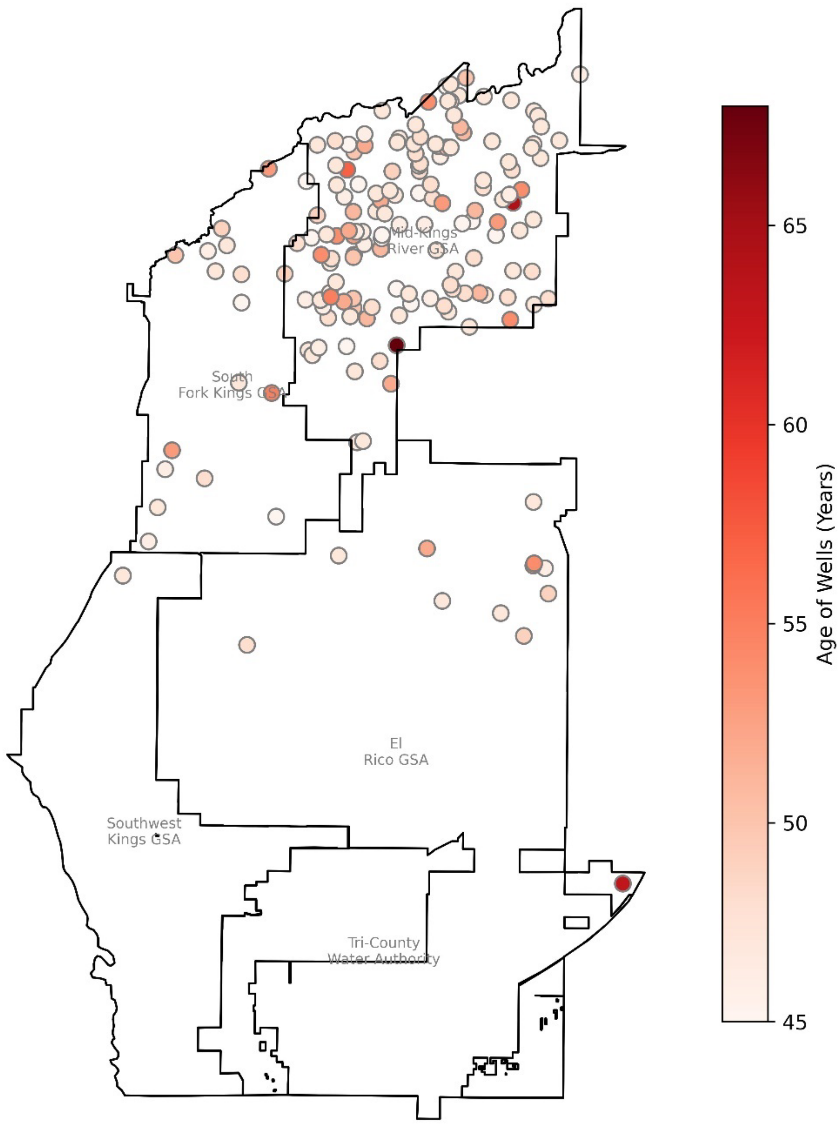


Figure I1-5: Spatial Distribution of the Older Wells Map shows the locations of wells aged 45 years and over. These wells are represented in a gradient from white to dark red, corresponding to their age. Wells of the greatest age exceed 65 years.

2. EVALUATION OF THE RELIED-UPON WELL RECORDS

Due to the complexity of the hydrogeologic setting in the Subbasin, as discussed in Chapter 3, "Basin Setting" (Wood 2020), the aquifer is divided into three zones for groundwater level monitoring: the unconfined A-Zone, the semi-confined to unconfined B-Zone, and the confined C-Zone aquifer. To assess the impact of groundwater management decisions on well infrastructure, it is essential to classify well records according to these three distinct aquifer zones. Thus, a crucial step in transforming the TLS database into a water management tool was to assign aquifer zones to well records. This assignment was based on comparing each well's location and screen interval with the interpolated surfaces of the clay layers (A-Clay and E-Clay), which delineate the depth and extent of the three aquifer zones. Geographic Information System (GIS) technology facilitates this classification, as described below.

2.1 Assign Aquifer Zone to Well Completion Reports

The process of associating well completion records with specific aquifer zones begins with mapping the geographical distribution of wells across the Subbasin. This step is followed by overlaying digital elevation models (DEMs) that represent the two principal regional clay layers, the A-Clay and the E-Clay (also known as Corcoran Clay). Well records are then assigned to an aquifer zone based on GIS spatial queries that compare the depths of the clay surfaces with the screen interval at the well record's location.

Well records were categorized based on deriving a beneficial use specific to either the A-Zone, B-Zone, or C-Zone aquifer. This categorization depends on the relationship between the screen interval depths and the depths of the A-Clay and E-Clay layers as represented by the DEMs, and is as follows for the majority of well records in each zone:

- A-zone well records - Well screen interval located above the A-Clay (less than 100 ft bgs).
- B-zone well records - Well screen interval located neither above the A-Clay nor below the E-Clay (up to 700 ft bgs).
- C-zone well records - Well screen interval located below the E-Clay (greater than 700 ft bgs in some areas).

Some wells may be completed across multiple aquifer zones, particularly those in the northeast near the boundary of the Corcoran Clay (see Chapter 3, Basin Setting, Figure 3.1.8-3). Well records with multiple screen intervals were assigned to the aquifer zone of the deepest screened interval. In cases where well records lacked complete screen interval information, the analysis either utilized the available incomplete data or assumed the bottom of the screen interval to be 10 feet above the well completion depth. As the implementation of the GSP progresses and more information on well screen intervals and water levels in these wells becomes available, these records will be updated to more accurately represent the zone upon which their beneficial use relies.

2.1.1 Digital Elevation Surfaces That Define Aquifer Zones

The contours used for interpolating the A-Clay and E-Clay layers into continuous raster surfaces were based on an original map prepared by Croft (1972), which the USGS later modified (Faunt et al., 2009). For a visual representation of the A-Clay and E-Clay, refer to Chapter 3, "Basin Setting," Figures 3.1.8-1 and 3.1.8-3. The depths of these surfaces were subsequently calibrated using recent data from the DWR's Basin Characterization Program's airborne electromagnetic (AEM) surveys and new borehole logs. The DWR's AEM surveys provide fence diagrams that illustrate the approximate elevation of the Corcoran Clay across the Subbasin. These diagrams along with lithologic descriptions obtained from new well logs were used as a reference for the calibrated depth of the Corcoran Clay. The calibrated surfaces representing the depth to the A-Clay and E-Clay are shown in Figure I2-1.

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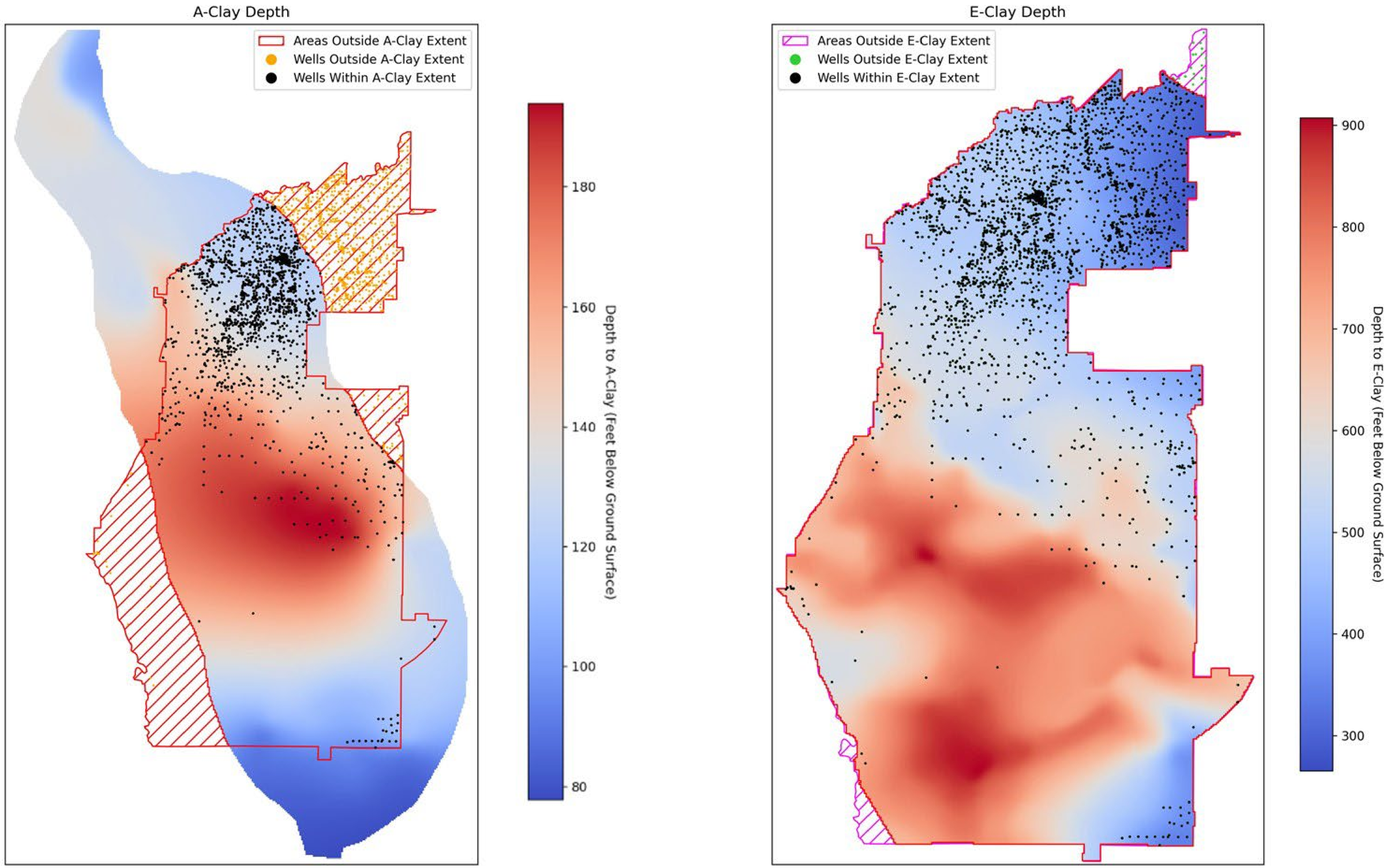

Figure I2-1: Well Records Assigned to Aquifer Zones The map on the left shows the extent of the calibrated raster surface that represents the depth to the A-Clay and the map on the right shows the extent of the raster surface that represents the depth to the top of the E-Clay. The surfaces are shaded from blue (shallow) to red (deeper). Well records located within the clay extents are represented by black dots.

2.2 Distribution of Well Records

Following the assignment of an aquifer zone to each well record as discussed in section 2.1, the allocation of well records to aquifer zones is detailed as follows: 790 records are assigned to the A-Zone, 1,651 records to the B-Zone, and 1,113 records to the C-Zone aquifer.

Tables I2-1a through I2-1c provide details on the number of beneficial uses by aquifer and GSA. In the A-Zone aquifer, agriculture is the most common planned beneficial use type. The majority of beneficial uses derived from the B-Zone are domestic, with most located within the Mid-Kings River GSA (927 wells). In the C-Zone aquifer, agricultural wells constitute the majority of records, with the Mid-Kings River GSA hosting the most (487 wells), followed by the South Fork Kings GSA (165 wells).

Maps showing the PLSS TRS grid labeled with the number of well records assigned to each aquifer zone are provided in Figure I2-2. Based on Figure I2-2, wells across all three aquifer zones are concentrated in the northern portion of the Subbasin between the cities of Hanford and Lemoore. South of Lemoore, the well counts decrease to single digits, continuing until reaching the Lake-Bottom area and areas further south.

Table I2-1a: Well Counts by GSA in the A-Zone Aquifer

Aquifer	GSA	Planned Use	Count
A-Zone	El Rico GSA	Agriculture	4
		Domestic	6
	Mid-Kings River GSA	Agriculture	269
		Domestic	122
		Irrigation / Industrial	2
		Unknown	6
	South Fork Kings GSA	Agriculture	210
		Domestic	161
		Irrigation / Industrial	1
		Unknown	5
	Tri-County Water Authority GSA	Agriculture	1

Table I2-1b: Well Counts by GSA in the B-Zone Aquifer

Aquifer	GSA	Planned Use	Count
B-Zone	El Rico GSA	Agriculture	33
		Domestic	27
		Irrigation / Industrial	7
		Municipal	5
		Unknown	1
	Mid-Kings River GSA	Agriculture	310
		Domestic	927
		Industrial	6
		Irrigation / Industrial	4
		Municipal	12
		Unknown	13
	South Fork Kings GSA	Agriculture	87
		Domestic	183
		Irrigation / Industrial	1
		Municipal	15
		Unknown	4
		Agriculture	4
		Domestic	5
		Industrial	1
		Municipal	7
	Tri-County Water Authority GSA	Agriculture	3
		Domestic	1

Table I2-1c: Well Counts by GSA in the C-Zone Aquifer

Aquifer	GSA	Planned Use	Count
C-Zone	El Rico GSA	Agriculture	181
		Domestic	7
		Industrial	1
		Irrigation / Industrial	3
	Mid-Kings River GSA	Agriculture	487
		Domestic	136
		Industrial	4
		Irrigation / Industrial	2
		Municipal	32
		Unknown	2
	South Fork Kings GSA	Agriculture	165
		Domestic	15
		Industrial	1
		Irrigation / Industrial	8
		Municipal	11
		Unknown	1
		Agriculture	22
		Irrigation / Industrial	2
		Municipal	3
	Tri-County Water Authority GSA	Agriculture	27
		Domestic	1

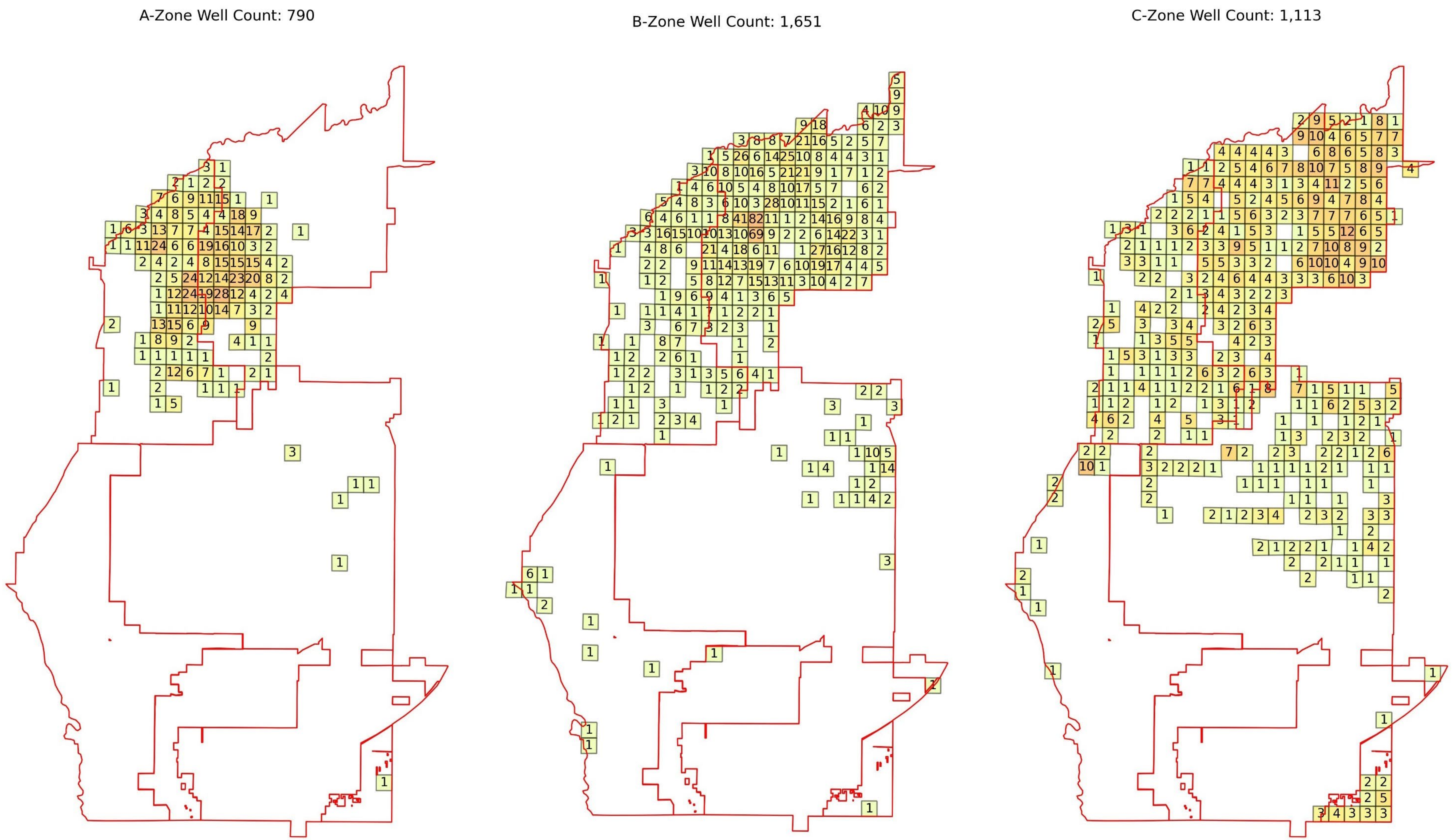

Figure I2-2: Distribution of Well Records by Aquifer Zones The maps display the PLSS TRS section counts for the 790 well records assigned to the A-Zone (left map), the 1,651 well records assigned to the B-Zone (center map), and the 1,113 records assigned to the C-Zone (right map). Sections are shaded from yellow to dark orange corresponding to the increasing number of wells labeled in each section.

2.3 Convert Well Construction Records to Elevation

The primary objectives of the well database are to monitor well infrastructure and predict dry wells by identifying those whose bottom screen intervals are above the groundwater elevation in the aquifer they are accessing. To assess well screen intervals relative to groundwater elevations, well construction details must be converted from depth below ground surface (bgs) to an elevation metric relative to mean sea level. This step requires knowledge of the ground surface elevation at the well locations; however, most well records lack this information. A ground surface elevation DEM was utilized to supplement each well record with the necessary ground surface elevation data. The DEM was sourced from the U.S. Geological Survey's nationalmap.gov downloader webpage in January 2024 in the form of two 1/3 arc-second DEMs with a spatial resolution of 10 meters, published on October 6, 2021, and November 16, 2021. The ground surface DEM is depicted in Figure I2-3.

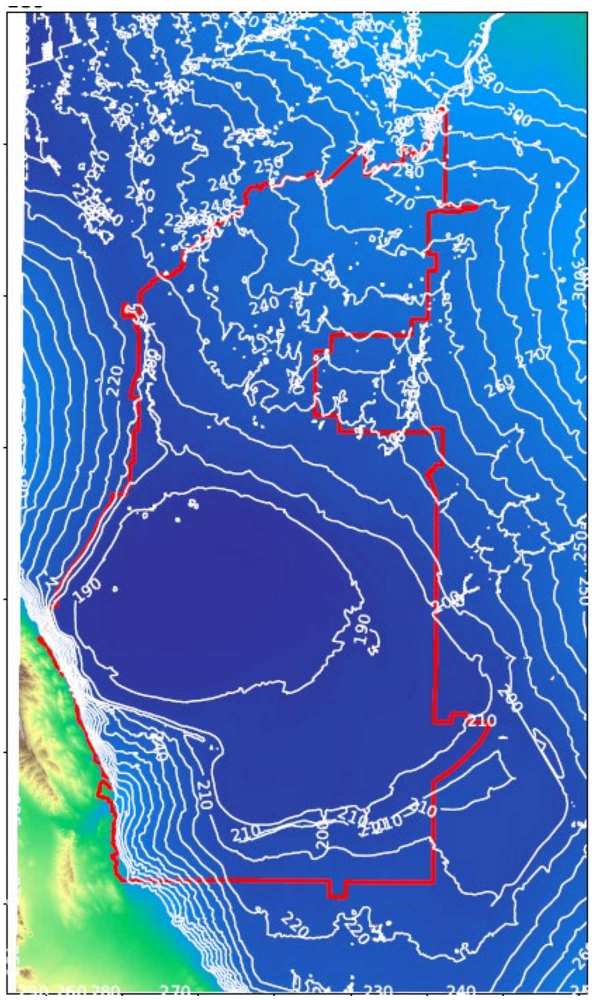

Figure I2-3: USGS 1/3 arc-second Digital Elevation Map The elevation map is contoured by intervals of 10 feet with the Tulare Lake Subbasin boundary shown red.

2.4 Distribution of Well Record Elevation and Completion Year by Aquifer Zone

The distribution of bottom screen elevation assigned to each aquifer is provided in Figure I2-4a histograms. Domestic Wells and agriculture wells were chosen because together these well types make up the majority of wells in the subbasin. From the completion depths in Figure I2-4a, A-Zone domestic and agriculture wells occur at similar depths of less than 180 ft elevation. Domestic wells in the B-Zone are screened from 200 to -200 feet elevation while the agricultural wells are screened from 200 feet to -300 feet elevation. In the C-Zone, domestic wells are commonly screened from approximately -10 to -400 feet elevation while the agriculture wells range from -10 to -1400 feet below ground surface and deeper.

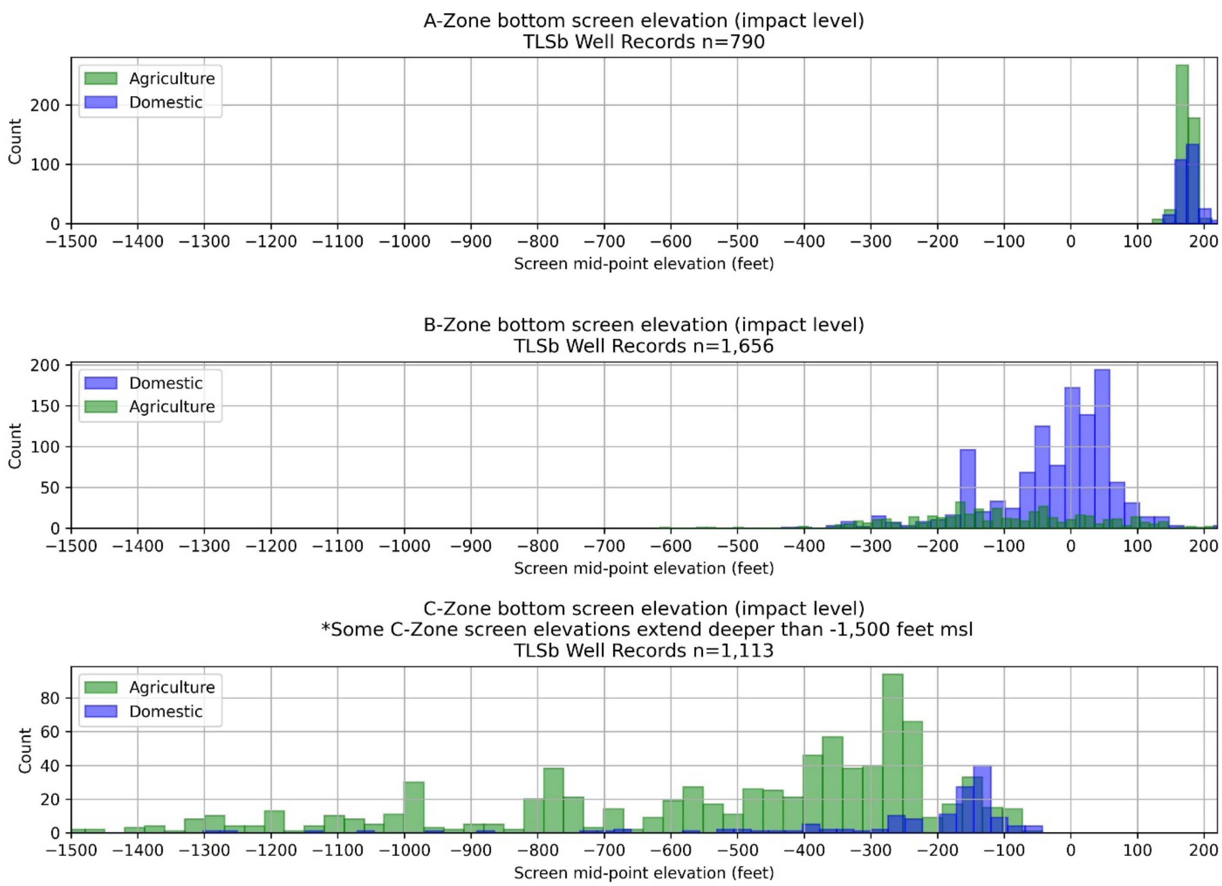

Figure I2-4a: Histogram of Well Record Bottom Screen Level by Aquifer-Zone Three histograms are presented, one for each of the aquifer zones, each presents the distribution of bottom screen elevations for well records assigned to each aquifer zone. The upper histogram represents the A-Zone bottom screen elevations, the middle histogram exhibits the B-Zone bottom screen elevations, and the lower histogram displays the C-Zone bottom screen elevations. Within each histogram, the distribution of agricultural wells is depicted in green, while the distribution of domestic wells is shown in blue.

To understand temporal trends by aquifer and well-type, histograms for the domestic and agriculture well completion dates were generated (see Figure I2-4b). Trends in well completions between the three aquifers follow similar trends of increasing and decreasing patterns through the years, following drought trends discussed in Section 1. The data show that in the year 2000, there was a noticeable increase in the number of wells being drilled in the Subbasin. In zones A and C, the majority of the newer wells are agriculture while in the B-Zone, domestic wells have steadily outpaced the number of agriculture wells being drilled.

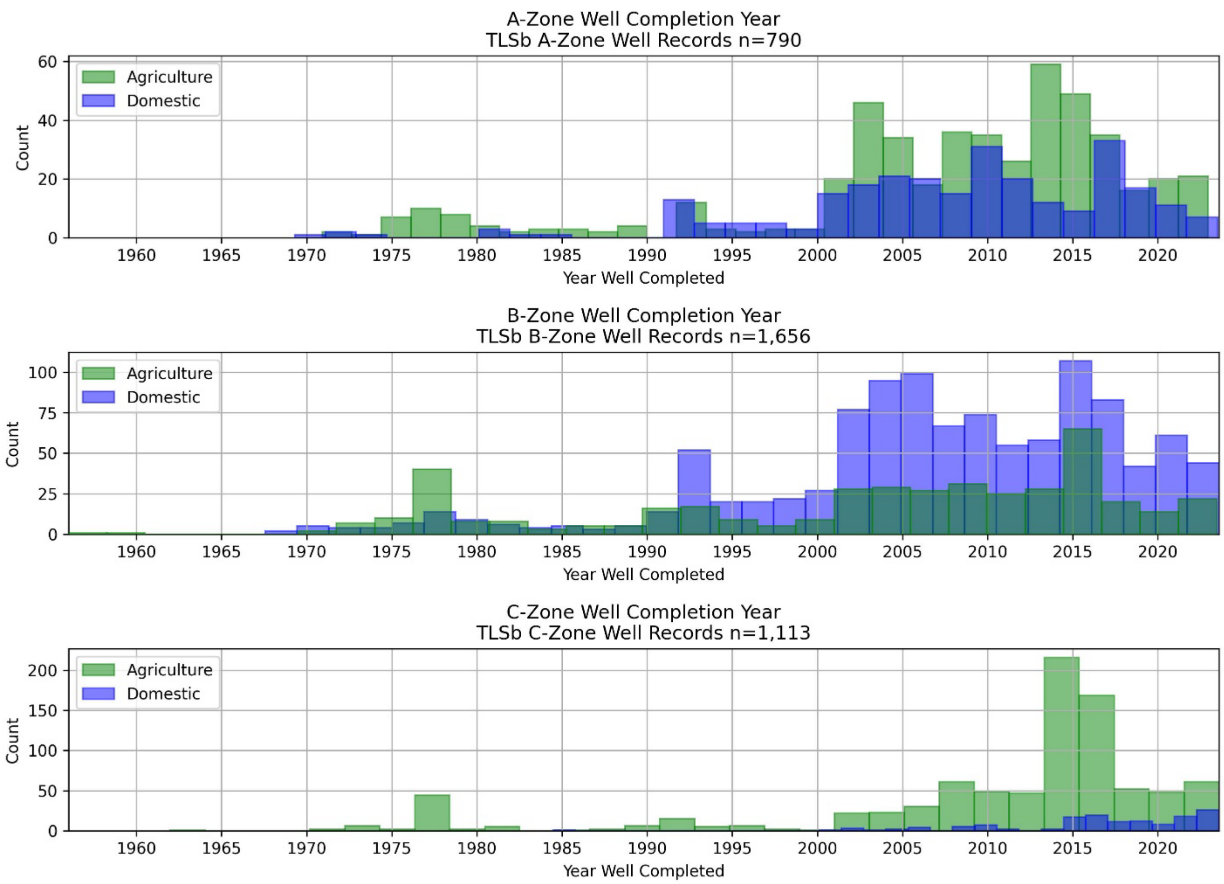

Figure I2-4b. Histogram of Well Record Completion Year by Aquifer Zone Three histograms are presented, each illustrating the distribution of well completion dates for well records across the three aquifer zones. The upper histogram represents the A-Zone completion dates, the middle histogram details the B-Zone completion dates, and the lower histogram displays the C-Zone completion dates. Within each histogram, the distribution of agricultural wells is depicted in green, while the distribution of domestic wells is shown in blue.

2.4.1.1 Recent Trends in Well Record Completion Year and Depth

To assess the temporal variations in well completions, the relationship between well completion depth and well completion date were analyzed using cross plots shown in Figure I2-5. Based on the plots, the number of domestic wells completed at depths shallower than 200 feet in the B-Zone decreased to zero by 2020. In the C-Zone, the number of domestic wells completed at deeper elevations increased since 2020. These plots highlight a shift towards deeper well completions over the last 15 years.

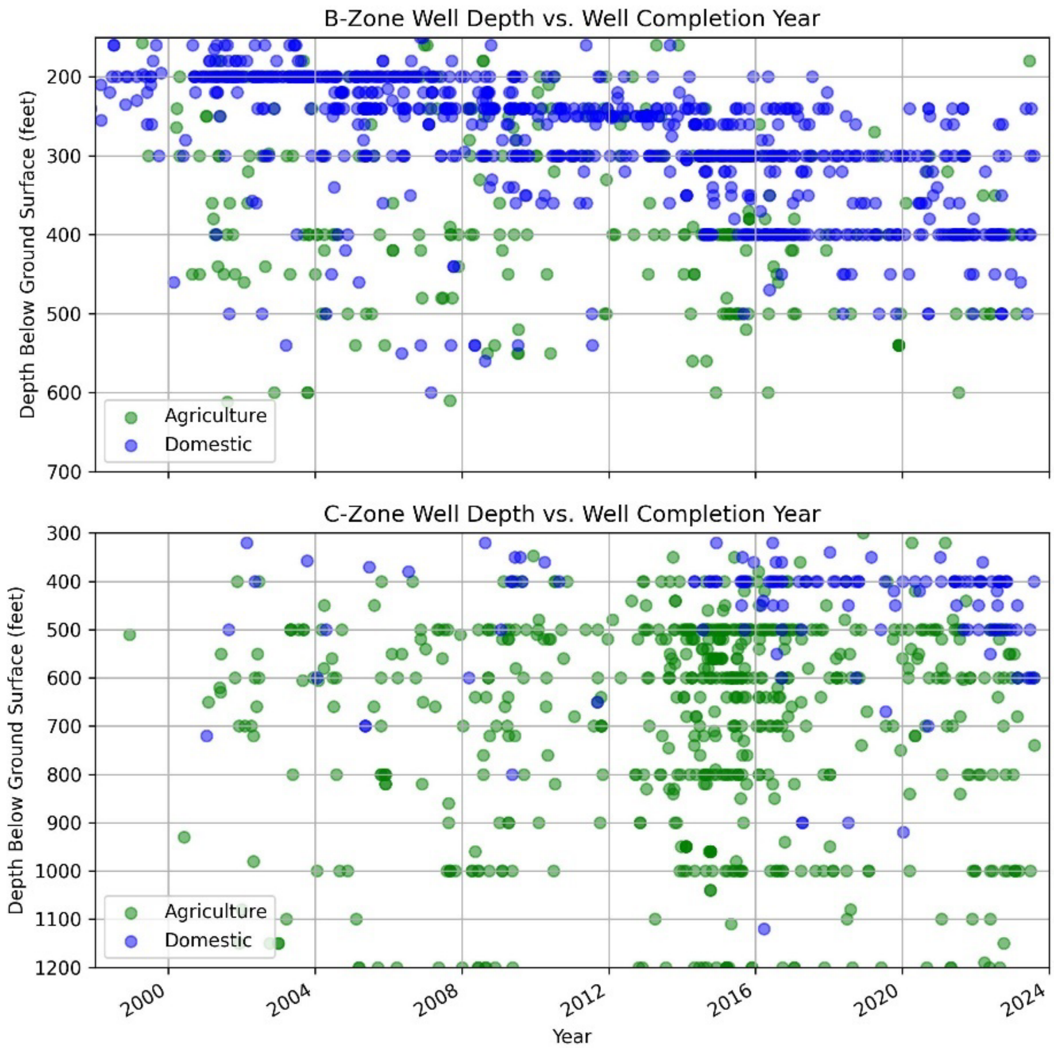

Figure I2-5: Well Completion Trends Since 2000 in the B-Zone and C-Zone Aquifer Wells are colored by their reported beneficial-use. Agricultural wells are marked green and domestic wells are marked blue.

2.5 Representative monitoring areas

Representative Monitoring Areas (RMAs) have been established for each of the three aquifer zones. The RMAs for zones A and B were developed based on well records, employing a consistent methodology that considers both the spatial density of wells and their screen depths. Conversely, the RMAs for the confined aquifer C-Zone were specifically designed to examine the relationship between changes in ground subsidence and the potentiometric water levels of the confined aquifer.

2.5.1 RMAs for the Unconfined A-Zone and B-Zone Aquifers

The RMAs for zones A and B were established to group wells into clusters with simlar screened intervals. Efforts were also made to distribute the number of wells as evenly as possible across clusters. This approach led to the formation of smaller RMAs in areas with a high density of wells and larger RMAs where wells were more sparsely located.

To group wells, the K-means clustering technique was utilized. The K-means clustering is a widely used partitioning method that separates data into "k" (a specified number of) non-overlapping subsets (or clusters). To determine the optimal "k" (number of clusters), an iterative process aimed at minimizing the standard deviation of well bottom screen intervals within each cluster was utilized. By this process, the optimal cluster groupings were determined.

After grouping the wells, Thiessen Polygons were drawn around each grouping to form the final RMAs. The Subbasin-scale maps in Figure I2-6 show the RMAs for the A- and B-Zone aquifers labeled with the number of wells counted in each RMA. By this process, A-Zone wells were divided into 30 A-Zone RMAs. In the B-Zone aquifer, B-Zone well records were divided into 44 B-Zone RMAs. As described in GSP Table 4.3.2-1a and 4.3.2-1b, there are 16 RMS wells in the A-Zone and 34 RMS wells in the B-Zone.

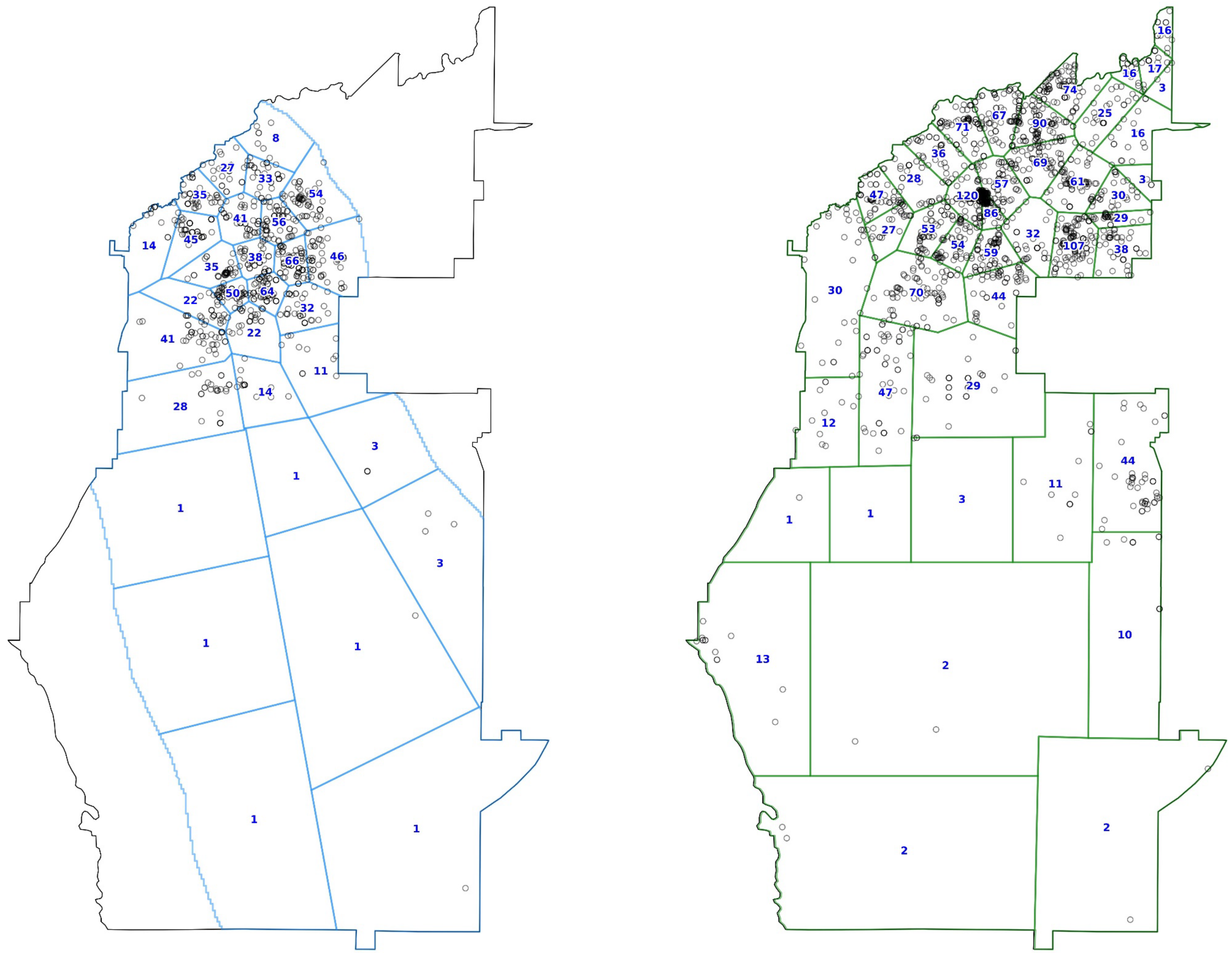

Figure I2-6. Distribution of Beneficial-use Wells across the A-Zone and B-Zone RMAs Left Map: Displays the A-Zone aquifer RMAs. Right Map: Displays the B-Zone aquifer RMAs. RMAs are labeled according to the count of beneficial-use wells located within each RMA. The locations of the beneficial-use wells are marked by black circles.

2.5.2 RMAs for the Confined Aquifer

For the C-Zone, which lies beneath the E-Clay layer, the aquifer is considered confined, and wells within this zone are protected from 'going dry' in the traditional sense seen in unconfined aquifers. Therefore, the primary indicator of undesirable conditions is not the potential for wells to run dry but rather the occurrence and extent of land subsidence. As discussed in Chapter 3A, without high-resolution historical data, accurately linking changes in water levels to changes in the land surface elevation is challenging. The minimum threshold for C-Zone water levels is set at each RMA as 50 feet above the top of the E-Clay. If an RMS well is present, this elevation is selected at the RMS well located at the RMA. In C-Zone RMAs where RMSs are proposed to be added, the current MT is set at 50 feet on top of the average E-Clay elevation over the RMA.

The C-Zone RMA is illustrated in Figure I2-7. Outside the El Rico GSA, the shape of the RMA is based on a grid rotated 45 degrees clockwise, making it perpendicular to the groundwater flow in the northern half of the Subbasin. Where not truncated by the Subbasin boundary, these RMAs each span approximately 36 square miles, roughly equivalent to the size of one Township in the PLSS system. Details on the context and methodology for developing the C-Zone RMAs within the El Rico GSA are provided in Appendix K.

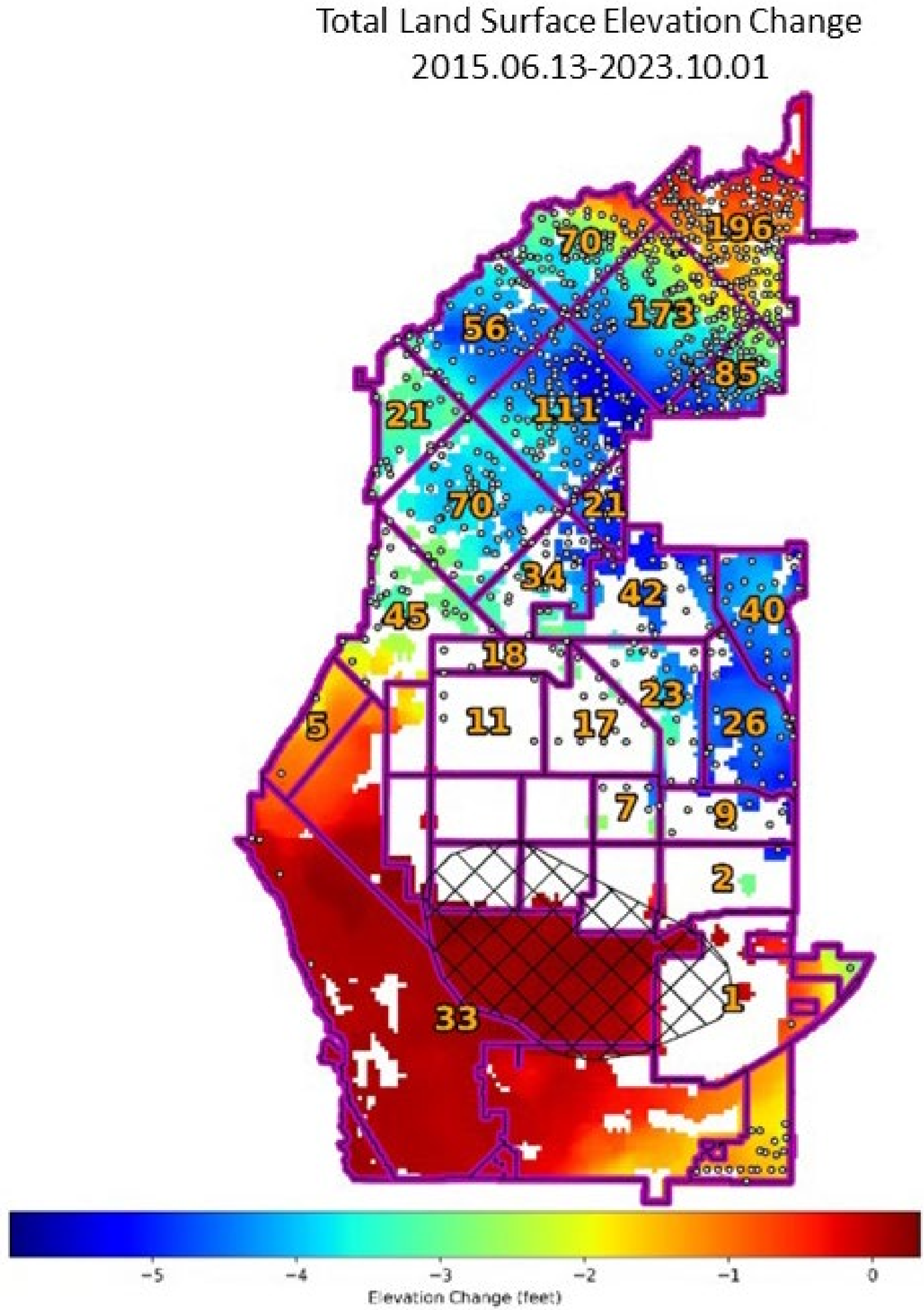

Figure I2-7: Distribution of Beneficial-Use wells across the C-Zone RMAs The C-Zone RMAs are outlined purple and labeled by the number of C-Zone beneficial-use wells that occur in each RMA. InSAR measurement locations are colored by the total change in land surface elevation between June 2015 and October 2023. The locations of beneficial use-wells are marked as white circles.

3. WELL IMPACT ANALYSIS

An undesirable result in groundwater management, metaphorically speaking, is minimizing the occurrence of dry wells and effectively mitigating the impacts on those that do go dry. The undesirable result can be related to the effectiveness of RMS well monitoring and the establishment of a minimum threshold (MT) for each RMA. The impact of such an undesirable result is determined by the relationship between the MT for a given RMA and the number of wells within that RMA that have their completion intervals at or above this threshold. The MT is defined as the water level at a selected percentage of completion intervals within each RMA, thereby setting a benchmark for assessing and managing the risk of well failure due to falling water levels. This approach underscores the importance of strategic monitoring and threshold setting in safeguarding groundwater resources and ensuring the sustainability of well operations within various RMAs.

The measurable objective (MO) for addressing the chronic lowering of groundwater levels within the A-Zone and B-Zone was established based on the Fall 2015 Water Surface Elevation recorded at the RMS wells. This recorded elevation was then set as the threshold for each respective RMA. For RMAs lacking an RMS monitoring well, measurements were interpolated, and the average water surface elevation across each RMA was established as the MO.

In the final step, the number of impacted wells was assessed by counting the well records with bottom screen intervals situated above the established elevation thresholds for the MT at each RMA. Completions counted above the MO were not included in number of wells impacted at the MT, as these wells were impacted by the 2015 water surface elevation at the beginning of SGMA and are considered to have been addressed by efforts prior to SGMA.

3.1 Minimum Thresholds and Measurable Objectives

The MOs and MTs set for each RMA in the A-Zone aquifer are mapped in Figure I3-1. To account for natural variability and dry cycles, the MT for the A-Zone was set at 10 feet below the MO established at each respective RMA. This 10-foot buffer is designed to accommodate fluctuations caused by droughts.

The MOs and MTs set for each RMA in the B-Zone aquifer are mapped in Figure I3-2. To account for natural variability and dry cycles, the MT for the B-Zone was set at 30 feet below the MO established at each respective RMA. This 30-foot buffer is designed to accommodate fluctuations caused by droughts.

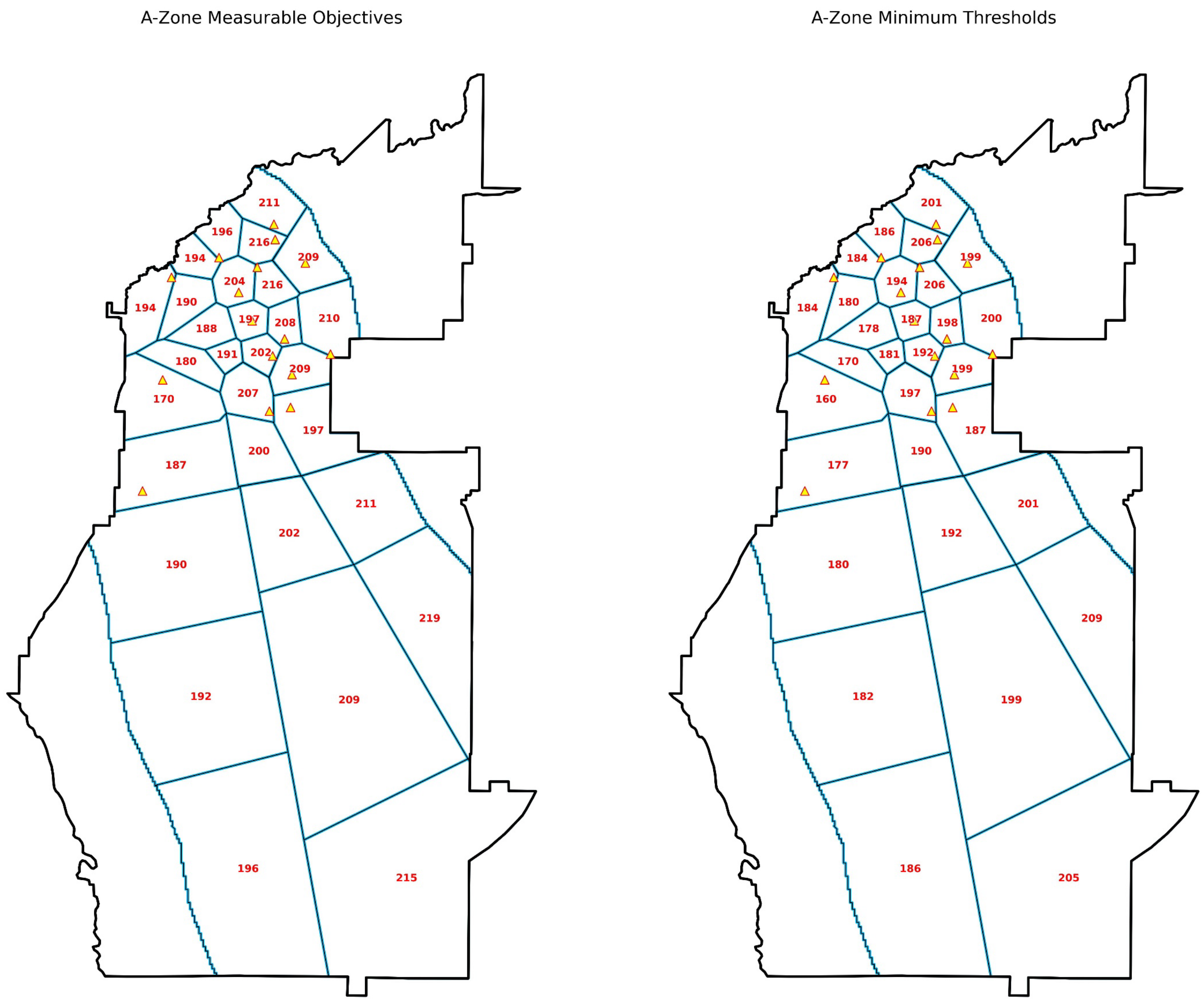

Figure I3-1: Representative Monitoring Areas for the A-Zone Labeled with the MO and MT The map on the left shows the MO elevation assigned to each A-Zone RMA and the map on the right shows the MT elevation assigned to each A-Zone RMA. A-Zone RMS wells are shown as yellow triangles.

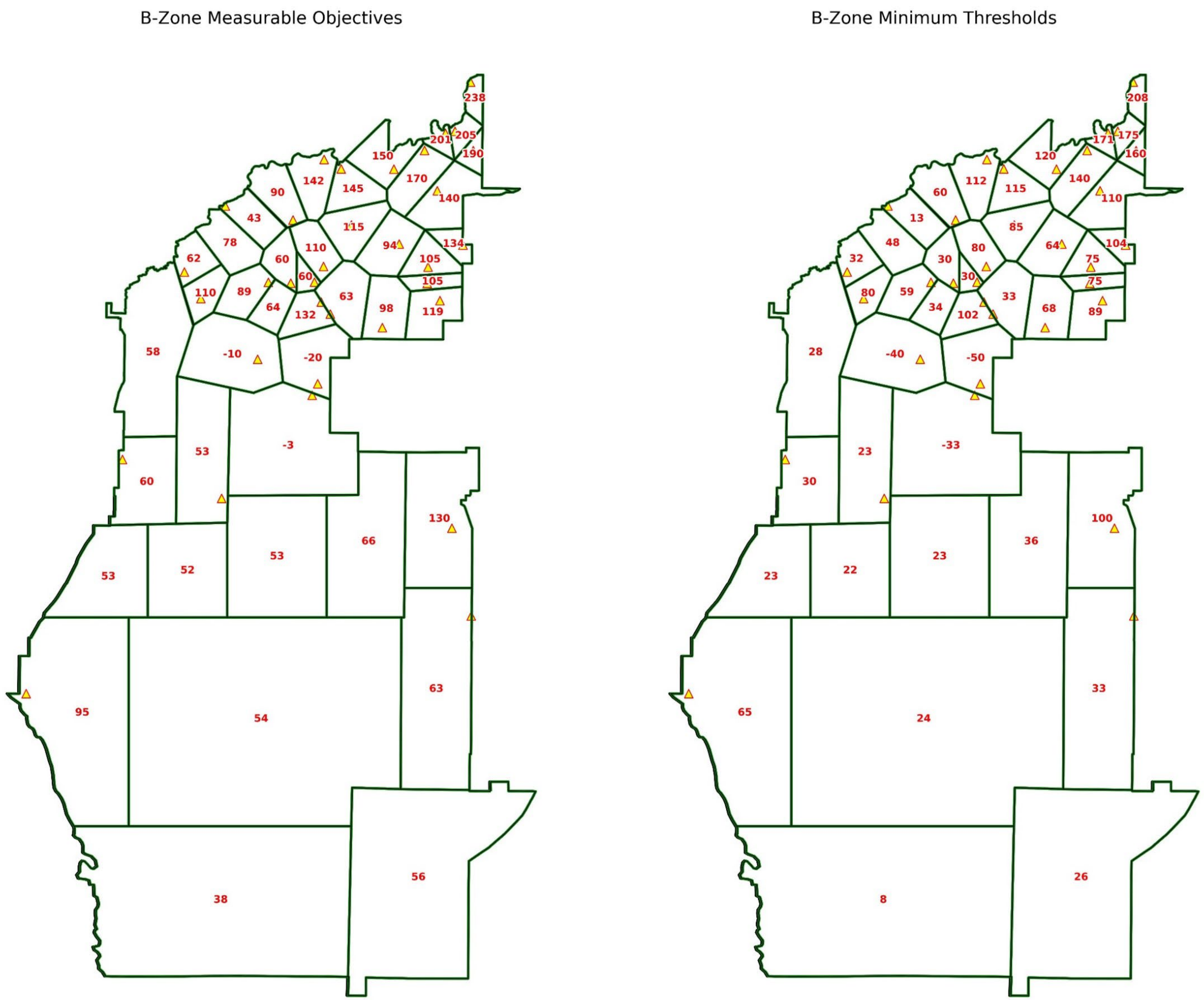

Figure I3-2: Representative Monitoring Areas for the B-Zone Labeled with the MO and MT The map on the left shows the MO elevation assigned to each B-Zone RMA and the map on the right shows the MT elevation assigned to each B-Zone RMA. B-Zone RMS wells are shown as yellow triangles.

3.2 A-Zone Well Impacts at the MT

In the A-Zone, a total of 57 wells (~7% of all A-Zone wells) were counted as impacted at the MT. Figure I3-3 illustrates the distribution of these impacts across agriculture, domestic, and water supply wells. The majority of impacts in the A-Zone are domestic wells (35) followed by agricultural wells (21) located in the northern half of the subbasin. The locations of the domestic well impacts in the A-Zone are concentrated east and south of Lemoore in the same areas as the Agricultural wells. Table I3-1 lists the number of A-Zone impacts by GSA and well type.

Table I3-1. A-Zone Potential Impacts by GSA at the MT

GSA	Planned Use	Count
Mid-Kings River GSA	Agricultural	1
	Domestic	2
South Fork Kings GSA	Agricultural	20
	Domestic	33
	Water Supply	1
El Rico GSA	--	0
Southwest Kings GSA	--	0
Tri-County Water Authority	--	0

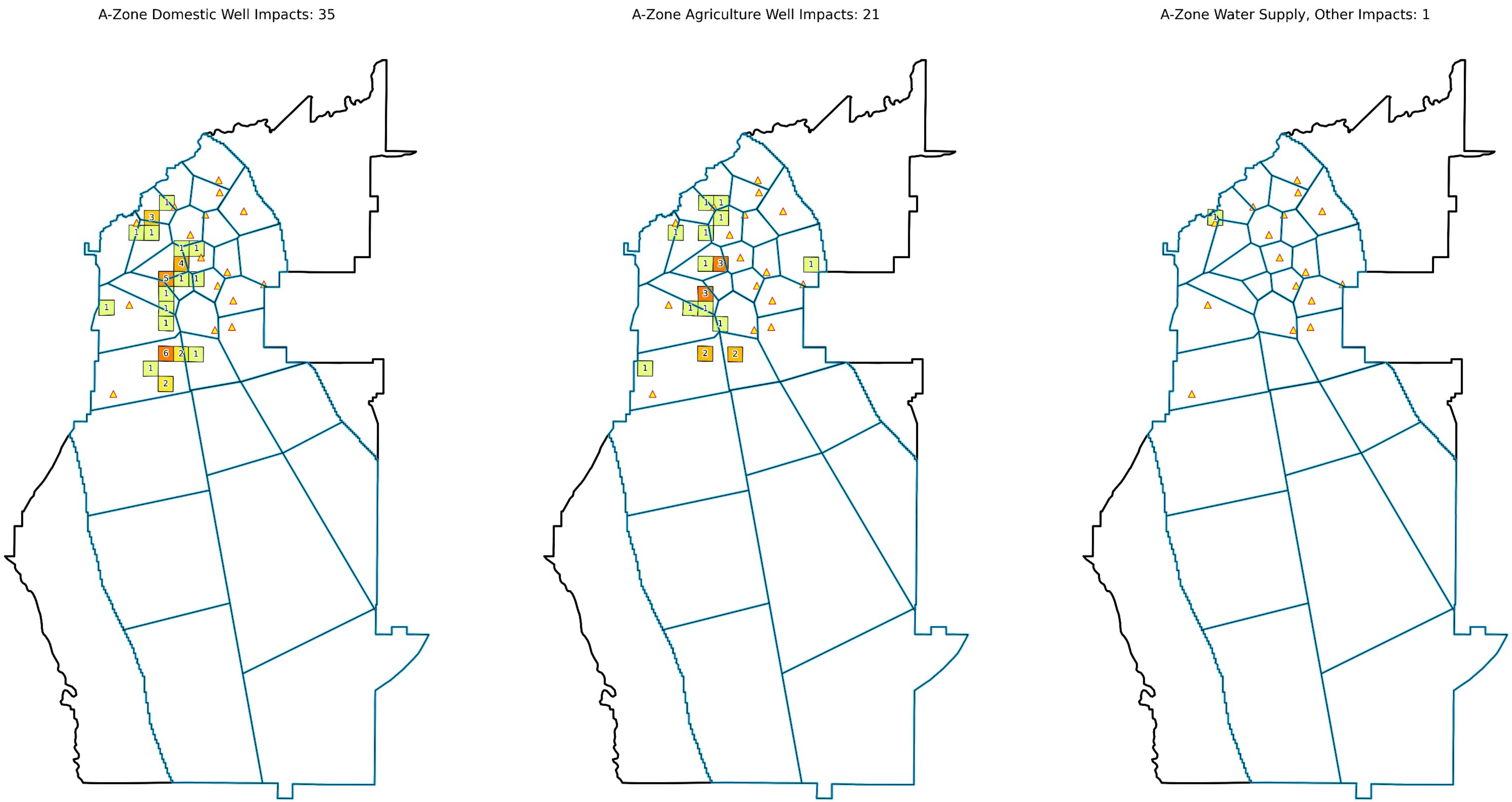

Figure I3-3: Spatial Distribution of the A-Zone Wells Impacted at the MT Maps display the distribution of impacted wells within the A-Zone aquifer, with each PLSS TRS marked by the number of impacts observed. The left map details the locations of domestic well impacts, the center map shows the locations of impacted agricultural wells, and the right map shows the locations of impacted water supply wells. A-Zone RMS wells are shown as yellow triangles.

3.3 B-Zone Well Impacts at the MT

In the B-Zone, a total of 142 wells (~9% of all B-Zone wells) were recorded as impacted at the MT. Figure I3-4 maps the distribution of the B-Zone wells impacted at the MT for agriculture, domestic, and water supply wells. Table I3-2 lists the number of B-Zone impacts by GSA and well type. The majority of impacts in the B-Zone are on domestic wells (126), located in the center of the northern half of the subbasin. Domestic well impacts are concentrated between Lemoore and Hanford, where the majority of domestic wells are located, as shown previously in Figure I1-4. The locations of the impacted domestic wells differ from those in the A-Zone, which are concentrated south of Lemoore.

Table I3-2: B-Zone Potential Impacts at the MT by GSA

GSA	Planned Use	Count
Mid-Kings River GSA	Agricultural	5
	Domestic	110
	Municipal	4
South Fork Kings GSA	Agricultural	3
	Domestic	16
	Municipal	2
El Rico GSA	Agricultural	2
Southwest Kings GSA	--	0
Tri-County Water Authority GSA	--	0

Domestic Well Impacts: 126 | Agriculture Well Impacts: 10 | Water Supply, Other Impacts: 0

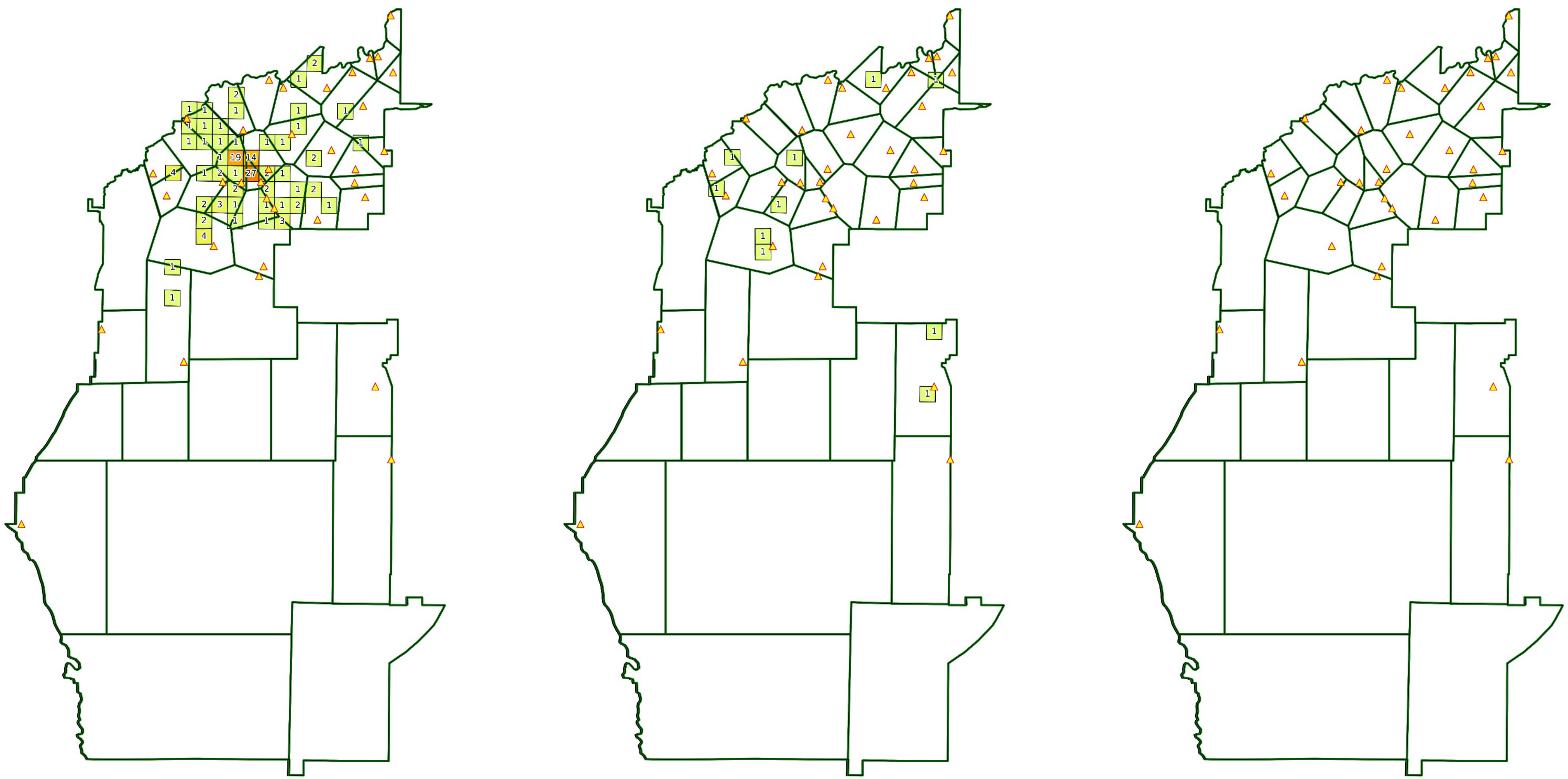

Figure I3-4: Spatial Distribution of the B-Zone Wells Impacted at the MT Maps display the distribution of impacted wells within the B-Zone aquifer. Sections where impacts have been recorded are highlighted in yellow, with darker shades indicating a higher concentration of impacts within that section. The left map shows the locations of domestic well impacts, the center map shows the agricultural well impacts, and the right map shows the locations of the water supply wells and wells of other types impacted at the MT. B-Zone RMS wells are shown as yellow triangles.

4. REPORTED DOMESTIC WELL IMPACTS TO DATE

The California State Dry Well Database is an essential tool developed to monitor and manage the impacts of drought and groundwater depletion across the state. By systematically recording instances of wells running dry, including details such as location, date of report, well depth, and usage type, the database provides valuable insights into the challenges faced by water users in various parts of the Subbasin.

Integrating the TLS Well Records Database with insights from the California State's Dry Well Database by correlating data on wells that have run dry, including their locations, depths, and usage types, with the detailed aquifer zone classification and impact assessments from the TLS database, water managers are equipped with a multifaceted view of groundwater vulnerabilities and trends. This enables a more informed approach to identifying beneficial users at greater risk of impacts, and tailoring interventions to mitigate these risks effectively.

From the available records which date back to 2008, a total of 118 wells were reported as having issues affecting their ability to provide a reliable water source, based on various types of documented well-related problems. Among these, 77 wells were reported as dry, 2 had collapsed, and there was one record of a non-functioning pump. Approximately half of the reported issues within the Subbasin noted the specific type of well related issue experienced. Figure I4-1 maps the distribution of impacted domestic wells that were attributed a location. Based on the map in Figure I4-1, areas south of Lemoore show the highest number of domestic well impacts, followed by areas east of Hanford. A review of the distribution of the reported dates, as shown in the histogram in Figure I4-2, indicates that the majority of the issues were reported prior to 2015.

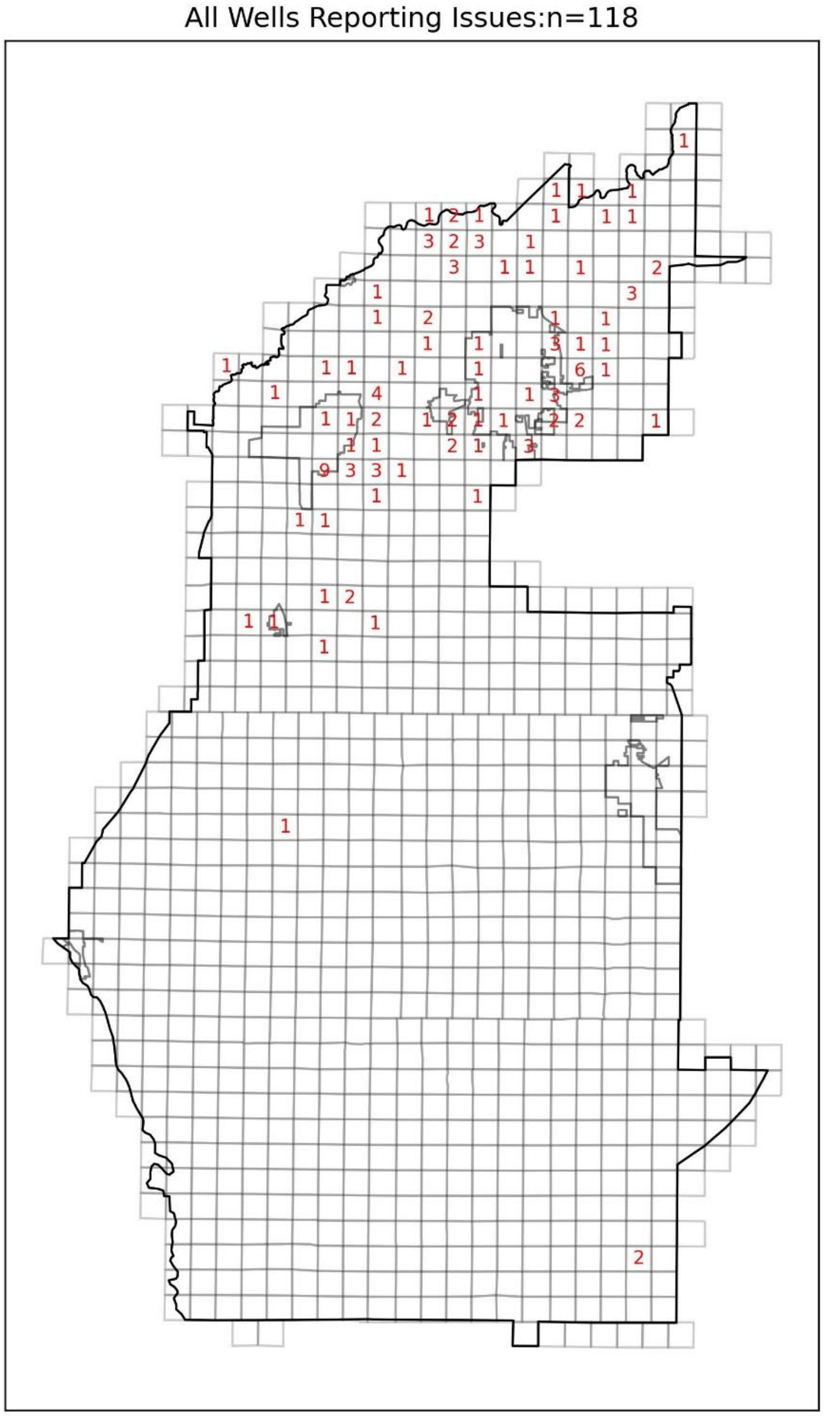

Figure I4-1: All Well Records Reporting Issues The map depicts the Subbasin's TRS grid, with TRS sections labeled by the number of domestic wells located in them that have reported issues since 2008.

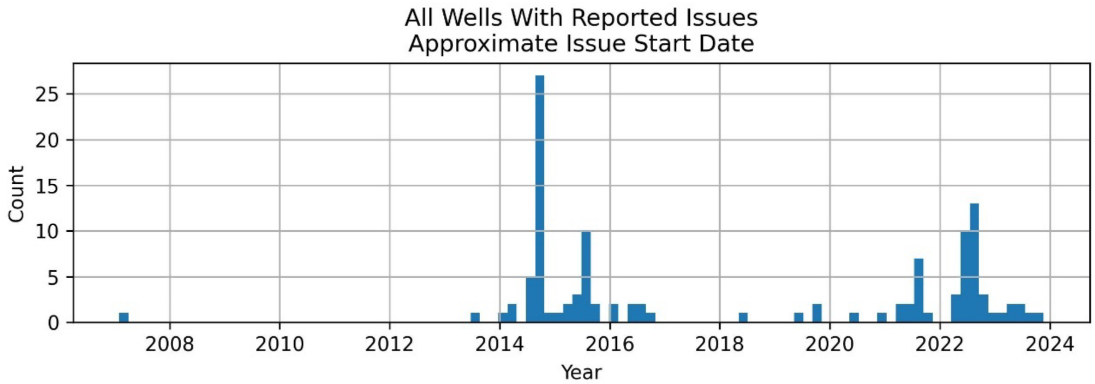

Figure I4-2: Histogram of Approximate Issue Start Date The histogram shows the distribution of reporting dates of wells having issues within the TLS boundary as reported in the dry well database. Between 2014 and 2016 the number of wells reporting issues peaked to more than 25.

Figure I4-3 illustrates the locations of the wells reporting issues in the A-Zone and B-Zone since 2015. Dry well records attributed with depth and location were assigned to an aquifer zone using the A-Clay and E-Clay DEMs and method described in Section 2.1. The majority of A-Zone wells with reported issues are located southeast of Lemoore, while wells with reported issues that are screened in the B-Zone are commonly located east of Hanford. These wells are typically less than 200 feet bgs and are situated east of the A-Clay extends boundary, shown previously in Figure I2-1. The distribution of wells that have reportedly gone dry closely aligns with the high well density areas in zones A and B shown in Figure I2-2. This trend is most noticeable for A-Zone wells south of Lemoore.

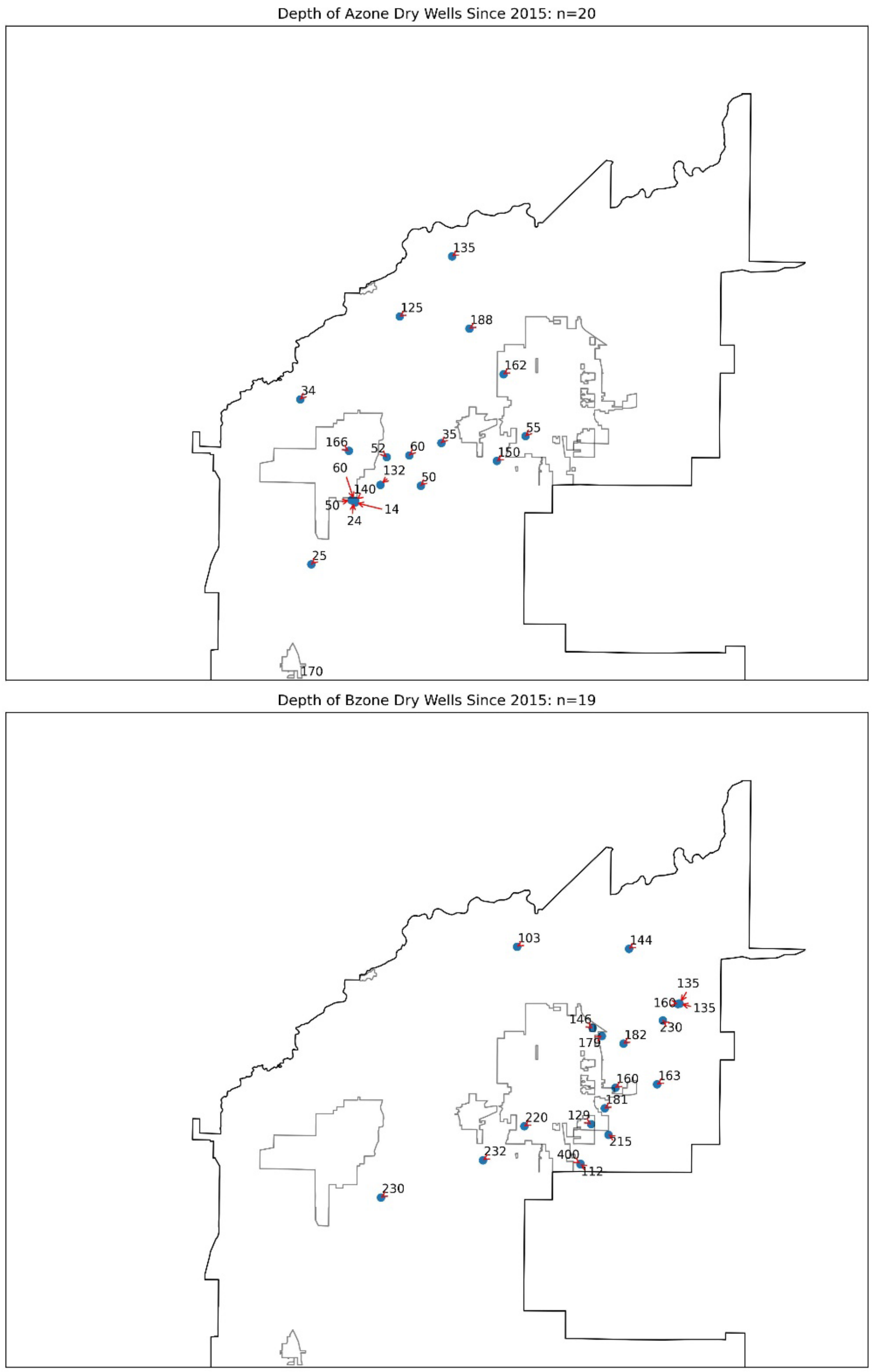

Figure I4-3: Wells with Issues Since 2015 by Aquifer Zone and Location This figure displays wells in the TLS that have reported issues since 2015 with a location and depth attributed. The top map shows wells screened the A-Zone, and the bottom map displays wells screened in the B-Zone. Each well location is labeled by its depth.

5. SUMMARY

Analysis of the geographic distribution of wells indicates that both domestic and agricultural wells are primarily located between Lemoore and Hanford, with the highest densities of domestic wells found to the west and southeast of Hanford. These wells, both domestic and agricultural, tend to be concentrated in similar geographic areas. Furthermore, a comparison with the State domestic dry well database reveals that wells reporting issues are predominantly located in areas where domestic wells are concentrated.

Analysis of time series graphs and histograms reveals distinct patterns in well depths and uses across the three different aquifer zones. In the A-Zone, the majority of wells are shallow (less than 100 feet) and serve an agricultural beneficial use, whereas in the B-Zone, most wells serve a domestic use with most wells screened in this zone between 300 to 500 feet bgs. The C-Zone predominantly features wells used for agricultural beneficial use. From these plots, a notable trend emerges: the completion of wells at deeper intervals over time. New domestic wells are being installed deeper, sometimes even reaching into the C-Zone and suggests that some of the older shallow wells are being replaced with deeper wells.

Ongoing efforts to refine and validate the TLS database underscore a commitment to enhancing the Subbasin's groundwater management strategies, aiming for a sustainable balance. This endeavor not only facilitates a better understanding of the current state of groundwater resources but also guides the development of targeted and effective interventions if water levels begin to decline. As the database continues to evolve, it serves as the foundation of a subbasin-wide well registry.

6. REFERENCES

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Appendix J

Undesirable Results, Minimum Thresholds, and Measurable Objectives for Ground Subsidence

1 GROUND SUBSIDENCE

An undesirable result for subsidence occurs when there is significant and unreasonable land subsidence that interferes with surface land uses (DWR, 2017). The criteria that define conditions that avoid an undesirable result for subsidence in this GSP are a total amount of ground subsidence that does not interfere with delivery of surface water via canals or significantly increase the total area of FEMA 100-year flood zones in the Tulare Lake Subbasin (see Section 1.1.5 and 1.1.6 of this appendix). Because the criteria are defined as a total amount of subsidence, and because subsidence is a process that has been ongoing for many years, a time reference point was selected to define how total subsidence is calculated. This time-reference point is 2020, which is the point in time that the technical analysis of subsidence undesirable result was made. Measurement of subsidence will be based on InSAR data, which meets appropriate levels of quality and effectiveness, particularly with respect to spatial and temporal coverage of subsidence measurement across the Subbasin.

1.1 Undesirable Result for Land Subsidence

23 CCR §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.*

As described in Section 3A.5, subsidence has been occurring in the San Joaquin Valley (SJV) and thus in the Tulare Lake Subbasin since the 1920's. The phenomenon is primarily attributed to consolidation of the Corcoran Clay layer in response to a reduction of the elevation of the piezometric surface in the confined aquifer due to groundwater withdrawal in excess of the recharge rate of the aquifer (see Sections 3A.5.2, 3A.5.5, and 3A.5.6).

Per SGMA definitions in the California Water Code 10721, an undesirable result occurs when subsidence interferes with surface land uses. In this context, "land uses" refer to man-made infrastructure such as roads, buildings, canals, wells, levees, and rail roads.

A piece of infrastructure is seldom damaged when all the points of that infrastructure move vertically downwards by the same amount and at the same time. The undesirable results of subsidence on infrastructure are typically associated with differential subsidence between points on the infrastructure that exceeds design values.

Differential subsidence refers to the change in elevation over a given distance over a given time period. Differential subsidence is expressed in terms of slope gradient or angular distortion, where the difference in change in elevation over a given period of time between two contiguous points is divided by the horizontal distance between them. This value is then multiplied by 100 to express it as a percentage. Since differential subsidence numbers are small (i.e., fractions of one percent), another way to express differential subsidence is using fractions. For example, if a 0.1 feet (ft) change in elevation difference was measured between two points that are 100 ft apart, then 0.1 ft/100 ft = 0.001 (or 0.1%). The change in slope between the two points can also be expressed in fractions as 1/1,000 (i.e., 1 ft of subsidence over a distance of 1,000 ft).

Although differential subsidence is the factor that affects the performance of infrastructure, it is difficult to directly measure differential subsidence at a basin scale such that at any given location, it can be compared against the individual types of infrastructure that it may impact. As such, the undesirable result is instead defined in terms of the total amount of subsidence, which is the total change in vertical elevation of a point or area relative to a baseline elevation. As described in Section 4.7.1, total subsidence represents the accumulated incremental effect of cyclical changes in groundwater level in the confined aquifer. The incremental changes in ground level "accumulate" over time, resulting in an observed total subsidence at the ground surface that could be detrimental to certain types of infrastructure. As described in Section 4.7.1, the point in time from which total subsidence is calculated is the year 2020.

The next sections describe the undesirable result from subsidence for each type of infrastructure in the Subbasin.

1.1.1 Buildings

The structure of a building is not detrimentally affected when the downward movement is uniform across the footprint of the building. Individual buildings are detrimentally affected by subsidence when the downward movement is different across supports (i.e., columns or other bearing structures) as this condition imposes shear forces on the structure that can cause architectural and structural damage. Individual buildings may also be affected by the effect of downward movement when the downward movement of the building is different than the downward movement of the surrounding ground as this leads to unexpected shear forces in the connections of utilities and can lead to gaps and offsets in access facilities (e.g. stairs and ramps). Differential movement within the footprint of buildings supported on a single mat-type foundation is more evident in tall structures since the lean is evident to the naked eye.

Figure J1-1 shows the total magnitude of subsidence in the Tulare Lake Subbasin area between June 2015 and January 2023 as measured using InSAR and the alignment of two sections. Figure J1-2 shows the progression of total subsidence from January 2016 to January of 2017 2018, 2019, 2020, 2021, 2022, and 2023 along the southwest to northeast section and the northwest to southeast section, where the slope of the lines indicate areas with lower or greater differential subsidence. The scales on the horizontal and vertical axes of the figure are different and thus show significant vertical exaggeration for improved visualization purposes. As may be noticed, the steepest portion of the line of total subsidence is approximately between stations 146,000 and 147,500, where the slope is in the range of 1/5,000.

Table J1-1 lists tolerance and performance criteria for buildings that can be used to evaluate the effect of local differential subsidence. The change in slope of the ground surface caused by differential subsidence at its steepest location in the Subbasin is much smaller than the most stringent value listed in Table J1-1. This leads to the conclusion that historical subsidence in the Subbasin is unlikely to have caused a detrimental effect on the performance of buildings. Moreover, in areas where the greatest amount of historical subsidence has occurred near the City of Corcoran (see Figure J1-1 and Figure J1-2) there are no reports of subsidence-induced damage to buildings (City of Corcoran, personal communication, 2023). Subsidence is therefore considered to not have undesirable results on the performance of buildings within the Tulare Lake Subbasin.

Table J1-1: Tolerable settlements for buildings (Bjerrum, 1963 and Fang, 1990)

Differential Downward Movement Threshold	Performance Criteria
1/1,000	Limit where difficulties with machinery sensitive to settlements are to be feared
1/750	Multistory concrete rigid frame on mat foundation 4 ft ± thick
1/600	Limit of danger for frames with diagonals
1/500	Safe limit for buildings where cracking is not permissible. Rigid circular mat or ring footing for tall and slender rigid structures.
1/300	Limit where first cracking in panel walls is to be expected. Limit where difficulties with overhead cranes are to be expected.
1/250	Limit where tilting of high, rigid buildings might become visible.
1/150	Limit where structural damage of buildings is to be feared.

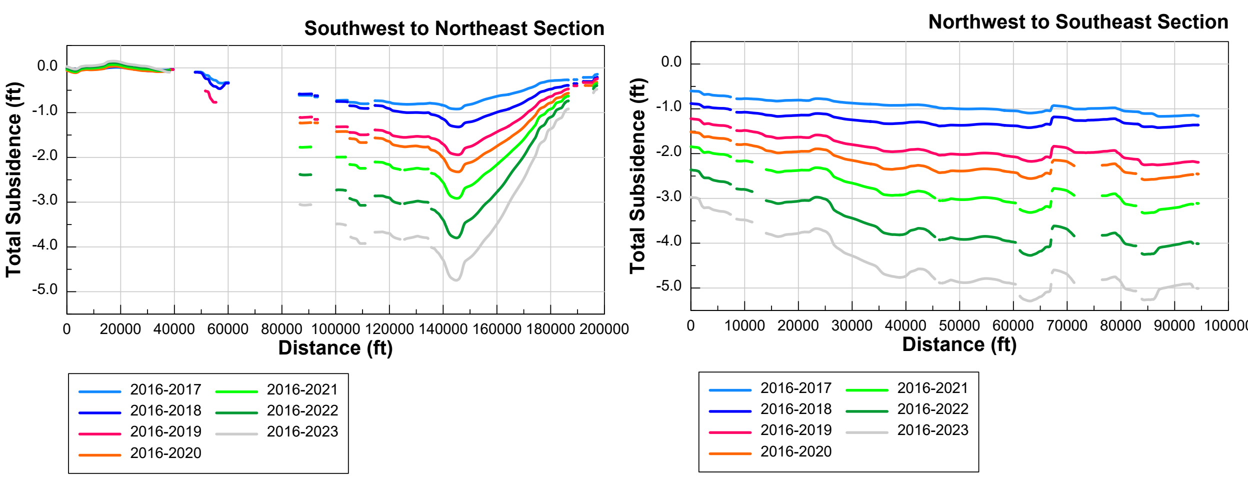

Figure J1-2: Total subsidence measured along the southwest to northeast section (left) and northwest to southeast section (right) that are shown on Figure J1-1.

1.1.2 Flood Protection Levees

Flood protection levees are earthen embankments that are built along rivers to protect areas of interest from seasonally high flood water levels. Engineered levees are typically designed following guidance from the US Army Corps of Engineers (e.g., USACE, 2000). Accordingly, levees typically fail due to one or more of the following conditions:

- Overtopping: flood water elevation exceeds the elevation of the crown of the levee
- Surface erosion: water flowing over the levee erodes the embankment and reduces its section.

- Piping: water flowing through the levee develops into a spring which causes internal erosion that in turn causes more flow through the levee and more erosion, eventually leading to a breach of the levee.
- Slides: movement within the levee or the foundation soils due to insufficient strength in the soils.

The Urban Levee Design Criteria (DWR, 2012) indicates that levees should be designed to protect against the 200-year return period flood event and that the crown of the levees (i.e., top of levee) should have a minimum 3-foot freeboard. Downward movement (i.e., settlement) of the crown of a levee with respect to the floodplain (i.e., differential vertical displacement between the levee and the floodplain) can reduce the freeboard. This amount of settlement should be incorporated in the design as additional freeboard, or the levee should be topped off as settlement[1] accumulates over time.

The effect of subsidence on the performance of levees is not addressed in USACE (2000) or DWR (2012). However, the performance of levees could potentially be affected by regional subsidence in two ways:

- Case 1: By lowering the elevation of the crown of the levee with respect to the elevation of the flood area that the levee is containing.
- Case 2: By inducing differential amounts of subsidence along the longitudinal axis of the levee that can lead to longitudinal cracking and other types of distress to the earthen embankment.

When considering Case 1 (and given that subsidence is a regional phenomenon) the elevation of the flood protection levees and the elevation of the adjacent flood-prone areas (i.e., floodplain) will generally decrease uniformly. With little or no differential movement between the crown of the levee and the floodplain, the performance of the levee is unaffected (i.e., the volume of water contained by the levee remains similar to the design value).

Regarding Case 2, in general, levees are flexible earthen structures that can tolerate typical differential longitudinal settlement that occurs due to variability of soils in their foundation. As such, there is very little literature on performance limits of levees affected by differential settlement along their longitudinal axis. In lieu of any other guidance by USACE or DWR, in their Geotechnical Design Manual, the South Carolina Department of Transportation (SCDOT, 2019) imposes a limit for settlement of paved road embankments, i.e., embankments with a brittle layer on their crown, of 1 inch measured over a distance of 50 ft, which is equivalent to a slope of 1/600. This is considered to be a conservative value for levees given that levees do not typically have paved roads on their crown. Therefore, in lieu of any other applicable guidance, a value of 1/600 should be used to increase awareness by infrastructure managers (i.e., alert level) and trigger

[1] In this instance, settlement refers to downward movement of the levee with respect to the ground surrounding it thus reducing the elevation difference between the levee and the floodplain.

actions such as visual inspections to identify cracks that may be detrimental to the performance of the embankments.

As was discussed in the previous section, the maximum slope of subsidence between January 2016 and January 2023 was in the range of 1/5,000, which is much smaller than the 1/600 damage threshold. The integrity of flood protection levees is therefore not considered to be affected by past subsidence and is not considered a potential undesirable result for future subsidence. However, subsidence of flood protection levees causes an undesirable result when the crown of the levee subsides more than the flooded area it is designed to contain (i.e., Case 1). This condition will be addressed in Section 1.1.6.

1.1.3 Roads and Railroads

Similar to flood protection levees, embankments for roads, rail lines, and airports are earthen structures that can be affected by subsidence. Perhaps the main difference between embankments for levees and those for roads, rail lines, and airports is that the latter have been typically built with higher engineering standards such as soil placement following specifications and construction quality control. If the amount of differential subsidence along the longitudinal access of the road or runway is excessive, it can cause the development of cracks on the surface pavement or dips and bumps on the road that can pose a hazard to vehicles (cars and planes).

In their Geotechnical Manual, Caltrans (2014) does not limit the amount of differential settlement that can be tolerated by a road embankment. Instead, Caltrans (2014) indicates that applicable design criteria should be determined on a project-by-project basis. In lieu of guidance specific to California, the 1/600 criteria cited by SCDOT and described as a criterion for levees can be applied to road embankments.

Amec (2017) describe that representatives of Burlington Northern-Santa Fe and Union Pacific Railroad were interviewed regarding subsidence impacts to their infrastructure. These representatives indicated that periodic rail track maintenance is carried out as part of the operations and maintenance program and that they have not noticed any increases or changes to maintenance that can be attributed to subsidence. Similarly, Amec (2017) discusses interviews with officers at Caltrans Office of Structure Investigations – North, Caltrans District 6, and Caltrans District 10, which have jurisdiction over areas subjected to subsidence. Accordingly, all Caltrans representatives indicated that they were not aware of any subsidence that has impacted bridges or roadways.

In regard to the proposed high-speed rail (HSR) through the area, Amec (2017) indicated that the maximum induced slope change should not exceed 1.25% (1/80).

As described previously, the maximum differential slope of subsidence between January 2016 and January 2023 was in the range of 1/5,000, which is much smaller than the 1/600 criteria for road embankments and the 1/80 criteria for HSR. Subsidence is therefore not considered to have an undesirable result on the performance of road and rail embankments within the Subbasin.

1.1.4 Bridges

Bridges within the SJV are typically not impacted by the direct effect of downward movement caused by subsidence because the differential downward displacement between abutments or

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supports is small or negligible. However, numerous bridges spanning canals in the SJV are affected by subsidence in that they are located in an area of the canal where the slope has decreased and the water level in the section of the canal has risen up to the top of the design freeboard. In some instances, the water level reaches the soffit of the bridge. This condition has lead road and highway authorities to be concerned for overtopping and flooding of the bridge deck, which can be a safety hazard to vehicles driving over the bridge.

Given that bridges are only affected by subsidence where canals have been affected by subsidence, the undesirable result will be discussed and addressed in Section 1.1.5, which refers to Canals and Streams. Otherwise, subsidence on its own is not considered to have an undesirable result on the performance of bridges within the Subbasin.

1.1.5 Local Canals and Streams and the California Aqueduct

Canals convey water by gravity and thus rely on the slope of the channel (S) for conveyance. Streams also convey water through gravity and rely on levees to protect neighboring areas from flooding when water levels exceed the cross-sectional area of the stream. The slope of a canal is the difference between the elevation of two points on the canal divided by the horizontal distance between the two points.

Open channel flow is governed by Manning's equation (Eq. K-1), where Q is the volumetric flow rate in cubic feet per second (cfs), n is Manning's roughness coefficient of the channel, A is the flow area in square feet (ft^2), and R is the hydraulic radius, which is defined as the ratio of the area and the wetted perimeter and is expressed in ft.

$$Q = \frac{1.486}{n} \cdot A \cdot R^{\frac{2}{3}} \cdot S^{\frac{1}{2}} \qquad \textbf{Eq. K-1}$$

The slope of a canal or of a stream with flood protection levees will change only if the amount of subsidence is different at two given points along the canal. If the downstream point subsides more than the upstream point, then the slope of the canal will increase, and the flow depth is expected to decrease resulting in a smaller flow area and larger flow velocity (Eq. K-1), but similar flow rate. Alternatively, the flow rate in that canal may increase if the area, roughness, and wetted perimeter remain equal. Conversely, if subsidence of a downstream point of a portion of a canal is less than subsidence at an upstream point on the canal, then the slope of the canal will decrease, and the flow depth is expected to increase resulting in a larger flow area and smaller flow velocity to maintain the same flow rate. Using Eq. K-1, it can also be shown that the conveyance capacity (i.e., flow rate Q) of the canal decreases if the slope decreases and the magnitude of the area, roughness, and hydraulic radius remain equal.

The Friant-Kern Canal is an example of a canal that lost conveyance capacity due to subsidence and is currently undergoing repairs. This 151.8-mile-long canal transports water southward by gravity flow from the Friant Dam at the San Joaquin River near Fresno to the Kern River in Bakersfield and was constructed by the United States Bureau of Reclamation (USBR) as part of the Central Valley Project (CVP). As described in USBR (2023), the 33-mile-long Middle Reach of the Friant-Kern Canal is currently undergoing repairs after subsidence caused a decrease in the slope of the canal that resulted in loss of conveyance of 60% of the flow capacity (from 4,000 cfs to 1,600 cfs).

The performance of canals and streams with flood protection levees in the Tulare Lake Subbasin is considered to be affected by the detrimental effects of subsidence and lead to an undesirable result when there is a reduction in the conveyance capacity (i.e., Q) of approximately 20%. However, DWR has indicated that it is undesirable for the California Aqueduct to experience a reduction in conveyance capacity. The magnitude of the reduction of conveyance capacity for the California Aqueduct is therefore 0%.

The minimum threshold amount of subsidence will be developed in Section 1.2.1. The measurable objective is discussed in Section 1.2.3.

1.1.6 Flooding

In simple terms, flooding occurs when the volume and/or rate of flow of water flowing through water conveyance systems exceeds the design capacity of the system to store and convey the water to other drainage and storage areas that are typically at lower elevations. Importantly, flooding may even occur in engineered systems and locations if the volume and/or flow rate exceed the design criterion of the water conveyance system. For example, a levee system that was designed considering the volume of water through the stream for the 100-year return period storm event is likely to be overwhelmed if subjected to a storm event with a 200-year return period.

Nonuniform or differential amounts of subsidence within areas of the Subbasin can cause changes to surface drainage patterns, which can lead to ponding or flooding in areas not previously known to be susceptible to flooding. Subsidence can also decrease the slope of a stream leading to a rise in the water level of the section of the stream (see Section 1.2.1.1). The water level may overtop the banks and flood surrounding areas. Additionally, subsidence can cause a reduction of the elevation of a flood protection levee with respect to the flood area that it is meant to contain and thus reduce the total volume of water that is meant to be stored. These are undesirable results associated with subsidence.

As mentioned, an undesirable result related to flooding would be water ponding in previously unexpected areas. The first step in identifying areas of the Subbasin where this may occur is to set the expectation for flooding. The Federal Emergency Management Agency (FEMA) sets the expectation for flooding through the development of Flood Insurance Rate Maps (FIRMs). All home and business owners in high-risk areas (i.e., within the flood zones set in FIRMs) with mortgages from federally regulated or insured lenders are required to buy flood insurance. Figure J1-3 presents the areas set by FEMA in the 2009 FIRM as being prone to flooding for a 100-year return period (i.e., 100-year flood zone). The undesirable result related to flooding is therefore defined as an expansion or readjustment of the limit of the 100-year flood zone as defined by FEMA into critical areas such as population centers (i.e., areas within city limit boundaries) or locations containing public water supply infrastructure, or other infrastructure that serves a broad public use. The undesirable result as it relates to this GSP is constrained to the expansion of the flood zone that is solely caused by subsidence. Other factors that contribute to flooding are not incorporated, including changes to the land use of the watershed; changes to or lack of maintenance of drainage infrastructure such as levees, canals, embankments; climate change; and other factors can affect the shape of a flood zone. Expansion or readjustment of the FEMA 100-year flood zone based on these “non-subsidence” factors are not considered an undesirable result that the GSAs can manage.

1.1.7 Wells

Subsidence-induced damage to wells is caused by yielding of the well casing under the drag load applied by the soil around the casing. Drag load is a force, typically calculated for the design of foundation piles (e.g., Fellenius, 1989), that develops along the surface area of a well casing when the soil surrounding the casing moves downward relative to the casing.

The mechanics of drag loads acting on a well casing is illustrated in Figure J1-4, which shows a relatively shallow well that terminates in the upper aquifer above the Corcoran Clay (Well #1) and a relatively deep well that terminates in the lower aquifer that is confined by the Corcoran Clay (Well #2). Along their length, both wells are in contact with the surrounding soil, which allows friction to develop along the well casing. As the Corcoran Clay consolidates, the soil above this layer also settles causing subsidence at ground surface, but the soil below the Corcoran Clay does not move downwards. Well #1, which terminates above the Corcoran Clay, will move downward with the soil above the Corcoran Clay and no significant amount of relative movement is expected between the well and the soil. However, as the Corcoran Clay consolidates and settles, the soil within and above this layer will drag on the casing of Well #2, which is not moving uniformly at the same rate because the lower portion of the well within the lower aquifer is providing resistance due to friction along the casing. If the drag load applied on the casing exceeds the structural capacity of the well casing, then the well casing could yield and fail to provide its intended service. Yielding of a well casing is an undesirable result of subsidence because it renders the well inoperable.

Damage to wells is an undesirable result of subsidence and some domestic and industrial wells are known to have been damaged by subsidence.

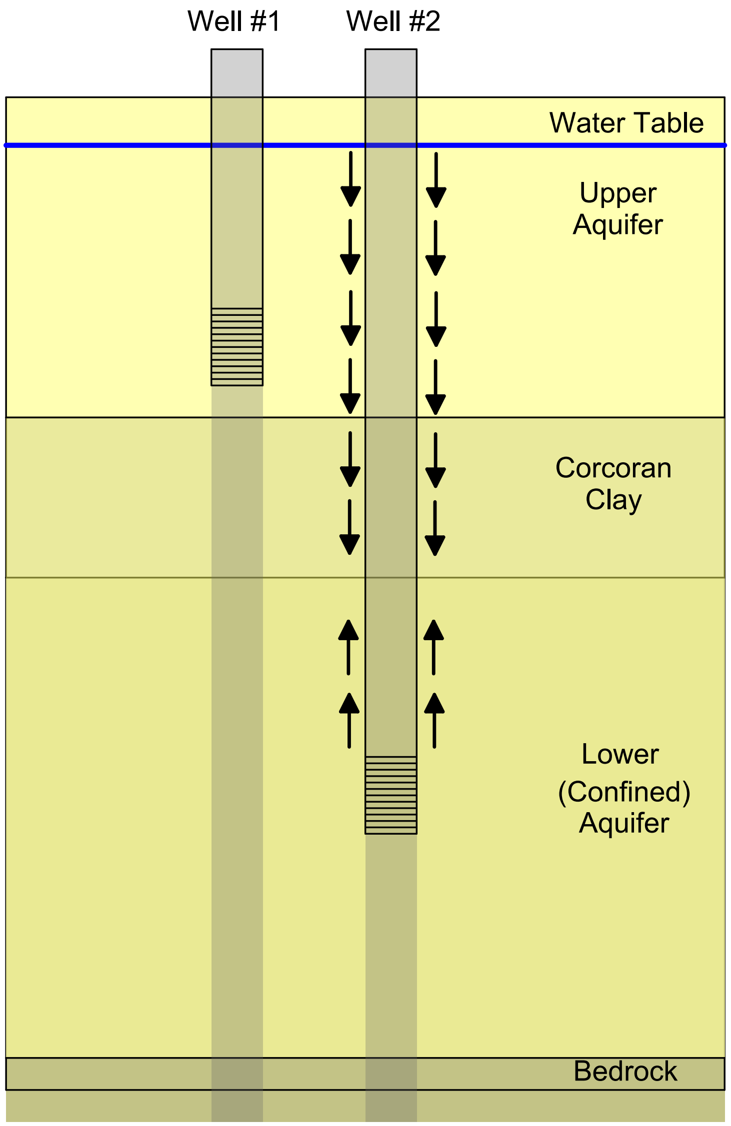

Figure J1-4: Schematic of a well terminating above the Corcoran Clay (Well #1) and another terminating below the Corcoran Clay (Well #2).

1.1.8 Pipelines

Differential subsidence may cause strain on buried hydrocarbon or water pipelines. In regard to steel pipelines carrying hydrocarbons, PRCI (2009) indicates that the lateral component of displacement that may accompany subsidence is responsible for greater potential damage because it can cause large compressive forces in the pipeline and lead to upheaval buckling. General rules cannot be applied to the estimation of the effect of differential subsidence on the integrity of pipelines given that many factors such as pipe material type, diameter, wall thickness, internal operating pressure, weld strength, burial depth, and burial material, need to be considered. Instead, analysis and modeling on a case-by-case basis is required.

Yang et al. (2023) conducted a thorough review of the reportable incident database of the Pipeline and Hazardous Materials Safety Administration (PHMSA) to identify the instances in which subsidence, among other natural hazards, had caused a reportable incident as defined by 49 CFR 191.3 for natural gas pipelines and 49 CFR 195.50 for hazardous liquids and CO_2 pipelines. Figure A-8 of Yang et al. (2023) indicates that there have been no reportable incidents caused by subsidence in the state of California.

A very significant magnitude of subsidence has occurred in California due to groundwater extraction (e.g., Figure 3A.5.0-1) as well as hydrocarbon extraction for over 100 years. Subsidence is not considered to have undesirable results on the performance of hydrocarbon pipelines based on the fact that no incidents have been reported in the state through 2023.

1.1.9 Summary of Undesirable Results Caused by Subsidence

The undesirable results of subsidence on each type of infrastructure located within the Subbasin was independently discussed in the previous sections and are summarized in Table J1-2. Subsidence is considered to substantially interfere with surface land uses for the following infrastructure:

- Local Canals and Streams : The undesirable result is defined as a loss of conveyance of 20%.
- California Aqueduct : The undesirable result is defined as a loss of conveyance greater than 0%.
- Flooding and Flood Protection Levees : The undesirable result is defined as an increase in the height of the wetted perimeter of a canal or stream of 3 ft or more, or a decrease in the volume of water behind a flood protection levee that leads to an increase in water elevation of 2 ft or more, or a reversal of existing (i.e., in 2015) surface water drainage patterns in a way that causes local flooding.

Subsidence goals (i.e., minimum thresholds and measurable objectives) to meet sustainable goals that will mitigate the undesirable results will be developed and discussed in Section 1.2.1 and 1.2.3.

1.1.10 Potential Impacts to Beneficial Uses from Ground Subsidence

There are two types of potential impacts to beneficial uses resulting from an undesirable result in the confined aquifer.

1. *Impacts to beneficial uses and users of surface water.* If the subsidence undesirable result occurs, then transmission capacity of canals delivering surface water could be reduced by as much as 20% in one or more of the main delivery canals. Therefore, the impact to beneficial uses is a loss of delivery capacity that has historically been available to provide beneficial uses to irrigated lands. Since 2015, surface water delivery has averaged about 300,000 acre-feet per year (AF/Y), with a high of over 600,000 AF during the 2017 wet year and a low of about 54,000 AF in 2015. Therefore, the potential impact to beneficial uses and users of surface water are a reduction in canal capacity of up to 60,000 AF/Y (20% x 300,000). The actual value and the spatial distribution of these impacts will depend on site specific conditions in each canal and

canal system; the specific hydraulic profile at various delivery rates; and the ability of irrigation managers to adjust operations to respond to canal capacity losses.

2. *Impacts to beneficial uses and users in the confined aquifer*. Avoidance of undesirable results for subsidence will require pumping reductions in the confined aquifer, which will reduce the rate of groundwater levels in the confined aquifer (assuming that pumping reductions are also implemented in adjacent subbasins). Therefore, the impact to beneficial uses and users in the confined aquifer is a loss of production capacity in areas that have historically been put to beneficial use. The 2020 groundwater model indicated that a zero-change in aquifer storage in the confined aquifer was at a pumping rate of about 150,000 AF/Y. Recent pumping rates from the confined aquifer in dry years are estimated to be over 300,000 AF/Y. Therefore, the impact to beneficial uses in the confined aquifer are a pumping reduction of up to 150,000 AF/Y during a dry year. The spatial distribution of these impacts amongst beneficial users of the confined aquifer will need to be resolved through actual metering of pumping from the confined aquifer and an allocation process as part of GSP implementation.

Table J1-2: Summary of the effects of subsidence on beneficial users for each type of infrastructure

Possible Impacts to Beneficial Users from Subsidence	Does it meet definition of Undesirable Result?	Rationale and Definition of Undesirable Result (if Applicable)
Buildings Differential vertical movement between supports that could lead to increased stress in structural members that leads to collapse or renders the structure unsafe.	No	Buildings are only affected by differential subsidence over their footprint, which too small to affect the structural integrity of the building. No reports of historical damage to buildings from subsidence within basin.
Flood Protection Levees Decrease in the elevation of the top of the levee with respect to the elevation of the flood water that it is designed to contain (i.e., a reduction in the design storage volume), which could lead to flooding.	Yes	Population centers, critical facilities, and other lands need the protection that these structures provide. The undesirable result is defined within canals and flooding.
Roads and Railroads Differential vertical movement that causes pavement/embankment cracking, which could result in unsafe driving conditions.	No	Caltrans does not identify subsidence as a design factor because impacts from subsidence on roadways are repaired as result of normal maintenance. Caltrans and other road authorities conduct frequent inspections and implement local repairs to roads, where appropriate.
Bridges Differential vertical movement between piers and abutments that could lead to increased stress in structural members causing the structure to be inoperable or unsafe.	No	Bridges are unlikely to exhibit substantial differential subsidence across their span and they are unaffected by total subsidence. Bridges over canals may be affected by subsidence when the water level in the canal rises due to slope changes. This is addressed as an issue affecting Local Canals.

Possible Impacts to Beneficial Users from Subsidence	Does it meet definition of Undesirable Result?	Rationale and Definition of Undesirable Result (if Applicable)
Local Canals Decrease in regional or localized slope of the channel can lead to decreased ability to convey flow. Loss of freeboard. Cracking of lined canals could result in decreased ability to convey flow.	Yes	Decreased flow of a canal has an undesirable result on the users of the canal. Overflowing canals can cause flooding. Repair can be expensive. The undesirable results is defined as a loss of conveyance of 20% or more.
California Aqueduct Decrease in regional or localized slope of the channel that leads to decreased ability to convey flow. Loss of freeboard. Cracking of lining could result in decreased ability to convey flow.	Yes	Large portion of the population of California depends on the water conveyed by the California Aqueduct. Repair can be expensive. The undesirable result is defined as a loss of conveyance greater than 0%.
Flooding Reversal of surface water drainage patterns that may lead to flooding in areas not previously known to be susceptible to flooding.	Yes	Large areas can be affected by rising water leading to substantial property damage and possible loss of life. The undesirable result related to flooding is defined as an expansion or readjustment of the limit of the 100-year flood zone as defined by FEMA into critical areas such as population centers (i.e., areas within city limit boundaries) or locations containing public water supply infrastructure, or other infrastructure that serves a broad public use.

Possible Impacts to Beneficial Users from Subsidence	Does it meet definition of Undesirable Result?	Rationale and Definition of Undesirable Result (if Applicable)
Water Wells Vertical drag loads that exceed the capacity of the well leading to well failure	No	Subsidence is known to damage well casings, but domestic wells are less frequently screened in the C-Zone (i.e., below the Corcoran Clay). The parties more likely to be most affected are those benefiting from groundwater extraction in the C-Zone.
Pipelines Differential vertical movement between points that induces axial strain exceeding strain capacity.	No	According to the PHMSA database, past subsidence is not known to have had an impact on the integrity of pipelines in the San Joaquin Valley. Subsidence will decrease in the future as an effect of the implementation of the sustainability plan described in this report.

1.2 C-Zone Beneficial Uses Impacted by the Ground Subsidence Minimum Threshold

> **23 CCR §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.*

The potential C-zone beneficial uses that could be impacted by the subsidence minimum threshold (MT), fall into two types:

- *Impacts to beneficial uses and users of surface water.* If the MT for subsidence is reached near surface water delivery infrastructure, then transmission capacity of canals delivering surface water could be reduced by as much as 20%. Therefore, the potential impact to beneficial uses is a loss of delivery capacity that has historically been available to provide beneficial uses to irrigated lands. The actual impact to beneficial uses will depend on: which RMAs reach the MT; site specific conditions in the canals within that RMA; the specific hydraulic profile at various delivery rates; and the ability of irrigation managers to adjust operations to respond to canal capacity losses.
- *Impacts to beneficial uses and users of groundwater in the confined aquifer.* Compliance with the MTs for subsidence will require pumping reductions in the confined aquifer, which will reduce the rate of decline of groundwater levels in the confined aquifer. Therefore, the impact to beneficial uses and users in the confined aquifer is a loss of production capacity from wells that have historically been put to beneficial use. The magnitude and distribution of these impacts amongst beneficial users of the confined aquifer will need to be resolved through actual metering of pumping from the confined aquifer and an allocation process as part of GSP implementation.

1.2.1 Minimum Thresholds for Ground Subsidence

The minimum thresholds for subsidence are defined as the magnitude of total subsidence that leads to the undesirable result that was defined for each type of infrastructure in Section 1.1. The quantitative value for the minimum threshold is described in this section for canals and flood protection levees and flooding. Minimum thresholds for roads, bridges, buildings, wells, and pipelines are not defined because, as discussed in Section 1.1, subsidence alone does not have a detrimental effect on the performance of these infrastructure.

1.2.1.1 Local Canals and Streams

The amount of subsidence that may result in an undesirable result for canals and streams lined with flood protection levees is defined in Section 1.1.5 as a loss of conveyance or flow rate of 20%. This quantifiable undesirable result will be defined by a total amount of subsidence, as described below. Based on the technical analysis, MTs are defined for specific segments of the Last Chance Ditch System, Kings River (Federal Levees), Lemoore Canal System, and Kaweah River.

1.2.1.1.1 Technical Background

Following from Manning's equation for flow rate in open channels that was defined in Section 1.1.5 (Eq. J-1), the initial (Q_i) and final (Q_f) flow rate through a channel can be described by the following equations:

$$Q_i = \frac{1.486}{n} \cdot A \cdot R^{\frac{2}{3}} \cdot S_i^{\frac{1}{2}} \qquad \textbf{Eq. J-2}$$

$$Q_f = \frac{1.486}{n} \cdot A \cdot R^{\frac{2}{3}} \cdot S_f^{\frac{1}{2}} \qquad \textbf{Eq. J-3}$$

If the flow area (A), roughness coefficient (n), and hydraulic radius (R) are unchanged, the ratio of the initial and final flow rate of the channel can be defined by a factor F as follows:

$$F = \frac{Q_i}{Q_f} = \sqrt{\frac{S_i}{S_f}} \qquad \textbf{Eq. J-4}$$

The final slope (S_f) is equal to the initial slope (S_i) plus the change in slope (ΔS, which is defined here as a positive number if the final slope is steeper and a negative number if the final slope is flatter), hence:

$$F = \sqrt{\frac{S_i}{S_f + \Delta S}} \qquad \textbf{Eq. J-5}$$

The factor F can be used to assess the detrimental effect of subsidence on the ability of a channel to convey flow. For example, if the final flow rate of the channel is 90% of the initial flow rate, or a 10% reduction in the flow rate, then F is 1.0/0.9 = 1.11.

Thus, with knowledge of the initial slope of a channel, we can calculate the change in slope that would cause a 10% reduction of the flow rate using the following equation (Eq. J-6):

$$\Delta S = S_i \cdot (1/F^2 - 1) \qquad \textbf{Eq. J-6}$$

The change in slope (ΔS) is also equal to the ratio of the change in ground elevation (ΔE) between two points along the channel (A and B) and the distance between the points (d_{AB}) (see Figure J2-1):

$$\Delta S = \frac{\Delta sub}{d_{AB}} = \frac{\Delta E_B - \Delta E_A}{d_{AB}} \qquad \textbf{Eq. J-7}$$

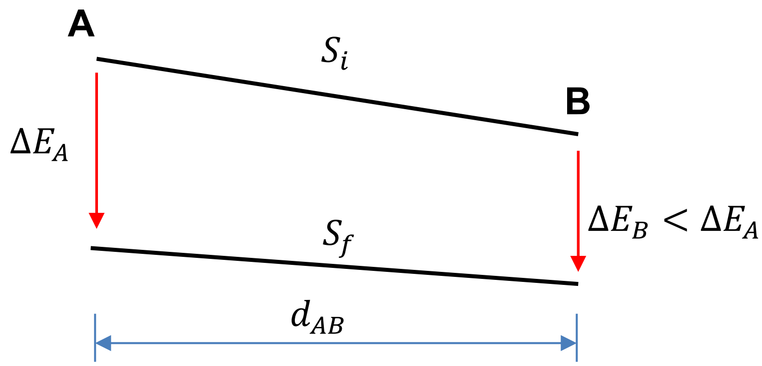

Figure J2-1: Definition of terms used to define subsidence minimum thresholds for canals

Eq. J-6 and Eq. J-7 can be used (directly or rearranged) to calculate the amount of differential subsidence that would cause a given loss of flow rate in a canal. The California Aqueduct, for example, was designed with an initial slope of $4x10^{-5}$ (ft/ft), thus from Eq. J-6, a reduction of 10% in flow (i.e., F = 1.11) would develop if the change in slope (ΔS) is $-7.6x10^{-6}$ (ft/ft). Using Eq. -7, this change in slope corresponds to differential subsidence (Δsub) of 0.40 feet over a 10-mile length (0.4 ft/52,800 ft = $-7.6x10^{-6}$ ft/ft).

The difference between the elevation of two points A and B on the canal is Δsub per Eq. -8. This term can be obtained through Eq. J-9 by calculating the term ΔS from Eq. J-6 and by defining two points A and B with a known distance between them (d_{AB}).

$$\Delta sub = \Delta E_B - \Delta E_A$$ **Eq. J-8**

$$\Delta sub = \Delta S \times d_{AB}$$ **Eq. J-9**

The total amount of subsidence (or change in elevation) at points A and B can be obtained after calculating Δsub. This is done by first introducing a term R that defines the ratio of the change in elevation of point B and point A along a channel (Eq. J-10), and substituting Eq. J-10 in Eq. J-8. The result is Eq. J-11, where the magnitude of the Δsub is a function of R and the amount of total subsidence at point A (ΔE_A).

$$R = \frac{\Delta E_B}{\Delta E_A}$$ **Eq. J-10**

$$\Delta sub = \Delta E_A \cdot (R - 1)$$ **Eq. J-11**

Rearranging Eq. J-11, the amount of subsidence at a given point A (ΔE_A) that incorporates the minimum threshold that is defined for a given loss of conveyance can be established with Eq. J-12.

$$\Delta E_A = \frac{\Delta sub}{(R - 1)}$$ **Eq. J-12**

The total amount of subsidence for points along channels within the Tulare Lake Subbasin will be calculated in the next section using the equations defined above.

1.2.1.1.2 Calculation of Minimum Thresholds and Total Subsidence

As previously discussed, InSAR data are available for the Subbasin area and can be used to evaluate the amount and rate of subsidence that has occurred since June 2015. Figure J2-2 shows the amount of subsidence in the Tulare Lake Subbasin between June 2015 and January 2023 and the alignment of five canals, namely People's Ditch, Kings River, Lemoore System, Last Chance Ditch, and Kaweah River that were selected because they flow from north to south. As may be noticed on Figure J2-2, the canals traverse areas with a non-uniform amount of subsidence such that the slope of the canal will have increased in portions of the canal and decreased in other portions of the canal due to subsidence. The total amount (i.e., cumulative amount) of subsidence calculated using the InSAR data since January 2016 and the resulting annual rate of subsidence for every year calculated in the month of January (e.g., January 2016 to January 2017, etc.) is plotted as a function of the distance from the northernmost point for People's Ditch, Kings River, Lemoore System, Last Chance Ditch, and Kaweah River on Figure J2-3 to Figure J2-7, respectively. In the plots, subsidence is presented as a negative value when the direction is downwards, and positive when there is upwards rebound.

The plots of rate of subsidence on Figure J2-3 to Figure J2-7 show that:

- subsidence has occurred along these canals every year since 2016,
- the magnitude and rate of subsidence has not been uniform on an annual basis since January 2016,
- the rate of subsidence was similar and can be grouped for the following time periods:
    - January 2022 and 2023, January 2016 and 2017, and January 2021 and 2022,
    - January 2018 and 2019, and January 2020 and 2021
    - January 2017 and 2018, and January 2019 and 2020.
- the highest rate of subsidence was measured to be in the high-end range of 0.9 to 1.0 ft/year. The lowest rate of subsidence in areas where the highest amount of subsidence had been measured, is in the range of 0.3 and 0.4 ft/year.
- the areas along the alignment of the canals that exhibited the highest amount of subsidence experienced up to 5 ft of total subsidence between January 2016 and January 2023. Additional amounts of subsidence have occurred since January 2023.
- The curves of Figure J2-3 show that the slope along the People's Ditch has been increasing almost entirely throughout the length of the channel.
- The curves of Figure J2-4 show that the slope along the levees next to the Kings River has been increasing from station 0 to approximately station 100,000. The slope appears to be decreasing approximately from station 100,000 to station 110,000 and from station 145,000 to station 162,000.
- The curves of Figure J2-5 show that the slope of the Lemoore System has been increasing from station 0 to approximately station 40,000. The slope appears to be decreasing approximately from station 40,000 to station 52,000 and from station 85,000 to station 97,000.

- The curves of Figure J2-6 show that the slope of the Last Chance Ditch has been decreasing. The starting point of the canal in the north is subsiding more than the terminus in the south.
- The curves of Figure J2-7 show that the slope of the Kaweah River has been increasing from station 0 to approximately station 50,000. The slope appears to be decreasing approximately from station 50,000 to station 70,000 and from station 100,000 to station 125,000.

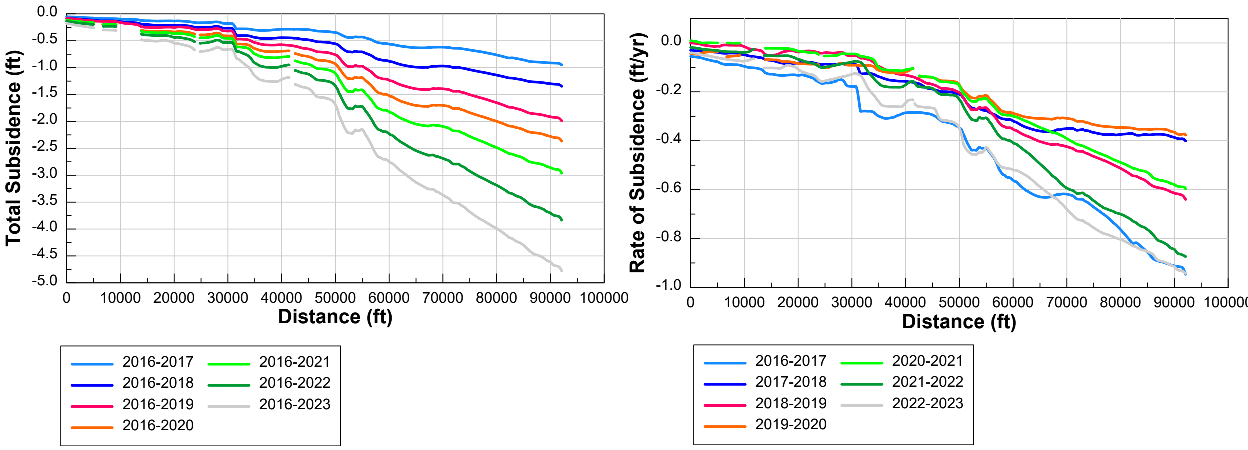

Figure J2-3: Total subsidence (left) and annual rate of subsidence (right) for People's Ditch

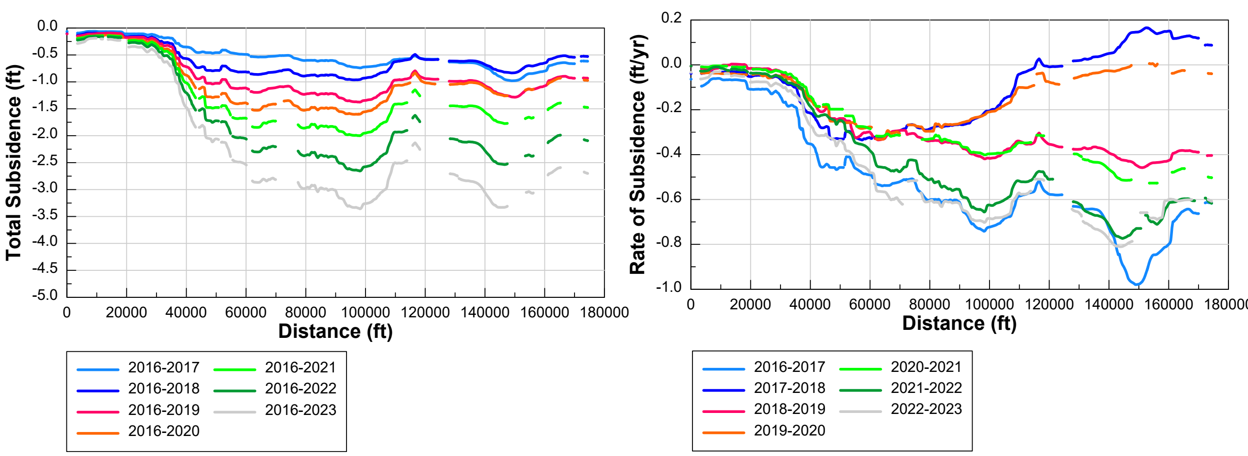

Figure J2-4: Total subsidence (left) and annual rate of subsidence (right) for Kings River

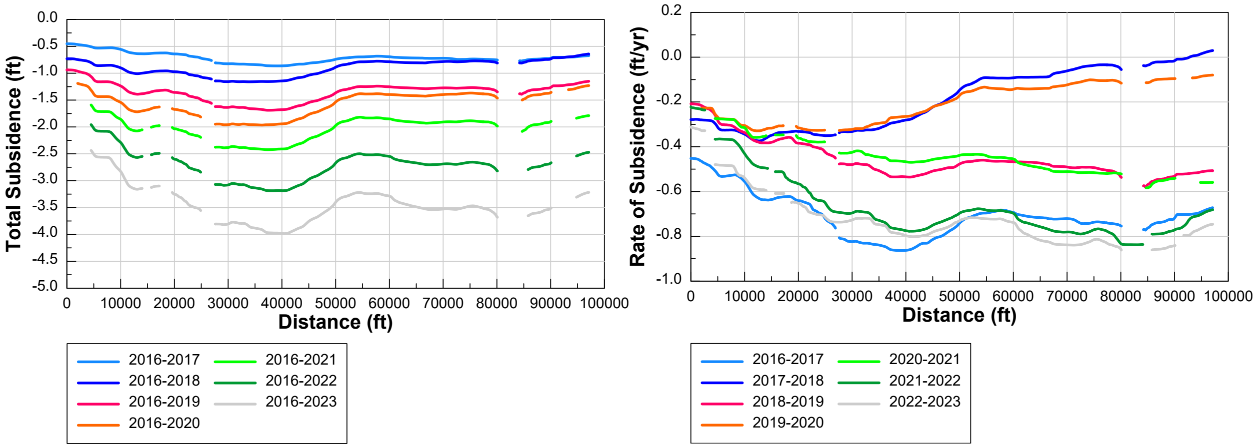

Figure J2-5: Total subsidence (left) and annual rate of subsidence (right) for the Lemoore System canal

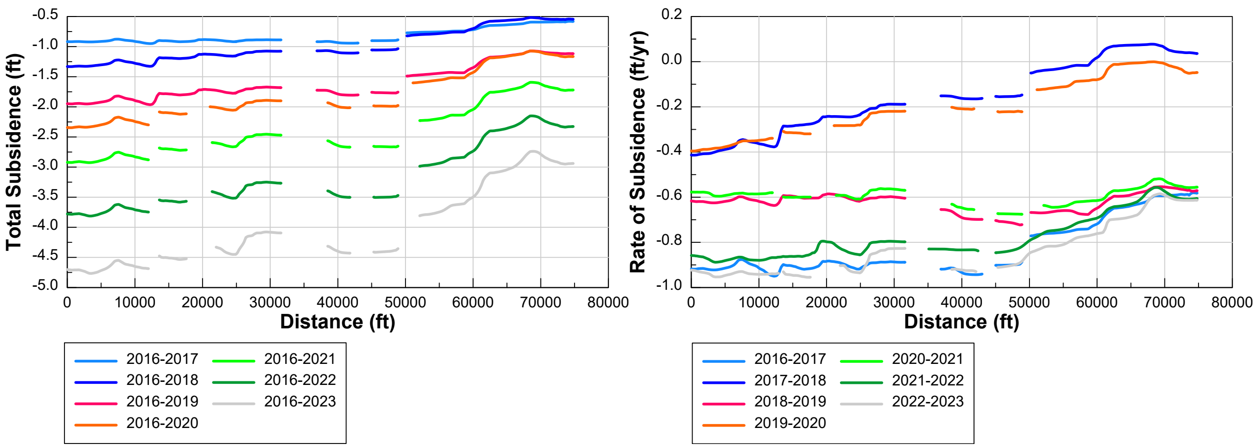

Figure J2-6 Total subsidence (left) and annual rate of subsidence (right) for Last Chance Ditch

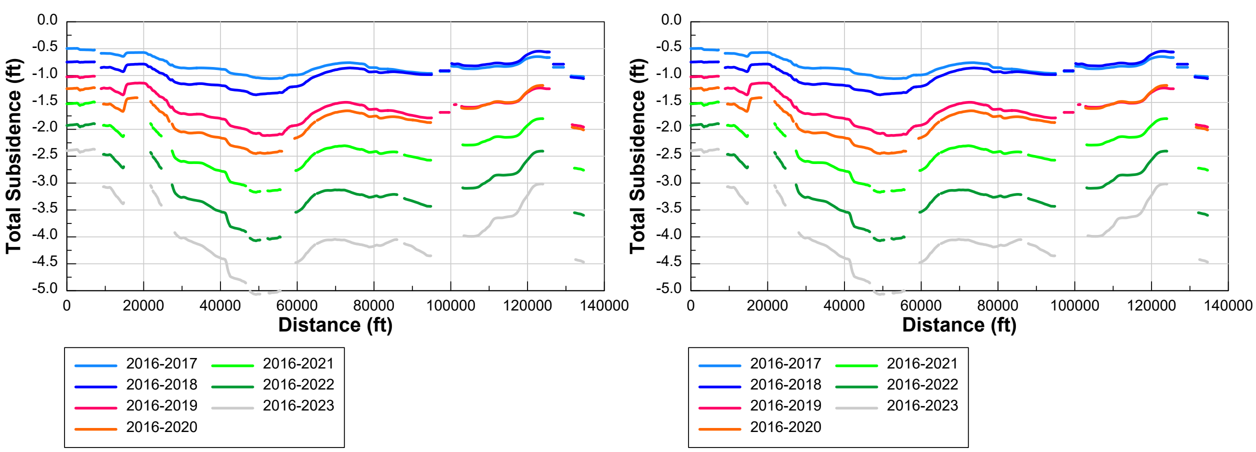

Figure J2-7 Total subsidence (left) and annual rate of subsidence (right) for Kaweah River

The subsidence data presented can be used to understand how the non-uniformity of the rate of subsidence and total amount of subsidence could be affecting the slope of the ground surface and therefore the ability of canals to convey flow.

The elevation profile of the canals is presented in Figure J2-8 using topographic data from 2020 and the average slope of the canals is listed in Table J2-1. The change in slope needed to cause a loss of conveyance of 20% per Eq. J-6 is also listed on Table J2-1.

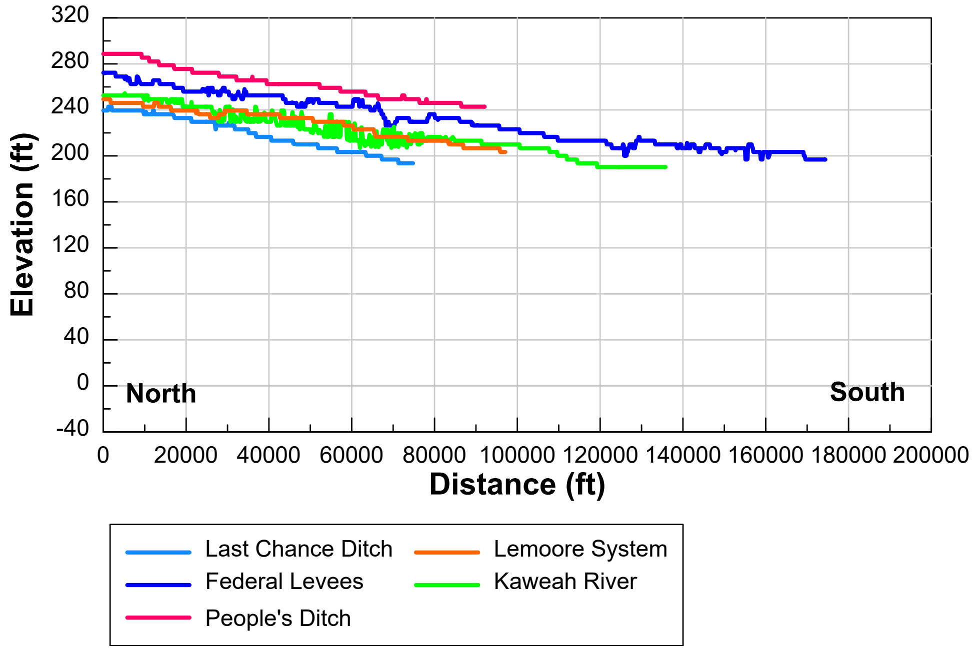

Figure J2-8: Elevation profiles of five canals that flow from north to south in the Tulare Lake Subbasin

Table J2-1. Initial slope of five north-south flowing canals in the Tulare Lake Subbasin

Canal	Slope (ft/ft)	ΔS per Eq. K-6 for 20% Loss of Conveyance
Last Chance Ditch	6.92×10^{-4}	-2.49×10^{-4}
Kings River (Federal Levees)	4.21×10^{-4}	-1.51×10^{-4}
Lemoore System	4.59×10^{-4}	-1.65×10^{-4}
Kaweah River	6.05×10^{-4}	-2.18×10^{-4}
People's Ditch	5.18×10^{-4}	-1.87×10^{-4}

Observation of Figure J2-3 to Figure J2-7 allow the identification of points along the alignment of the channel where the slope is reversing. Two points (A and B) were selected on the Kaweah River, and two pairs of points were selected for the Last Chance Ditch System, Lemoore System, and the Kings River. The station of these points is listed on Table J2-2, where the magnitude of the relative subsidence to cause an undesirable result of 20% loss of conveyance is also provided based on Eq.

J-9. The value of the ratio of subsidence between June 2015 and January 2023 measured at these points (R) was used to calculate the change in elevation (i.e., subsidence) at point A (ΔE_A) using Eq. J-12 and point B (ΔE_B) using Eq. J-10. The results of these calculations are listed in Table J2-2, where subsidence is expressed as a positive value. The values of subsidence calculated for points A and B (ΔE_A and ΔE_B, respectively) are also plotted in Figure J2-9.

Table J2-2: Calculation of the amount of subsidence associated with the minimum threshold

Canal	Station of Point A	Station of Point B	Distance, d_{AB} (ft)	Δsub (ft)	R	ΔE_A (ft)	ΔE_B (ft)
Last Chance Ditch System	5,000	55,000	50,000	-12.46	0.60	31.3	18.8
Last Chance Ditch System	25,000	27,000	2,000	-0.50	0.93	7.4	6.9
Kings River (Federal Levees)	100,000	105,000	5,000	-0.76	0.90	7.6	6.8
Kings River (Federal Levees)	145,000	162,000	17,000	-2.57	0.70	8.6	6.0
Lemoore System	42,000	50,000	8,000	-1.32	0.80	6.6	5.3
Lemoore System	86,000	96,000	10,000	-1.65	0.85	11.0	9.4
Kaweah River	60,000	66,000	6,000	-1.31	0.82	7.3	6.0

With the exception of the values calculated for two of the points on the Last Chance Ditch System, which exhibits the highest initial slope of the canals that were evaluated (see Table J2-1) and is aligned within an area that has not undergone very significant differences in subsidence (see Figure J2-6, the values of total subsidence listed in Table J2-2 range between 11 ft and 5.3 ft, which is a relatively narrow range. Figure J2-10 shows contours of total subsidence that were developed using the results of the analysis described above. These contours restrict the amount of subsidence within the areas that have historically exhibited the greatest amount of subsidence to 6 ft in order to avoid a reduction of 20% in conveyance capacity of the canals. However, areas within TLSB that have historically exhibited small amounts of subsidence can continue to exhibit similar rates of subsidence without perceived effects on the canals that were evaluated herein.

Subsidence Management Area 1 includes three active subsidence monitoring stations; LEMA, SUB111, and SUB055. SUB055 is not within the boundaries of the TLSB, but it provides data that can be used for the following assessment. Figure J2-11 presents plots of subsidence at these monitoring stations since January 1, 2020 (i.e., the date of the first submittal of the Subbasin's first GSP) as well as a 6-ft subsidence minimum threshold, which indicate that between approximately 3 and 4 ft of subsidence may be allowed to occur in this area at individual monitoring stations before reaching the minimum threshold value.

Figure J2-12 shows the plots of subsidence monitoring stations within Subsidence Management Area 2, where their location closest to reaching the minimum threshold value of 7 ft is the CRCN station located in the City of Corcoran, where approximately 4.5 ft of subsidence may be allowed to occur as a sustainable groundwater water level is developed in the confined aquifer before reaching the minimum threshold value. However, approximately 6 ft of subsidence may be allowed to occur at monitoring stations SUB028, SUB032, SUB61, SUB86, SUB102 before reaching the minimum threshold value.

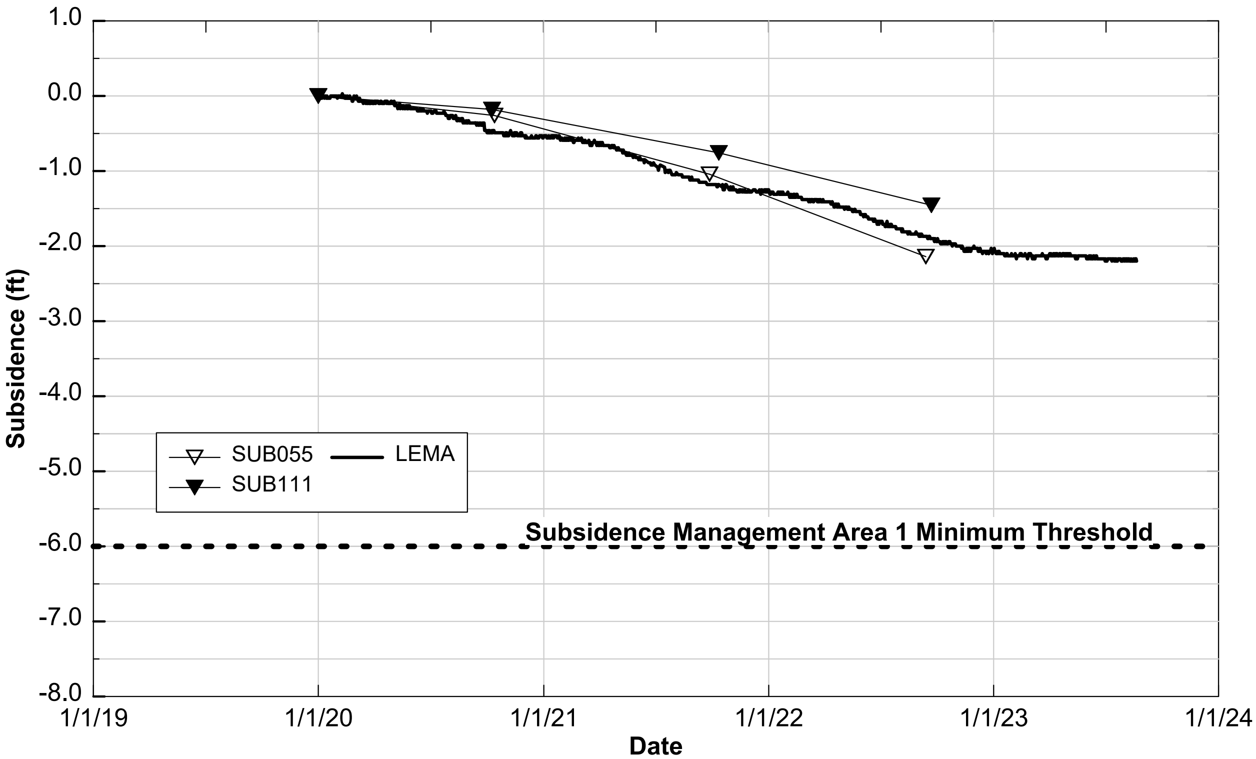

Figure J2-11: Subsidence since January 2020 within Subsidence Management Area 1.

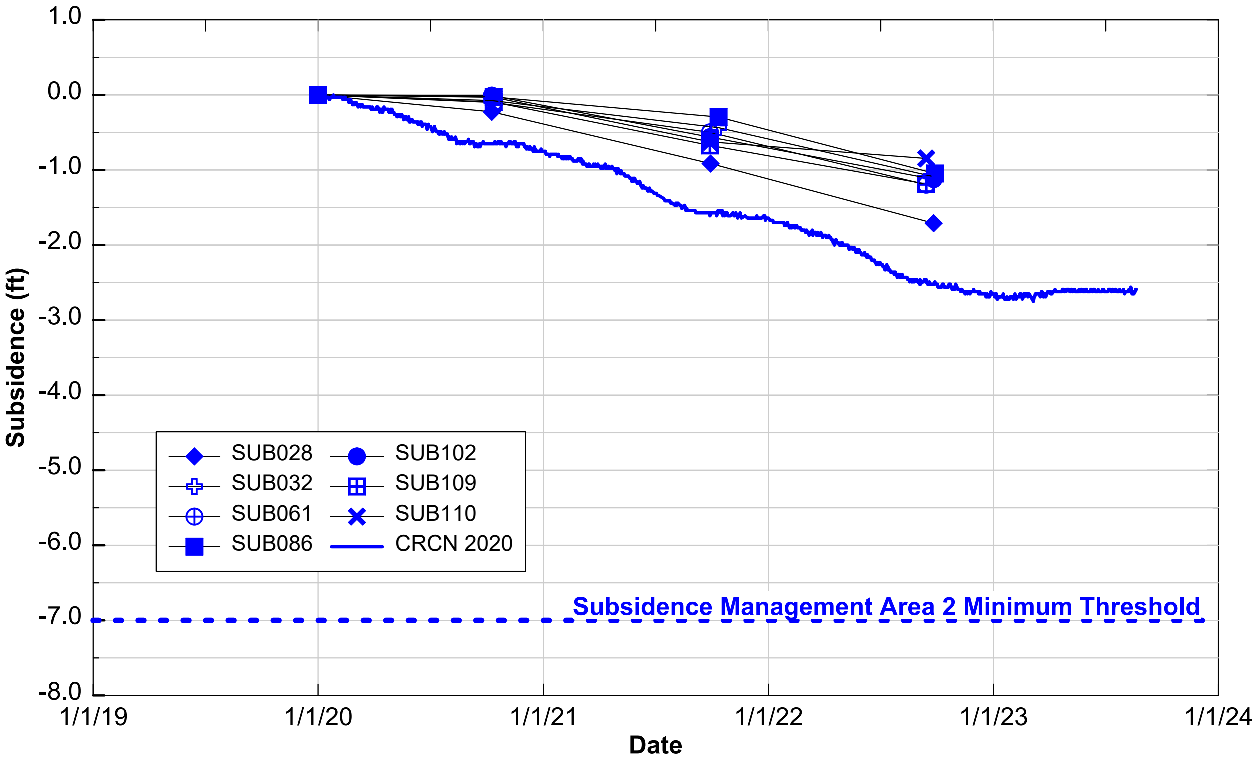

Figure J2-12: Subsidence since January 2020 within Subsidence Management Area 2.

1.2.1.1.3 Estimation of Groundwater Elevations in Wells

Analysis of the continuous subsidence measurements from stations LEMA in Figure J2-11 and CRCN in Figure J2-12 shows that subsidence at these locations was small or approximately zero in 2017, and 2019. Inspection of Figure 3A.5.6-3 shows that the CRCN monitoring station also exhibited near zero subsidence in 2011. This was also the condition at the LEMA monitoring station, but the data is not presented in this report. Similarly, plots of InSAR data through five canals presented in Figure J2-3 to Figure J2-7 showed that calendar years 2017 and 2019 exhibited the lowest rate of subsidence, but not zero everywhere. The relationship between groundwater elevation in the confined aquifer and subsidence that was discussed in Section 3A.5.6 can be used to estimate the elevation of groundwater that leads to lower rates of subsidence measured in 2011, 2017, and 2019.

Figure J2-13 presents hydrographs of observation wells screened in the C-Zone (i.e., below the Corcoran Clay and within the confined aquifer) that have measurements in the 2011, 2017, or 2019 period. There are only 12 C-Zone observation wells in the Subbasin with data in any of these periods. Of these, the well that provides the greatest insight is MWH Deep, which contained an electronic transducer that recorded water levels at 4-hour intervals. The hydrograph of this well shows how water levels fluctuate throughout the year from peak low values that occur at the end of the growing season, which is in mid to late October, to peak high values that occur after pumping has been shut off following the end of the growing season and water levels recover to static levels. Regarding peak and troughs, the hydrograph of DWH Deep shows that:

- the peak high value was approximately constant and between 75 and 80 ft in 2016, 2017, 2018, 2019, and 2020, but decreased more than 20 ft and in the range of 50 and 60 ft in 2021, 2022, and 2023.
- the lowest measurements in 2017 and 2019 are higher than in the other years which is consistent with lower rates of subsidence during that period that have been discussed above.
- The troughs of 2020, 2021, and 2022 are each lower than the previous year, which consistent with a decreasing peak shows evidence of the need to lower the water level to extract similar flow rates as previous years, which is unsustainable in the long term.

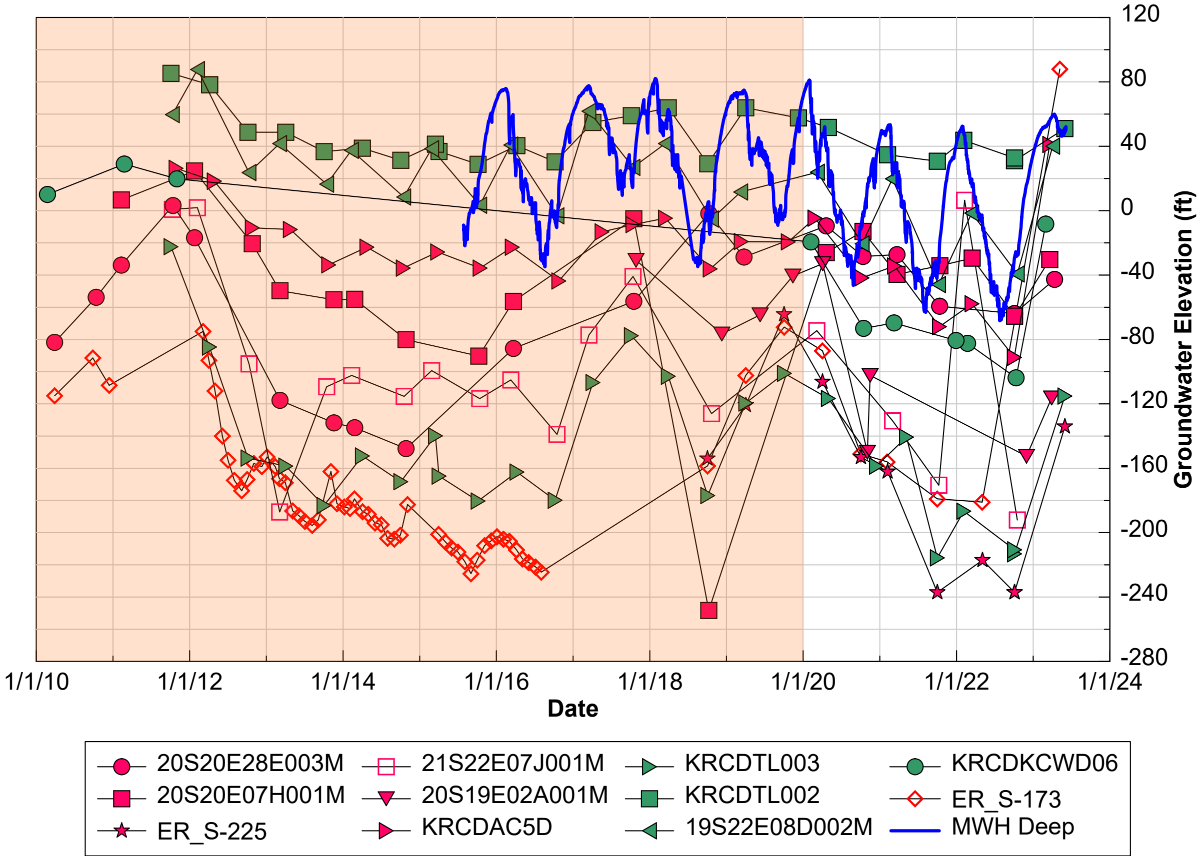

Figure J2-13 Hydrographs of groundwater elevation in C-zone wells that have data for the 2011, 2017, or 2019 period.

The groundwater elevation in these wells during 2011, 2017, and 2019 are summarized in Table J2-3, where values were averaged at wells that had more than one measurement in a given year and were rounded to whole numbers. These groundwater elevation values can be used as proxies for conditions that lead to low rates of subsidence at each well location. As such the last column of Table J2-3 lists the proxy values that were selected by choosing the lowest groundwater elevation measured in any of the low subsidence years.

Table J2-3. Groundwater elevation in C-zone wells within TLSB that have data for the 2011, 2017, or 2019 period

C-Zone Well Name	Groundwater Elevation During Periods of Low Subsidence			Groundwater Elevation Proxy for Low Rate of Subsidence
	2011	2017	2019	
19S22E08D002M	60	45	12	12
KRCDTL002	86	57	61	61
KRCDTL003	-22	-92	-110	-110
KRCDAC5D	27	-11	-19	-19
KRCDKCWD06	25	No Data	No Data	25
ER_S_225	No Data	No Data	-85	-85
ER_S_173	No Data	No Data	-95	-95
20S20E28E003M	-15	-57	-29	-57
20S20E07H001M	7	-5	No Data	-5
20S19E02A001M	No Data	No Data	-52	-52
21S22E07J001M	1	-59	No Data	-59
MWH Deep	No Data	51	44	44

1.2.1.1.4 Undesirable Result and Minimum Threshold

The undesirable result for local canals and streams was defined as a 20% reduction in conveyance capacity for channels (Section 1.1.5). The total amount of subsidence that can lead to this undesirable result was calculated for sections of five canals that flow north to south through areas where subsidence has caused reduction in the slope of the channel. The calculated total amount of subsidence was then used to establish minimum thresholds for two RMAs. The process that will be followed to relate exceedance of minimum thresholds with undesirable results related to local canals and streams is illustrated in Figure J2-14. As shown, if minimum thresholds are exceeded in the InSAR data within 10% of the respective subsidence RMA, then the GSAs will evaluate the slope of the canal to confirm that the change has caused an undesirable result.

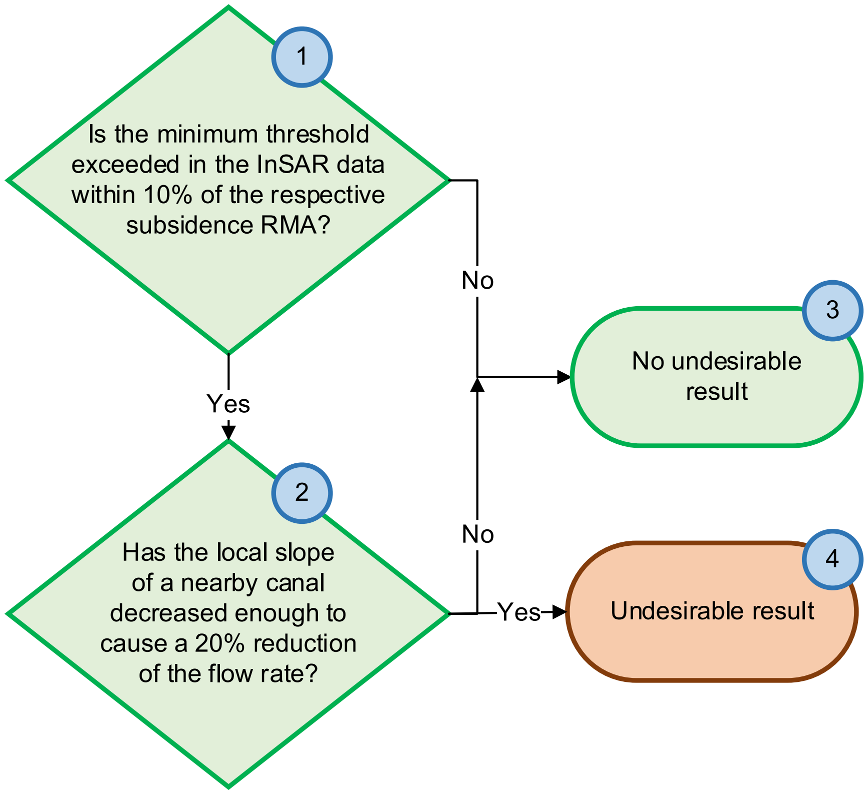

Figure J2-14 Relationship between minimum thresholds for local canals and streams and undesirable results.

1.2.1.2 California Aqueduct

As discussed in Section 1.1.5, DWR has expressed that any loss of conveyance in the California Aqueduct is an undesirable result. Therefore, the minimum threshold for subsidence along the California Aqueduct is 0 ft.

Figure J2-15 presents the subsidence measurements at monitoring stations SUB027, SUB030, and SUB076 located along the alignment of the California Aqueduct since 2010. As shown, less than 0.5 ft of subsidence occurred since 2010 and data is discontinuous and insufficient to estimate the amount of subsidence that has occurred along the structure since 2015. However, all three monitoring stations exhibit a tendency since late 2019 indicative of upward movement that may represent rebound of previously induced elastic subsidence.

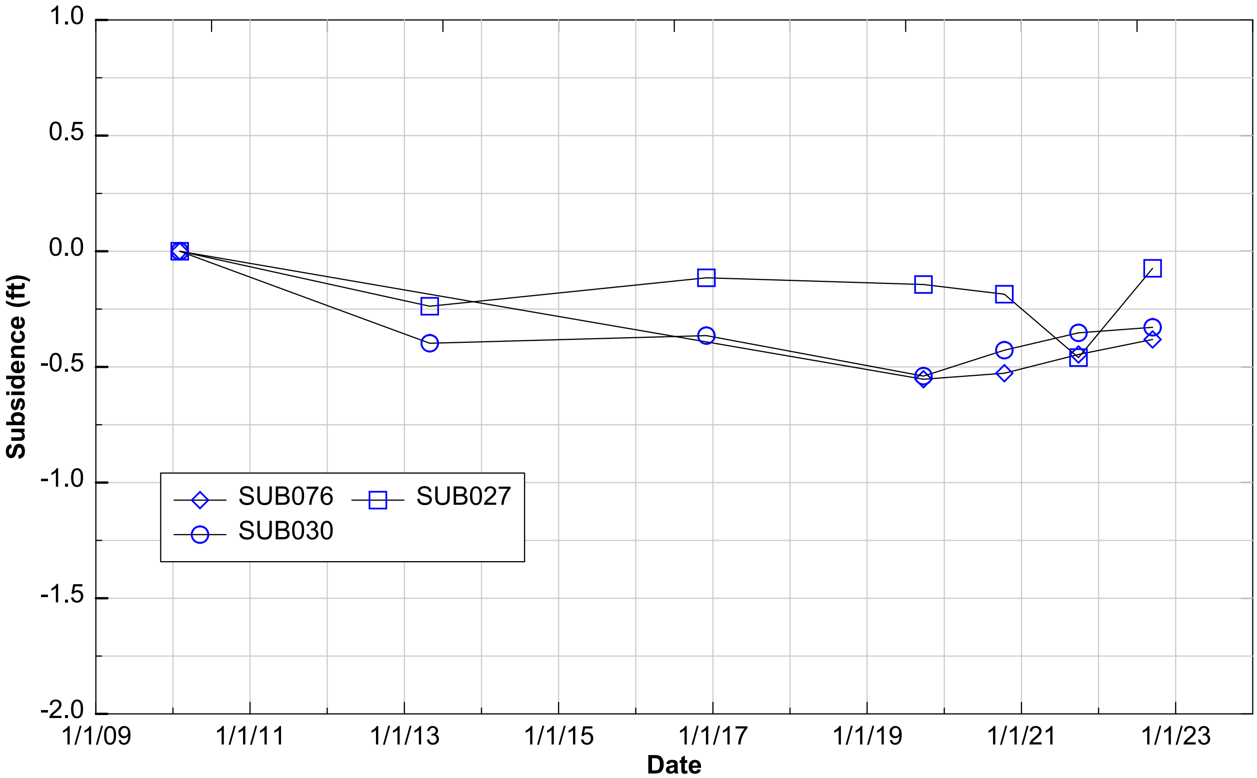

Figure J2-15 Subsidence measurements at existing monitoring stations along the California Aqueduct.

1.2.1.3 Flooding

In Section 1.1.6, the undesirable result for flooding was defined as an expansion of the 100-year flood zone defined by FEMA that is solely caused by subsidence. There are many factors that could cause an expansion of the 100-year floodplain, including changes to the land use in the watershed; changes to or lack of maintenance of drainage infrastructure such as levees, canals, embankments; or changes in precipitation patterns due to climate change. So, although the undesirable result is defined as expansion of the 100-year flood zone, there are multiple factors in addition to subsidence that can affect the shape and extent of a flood zone (i.e. the undesirable result may not be caused exclusively by subsidence). The following subsidence related effects can cause migration of the flood zone:

- Reduction of the slope of a canal or stream leading to a rise in the water level at that section of the canal or stream beyond the freeboard included in the design. In this case, the section of the canal or stream also includes the flood protection levees, where present.
- Reduction of the elevation of a flood protection levee with respect to the flood area that it is meant to contain and thus reduce the total volume of water that is meant to be stored.

- Nonuniform or differential amounts of subsidence within areas of the Subbasin that cause changes to surface drainage patterns, which can lead to ponding or flooding in areas not previously known to be susceptible to flooding.

Therefore, minimum thresholds for each of these conditions are defined separately and independently from the various other factors that could contribute to expansion of the 100-year flood zone. Table J2-4 summarizes subsidence MTs related to flooding.

IMPORTANT NOTE: Because subsidence is a regional phenomenon, the total subsidence that will occur in the future will depend on whether there is sufficient regional reduction in pumping from the confined aquifer in basins adjacent to the Tulare Lake Subbasin. Thus, if MTs are reached, it may not be the result of inadequate implementation of the GSP by the GSAs in the Tulare Lake Subbasin.

Table J2-4. Minimum thresholds for flooding

Undesirable Result	Minimum Threshold
Reduction of the slope of a canal or stream leading to a rise in the water level at that section of the canal or stream beyond the freeboard included in the design.	The minimum threshold for this condition is defined as an increase in the height of the wetted perimeter of a canal or stream that is equal to the freeboard, which is considered to be 3 ft for most canals and USACE designed levees.
Reduction of the elevation of a flood protection levee with respect to the flood area that it is meant to contain and thus a reduction of the total volume of water that is meant to be stored behind the levee.	The minimum threshold for this condition is defined as a decrease of the volume of water that leads to an increase in water elevation of 2 ft for the volume defined for the original condition.
Nonuniform or differential amounts of subsidence within areas of the Subbasin that cause changes to surface drainage patterns	Reversal of existing (i.e., in 2015) surface water drainage patterns in a way that causes local flooding.

1.2.2 Relationship to Other Sustainability Indicators

Described below are the relationship between MTs for each sustainability indicator, including an explanation of how it was determined that basin conditions at the MTs for degraded water quality will avoid undesirable results for each of the other applicable sustainability indicators to the Subbasin.

MTs for degraded water quality are selected to avoid undesirable results for the other applicable sustainability indicators in the Subbasin.

- **Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage**. There are limited groundwater quality data available in the Subbasin to support a connection between groundwater levels or storage changes and elevated concentrations of COCs. However, the MTs established for degraded water quality could impact direct use of supplemental water supplies for groundwater recharge projects, where ambient water quality may constrain supplies available for recharge or require additional treatment prior to land application or injection, and could thus limit the ability to maintain the measurable objectives established for the chronic lowering of groundwater levels or reduction of groundwater storage sustainability indicator if such projects were to be identified for implementation.

- **Seawater Intrusion**. This sustainability indicator is not applicable to the Subbasin.
- **Land Subsidence**. Based on local knowledge and the best available science, degraded water quality and land subsidence MTs are not related. Therefore, MTs for degraded water quality are not anticipated to cause undesirable results for land subsidence.
- **Depletion of Interconnected Surface Water**. For areas within the Subbasin where interconnected surface water may exist, MTs for degraded water quality are established to be protective of drinking water standards or current water quality (based on available data from 2000 to 2020) where current conditions exceed drinking water standards (the highest beneficial use of water in California), consistent with California's Antidegradation Policy. Additionally, the volume of surface water in the interconnected surface water courses in the Subbasin is much larger than the volume of water that the aquifer is contributing to those streams. As such, while surface water quality is not within the purview of SGMA, the MTs for degraded water quality are not anticipated to degrade the quality of interconnected surface water.

1.2.3 Measurable Objectives for Subsidence

The measurable objective for subsidence is defined as a zero or near-zero subsidence rate by the year 2040. The current rate of subsidence is on the order of 1 foot per year. The rate at which subsidence rates decrease is expected to be proportional to rate at which pumping decreases in the confined aquifer. Between now and 2040, there will be continued subsidence as pumping restrictions are implemented in the confined aquifer. However, the MT for subsidence establishes that no more than 6 additional feet of subsidence will occur.

1.2.3.1 Interim Milestones

Interim milestones for subsidence are set based on a reduction from the current rate of 1 foot per year to a rate of 0 feet per year by the year 2040 in each Subsidence RMA. The interim milestones are expresses as a percentage reduction from the current average subsidence in each RMA. These percent reductions as summarized below:

- 2025-2030: Average Subsidence rate of 0.65 ft/yr
- 2030-2035: Average Subsidence rate of 0.15 ft/yr
- 2035-2040: Average Subsidence rate of 0.05 ft/yr
- 2040: Average subsidence rate of 0 ft/yr

IMPORTANT NOTE: Because subsidence is a regional phenomenon these measurable objectives likely will not be achieved without a regional reduction in pumping from the confined aquifer.

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Thus, if these interim milestones are not reached, it may not be the result of inadequate implementation of the GSP by the GSAs in the Tulare Lake Subbasin.

1.2.4 Land Subsidence Interim Milestones

The interim milestones will be based on the cumulative amount of subsidence observed within a Subbasin over five-year incremental periods. The interim milestones are 2 feet of subsidence over a 5-year period. Subsidence of 2 foot within the Subbasin over 5 years would trigger the following actions:

1. Capacity analysis to evaluate the impact of subsidence on critical infrastructure. If no capacity issues are identified, then there is no undesirable result
2. If there is a capacity issue, then the facility will be mitigated through modifications and retrofits
3. Investigate what is causing the land subsidence, and whether actions to decrease or eliminate subsidence are within the GSAs control
4. If the facility cannot be restored to its original functions, then significant actions may be needed, such as reductions in pumping or importation of additional surface water supplies, to minimize further subsidence.

If land subsidence exceeds the interim milestone, then there will be increased monitoring of impacts to infrastructure and coordination with neighboring subbasins who may be causing the undesirable results. If the land subsidence exceeds the Minimum Threshold and causes an undesirable result, then GSAs will implement actions identified in this GSP.

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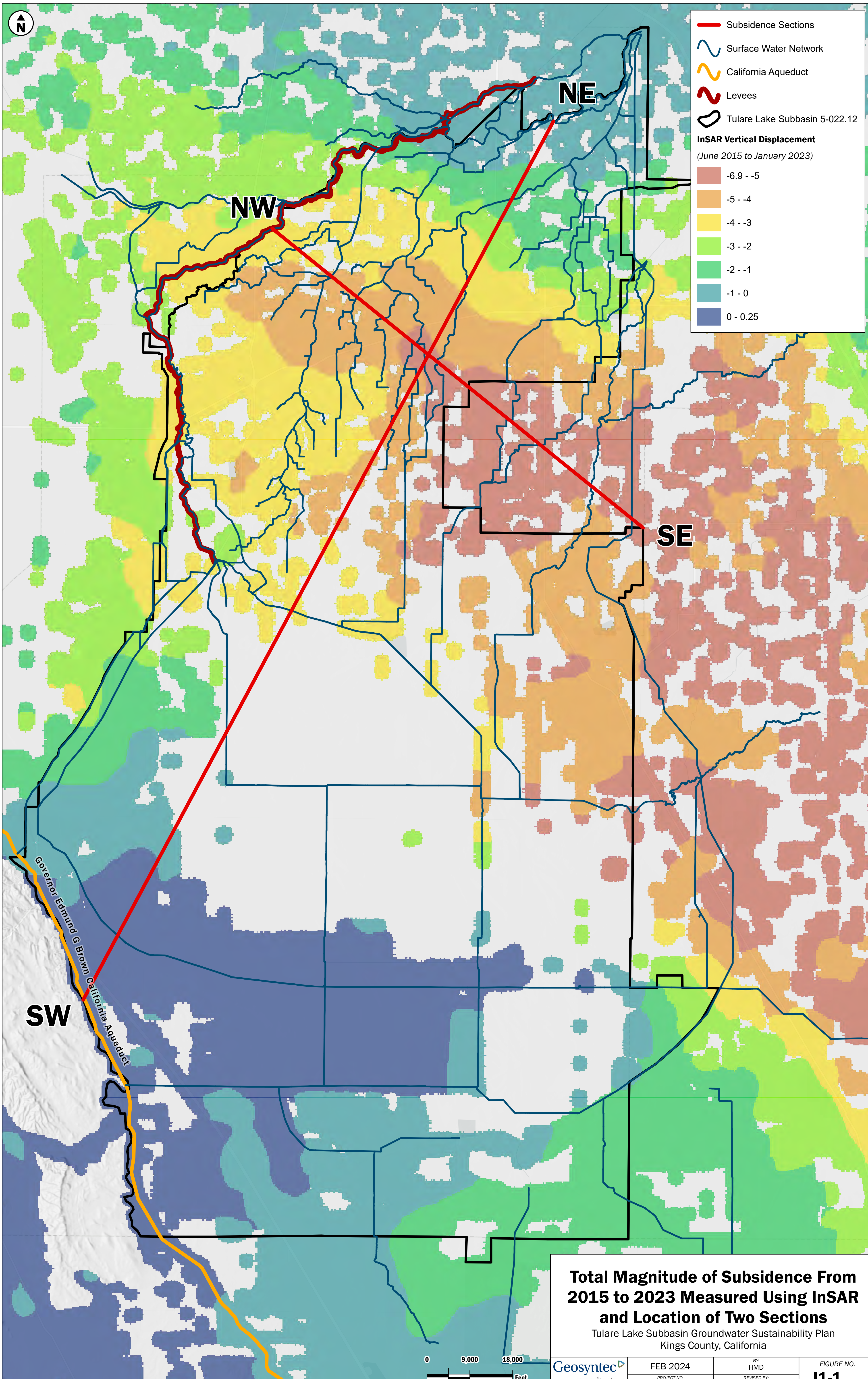
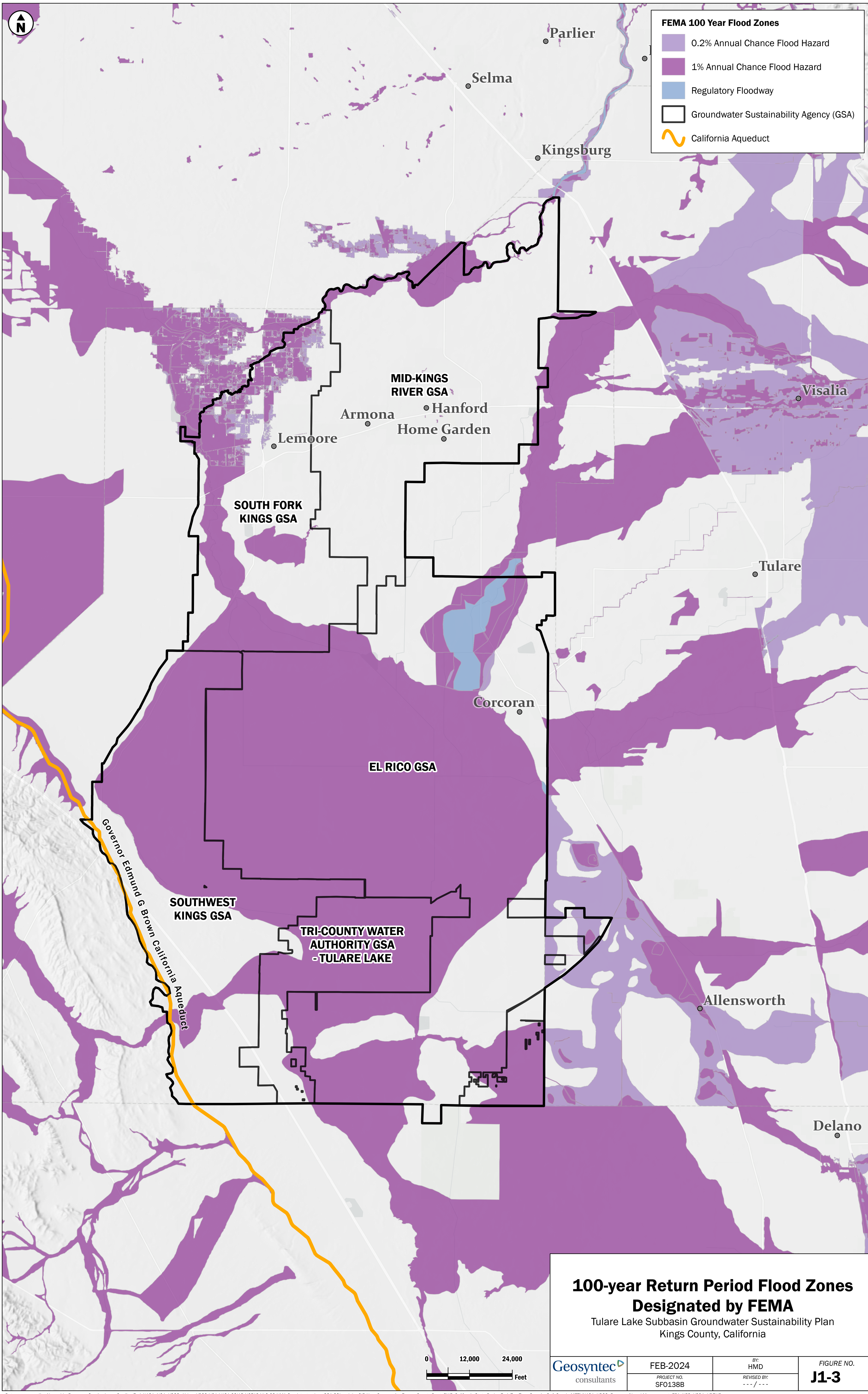


Total Magnitude of Subsidence From 2015 to 2023 Measured Using InSAR and Location of Two Sections

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	J1-1

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

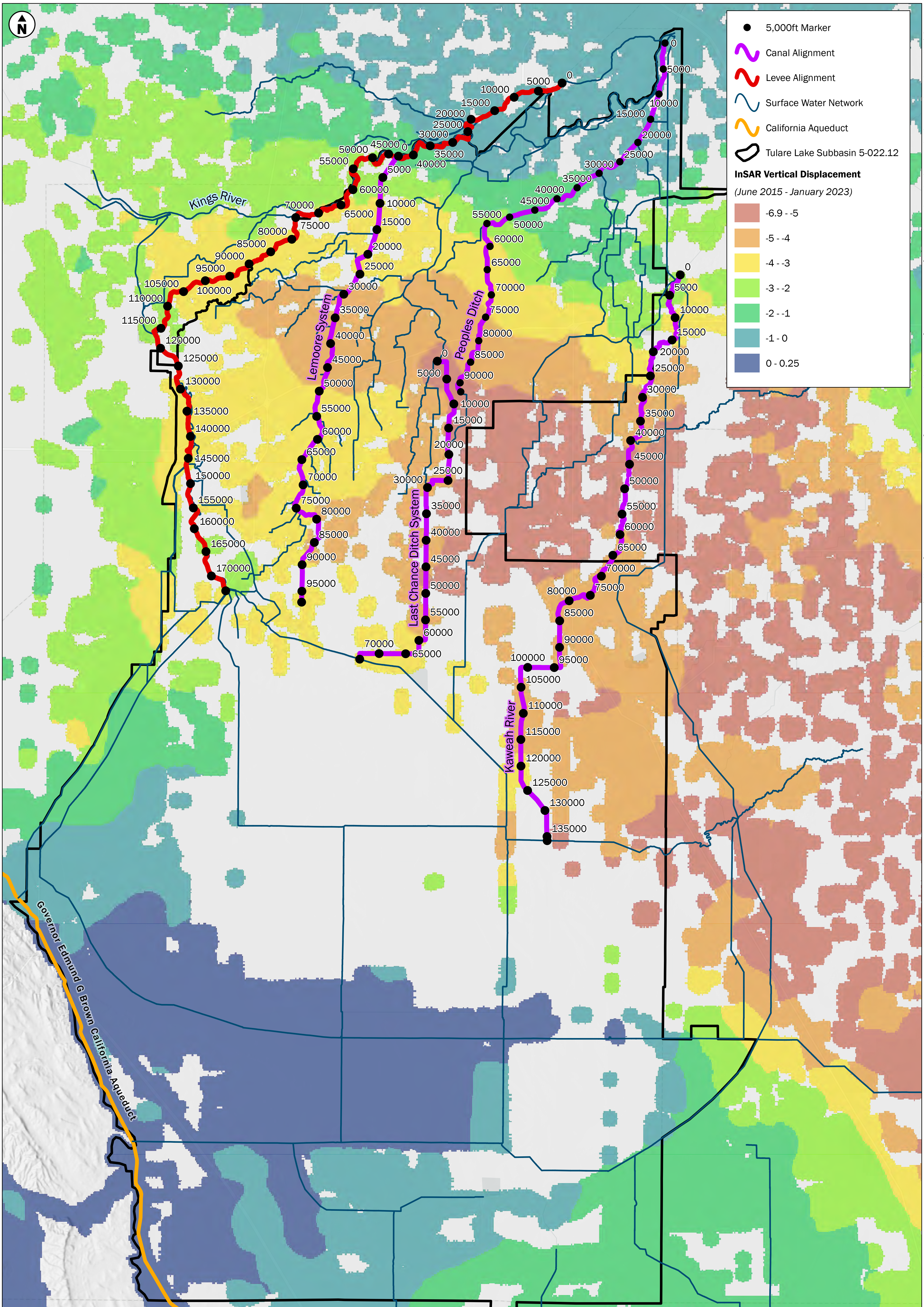


100-year Return Period Flood Zones Designated by FEMA

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO. J1-3
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	

Data source credits: None || Basemap Service Layer Credits: Esri, NASA, NGA, USGS, Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

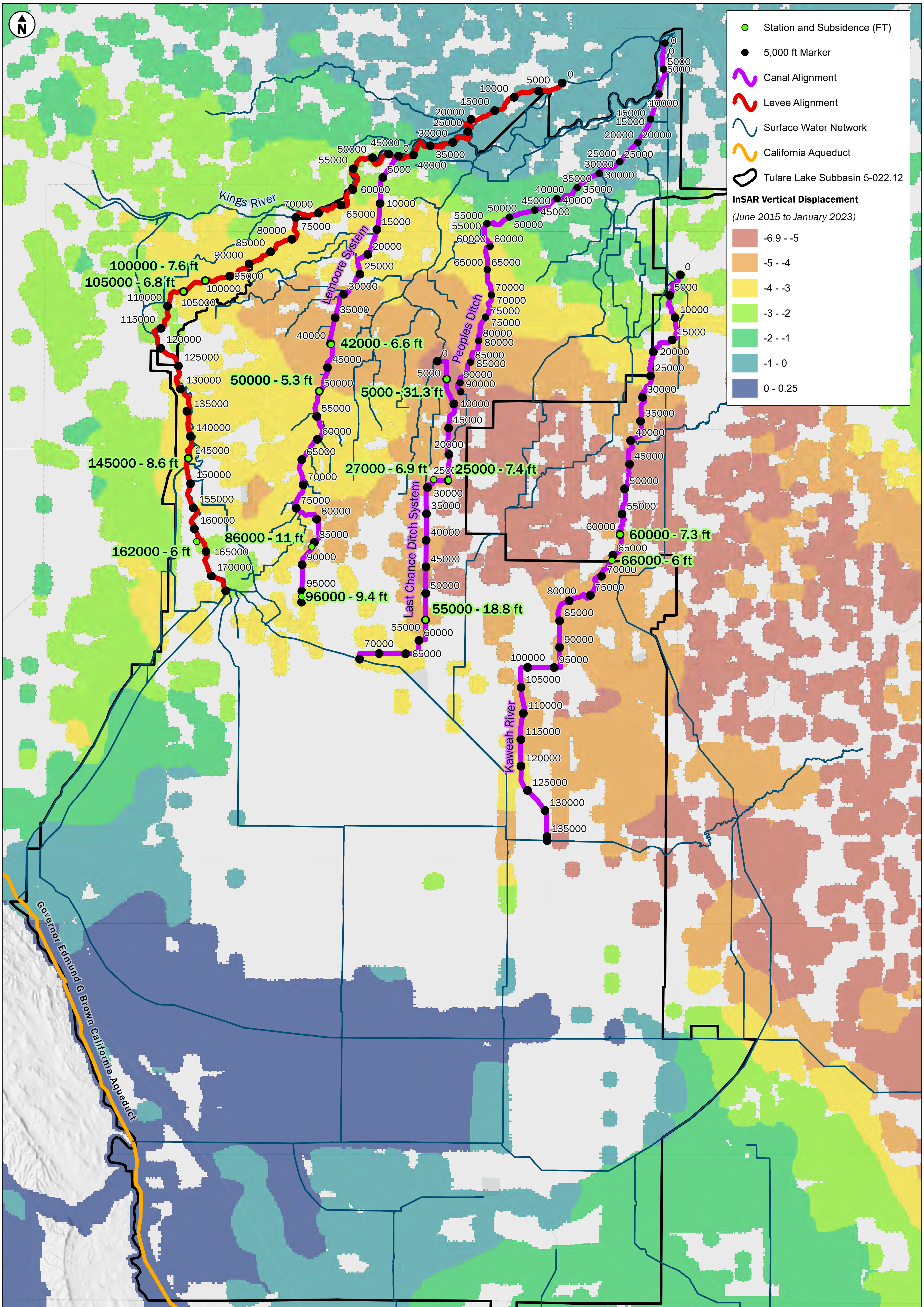


Alignment of Five North-South Flowing Canals in TLSB Superimposed on the Total Magnitude of Subsidence from 2015 to 2023 Measured Using InSAR

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: ---/---	**J2-2**

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

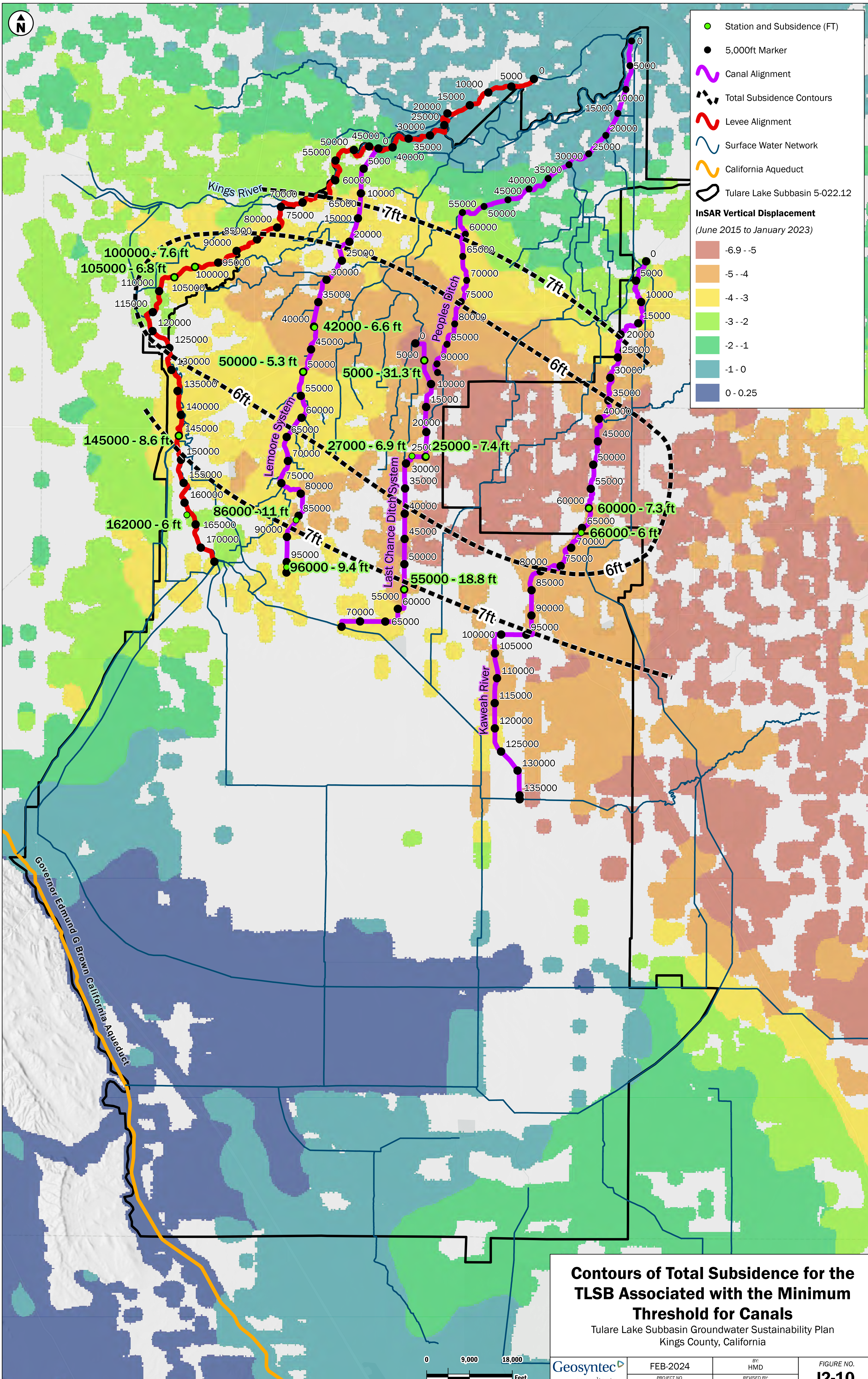


Calculated Values of Minimum Threshold Subsidence Along Five North-South Trending Canals

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants	FEB-2024	BY: HMD	FIGURE NO.
	PROJECT NO. SF0138B	REVISED BY: - - - / - - -	J2-9

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS



Contours of Total Subsidence for the TLSB Associated with the Minimum Threshold for Canals

Tulare Lake Subbasin Groundwater Sustainability Plan
Kings County, California

Geosyntec consultants

FEB-2024	BY: HMD	FIGURE NO. J2-10
PROJECT NO. SF0138B	REVISED BY: - - - / - - -	

Data source credits: None || Basemap Service Layer Credits: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Fresno County Dept. PWP, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS

Appendix K
GSA Policies

Mid-Kings River GSA

RESOLUTION NO. 2022-2

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY APPROVING EFFORTS TO ADDRESS GSP RESPONSIBILITIES OUTLINED IN THE RECENT GOVERNOR'S EXECUTIVE ORDER N-7-22 WHICH DECLARES AN EMERGENCY RELATED TO DROUGHT CONDITIONS

1) WHEREAS, in September 2014, the Sustainable Groundwater Management Act ("SGMA") was signed into law, with an effective date of January 1, 2015, and codified at California Water Code, Section 10720 et seq;

2) WHEREAS, SGMA is arguably the most significant change to California water law in the last 100 years and provides an Implementation Period of twenty years, from 2020 through 2040, to adjust local conditions to reach sustainability, but does not provide each local area with the funding for the required adjustments and provides no authority over existing surface water rights;

3) WHEREAS, the Mid-Kings River Groundwater Sustainability Agency ("MKR GSA") is a California groundwater sustainability agency formed to implement SGMA in a portion of the Department of Water Resources Bulletin 118 Tulare Lake Subbasin;

4) WHEREAS, there have been conditions of chronic groundwater level decline present in the majority of the Tulare Lake Subbasin for several decades as evidenced by multiple evaluations by DWR in versions of Bulletin 118 going back to the early 1980s;

5) WHEREAS, due to the multi-decade pattern of chronic groundwater level declines, this condition has become one of the most significant limitation to the viable lifespan of groundwater recovery facilities, and the persistent decline has produced a cycle of somewhat regular well deepening to keep pace with declining levels;

6) WHEREAS, local surface and groundwater management agencies, such as the members of the Joint Powers Authority (JPA) that makes up the MKR GSA, have worked for decades to develop programs and facilities to utilize available floodwater available in years like 1983, 1995, 1997, 1998, 2005, 2006, 2011, 2017 and 2019 for groundwater recharge in efforts to address chronic groundwater level declines;

7) WHEREAS, the most significant issue relative to the increase in the number of local wells going dry is the occurrence of long critical droughts, like the drought experienced between 1985 – 1991, 2007 – 2009, 2012 – 2016, and the current drought of 2020 – 2022;

8) WHEREAS, the Tulare Lake Subbasin's area (~524,000 acres) covers roughly 80% of Kings County.

9) WHEREAS, the MKR GSA area is very large and diverse, having fresh groundwater down to a depth of roughly 3,000 feet below ground surface, and having two primary groundwater

aquifers, a semi-confined one above the Corcoran Clay and a confined one below the Corcoran Clay;

10) WHEREAS, agriculture is, by far, the dominant local economy in the region, and the economic wellbeing of every local community is in many ways connected to the local agricultural economy;

11) WHEREAS, landowners that have chosen to live and/or work in rural areas have chosen to take on the responsibility to operate, maintain and, if necessary, replace a groundwater well, have done so with the understanding of persistent local chronic groundwater level declines;

12) WHEREAS, there are many various reasons why local wells go dry beyond regional groundwater level declines, including the emergency conditions that develop in critical drought years, failure due to the age of components, casing failures, issues with the vertical alignment of wells, the plugging of perforations due to local geologic groundwater constituents, and the operation of a proximate well that impacts the water level in the adjacent facility;

13) WHEREAS, significant groundwater management data gaps exist in the Subbasin on matters such as i) databases containing misleading records of historic wells that are no longer in production, ii) the lack of a well registry for active wells, iii) the lack of information on groundwater pumped per well, iv) the lack of records on how deep current active wells are, where they are perforated and which aquifers they draw from, and v) historic groundwater monitoring data which largely comes from ag wells perforated in multiple aquifers;

14) WHEREAS, the MKR GSA has considered all of the known uses of groundwater in the service area and attempted to balance the interests and concerns of users against the impacts of projects and management actions that it believes are needed to adjust the amount of groundwater use and groundwater recharge in the area;

15) WHEREAS, the MKR GSA has developed a Groundwater Sustainability Plan that includes projects and management actions that are just beginning to be implemented as a local assessment-based funding stream has not yet been developed for this relatively new agency;

16) WHEREAS, on March 28, 2022, Governor Gavin Newsom proclaimed that previous states of emergency declared, continued across all counties in California, due to extreme and expanding drought conditions, and that delivery of water by bottle or truck is necessary to protect human safety and public health in those places where water supplies are disrupted;

17) WHEREAS, the Governor's recent Executive Order N-7-22 from March 28, 2022 contains the following directive in paragraph 9;

> *"To protect health, safety, and the environment during this drought emergency, a county, city, or other public agency **shall not**:*

> *a) Approve a permit for a new groundwater well or for alteration of an existing well in a basin subject to the Sustainable Groundwater Management Act and classified as medium- or high-priority without first obtaining written verification from a Groundwater Sustainability Agency managing the basin or areas of the basin where the well is proposed to be located that groundwater extraction by the proposed well would not be inconsistent with an sustainable groundwater management program established in any applicable Groundwater Sustainability Plan adopted by that Groundwater Sustainability Agency and would not decrease the likelihood of achieving a sustainability goal for the basin covered by such a plan;* ***or***
>
> *b) Issue a permit for a new groundwater well or for alteration of an existing well without first determining that extraction of groundwater from the proposed well is (1) not likely to interfere with the production and function of existing nearby wells, and (2) not likely to cause subsidence that would adversely impact or damage nearby infrastructure.*

This Paragraph shall not apply to permits for wells that will provide less than two acre-feet per year of groundwater for individual domestic users, or that will exclusively provide groundwater to public water supply systems as defined in section 116275 of the Health and Safety Code."

18) WHEREAS, upon receipt of Governor's Executive Order N-7-22, Kings County stopped issuing well permits, other than domestic and municipal permits, due to both of the requirements in paragraph 9;

19) WHEREAS, upon further discussions with Kings County staff, it appears that the County does not have the ability to make the determination in paragraph 9b as those topics are not part of current County ordinances, and the determination cannot technically be made at the permitting stage given that neither the landowner nor the driller know a) the depth to which the well will be drilled, b) the soil layers and soil properties encountered at the new well location, c) the static groundwater in the well or the yield of the well after development, d) the motor size or pump bowls that will be outfitted on the well, or e) how the landowner will operate the new well;

20) WHEREAS, previous efforts have been conducted to document disadvantaged community water supply infrastructure needs in the larger Tulare Lake Basin area, particularly those disadvantaged communities that do not have centralized municipal water systems and rely on individual domestic wells per home. The general conclusion of these previous efforts has been that the development of a community system should have been pursued, and continued to be the primary issue, as groundwater recovery infrastructure was unnecessarily unreliable.

Given all of the previous statements of understanding, BE IT RESOLVED that:

A) The MKR GSA views its primary responsibility as the adjustment from the long-term trend in local groundwater conditions coming into the SGMA Implementation Period (pre 2020 trend) and the active management necessary to eventually accomplish long-term sustainability by the end of the Implementation Period in 2040. However, the agency does not view its responsibility as encompassing all of the existing issues associated with the long-term trend preceding the SGMA Implementation Period.

B) The MKR GSA understands that the service area is currently experiencing the third consecutive year of drought (WY 2020 – 2022). Due to the lack of available surface water, all parties in the Subbasin are heavily relying on groundwater to sustain their existing water uses, which is putting significant strain on the groundwater system as evidenced by the annual declines in groundwater levels. However, the MKR GSA currently understands that the number of well permits being requested by landowners in Kings County has not risen to the levels experienced during the 2012 – 2016 drought.

Kings County Well Permits			
CY	Domestic	Ag	Total
2001	78	53	170
2002	69	78	188
2003	94	70	215
2004	75	74	210
2005	101	73	199
2006	71	55	158
2007	38	29	213
2008	36	35	221
2009	53	44	242
2010	32	39	163
2011	25	20	137
2012	27	38	159
2013	25	44	249
2014	51	120	381
2015	67	147	414
2016	80	82	389
2017	64	73	176
2018	60	81	202
2019	38	67	177
2020	58	77	178
2021	87	81	211

The issue in the MKR GSA is not a groundwater availability issue, as there are very deep and plentiful groundwater aquifers in this area. The issue relates to the infrastructure that allows landowners to access the available supplies, below their properties, given the long-term groundwater level declines that have been experienced in the area for decades. Generally, what has been observed to date, is that the well infrastructure in the area was significantly deepened through the 2012 – 2016 drought such that the number of replacement wells currently being drilled is not overloading the available number of well drillers.

C) The MKR GSA is concerned with how the Governor's EO might or might not fit with SGMA. The language in the EO does not seem to be consistent with the terms commonly used in SGMA (i.e. Sustainability Goal, Sustainable Management Criteria, conditions that are Significant and Unreasonable, Critical Infrastructure, Undesirable Results, Minimum Thresholds, Measurable Objectives), and while SGMA promotes local control and implementation as guided through technical justification, these concepts don't seem to be prominent in the Governor's EO. Also, the SGMA process has been required to be very open and to receive significant input from all stakeholders. It is the current understanding of the MKR GSA that none of the Counties in the South Valley, nor any of the GSAs in that same area were consulted related to the Governor's EO prior to its issuance or his view of emergency conditions.

D) The MKR GSA is concerned with whether the Governor's EO appropriately handles existing groundwater rights, as limiting the groundwater use of any existing groundwater user, during the current drought conditions, would lead to significant impacts. There is no information in the EO to establish that local conditions in the MKR GSA have become an emergency, or a required method of evaluation to make that case. Also "groundwater law" seems to heavily rely on the concept of correlative rights in an aquifer shared by users. Not allowing a current ag or industrial user of groundwater to modify or re-drill a well to continue their use of groundwater seems speculative, given that there has been no groundwork laid that the party is over-using groundwater, that the use is any less significant than other existing uses, that the use is from the same aquifer as other users, or that the use is damaging to other parties. Similarly, the EO did not attempt to establish a method to evaluate whether a party that needed to deepen a well should justifiably use some lesser amount of groundwater than was used before, given the stated emergency condition. Also, any quantifiable protection of "health, safety and the environment" from the denial of a well permit would seem to be highly speculative given the information available at the time of permit issuance.

E) The MKR GSA views that it does not have any jurisdiction over surface water. However, the MKR GSA also views that the surface water deliveries, generally from local agencies, ditch companies and private growers, have the effect of benefitting all wells that are relatively close to local earthen canals that pump from the aquifer above the Corcoran Clay. The MKR GSA service area has been blessed to have some available surface water that has been delivered in each of the last two years. Also it appears that surface water deliveries will be made in local earthen canal systems later this summer. The seepage that occurs from operating earthen canals does not happen due to the efforts or rights of the landowners along the local canals, however the recharge to groundwater can be observed in their wells. This does not seem to be acknowledged in the Governor's EO.

F) The MKR GSA views Kings County as the local agency in charge of local well permitting, as they derive the authority for this activity from the State. The County also has several existing ordinances that relate to well permitting for things like set-backs from a number of facilities, required sanitary seals, inspection during construction, and submittal of a Well Completion Report. The MKR GSA is a local agency, developed consistently with SGMA, which is pursuing efforts consistent with the Groundwater Sustainability Plan (GSP) for the area, and does not have the authority to permit wells. Currently, the MKR GSA does not have any policies regarding groundwater wells or permitting in the service area, and SGMA makes domestic wells pumping less than two acre-feet per year outside of the jurisdiction of GSA (viewed as de minimis).

G) The MKR GSA views that efforts and process described in this resolution to be initial efforts that can be immediately implemented in response to the Governor's EO N-7-22. There was no communication to local agencies about this EO prior to its issuance, so these initial efforts are based on what is currently understood about local conditions and the local view of requirements. Future efforts may change and pursue other approaches as conditions change or as clarification is provided regarding the meaning of various requirements.

H) The MKR GSA directs staff to contact each local municipal water supply system in the service area (City of Hanford, Armona CSD, Home Garden CSD, Hardwick WC, and potentially local County Schools) and request information on their most recent monitored groundwater levels, the relative depth of their groundwater wells, and whether they view the current conditions as the "emergency" described by the Governor's EO N-7-22.

I) The MKR GSA directs staff to make a formal request of Kings County for all well permit info from January 1, 2022 to present in order to conduct an investigation into the issues being experienced by applicants for domestic and municipal wells. The intent would be to have the GSAs consultant contact all domestic and municipal well applicants and gather additional information to better understand current conditions being experienced in the MKR GSA area of the Tulare Lake Subbasin.

J) In response to the Governor's EO N-7-22, the MKR GSA will require all landowners in the service area with active wells from January 1, 2015 to present to immediately register those wells with the MKR GSA, provide the Well Completion Report for the construction of those wells, and grant access to MKR GSA staff, as needed, to monitor groundwater extraction facilities for the purposes of compliance with the Governor's EO N-7-22 and SGMA. This information is critical in addressing a key SGMA "data gap" in the area.

K) The MKR GSA will develop and provide information from the 2020 Tulare Lake GSP, and any future GSP updates, to Kings County, the local well permitting agency, on the most recent groundwater levels measured in various areas, information on regional long-term groundwater level declines over time, and recent groundwater declines in previous drought years that landowners should considered in light of the current drought conditions and the expected conditions during the SGMA Implementation Period. This information will be provided as a recommendation, as local owners will continue to make their own decisions based on their situation and views of what is advisable.

L) The MKR GSA views that it can "verify that groundwater extraction from a proposed well would not be inconsistent with any sustainable groundwater management program established in the 2020 Tulare Lake Subbasin GSP adopted by the Mid-Kings River GSA and would not decrease the likelihood of achieving a sustainability goal for the Tulare Lake Subbasin in the Mid-Kings River GSA area, as described in the 2020 Tulare Lake Subbasin GSP" under the following conditions:

i) If the well permit is for a well replacement, that the applicant provide the MKR GSA the location and Well Completion Report for the well being replaced, so that the location and construction of that well can be reviewed and understood.

ii) That the applicant is fully aware of the Governor's Executive Order N-7-22, that the order's primary intent is to "protect health, safety and the environment", and that if at any point the MKR GSA views that the issuance of the replacement permit endangers health, safety or the environment, then the verification will not be provided.

iii) That the applicant has made him or herself fully aware of the current groundwater conditions in the area, the long-term groundwater level declines, the most recent annual level declines during drought years, the expected conditions during the SGMA Implementation Period as described in the Tulare Lake GSP and is prepared to developed a well based on their situation and their views of what is advisable.

iv) That any currently operable well within 1,000 feet of the well site be located by the applicant, identified by type (agricultural, domestic, municipal, industrial, other) to the extent possible, and that those adjacent landowners be asked by the applicant for well depth information so that it can be reviewed.

v) That the well be outfitted with a totalizing flow meter and the MKR GSA be allowed to enter the property and check the flow rate and amount pumped from the well periodically.

vi) That the landowner agree to install facilities as necessary to limit or "throttle" the well, if necessary, while the Governor's emergency declaration exists.

vii) That the applicant is aware that the MKR GSA's verification does not shield him or her in any way from any credible complaint made from an adjacent landowner that can document that the operation of the well is impacting the water level in the adjacent landowner's well. The applicant acknowledges that the MKR GSA views this as a matter between landowners that can sometimes be resolved through cooperation or negotiation, but sometimes has to be resolved in court.

M) The MKR GSA understands there is a parallel process that Kings County must administer, as described in EO N-7-22, paragraph 9b. Related to that, the MKR GSA would make the following statements related to paragraph 9b requirements:

i) The determination required in paragraph 9b appears to be impossible to develop given the information available to the County during the permit stage (prior to construction).

ii) The centralized municipal water systems for local cities like Hanford and communities like Armona, Home Garden and Hardwick employ wells that are intentionally drilled deep, into the confined aquifer below the Corcoran Clay, because of geologic quality concerns in the shallower zones. These wells do not appear to currently be at risk because the infrastructure does not rely on shallow groundwater supplies.

iii) In the case of agricultural or industrial replacement wells, if the replacement well is in approximately the same relative location, its impact on other nearby wells should be similar to the original well.

iv) In the case of a new agricultural or industrial well or a replacement agricultural or industrial well in a different location on the property, if the well is at least 660 feet from any other existing well owned by a different party or was primarily perforated in a deeper zone than existing domestic wells that were owned by different parties, this would seem to meet the MKR GSA's understanding of the intent of EO N-7-22.

v) Subsidence has been an issue in the Hanford-Visalia-Tulare area for many decades, as evidenced by numerous USGS technical reports on the matter. The primary issue appears to be that the geologic properties of the soils in this area are susceptible to subsidence, and as groundwater levels decline subsidence is a byproduct. However evaluating whether an individual well is causing subsidence is often very difficult given how many others are also pumping from the same zones. Recent modeling by Stanford University has suggested that a significant portion of the subsidence being currently experienced in the area is a legacy issue that has compounded over time. The GSA does not know of any technical method to evaluate whether a proposed well with an assumed total depth and an assumed flow rate along with assumed soil characteristics would be likely to cause subsidence.

N) The MKR GSA will charge applicants requesting verification of a County well permit a fee of at least $50 per permit to cover staff time and expenses. If the effort for a permit increases to require additional staff time or consultant services, those costs will be passed on to the applicant as well.

O) The MKR GSA views that landowners that have both a domestic well on their property as well as an agricultural or industrial well are not the landowners targeted for protection in the Governor's EO N-7-22. The MKR GSA views the use on that parcel as a combination of uses by the landowner that cannot be split apart by the agency.

P) The MKR GSA will encourage local partnering agencies to proceed with groundwater recharge projects as quickly as possible in the hopes that they will be ready for the fall season that will hopefully bring a wetter year and available supplies for groundwater recharge.

Passed and adopted by the following vote at a meeting of the Board of Directors of the Mid-Kings River Groundwater Sustainability Agency on Tuesday, April 19, 2022.

AYES: Barry McCutcheon, Steven P. Dias, Michael Murray and Diane Sharp

NOES: None

ABSTAIN: None

ABSENT: None

Barry McCutcheon

Barry McCutcheon, Board Chair

ATTEST:

Dennis Mills

Dennis Mills, Secretary

CERTIFICATION

I do hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the Board of Directors of the Mid-Kings River Groundwater Sustainability Agency held on Tuesday, April 19, 2022.

Dennis Mills

Dennis Mills, Secretary

MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY

County of Kings

City of Hanford

Kings County Water District

Barry McCutcheon
Chair

Michael Murray
Vice-Chair

Diane Sharp

Steven P. Dias

Dennis Mills
Secretary

200 North Campus Dr.
Hanford, CA 93230
Phone: (559) 584-6412
Fax: (559) 584-6882

MID-KINGS RIVER
GROUNDWATER SUSTAINABILITY AGENCY

RE: ***ACTIVE GROUNDWATER WELL METER POLICY***

A POLICY REQUIRING WATER FLOW METERS ON ALL ACTIVE GROUNDWATER WATER WELLS. The policy hereby contains as follows:

BACKGROUND AND PURPOSE

I. The Mid-Kings River GSA (MKR GSA) is committed to sustainably managing groundwater in its jurisdictional area, consistent with views of significant and unreasonable undesirable results as set out in the Tulare Lake Subbasin's Groundwater Sustainability Plan (TLS GSP).

II. MKR GSA understands that estimates of groundwater pumping can be made using satellite imagery. These estimates have to include assumed values related to crop evapotranspiration, ideal irrigation, soils conditions and irrigation efficiencies. These kinds of assumptions were made and these types of estimates were developed for use in the TLS GSP because other better information was not available in the MKR GSA area. However, the direct measurement of groundwater pumping through flow meters is viewed as significantly superior quality monitoring data given the number of estimates and assumptions involved in estimating groundwater use from satellite imagery. Direct flow measurement would also provide important information to local groundwater users that they will need to better understand as efforts during the SGMA Implementation period progress.

III. MKR GSA acknowledges that this Policy will increase costs on landowners related to new flow meters on groundwater wells and regular certification. MKR GSA intends to pursue grant funds, to the extent they are available, in order to offset initial groundwater well flow meter purchase costs and installation costs for landowners. At this time, it is not well understood how many groundwater wells are active in the MKR GSA area, how many active groundwater wells have flow meters and how many active groundwater wells do not have flow meters. However, the MKR GSA views that a flow meter requirement is necessary to develop a defendable view of groundwater use in the MKR GSA, that this requirement will aid and promote the sustainable management of groundwater and that it is in the best interest of the MKR GSA, its landowners, businesses and residents.

IV. MKR GSA understands that privacy is an ongoing concern of landowners in the area related to the agency's monitoring efforts. MKR GSA will make efforts to keep monitored information as private as possible, while being consistent with State laws and at the same time providing the Department of Water Resources (DWR) what they require.

V. MKR GSA understands that Kings County and the City of Hanford have required permits for the development and modification of groundwater wells for many years. This Policy is not intended to infringe on that authority or permitting process. However, MKR GSA will work with those agencies to develop a process, currently suggested as a "will serve letter", that recognizes the requirements set forth within this Policy. Currently, as Emergency Order N-7-22 is requiring GSA Verifications, this policy will become part of the MKR GSAs requirements for GSA Verification.

VI. The purpose of this Policy is to require the installation of WATER FLOW METERS ON ALL ACTIVE GROUNDWATER WELLS in the jurisdiction of the MKR GSA, and to establish other regulatory requirements in connection with these purposes.

VII. MKR GSA understands that it has the authority to require that "groundwater extraction facilities within the management area of the GSA be measured by a water-measuring device satisfactory to the GSA" and that "all costs associated with the purchase and installation of the water-measuring device shall be borne by the owner or operator of each groundwater extraction facility" through Section 10725.8 of the California Water Code.

VIII. Further, the MKR GSA Board of Directors finds that adopting and implementing a policy requiring the installation of WATER FLOW METERS ON ALL ACTIVE WATER WELLS in the jurisdiction of the MKR GSA is necessary to develop a defendable view of groundwater use in the MKR GSA, and is in the best interest of the MKR GSA, its landowners, businesses and residents.

IX. Finally, for the reasons set forth above, the MKR GSA Board of Directors finds that the adoption of this Policy will aid and promote the sustainable management of groundwater.

DEFENITIONS

"Aquifer" describes a groundwater well that is in use, or is planned for use.

"Certified" means to be tested for accuracy and verified it is within the allowed range. This can be done by taking the meter to a location where it is calibrated and certified, or by using another proven meter at the well to test the accuracy of the in-place meter.

"Groundwater" is underground water, or subsurface water, that is contained in aquifers.

"Groundwater well" means a facility used to extract groundwater.

"Groundwater extraction facility" is the term used in the California Water Code to mean Groundwater well.

"Overdraft" usually refers to an extended decline in the storage of an unconfined aquifer. This is also a term that sometimes get used with confined aquifers that relates to extended use beyond the sustainable yield.

"Recharge" means the intentional sinking of surface water to add volume stored in an aquifer.

"Seepage" means the incidental loss of water as it is being conveyed or put to beneficial use.

"Water flow meter" means a mechanical or electronic device that is used to measure the rate and amount of water being extracted by a groundwater well.

"Water table" means the level, generally observed in groundwater wells, at which saturated soil is observed.

"Water well motor" means the motor powering a groundwater well.

"Water well pump" means the pump used to extract groundwater from a well.

"Water well sounding" means the measurement of the distance from a reference point to the water level in a well, generally using a device known as a sounder.

GROUNDWATER WELL METER POLICY

A. Parties within the MKR GSA that have ACTIVE GROUNDWATER WELLS are required to have flow meters. The configuration of the installation shall conform to a drawing prepared by the permittee and shall conform to the technical standards set forth by MKR GSA.

B. Flow meters on groundwater wells must:

1) Have a totalizer with the ability to totalize tenths of an acre-foot (AF);
2) Read instantaneously in either gallons per minute (GPM) or cubic-feet per second (CFS); and
3) Be selected appropriately for the operating flow of the groundwater well; and
4) Be installed consistent with the manufacturer's specifications; and
5) Have an accuracy of at least plus or minus five percent (+/- 5%) when installed consistent with manufacturer's specifications and operating within intended flow ranges.

C. For the owners of rural domestic wells, on or near the first day of each year the well operator shall read, and maintain a log for, the water flow meter and provide this data to the MKR GSA during the first month of each year.

D. For all other active wells, on or near the first day of each month the well operator shall read, and maintain a log for, the water flow meter and provide this data to the MKR GSA during the first week of April and October of each year.

E. The well owner and/or well operator shall grant the MKR GSA staff access to inspect facilities in order to verify compliance with this Policy.

F. Groundwater well flow meters are required to be certified every five years by a qualified professional with supporting documentation provided to the MKR GSA.

G. Groundwater well flow meters are required to be certified if at any point MKR GSA's estimates of groundwater use differ significantly from totalized flow meter records.

ENFORCEMENT – VIOLATION

A. Penalties. Any person, firm or corporation, whether acting as principal, agent, employer or otherwise, who violates any provision of this Policy, or the terms and/or conditions of any permit issued pursuant to this Policy, may be punishable by a fine not to exceed one thousand ($1,000) dollars per violation.

B. Civil Action – Injunctive Relief. MKR GSA may elect additionally, or alternatively, to proceed with a civil action, including, but not limited to, seeking injunctive relief, rather than, or in addition to other actions described in subsection (A) of this section. Any person, firm or corporation, whether acting as principal, agent, employer or otherwise, who willfully violates any provision of this Policy, or the terms and/or conditions of any permit issued pursuant to this Policy, may be liable for a civil penalty not to exceed one thousand ($1,000) dollars for each day or portion thereof, that the violation continues to exist. In determining the amount of the civil penalty to impose, the court shall consider all relevant circumstances, including, but not limited to, the administrative and legal costs incurred by the MKR GSA to address the violation, the extent of the harm caused by the conduct constituting the violation, the nature and persistence of such conduct, the length of time over which the conduct occurred, the assets, liabilities, and net worth of the violator, whether corporate or individual, and any corrective action taken (and timing of such corrective action), or lack thereof, by the violator.

SEVERABILITY

If any section, sub-section, sentence, clause or phrase of this Policy is held by a court of competent jurisdiction to be invalid, such decision shall not affect the remaining portions of this Policy. The MKR GSA Board of Directors hereby declares that it would have passed this Policy, and each section, sub-section, sentence, clause, and phrase hereof, irrespective of the fact that one or more sections, sub-sections, sentences, clauses and phrases be declared invalid.

EFFECTIVE DATE

Landowners and/or operators will be required to have flowmeters on active wells by January 1, 2024.

The Policy shall take effect and be in force thirty (30) days after its passage and prior to expiration of fifteen (15) days after its passage thereof, shall be published by title and summary on the MKR GSA's website together with the names of members of the MKR GSA Board of Directors voting for and against the same.

Respectfully submitted for your consideration,

Dennis Mills

Dennis Mills, General Manager

Cc: Jason Waters, City of Hanford
Ray Carlson, MKR GSA Attorney

Chuck Kinney, Kings County

MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY

County of Kings

City of Hanford

Kings County
Water District

Barry McCutcheon
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Diane Sharp

Steven P. Dias

Dennis Mills
Secretary

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RE: ***GROUNDWATER WELL REGISTRATION POLICY***

AN MKR GSA POLICY TO REQUIRE THE REGISTRATION OF ALL GROUNDWATER WELLS AND TO DEVELOP AND MAINTAIN A REGISTRY OF GROUNDWATER WELLS. The policy hereby contains as follows:

BACKGROUND AND PURPOSE

I. The Mid-Kings River GSA (MKR GSA) is committed to sustainably managing groundwater in their jurisdictional area, consistent with views of significant and unreasonable undesirable results as set out in the Tulare Lake Subbasin's Groundwater Sustainability Plan (TLS GSP).

II. MKR GSA understands that the estimates of groundwater pumping, made from satellite imagery, involved assumptions on well locations because there was not available local active well registry. These assumptions were the best that could be made at the time, but can significantly be improved through the understanding of where all the active groundwater wells in the MKR GSA are located. Using the locations of active wells along with the measurement of pumped groundwater would significantly improve the MKR GSA's ability to understand and potentially manage resources in the area.

III. MKR GSA views that a well registration requirement is necessary to develop a defendable view of groundwater use in the MKR GSA, that this requirement will aid and promote the sustainable management of groundwater and that it is in the best interest of the MKR GSA, its landowners, businesses and residents.

IV. MKR GSA understands that privacy is an ongoing concern of landowners in the area related to the agency's monitoring efforts. MKR GSA will make efforts to keep registration information as private as possible, while being consistent with State laws and at the same time providing the Department of Water Resources (DWR) what they require.

V. The purpose of this Policy is to require the REGISTRATION OF ALL GROUNDWATER WELLS in the jurisdiction of the MKR GSA, and the DEVELOPMENT AND MATINANANCE OF A WELL REGISTRY for the MKR GSA, and to establish other regulatory requirements in connection with these purposes.

VI. MKR GSA understands that it has the authority to require "registration of a groundwater extraction facility within the management area of the groundwater sustainability agency" through Section 10725.6 of the California Water Code.

VII. Further, the MKR GSA Board of Directors finds that adopting and implementing a policy requiring the REGISTRATION OF ALL GROUNDWATER WELLS in the jurisdiction of the MKR GSA and the DEVELOPMENT AND MAINTENANCE OF A WELL REGISTRY for the MKR GSA is necessary to develop a defendable view of groundwater use in the MKR GSA, and is in the best interest of the MKR GSA, its landowners, businesses and residents.

VIII. Finally, for the reasons set forth above, the MKR GSA Board of Directors finds that the adoption of this Policy will aid and promote the sustainable management of groundwater.

DEFENITIONS

"Active" describes a groundwater well that is in use, or is planned for use.

"Aquifers" are geological formations saturated with groundwater.

"Confined Aquifer" means an aquifer that is pressurized, such that the level in a well drilled into such aquifer, corresponds to the pressure in the aquifer.

"Groundwater" is underground water, or subsurface water, that is contained in aquifers.

"Groundwater well" means a facility used to extract groundwater.

"Groundwater extraction facility" is the term used in the California Water Code to mean Groundwater well.

"Overdraft" usually refers to an extended decline in the storage of an unconfined aquifer. This is also a term that sometimes get used with confined aquifers that relates to extended use beyond the sustainable yield.

"Phreatic zone" means the geologic formation below the water table.

"Recharge" means the intentional sinking of surface water to add volume stored in an aquifer.

"Seepage" means the incidental loss of water as it is being conveyed or put to beneficial use.

"Water table" means the level, generally observed in groundwater wells, at which saturated soil is observed.

"Unconfined Aquifer" means an aquifer whose water table is at atmospheric pressure and that can rise or fall with changes in volume.

"Vadose zone" means the geologic formation above the water table.

GROUNDWATER WELL REGISTRATION POLICY

A. Parties within the MKR GSA that own or operate properties with groundwater wells are required to register the groundwater well with the MKR GSA. All active extraction facilities are required to be registered with the MKR GSA.

B. Parties registering a groundwater well will be asked to provide the following information:

1) The Kings County parcel number where the well is located and the wells location within the parcel;

2) The property owners name, mailing address, email address and contact information; and

3) The well operators name, mailing address, email address and contact information (such as in a lease arrangement); and

4) The groundwater wells construction information, which might include the year it was constructed, well driller, well completion report, geophysical log, e-log, total depth, zones of perforation, diameter of casing, motor horsepower, depth of sanitary seal, bowl depth, whether the well has a flow meter, etc.; and

5) Whether the well has a sounding port for groundwater levels.

C. The landowner shall grant MKR GSA staff access to inspect the property and facilities in order to verify compliance with this Policy.

ENFORCEMENT – VIOLATION

A. Penalties. Any person, firm or corporation, whether acting as principal, agent employer or otherwise, who violates any provision of this Policy, or the terms and/or conditions of any permit issued pursuant to this Policy, may be punishable by a fine not to exceed one thousand ($1,000) dollars per violation.

B. Civil Action – Injunctive Relief. MKR GSA may elect additionally, or alternatively, to proceed with a civil action, including, but not limited to, seeking injunctive relief, rather than, or in addition to other actions described in subsection (A) of this section. Any person, firm or corporation, whether acting as principal, agent, employer or otherwise, who willfully violates any provision of this Policy, or the terms and/or conditions of any permit issued pursuant to this Policy, may be liable for a civil penalty not to exceed one thousand ($1,000) dollars for each day or portion thereof, that the violation continues to exist. In determining the amount of the civil penalty to impose, the court shall consider all relevant circumstances, including, but not limited to, the administrative and legal costs incurred by the MKR GSA to address the violation, the extent of the harm caused by the conduct constituting the violation, the nature and persistence of such conduct, the length of time over which the conduct occurred, the assets, liabilities, and net worth of the violator, whether corporate or individual, and any corrective action taken (and timing of such corrective action), or lack thereof, by the violator.

SEVERABILITY

If any section, sub-section, sentence, clause or phrase of this Policy is held by a court of competent jurisdiction to be invalid, such decision shall not affect the remaining portions of this Policy. The MKR GSA Board of Directors hereby declares that it would have passed this Policy, and each section, sub-section, sentence, clause, and phrase hereof, irrespective of the fact that one or more sections, sub-sections, sentences, clauses and phrases be declared invalid.

EFFECTIVE DATE

Landowners and/or operators will be required to register active wells by May 1, 2023.

The Policy shall take effect and be in force thirty (30) days after its passage and prior to expiration of fifteen (15) days after its passage thereof, shall be published by title and summary on the MKR GSA's website together with the names of members of the MKR GSA Board of Directors voting for and against the same.

Respectfully submitted for your consideration,

Dennis Mills

Dennis Mills, General Manager

Cc: Jason Waters, City of Hanford
Ray Carlson, MKR GSA Attorney
Chuck Kinney, Kings County

MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY

County of Kings

City of Hanford

Kings County Water District

Barry McCutcheon
Chair

Michael Murray
Vice-Chair

Diane Sharp

Steven P. Dias

Dennis Mills
Secretary

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RE: ***INITIAL PRIVATE GROUNDWATER RECHARE POLICY***

AN MKR GSA POLICY TO ALLOW PRIVATE GROUNDWATER RECHARGE EFFORTS DURING FLOOD YEARS FOR FUTURE RECOVERY BEYOND FUTURE GROUNDWATER ALLOCATIONS. The policy hereby contains as follows:

BACKGROUND AND PURPOSE

I. The Mid-Kings River GSA (MKR GSA) is committed to sustainably managing groundwater in its jurisdictional area, consistent with views of significant and unreasonable undesirable results as set out in the Tulare Lake Subbasin's Groundwater Sustainability Plan (TLS GSP).

II. The MKR GSA plans to develop initial groundwater pumping allocations and a projected allocation ramp-down in the coming calendar year as part of SGMA compliance efforts.

III. Water Year 2023 has become a very large flood year and landowners within the MKR GSA have expressed interest in pursuing private groundwater recharge efforts using floodwater to increase their allowable groundwater pumping in future dry years.

IV. The Governor's recent Executive Order N-7-23 (May 17, 2023) contains the following limitations/restrictions on the use of diverted floodwater:

- Any barn, ponds, or lands to which manure or waste from an animal facility that generates waste from the feeding and housing of animals for more than 45 days per year in a confined area that is not vegetated are applied;
- Any agricultural field where pesticide or fertilizer application has occurred in the prior 30 days or in the period prohibited by applicable law, whichever is longer;
- Any area that could cause damage to critical levees, infrastructure, wastewater and drinking water systems, drinking water wells or drinking water supplies, or exacerbate the threat of flood and other health and safety concerns; or

- Any area that has not been in active irrigated agricultural cultivation within the past three years including grazing lands, annual grasslands, and natural habitats. This limitation does not apply to facilities already constructed for the purposes of groundwater recharge or managed wetlands.

V. The MKR GSA wishes to support the efforts to responsibly increase local recharge while acknowledging that there is much work to be done before a robust GSA policy on the matter is developed. MKR GSA intends to adopt this initial policy, putting in place several guidelines that will avoid negative impacts from the efforts.

VI. This is an initial policy and no assurance is given that this policy will not be modified or altered as additional information and experience occurs.

VII. Giving landowners recharge credit that can be used to justify future pumping will bring a significant administrative and monitoring burden on the MKR GSA. Landowners should expect that fees will be applied to the recharge amounts in the future when the administrative burden is better understood. MKR GSA understands that it has the authority to require "registration of a groundwater extraction facility within the management area of the groundwater sustainability agency" through Section 10725.6 of the California Water Code.

VIII. Finally, for the reasons set forth above, the MKR GSA Board of Directors finds that the adoption of this Policy will aid and promote the sustainable management of groundwater.

INITIAL PRIVATE GROUNDWATER RECHARGE POLICY

A. REGISTRATION

Parties within the MKR GSA that wish to pursue private groundwater recharge efforts to justify future groundwater pumping must register the fields or facilities where recharge would occur with the GSA prior to the effort beginning. Information like County APN, canal turnout locations, groundwater well location, groundwater well completion reports and other relevant items will need to be provided as well.

B. MONITORING

If landowners want to use recharge to justify future pumping, they must agree to allow GSA to access their property for monitoring.

C. CREDIT AGAINST FUTURE PUMPING

1) Landowners cannot receive credit for pumping outside the MKR GSA. There are no current agreements for this.
2) Landowners can receive credit for pumping if pumping occurs in the aquifer that is being recharged and within 1 mile from the recharge location.
3) Recharge on open fields will use the surface water diversion flow meter readings minus the ET readings for the fields in the month recharge occurred.

4) Recharged supplies can be used as follows:

   i. 1st year after flood year = 75%
   ii. 2nd year after flood year = 60%
   iii. 3rd year after flood year = 45%
   iv. 4th year after flood year = 30%
   v. 5th year after flood year = 0%

ENFORCEMENT – VIOLATION

If parties do not follow the requirements of this initial policy, the effort will not be allowed for use to justify future pumping.

SEVERABILITY

If any section, sub-section, sentence, clause or phrase of this Policy is held by a court of competent jurisdiction to be invalid, such decision shall not affect the remaining portions of this Policy. The MKR GSA Board of Directors hereby declares that it would have passed this Policy, and each section, sub-section, sentence, clause, and phrase hereof, irrespective of the fact that one or more sections, sub-sections, sentences, clauses and phrases be declared invalid.

EFFECTIVE DATE

The Policy shall retroactively take effect as of May 1, 2023, and shall be published by title and summary on the MKR GSA's website together with the names of members of the MKR GSA Board of Directors voting for and against the same.

Respectfully submitted for your consideration,

Dennis Mills

Dennis Mills, General Manager

Vote of all Directors at the Special May 16, 2023 meeting:

AYES:	Steven P. Dias, Barry McCutcheon, Diane Sharp
NOES:	None
ABSTAINED:	None
ABSENT:	Michael Murray

Cc: Ray Carlson, MKR GSA Attorney

Mid-Kings River
Groundwater Sustainability Agency

PROPOSITION 218
FEE STUDY

FEBRUARY 2024

Prepared for:

Mid-Kings River GSA

Prepared by:

PROVOST&PRITCHARD
CONSULTING GROUP

Clovis, California

DATE SIGNED: February 16, 2024

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ACRONYMS and ABBREVIATIONS

AF	Acre-feet
AF/ac	Acre-feet per acre
Agency	Mid-Kings River GSA
Art. XIII D	California Constitution Article XIII D
CASGEM	California Statewide Groundwater Elevation Monitoring
CSD	Community Services District
DWR	California State Department of Water Resources
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
MKRGSA	Mid-Kings River GSA
SGMA	Sustainable Groundwater Management Act
State Board	State Water Resources Control Board
TLS or Subbasin	Tulare Lake Subbasin

REPORT SUMMARY

The Sustainable Groundwater Management Act (SGMA) became law in September 2014. SGMA requires local government in high and medium priority basins to halt overdraft and to bring groundwater basins into balanced levels of groundwater pumping and recharge. Specifically, Groundwater Sustainability Agencies (GSAs) are required to manage basins sustainably and must adopt Groundwater Sustainability Plans (GSPs) to work towards the goal of reaching groundwater sustainability by 2040.

The Mid-Kings River GSA (MKRGSA or Agency) serves as the GSA for the lands within its boundaries, which overlies a portion of the Tulare Lake Subbasin (TLS or Subbasin). The Agency is working cooperatively with stakeholders to implement the TLS GSP for its lands and is collaborating with other GSAs within the Subbasin to attain groundwater sustainability.

On November 7, 2017, the Agency entered into an agreement with four other GSAs within the subbasin to develop the TLS GSP to address the management of current and future groundwater use within the subbasin to achieve sustainability. The Agency's portion of the costs to develop the GSP was borne by the Kings County Water District and the City of Hanford.

The Agency now proposes to charge each landowner an operations fee to pay for ongoing administrative and operations costs, and a groundwater extraction fee and to implement specific projects identified in the GSP to meet sustainability. **The Agency's Board of Directors is proposing to establish an operations fee of $25.00 per acre, a groundwater extraction fee of up to $95.00 per acre-foot and an exceedance penalty of up to $500 per acre-foot**. The fees will be set annually by the Board, based on the budget needs, but will not exceed the proposed maximum rates. Although the fee is based on projections through 2029, the fee will continue beyond 2029 to fund future GSP implementation costs.

The proposed fees are considered property-related fees and charges under SGMA (Water Code Section 10730.2) and are subject to the provisions of Sections 6(a) and (b) of Article XIII D of the California Constitution (Art. XIII D). The proposed operations fee was calculated using the District's projected annual budget for administration and operations to comply with SGMA, divided by the assessable acreage. The proposed extraction fees were calculated by taking the SGMA-related mitigation costs, project development and reserves divided by the initial allowable volume of groundwater pumping in the MKRGSA. Because the extraction fee is based on the allowable amount pumped, the fee is directly correlated to the lands which use groundwater, and in proportion to the use of groundwater.

To comply with Art. XIII D Section 6(a), the Board will conduct a public hearing for the proposed fee on April 23, 2024. Hearing notices will be mailed to all affected landowners at least 45 days in advance of the hearing date. Property owners may submit written protests to the proposed fee prior to the hearing. If a majority of property owners submit written protests, the District may not adopt the fee. Absent a majority protest, the District is authorized to adopt the proposed fee at its public adoption hearing on April 23, 2024.

1. LEGISLATIVE REQUIREMENTS

1.1. SGMA Legislation

The Sustainable Groundwater Management Act (SGMA) was passed by California Legislature in 2014. The Act requires that subbasins defined by the Department of Water Resources (DWR) Bulletin 118 that are deemed High- and Medium-Priority by the California Statewide Groundwater Elevation Monitoring Program (CASGEM) be sustainable by 2042. Further, if the subbasin is deemed Critically Overdrafted, the deadline is accelerated to 2040. Sustainability is defined as not creating undesirable results in the following categories:

- Lowering Groundwater Levels
- Reducing Groundwater Storage
- Seawater Intrusion
- Degrading Water Quality
- Land Subsidence
- Depleting Interconnected Surface Water

To comply with SGMA, local agencies were required to form Groundwater Sustainability Agencies ("GSA") by June 30, 2017. These GSAs were tasked with preparing Groundwater Sustainability Plans ("GSP") by January 31, 2020 (in Critically Overdrafted subbasin). The 2020 GSP developed a course of action to become sustainable by 2040. The 2020 GSP was first revised in July 2022 and resubmitted to DWR to address deficiencies identified by the State. The 2022 GSP was not viewed as adequate by DWR and referred the TLS to the State Water Resources Control Board (State Board). State Board staff developed a document describing the deficiencies in the 2022 GSP in October 2023. The TLS GSAs are currently revising the 2022 GSP to address State Board concerns. The State Board has scheduled a Probationary Hearing for the TLS on April 16, 2024 to consider whether the place the subbasin in probation. This action would trigger fees, reporting requirements and begin a timeframe after which the State Board could impose their own groundwater management plan (Interim Plan). The GSAs will have the ongoing responsibility to monitor the subbasin for compliance and develop Annual Reports and 5-Year Interim Updates. The State Board will intervene if the GSAs do not comply with SGMA, to ensure the subbasins are sustainable. However, GSAs are being directed by the State Board to continue implementing the current GSP.

1.2. District Compliance Activities and GSP Development

The Mid-Kings River GSA (MKRGSA or Agency) serves as the GSA for the lands within its boundaries, which overlie a portion of the Tulare Lake Subbasin (Subbasin). The Agency has worked cooperatively with stakeholders and other GSAs in the Subbasin to develop and implement a GSP for its lands to attain groundwater sustainability.

The Agency covers approximately 152 square miles (~93,500 acres) located in the northeastern portion of the Subbasin. The public and private agencies with the MKRGSA include the Kings County Water District, the City of Hanford, Armona CSD, Home Garden CSD, Hardwick Water Company, Alta Irrigation District, Lakeside Irrigation Water District, Kings River Conservation District and Kings County. Surface water delivery entities within this are the Riverside Ditch Company, the Peoples Ditch Company, the Settlers Ditch Company, the Last Chance Water Ditch Company, the Lemoore Irrigation and Canal Company, the New Deal Ditch Company, and the Lone Oak Ditch Company.

1.3. SGMA Extraction Fees and Art. XIII D Requirements

Water Code Section 10730.2 authorizes the MKRGSA to impose fees on the extraction of groundwater to fund costs of groundwater management, including, but not limited to (a) administration. operation and maintenance, including prudent reserve, (b) the acquisition of lands or other property, facilities, and services, and (c) supply, production, treatment, or distribution of water. The MKRGSA must comply with Sections 6(a) and (b) of Art. XIII D in adopting such fees.

1.3.1. Procedural Requirements

Section 6(a) of Art. XIII D requires:

- **Noticing Requirement** - The District must mail a notice of the proposed fee to all affected property owners or ratepayers. The notice must specify the amount of the fee, the basis upon which it was calculated, the reason for the fee, and the date/time/location of a public rate hearing at which the proposed fees will be considered/adopted.

- **Public Hearing** – The District must hold a public hearing prior to adopting the proposed fee. The public hearing must be held not less than 45 days after the required notices are mailed.

- **Rate Increases Subject to Majority Protest** - At the public hearing, the proposed rate increases are subject to majority protest. If more than 50% of affected property owners or ratepayers submit written protests against the proposed rate increases, the fees cannot be adopted.

1.3.2. **Substantive Requirements**

Section 6(b) of Art XIII D requires:

- **Cost of Service** - Revenues derived from the fee or charge cannot exceed the funds required to provide the service. In essence, fees cannot exceed the "cost of service".

- **Intended Purpose** - Revenues derived from the fee or charge can only be used for the purpose for which the fee was imposed.

- **Proportional Cost Recovery** - The amount of the fee or charge levied on a landowner shall not exceed the proportional cost of service attributable to that landowner.

- **Availability of Service** - No fee or charge may be imposed for a service unless that service is used by, or immediately available to, the owner of the property.

Charges for water services, such as the proposed property-related fee, are exempt from additional voting requirements of Proposition 218, provided the charges do not exceed the cost of providing service and are adopted pursuant to procedural requirements of Proposition 218.

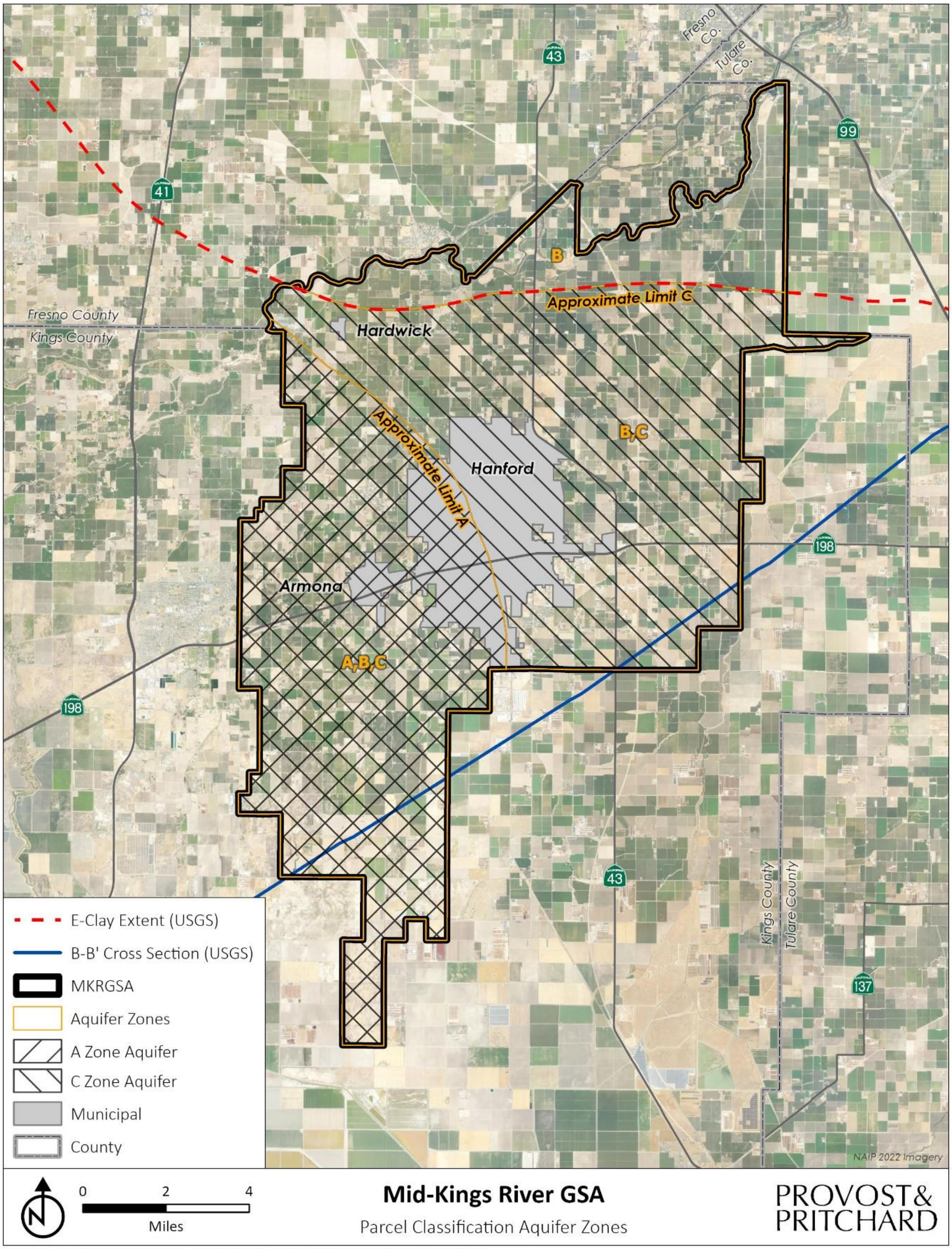
1.4. Legal Review

The Agency’s legal counsel has reviewed the provisions of SGMA and Proposition 218, and has determined that the Agency’s fees are property related and fees to recover the cost of compliance with SGMA, a service provided to lands within the Agency, and that the District must comply with Sections 6(a) and (b) of Art. XIII D in adopting the fee.

As described in this report, the fixed fees are calculated from the fixed cost portion of the Agency's proposed 5-year budget, which documents the cost of the administration and operations (i.e., the cost of service) on which the fees are based. The cost of service is divided by the assessable acreage to determine a per acre fee.

The extraction fees are calculated from the variable costs portion of the Agency’s proposed 5-year budget, which documents the cost of the shallow dry well mitigation, project development and subsidence mitigation which are proportional to the amount of pumping. The cost of service is divided by the estimated pumping volume to determine a per acre-foot pumped fee.

Figure 1. Agency Aquifer Map



2/15/2024 \\ppeng.com\pzdata\clients\Mid-Kings River GSA-2747\274724002-Prop 218\400 GIS\Map\ParcelClassification\ParcelClassification.aprx

2. COST OF SERVICE AND RATE DESIGN

2.1. Cost of Service

The cost of service for the fees recommended in this report are based on the MKRGSA's budget for fiscal year (FY) 2024 through FY2028 (see **Table 2-1**). The fixed costs relate to implementation of the GSP—those efforts will benefit all landowners in the Agency.

Table 2-1. MKRGSA Budget.

Fixed Costs	2024	2025	2026	2027	2028
KCWD/Hanford Payback	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ -
Administration					
Staff	600,000	618,000	637,000	656,000	676,000
Vehicles	100,000	0	106,000	0	112,000
Building Rental	20,000	21,000	22,000	23,000	24,000
Operations					
GSP Revisions	100,000	103,000	106,000	109,000	112,000
Annual Reports	20,000	21,000	22,000	23,000	24,000
Monitoring	150,000	155,000	160,000	165,000	170,000
Well Registration	100,000	0	0	0	0
Fee Structure Services	100,000	0	0	0	0
County Impact Study	50,000	0	0	0	0
New Monitor Wells	300,000	309,000	318,000	328,000	338,000
Reserves	360,000	360,000	360,000	360,000	360,000
Total Fixed Costs	$ 2,000,000	$ 1,687,000	$ 1,831,000	$ 1,764,000	$ 1,816,000
Variable Costs	2024	2025	2026	2027	2028
Dry Well Mitigation	$ 6,000,000	$ 6,000,000	$ 6,000,000	$ 6,000,000	$ 6,000,000
Recharge Basin Development	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000
Subsidence Mitigation	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Total Variable Costs	$ 9,500,000	$ 9,500,000	$ 9,500,000	$ 9,500,000	$ 9,500,000
Total Costs	$ 11,500,000	$ 11,187,000	$ 11,331,000	$ 11,264,000	$ 11,316,000

The variable costs shown in the budget represent expenses that will be incurred proportionately to the volume of pumping. The sustainability goals identified in the GSP involve different management objectives for each of the following three aquifers underlying the Agency as described below and shown in **Figure 1** and **Figure 2**:

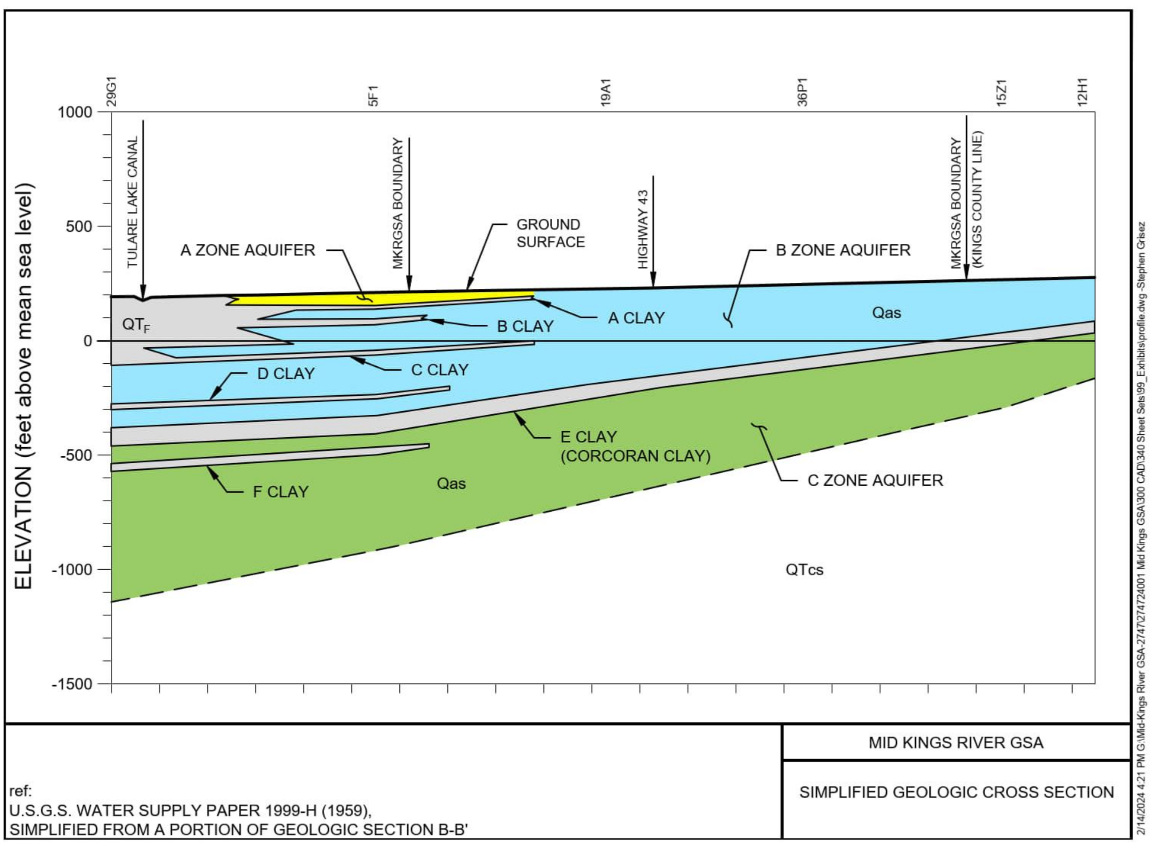
A-zone – this is an unconfined, shallow, perched aquifer that is approximately 70 feet deep located in areas containing the A-Clay (designation from USGS). As there are many shallow domestic wells pumping from this zone, the Agency's management objective is to minimize the number of wells going dry by developing recharge projects and reducing agricultural pumping from this zone. Wells pumping from the A-zone will be subject to a

0.5 acre-feet per acre (AF/ac) pumping cap initially, and the Agency estimates the allowable pumping volume from the A-zone to be 3,000 AF in 2024.

B-zone – this is an unconfined aquifer that is approximately 400 feet deep located above the E-Clay. As there are many shallow domestic wells pumping from this zone, the Agency's management objective is to minimize the number of wells going dry by developing recharge projects and reducing agricultural pumping from this zone. Wells pumping from the B-zone will be subject to a 3.0 AF/ac pumping cap initially, and the Agency estimates the allowable pumping volume from the B-zone to be 75,000 AF in 2024.

C-zone – this is a confined aquifer that is thought to be greater than 400 feet deep located below the E-Clay. While there are very few domestic wells pumping from this zone, pumping from this zone is understood to cause subsidence. The Agency's management objective is to reduce/eliminate subsidence by reducing agricultural pumping from this zone. Wells pumping from the C-zone will be subject to a 2.0 AF/ac pumping cap initially, and the Agency estimates the allowable pumping volume from the C-zone to be 60,000 AF in 2024.

Figure 2. Aquifers Underlying MKRGSA



The largest component of the variable costs is Shallow Dry Well Mitigation.

- The maximum shallow dry well replacement is budgeted for 60 wells per year.
- Mitigation would include provision of emergency services for owners whose shallow domestic wells go dry, such as bottled water and external tank service.
- Mitigation would include technical assistance when feasible.
- Mitigation would include redrilling and outfitting the drywell to reestablish use.
- Wells will be evaluated by the MKRGSA to determine whether the issue relates to general level declines.

The next largest component of the variable costs is the MKRGSAs plan for Recharge Basin Development. These recharge projects will provide the following benefits to groundwater pumpers within the GSA:

- Provide groundwater use benefits through increased floodwater layoff and groundwater recharge. The recharge facilities will allow increased diversion of available surface water that wasn't beneficial at that time and store it underground until it can be put to a beneficial use. The recharge facilities will be used, in conjunction with groundwater pumping limits, to eliminate long-term groundwater level declines.
- Provide some minor subsidence benefits by increasing recharge and reducing groundwater level declines in the B-zone.
- Provide water quality benefits by recharging high quality surface water through dedicated facilities to the A-zone and B-zone. The surface water (run-off from the Kings River) generally has lower TDS than groundwater and is excellent quality, so the recharged supplies should improve local groundwater quality.

The budgeted amounts include funding for land acquisition and construction of 50 acres of recharge basins per year, with the ultimate goal of 1,000 acres of recharge basins by 2039, generating an additional wet year recharge amount of 99,000 AF, and an average annual recharge benefit of 19,800 AF/year.

The final component of the variable costs is Subsidence Mitigation. These costs would mostly address subsidence related capacity impacts on canal systems in the MKRGSA and will be borne by the C-zone pumpers.

The variable costs shown in the budget represent expenses that will be incurred proportionately to the volume of pumping, and the budgeted amounts assume normal year pumping. In wetter years, there will be lower mitigation costs and less revenue, and in dry years, the mitigation costs will be higher.

The proposed pumping rates identified in this report document that a charge of up to $95.00 per acre foot charge is anticipated. This document also suggests in **Table 2-3** that rates could vary depending upon the aquifer from which groundwater is developed. At this time, it is unknown how many of the wells in the Agency are constructed in each aquifer zone and a separate policy has been developed that requires all wells to be registered with the Agency. Additionally, if there is no known information on the source of the groundwater the highest rate will prevail. Once information is known on the well construction the amount of water derived from the aquifer will be proportional to the screened interval in each aquifer.

2.2. Rate Design

2.2.1. **Methodology**

Art. XIII D Section 6(b) requires that fees charged to each customer be proportional to the cost of service attributable to that customer and be based upon the benefit received. There are many methods to achieve proportionality in structuring rates such as: per acre fees, rates charged per acre-foot of actual groundwater pumped (i.e. extraction fees), annual charges based on well capacity, etc.

In developing proposed fees, the Agency must consider how it incurs costs and the availability of customer data. At this point, the MKRGSA's fixed costs are largely administrative and centered around implementation of the GSP. There are also project development costs that are annually budgeted over the Implementation Period. These costs do not vary based on current pumping in the basin, but fees from pumping will be used to develop the projects.

The cost of shallow dry well and subsidence mitigation is expected to become more variable (as opposed to fixed) and reflect the seasonal amount of allowable groundwater pumping in the MKRGSA, so extraction fees based on the groundwater pumping of each landowner are more appropriate to proportionally distribute mitigation costs.

2.2.2. **Fee Calculation**

The proposed administration and operations fees are calculated as the annual cost of GSP implementation divided by the number of assessable acres (from **Table 2-2**) based on parcel information provided by the Kings County Assessor’s office. The City of Hanford, Armona CSD, Home Garden CSD and Hardwick Water Company are planned to pay MKRGSA related costs through agreements so that these costs can be collected from the users of their established water systems. These agreements are currently under development. The parties served by these water systems that are not otherwise pumping separately are excluded from the Agency charge. However, there will be some landowners or businesses that are within their jurisdictions that use private well facilities and will be subject to the fees described. Also excluded are parcels that are less than two acres.

Table 2-2. MKRGSA Parcels Subject to the Fee.

	Parcels	Acres
MKRGSA	24,999	93,486
Hanford	19,022	(8,769)
Armona	1,447	(598)
Hardwick	56	(57)
<2 acres	1,895	(1,266)
Net Assessable	2,579	82,797

The Agency has established initial allowable pumping caps that are connected to reaching the sustainability milestones described in the GSP. Pumping amounts from the A and B zones will be limited to reduce the highest use rates in all year types in an attempt to protect shallow wells against going dry, and the related groundwater pumping fees were developed to generate enough revenue to offset the anticipated dry well mitigation costs and to partially fund recharge basin project development. As pumping from the C zone mostly relates to subsidence development, the C zone pumping fees were established to generate enough income to offset the subsidence mitigation costs and to partially fund recharge basin development. **Table 2-3** illustrates projected revenues based on the sustainability targets developed in the GSP.

Table 2-3. Fee Estimate Calculation.

Revenue Source	Fee				Projected Revenue
Fixed Fees	$ 25.00	/ac	82,797	ac	$ 2,069,925
Variable Fees	**Fee**		**Initial Pumping Cap**		**Annual Revenue**
A Zone Pumping Fee	$ 95.00	/AF	3,000	AF	285,000
B Zone Pumping Fee	$ 95.00	/AF	75,000	AF	7,125,000
C Zone Pumping Fee	$ 35.00	/AF	60,000	AF	2,100,000
			Total Variable Fees		$ 9,510,000
			Total Revenue		$ 11,579,925

3. IMPLEMENTATION PROCEDURES

The Agency Board of Directors will be asked to: (a) approve and accept the Fee Study; (b) set a public hearing on the proposed fees; and (c) authorize a Proposition 218 effort to mail (i) notices to affected landowners informing them of the proposed fees at least 45 days in advance of the hearing date, and (ii) instructions to protest the proposed fees. At the public hearing, MKRGSA will state its intentions and justifications for pursuing this Proposition 218 effort, take into consideration any objections to the proposed fees, and count the written protests received as of the close of the hearing. If a majority of parcel owners submit written protests, MKRGSA will not adopt the fees at the meeting. Absent a majority protest, MKRGSA is authorized to adopt the proposed fees at its public hearing currently set for April 23, 2024 at 1:00 p.m.

4. REFERENCES

2020 Initial Tulare Lake Subbasin Groundwater Sustainability Plan, *January 2020. Wood Environment & Infrastructure Solutions Inc.*

2022 Revised Tulare Lake Subbasin Groundwater Sustainability Plan, *July 2022. Geosyntec Consultants.*

2024 Revised Tulare Lake Subbasin Groundwater Sustainability Plan, *March 2024. Geosyntec Consultants.*

Proposition 218, Local District Guidelines for Compliance, 2007 Update *(May 2007) Association of California Water Agencies*

Sustainable Groundwater Management Act, and related provisions, effective January 1, 2016, *http://groundwater.ca.gov/docs/2014 Sustainable Groundwater Management Legislation with 2015 amends 1-15-2016.pdf*

Bulletin No. 118, California's Groundwater, 2003 and 2016 Interim Update *California Department of Water Resources*

Kings County Assessor's Office*, Ownership Records, January 2024.*

California Department of Water Resources*, Groundwater Information Center Interactive Map Application,* *https://gis.water.ca.gov/app/gicima/#bookmark_DepthBelowGroundSurface*

5. AFFECTED PARCELS

APN	Record Owner	Acres	Pumping Zone
002-020-125	OLSON, ROBERT W & EILEEN	4.90	B
002-030-001	KINGS COUNTY WATER DISTRICT	18.00	B
002-030-006	WARD, MICHAEL G FAMILY TRUST 50%	60.00	B
002-030-007	WARD, MICHAEL G FAMILY TRUST 50%	61.54	B
002-030-008	KINGS COUNTY WATER DISTRICT	41.40	B
002-030-011	TE VELDE, DAVID & ALICE REVOC FAM TRUST	80.00	B
002-030-012	WARD, MICHAEL G FAMILY TRUST 50%	120.80	B
002-030-013	KINGS COUNTY WATER DISTRICT	89.40	B
002-030-014	WARD, MICHAEL G FAMILY TRUST 50%	42.71	B
002-030-016	PEOPLES DITCH CO	45.43	B
002-030-019	KIRSCHENMAN ENTERPRISES SALES LP 79.16%	80.00	B
002-030-021	JADJ LAND HOLDINGS LLC	2.50	B
002-030-022	DIEPERSLOOT, CALEB A	46.97	B
002-030-023	TE VELDE, DAVID & ALICE REVOC FAM TRUST	76.90	B
002-030-024	COLEMAN, ROBERT L & JULIE A H/W	3.59	B
002-030-025	TE VELDE, DAVID & ALICE REVOC FAM TRUST	39.60	B
002-030-027	TE VELDE, DAVID & ALICE REVOC FAM TRUST	39.60	B
002-030-030	SILVA, RANDALL & RHONDA H/W	20.08	B
002-030-031	CAETANO, WILLIAM 50%	20.08	B
002-030-032	WARD, MICHAEL G FAMILY TRUST	20.08	B
002-030-033	WARD, MICHAEL G FAMILY TRUST	20.08	B
002-060-025	KINGS RIVER PROPERTY LLC	4.56	B
002-060-026	TEVENDALE, ROBERT FAMILY TRUST	6.65	B
002-060-032	TEVENDALE, ROBERT FAMILY TRUST	26.55	B
002-060-035	TOS LAND CO INC	37.13	B
002-060-036	STATE OF CALIFORNIA	6.30	B
002-060-037	TOS LAND CO INC	42.74	B
002-070-050	JUAREZ, FERNANDO & PAULINE H/W	8.76	B
002-070-051	TOS, MARK & JORDAN LIVING TRUST 50%	17.00	B
002-070-083	JUAREZ, FERNANDO & PAULINE H/W	20.92	B
002-070-085	COUNTY OF KINGS	45.44	B
002-070-096	WESTFALL, BOBBY W REVOC TRUST	12.86	B
002-080-026	KINGS COUNTY WATER DISTRICT	138.15	B
002-080-027	DIEPERSLOOT JACOB & KATHRYN	20.38	B
002-080-028	DIAS FAMILY TRUST	4.86	B
002-080-030	ESCOTO, ANTELMO & CARMEN H/W 50%	20.16	B
002-080-032	KINGS COUNTY WATER DISTRICT	41.24	B
002-080-033	WARD, MICHAEL G FAMILY TRUST 50%	98.85	B
002-080-037	KINGS COUNTY WATER DISTRICT	18.60	B
002-080-041	CORCORAN IRRIGATION DISTRICT	24.24	B
002-080-051	TE VELDE, KARL J & LAUREN N REV FAM TRUST	70.24	B
002-080-054	REA, SETH	78.80	B
002-080-055	TE VELDE, DAVID & ALICE REVOC FAM TRUST	80.00	B
002-080-057	TE VELDE, KARL J & LAUREN N REV FAM TRUST	58.91	B
002-080-058	TE VELDE, DAVID & ALICE REV FAM TRUST	80.72	B
002-080-059	MORENO, JAVIER F JR	2.40	B
002-080-062	JOST 2018 REVOCABLE TRUST	76.17	B
002-080-063	ALTA IRRIGATION DISTRICT	5.47	B
002-080-064	JOHNSTON FAMILY TRUST	14.84	B

APN	Record Owner	Acres	Pumping Zone
002-080-065	JOHNSTON FAMILY TRUST	2.57	B
002-090-001	ESCOTO, ANTELMO & CARMEN H/W 50%	4.83	B
002-090-003	DIEPERSLOOT JACOB & KATHRYN	112.30	B
002-090-004	ROSANDER DECEDENT'S TRUST	129.71	B
002-090-005	TE VELDE, KARL J & LAUREN N REV FAM TRUST	27.22	B
002-090-006	TE VELDE, KARL J & LAUREN N REV FAM TRST	90.00	B
002-090-007	TE VELDE, KARL J & LAUREN N REV FAM TRST	59.10	B
002-090-010	DIEPERSLOOT, JACOB J & KATHRYN H/W	38.76	B
002-090-011	TE VELDE, KARL J & LAUREN N REV FAM TRUST	160.00	B
002-090-012	TE VELDE, KARL J & LAUREN N REV FAM TRUST	160.00	B
002-090-013	TE VELDE, KARL J & LAUREN N REV FAM TRUST	150.98	B
002-090-014	ALVES FARMS LLC	159.98	B
002-090-016	CEJA, RAFAEL JR	2.28	B
002-090-017	MPB RANCHES LLC	76.84	B
002-090-018	BUJULIAN FAMILY TRUST	2.50	B
002-090-019	MPB RANCHES LLC	77.23	B
002-090-026	DIAS FAMILY TRUST	13.14	B
002-100-002	DIEPERSLOOT, JACOB J & KATHRYN E H/W	38.56	B
002-100-006	BURRIS, DAVID & SHIRLEY BYPASS TRUST	39.25	B
002-100-009	WARMERDAM LAND CO LP	174.00	B
002-100-010	TOS, JOHN W & VICTORIA F LIV TRUST 50%	130.49	B
002-100-011	BURRIS, DAVID & SHIRLEY BYPASS TRUST	100.32	B
002-100-013	TOS, MARK & JORDAN LIVING TRUST 50%	5.80	B
002-100-014	JUAREZ HECTOR & AMANDA	9.60	B
002-100-016	TOS, MARK & JORDAN LIVING TRUST 50%	20.00	B
002-100-018	TOS, MARK & JORDAN LIVING TRUST 50%	19.25	B
002-100-019	TOS, MARK & JORDAN LIVING TRUST 50%	34.64	B
002-100-020	TOS, MARK & JORDAN LIVING TRUST 50%	19.51	B
002-100-021	BURRIS, DAVID & SHIRLEY BYPASS TRUST	35.97	B
002-100-022	DIAS MICHAEL A & GERMAINE FIRST AMENDED REV LIV TR	39.37	B
002-100-023	DIAS MICHAEL A & GERMAINE FIRST AMENDED REV LIV TR	38.57	B
002-100-024	DIAS MICHAEL A & GERMAINE FIRST AMENDED REV LIV TR	35.77	B
002-100-025	SWANSON FAM REV TRUST	39.55	B
002-100-027	TOS, MARK & JORDAN LIVING TRUST 50%	12.94	B
002-100-028	BURRIS, DAVID & SHIRLEY BYPASS TRUST	20.21	B
002-100-029	FINK, MARK & ROBIN H/W	2.50	B
002-100-030	DIEPERSLOOT, JACOB J & KATHRYN H/W	37.33	B
002-120-004	HANSEN, PHILLIP W SEP PROP TRUST 75%	40.00	B
002-120-005	DORAN, ROBERT D & CONNIE S REV FAM TRUST	30.00	B
002-120-007	LAWRENCE LAURA	8.19	B
002-120-010	BETTENCOURT KENNETH & CINDY LIV TRUST 50%	38.00	B
002-120-014	JACKSON, MATTHEW M FAM TRUST	42.00	B
002-120-015	NETTO ARNOLD & ALLISON TRUSTEE	10.00	B
002-120-016	NETTO LIVING TRUST	10.00	B
002-120-017	NETTO ARNOLD & ALLISON TRUSTEE	20.00	B
002-120-018	SIHOTA, PAUL & RAJNEET K H/W	16.63	B
002-120-044	HOLDER, ALDON & JANET LIVING TRUST	19.32	B
002-120-051	STATE OF CALIFORNIA	2.50	B
002-120-058	TOS LAND CO INC	5.59	B

APN	Record Owner	Acres	Pumping Zone
002-120-060	SIERRA VIEW FARMING COMPANY LLC	9.98	B
002-120-061	SIERRA VIEW FARMING COMPANY LLC	4.73	B
002-120-063	VAN CLEVE CONCRETE PRODUCTS INC	39.27	B
002-120-066	STATE OF CALIFORNIA	17.50	B
002-120-067	STATE OF CALIFORNIA	17.50	B
002-120-070	NETTO ARNOLD & NETTO ALLISON TRUSTEE	20.00	B
002-120-071	NETTO ARNOLD & ALLISON TRUSTEE	20.00	B
002-120-072	HANSEN, PHILLIP W SEP PROP TRUST	32.99	B
002-120-075	DILL, ANDERSON JR & GERMAINE H/W	17.50	B
002-120-076	MINTER, STACEY & ALISA H/W	2.50	B
002-120-081	HANSEN, ERIK & KRISTIE FAMILY TRUST	25.04	B
002-120-082	DORAN, ROBERT D & CONNIE S REV FAM TRUST	20.47	B
002-120-083	SUNNY RIVER FARMS FAM LTD PTP	17.50	B
002-120-084	VERDEGAAL, GEORGE & KIMBERLY 2023 LIV TRUST	2.50	B
002-120-085	DORAN, ROBERT D & CONNIE S REV FAM TRUST	13.69	B
002-120-086	DORAN, ROBERT D & CONNIE S REVOC TR	19.55	B
002-120-087	DORAN, ROBERT D & CONNIE S REV FAM TRUST	20.00	B
002-120-088	DORAN, ROBERT D & CONNIE S REV FAM TRUST	20.00	B
002-130-002	TOS, JEFF & SHERI LIVING TRUST 50%	6.51	B
002-130-003	TOS, JEFF & SHERI LIVING TRUST 50%	15.82	B
002-130-005	SIERRA VIEW FARMING COMPANY LLC	15.35	B
002-130-006	SUNNY RIVER FARMS FAM LTD PTP	18.60	B
002-130-009	SUNNY RIVER FARMS FAM LTD PTP	19.79	B
002-130-010	RAVEN, WILLIAM M & MARLENE A H/W	4.74	B
002-130-016	SCHLUND FAMILY TRUST	14.65	B
002-130-018	DUNN KAY E	18.80	B
002-130-020	NETTO LIVING TRUST	30.59	B
002-130-021	NETTO LIVING TRUST	16.53	B
002-130-022	MACIEL, DUSTIN P & THERESA J TRUST	2.17	B
002-140-003	KINGS RIVER FARMS LLC	33.00	B
002-140-004	VAN BEEK, NORMAN D	9.10	B
002-140-005	LAST CHANCE WATER DITCH CO	11.40	B
002-140-007	LAST CHANCE WATER DITCH CO	25.43	B
002-140-011	CAETANO PROPERTIES LLC	7.00	B
002-140-012	BETTENCOURT, MANUEL S JR BYPASS TRUST	19.65	B
002-140-013	FARMFUNDR3 LLC	25.60	B
002-140-014	CONTRERAS, RUBEN	20.00	B
002-140-015	KOPENHEFER, GLEN A & MARIA L H/W	29.29	B
002-140-018	WEISENHAUS, SUSAN M	5.00	B
002-140-019	THURMAN, OLIVE G 33.33%	25.83	B
002-140-022	NETTO LIVING TRUST	19.40	B
002-140-023	SOUZA, LEONARD J & MARY F LIVING TRUST	19.38	B
002-140-027	SARVER, DOUGLAS L & LINDA J REV TRUST	4.39	B
002-140-028	SARVER, DOUGLAS L & LINDA J REV TRUST	65.76	B
002-140-029	SOUZA, LEONARD J & MARY F LIVING TRUST	39.40	B
002-140-031	VAN BEEK, NORMAN D	24.75	B
002-140-032	LAST CHANCE WATER DITCH CO	12.00	B
002-140-035	LAST CHANCE WATER DITCH CO	3.80	B
002-140-036	KINGS COUNTRY CLUB	60.00	B

APN	Record Owner	Acres	Pumping Zone
002-140-039	BLACK OAK LLC	32.00	B
002-140-040	BISSIG, LOUIS F & SUSAN J 2023 TRUST	14.86	B
002-140-041	SOUZA, LEONARD J & MARY F LIVING TRUST	2.50	B
002-140-043	MIYA, MARK K REVOCABLE TRUST 2008 16.20%	102.50	B
002-140-044	VAN BEEK, NORMAN D	88.57	B
002-140-045	A T & SANTA FE RAILROAD	3.20	B
002-140-047	SOUZA, LEONARD & MARY LIVING TRUST	11.28	B
002-140-053	DUSTON, DOUGLAS J & LYNETTE L REV LIV TR	16.88	B
002-140-061	BISSIG, LAURIE	9.80	B
002-140-062	BISSIG, JODIE & RUSSELL W/H	3.11	B
002-140-063	NETTO LIVING TRUST	5.19	B
002-140-064	NETTO LIVING TRUST	106.16	B
002-140-065	MACIEL, DUSTIN P & THERESA J TRUST	2.80	B
002-150-001	BLACK OAK SHANE LLC 90%	27.64	B
002-150-002	MYERS, RICK & LINDA LIVING TRUST	7.00	B
002-150-003	MYERS, RICK & LINDA LIVING TRUST	7.00	B
002-150-004	HERNANDEZ, MARCOS	7.00	B
002-150-005	BRAZIL, JAMES F & TRACEY A H/W	11.83	B
002-150-008	HOLDER, ALDON & JANET LIVING TRUST	35.94	B
002-150-010	HUGH V JOHNS INC	115.00	B
002-150-012	AVILA, ANTHONY G	38.05	B
002-150-014	AVILA, ANTHONY G	24.00	B
002-150-016	NETTO, SARINA SPECIAL NEEDS TRUST	38.79	B
002-150-023	GRILIONE CRAIG AND MONICA LIVING TRUST	3.92	B
002-150-024	GRILIONE CRAIG AND MONICA LIVING TRUST	4.02	B
002-150-029	TOS, JOHN W & VICTORIA F LIV TRUST 50%	19.86	B
002-150-030	TOS LAND CO INC	20.13	B
002-150-031	TOS, JOHN W & VICTORIA LIVING TRUST 25%	39.05	B
002-150-032	TOS, JEFF & SHERI LIVING TRUST 25%	19.84	B
002-150-033	TOS, JEFF & SHERI LIVING TRUST 25%	60.00	B
002-150-034	TOS, JEFF & SHERI LIVING TRUST 25%	29.88	B
002-150-038	KINGS COUNTY WATER DISTRICT	12.23	B
002-150-044	NETTO LIVING TRUST	36.50	B
002-150-045	CHAVES, JOE M & RENNE L H/W	10.88	B
002-150-049	SELLERS, TIMOTHY & SARAH H/W	2.50	B
002-150-055	BETTENCOURT, RONALD W	2.50	B
002-150-056	BETTENCOURT, RONALD	36.28	B
002-150-058	TOS LAND CO INC	39.74	B
002-150-059	TOS LAND CO INC	9.85	B
002-150-062	SHELDON, RANDALL E	2.50	B
002-150-064	HOLDER, ALDON & JANET LIVING TRUST	72.60	B
002-150-065	J HOWER & ASSOCIATES	22.80	B
002-150-066	AVILA, ANTHONY G	20.00	B
002-150-067	SMALLWOOD, T KENNETH & VIRGINIA P H/W	8.68	B
002-150-069	STATE OF CALIFORNIA	2.00	B
002-150-070	TOS LAND CO INC	14.10	B
002-150-071	TOS, JOHN W & VICTORIA F TRUST 50%	9.31	B
002-150-072	KINGS COUNTY WATER DISTRICT	25.18	B
002-150-073	KINGS COUNTY WATER DISTRICT	22.54	B

APN	Record Owner	Acres	Pumping Zone
002-150-074	KINGS COUNTY WATER DISTRICT	20.00	B
002-150-075	DAVIS, KELTY & BENJAMIN A W/H	4.94	B
002-150-076	GRILIONE, CRAIG & MONICA LIVING TRUST	17.30	B
002-150-077	GRILIONE, CRAIG & MONICA LIVING TRUST	2.77	B
002-150-082	VALDENEGRO CHRISTIAN	8.56	B
002-150-088	JOHNS, BRAD V	47.50	B
002-150-089	JOHNS, BRAD V	72.88	B
002-150-093	JOHNS, BRAD V	25.55	B
002-150-094	JOHNS, BRAD V	9.86	B
002-150-098	TOS, JOHN W & VICTORIA F LIV TRUST 50%	75.14	B
002-150-102	TOS, WILLIAM JR & LINDA LIVING TRUST 50%	37.09	B
002-150-109	TOS LAND COMPANY INC	65.03	B
002-150-110	STATE OF CALIFORNIA	3.99	B
002-150-111	TOS LAND COMPANY INC	44.53	B
002-150-112	STATE OF CALIFORNIA	6.09	B
002-150-115	STATE OF CALIFORNIA	13.52	B
002-150-116	TOS JOHN W & VICTORIA F LIVING TRUST 50%	24.79	B
002-160-003	WARMERDAM LAND CO LP	160.00	B
002-160-006	GROUSE CREEK FARMS LLC	78.88	B
002-160-008	TOS, JEFF & SHERI LIVING TRUST	40.00	B
002-160-009	TOS, JEFF & SHERI LIVING TRUST 50%	40.00	B
002-160-010	TOS, JEFF & SHERI LIVING TRUST 50%	40.00	B
002-160-011	TOS, JEFF & SHERI LIVING TRUST 50%	40.00	B
002-160-014	EMCO INVESTMENT GROUP LLC	40.02	B
002-160-015	APRICOT 1031 LLC	40.02	B
002-160-016	APRICOT 1031 LLC	40.02	B
002-160-017	APRICOT 1031 LLC	20.03	B
002-160-018	APRICOT 1031 LLC	20.03	B
002-160-019	TOS, JEFF & SHERI LIVING TRUST 50%	38.87	B
002-160-020	TOS, JEFF & SHERI LIVING TRUST 50%	38.88	B
002-160-022	TOS, MARK & JORDAN LIVING TRUST	40.00	B
002-160-023	TOS, MARK & JORDAN LIVING TRUST 50%	40.00	B
002-160-026	VAN DYK FAMILY REVOC TRUST	60.49	B
002-160-027	TOS, JOHN W & VICTORIA F LIV TRUST 50%	100.84	B
002-160-028	TOS, JEFF & SHERI LIVING TRUST 50%	77.14	B
002-160-029	PARREIRA, HEATHER 50%	2.86	B
002-160-030	TOS, JEFF & SHERI LIVING TRUST 50%	78.61	B
002-160-032	TOS, JEFF & SHERI LIVING TRUST 50%	79.67	B
002-160-034	STATE OF CALIFORNIA	3.02	B
002-160-039	STATE OF CALIFORNIA	15.29	B
002-160-040	JOHNS, HUGH V INC	132.44	B
002-160-041	JOHNS, HUGH V INC	4.68	B
002-170-001	TE VELDE, KARL J & LAUREN N REV FAM TRST	45.49	B
002-170-005	TE VELDE, KARL J & LAUREN N REV FAM TRST	48.96	B
002-170-010	GIACOMAZZI, BOB & SONS LIMITED PTP	302.95	B
002-170-022	TE VELDE, KARL J & LAUREN N REV FAM TRST	62.61	B
002-170-024	TE VELDE, KARL & LAUREN REVOC FAM TRUST	40.32	B
002-170-025	TE VELDE, KARL & LAUREN REVOC FAM TRUST	40.32	B
002-170-028	GWDJ PROPERTIES LLC 25%	84.85	B

APN	Record Owner	Acres	Pumping Zone
002-170-029	JONES, JARED & MEGAN H/W	2.50	B
002-170-034	BARNETT, DOYLE H & LAURA J H/W	4.09	B
002-170-036	TE VELDE, KARL & LAUREN REVOC FAM TRUST	80.27	B
002-170-040	TOS, WILLIAM JR & LINDA LIVING TRUST 50%	55.91	B
002-170-041	TE VELDE, KARL J & LAUREN N REV FAM TRST	59.22	B
002-170-042	TE VELDE, KARL J & LAUREN N REV FAM TRST	100.89	B
002-170-045	JENSEN LVR RANCHES LP 50%	77.26	B
002-170-047	TOS, WILLIAM JR & LINDA LIVING TRUST 50%	17.97	B
002-170-048	TOS LAND CO INC	235.35	B
002-180-002	DOVER DAIRY HOLDINGS LLC	140.00	B
002-180-003	PIMENTEL, JOE & ESTHER LIVING TRUST	40.00	B
002-180-005	HABIB SAMUEL E	60.00	B
002-180-006	BARCELLOS, MARY J REVOC LIV TRUST 0	38.81	B
002-180-007	PIMENTEL, JOE & ESTHER LIVING TRUST	59.12	B
002-180-008	PIMENTEL, JOE & ESTHER LIVING TRUST	67.95	B
002-180-012	WADJ PROPERTIES LLC 24%	160.00	B
002-180-013	PIMENTEL, JOE & ESTHER LIVING TRUST	91.70	B
002-180-014	PIMENTEL, JOE & ESTHER LIVING TRUST	20.00	B
002-180-016	DOVER DAIRY HOLDINGS LLC	159.96	B
002-180-017	DOVER DAIRY HOLDINGS LLC	159.96	B
002-180-018	LJDJ PROPERTIES LLC 50%	49.85	B
002-180-019	GWDJ PROPERTIES LLC 50%	110.15	B
002-180-020	BARCELLOS, MARY J REVOC LIV TRUST	118.14	B
002-190-001	SULLIVAN, HELEN A LIVING TRUST 66.66% 0	40.00	B
002-190-002	SULLIVAN, HELEN A LIVING TRUST 66.66%	120.00	B
002-190-003	KINGS COUNTY WATER DISTRICT	80.00	B
002-190-004	DIAS, GABRIEL	80.00	B
002-190-009	STATE OF CALIFORNIA	40.00	B
002-190-016	NEGRETE, WILLIAM R & PATRICIA C TR 50%	80.00	B
002-190-020	MONTGOMERY FAMILY LIVING TRUST	52.65	B
002-190-021	MONTGOMERY FAMILY LIVING TRUST	52.64	B
002-190-023	DIAS, GABRIEL M	159.76	B
002-190-025	JESSUP, GIL A & YVONNE R H/W	10.00	B
002-190-026	MONTGOMERY, GARY & DIANE FAMILY TRUST	96.64	B
002-190-027	APRICOT 1031 LLC	243.53	B
002-190-029	STATE OF CALIFORNIA	3.70	B
002-190-030	BETTENCOURT, JOHN & LUCY LIVING TRUST	76.30	B
002-190-031	STATE OF CALIFORNIA	26.58	B
002-190-032	BETTENCOURT, JOHN & LUCY LIVING TRUST	17.83	B
002-190-034	APRICOT 1031 LLC	19.00	B
002-190-037	BRAZIL, GARY & JEANETTE H/W	11.12	B
002-190-038	BRASIL, JUSTIN & KAITLYN H/W 0	2.45	B
002-190-039	BRAZIL, GARY & JEANETTE H/W	20.49	B
002-190-040	TOS LAND COMPANY INC	32.80	B
002-200-001	BERTRAM FAMILY TRUST	77.57	B
002-200-002	TOS LAND COMPANY INC	80.00	B
002-200-003	SULLIVAN, HELEN A LIVING TRUST 66.66% 0	140.00	B
002-200-007	TOS, JEFF & SHERI LIVING TRUST 25%	20.00	B
002-200-009	MATSUBARA FAM TR OF 1991	39.40	B

APN	Record Owner	Acres	Pumping Zone
002-200-010	MATSUBARA FAM TR OF 1991	39.40	B
002-200-012	SULLIVAN, HELEN A LIVING TRUST 66.66%	48.60	B
002-200-013	BERTRAM FAMILY TRUST 50%	40.00	B
002-200-015	BRAZIL, MARY JANE LIVING TRUST 31.94%	79.50	B
002-200-017	BRAZIL FARMS A PTP	40.00	B
002-200-018	ESAJIAN, EDWARD V	40.00	B
002-200-022	VIERRA, MANUEL N LIVING TRUST	20.00	B
002-200-023	VIERRA, MANUEL N LIVING TRUST	40.00	B
002-200-024	VIERRA, NEIANI LEA TRUST 33.333%	40.00	B
002-200-025	VIERRA, NEIANI LEA TRUST 33.333%	48.86	B
002-200-028	TOS LAND CO INC	158.00	B
002-200-029	FERNANDES FAMILY TRUST THE	10.00	B
002-200-030	BROCK KYLE R	10.00	B
002-200-031	FERNANDES, LEE A & PENNY E H/W	2.50	B
002-200-032	TOS LAND COMPANY INC	57.50	B
002-200-033	TOS LAND CO INC	19.00	B
002-200-035	GILLUM, PAUL & JENNIFER H/W	18.58	B
002-200-041	SANGHA AJAYPREET SINGH	33.14	B
002-200-042	COSTA, EDWARD T SR & DEBRA M H/W	5.09	B
002-200-044	BERTRAM FAMILY TRUST	2.80	B
002-200-046	MATHEWS, RONALD J	40.05	B
002-200-047	MATHEWS, RONALD J & IVONE H/W	20.02	B
002-200-048	BERTRAM FAMILY TRUST 50%	38.66	B
002-200-049	MATHEWS, RONALD J	20.00	B
002-200-050	STATE OF CALIFORNIA	4.84	B
002-200-051	ESAJIAN, GARY E & ELENE P FAMILY TRUST	14.31	B
002-200-053	ESAJIAN, GARY E & ELENE P FAMILY TRUST	18.79	B
002-210-001	RGM LIVING TRUST THE	22.00	B
002-210-003	AVILA, ANTHONY G	80.00	B
002-210-004	LOWE, JACQUELINE S 2006 TRUST	20.00	B
002-210-009	MATSUBARA FAM TR OF 1991	20.00	B
002-210-018	KINGS RIVER CEMETERY	6.25	B
002-210-019	BETTENCOURT RONALD	150.73	B
002-210-022	KINGS RIVER SCHOOL DISTRICT	10.00	B
002-210-026	CARPENTER, WEALTHY A TRUST	40.00	B
002-210-027	SOUZA, LEONARD & MARY LIVING TRUST	40.00	B
002-210-028	SOUZA, LEONARD & MARY LIVING TRUST	40.00	B
002-210-031	AVILA, JOHN G & ROSEMARY E LIVING TRUST	131.81	B
002-210-032	SOUZA, WILLIAM A & DIANE T LIVING TRUST	30.00	B
002-210-036	MARTINS, JOHN A	2.50	B
002-210-038	BETTENCOURT, PAUL E & JULIE A H/W	2.66	B
002-210-039	SCHMITT, JULIANO S & ADRIANA Z H/W	16.78	B
002-210-040	CHAMPI, ONAN N & SARA M REVOCABLE TRUST	2.50	B
002-210-041	STANDARD PROPERTIES LLC	96.63	B
002-210-043	RIDDLE, HAROLD E & CATHERINE A TRUST	2.62	B
002-210-044	ACEVEDO ROBERTO SANDOVAL 50%	2.50	B
002-210-046	SEWELL, HANNIE BRIAN & MARCIE KAY REVOCABLE TRUST	12.00	B
002-210-050	MARTINS, JOHN A	55.00	B
002-210-051	COSTAMAGNA, ERNEST 50%	2.50	B

APN	Record Owner	Acres	Pumping Zone
002-210-052	LYNCH, WILLIAM K & KATHLEEN H/W	4.17	B
002-210-053	TOS LAND CO INC	64.42	B
002-210-057	WARMERDAM, TED A & JOANNE M TRUST	15.66	B
002-210-058	WARMERDAM, TED A & JOANNE M TRUST	2.68	B
002-210-061	DIAS, TONY SILVA & MARY FARIA REV LIV TRUST	3.30	B
002-210-063	A T & SANTA FE RAILROAD	12.81	B
002-210-069	WARMERDAM, SANDRA Y	12.04	B
002-210-070	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	20.00	B
002-210-071	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	20.00	B
002-210-072	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	20.00	B
002-210-081	ADC LLC	4.00	B
002-210-082	BARROS, DAVID J & E CARLEE LIVING TRUST	4.01	B
002-210-083	BARROS, DAVID J & E CARLEE LIVING TRUST	4.00	B
002-210-087	KINGS RIVER-HARDWICK UNION ELEM SCHOOL	15.00	B
002-210-091	CAMARA, JOSEPH & TERI FAM TRUST	12.11	B
002-210-092	TOSTE, STEVE M & SUSAN H/W 50%	3.35	B
002-210-095	KINGS RIVER-HARDWICK ELEMENTARY SCHOOL DISTRICT	14.44	B
002-210-096	TORRES OSCAR & SEVILLA CAROLINA	2.17	B
002-210-097	MATSUBARA FAM TR OF 1991	37.31	B
002-210-098	MATSUBARA FAM TR OF 1991	3.32	B
002-210-099	AVILA AND SONS FARMS LLC	26.09	B
002-210-100	AVILA AND SONS FARMS LLC	4.37	B
002-210-101	STANDARD PROPERTIES LLC	2.50	B
002-210-102	AVILA AND SONS FARMS LLC	20.87	B
002-210-107	TOS LAND CO INC	38.95	B
002-210-123	DIAS, GABRIEL	23.98	B
002-210-124	DIAS, GABRIEL	20.06	B
002-210-125	DIAS, GABRIEL	9.53	B
002-210-126	DIAS, GABRIEL	2.50	B
002-210-127	HASBROOK JAMES	4.93	B
002-210-128	EMCO INVESTMENT GROUP LLC	18.63	B
002-210-129	LITTLE LAND COMPANY GP 50%	21.51	B
002-220-004	DOOLEY, RICHARD & DORIS SURV TRUST 50%	7.09	B
002-220-005	MURRAY, BRENDA MARTIN	74.26	B
002-220-007	TOS, JEFF & SHERI LIVING TRUST 25%	40.00	B
002-220-010	ZONNEVELD, FRANK T & JANA C REV FAM TRU	40.00	B
002-220-012	NISHI, LESLIE 12.5%	40.47	B
002-220-013	MURRAY, MICHAEL D & BRENDA M H/W	80.00	B
002-220-015	VANDER VEEN, DARYL & KRISTIN H/W	2.00	B
002-220-016	MIYA, HARRY & NANCY LIVING TRUST 50%	37.49	B
002-220-019	GONSALVES, FRANKIE C & DANA L H/W	55.40	B
002-220-025	ZONNEVELD DAIRIES INC	33.67	B
002-220-026	MIYA, HARRY & NANCY LIVING TRUST 50%	4.40	B
002-220-028	ZONNEVELD DAIRIES INC	8.60	B
002-220-031	MIYA, HARRY & NANCY LIVING TRUST 50%	48.55	B
002-220-032	GONSALVES, FRANKIE C & DANA L H/W	5.00	B
002-220-033	GONSALVES, FRANKIE C & DANA L H/W	10.80	B
002-220-034	HANSE FARMS INC	53.34	B
002-220-035	MONTEIRO, MARIA C SURV TRUST A 50%	26.67	B

APN	Record Owner	Acres	Pumping Zone
002-220-036	KELLY, WILLIAM W & CINDY M REV TRUST	53.34	B
002-220-037	KELLY, WILLIAM W & CINDY M REV TRUST	106.66	B
002-220-051	DIAZ, DAVID TORRES	2.50	B
002-220-052	CHAMPLIN, RANDY P & DOREEN L H/W	2.50	B
002-220-053	CAMARA, KELLY J & TERRI L H/W	2.50	B
002-220-054	DUTRA CHRISTINE LIVING TRUST	2.50	B
002-220-056	REYNOLDS, BROOK	2.50	B
002-220-057	TESKE, MILDRED M LIVING TRUST	2.50	B
002-220-058	REYNOLDS BROOK R	35.13	B
002-220-064	AVILA, THOMAS C TEST BYPASS TRUST	80.05	B
002-220-065	EVANGELHO, RODNEY J & LINDA M TRUST	35.13	B
002-220-067	HOEHN, TERRY & KYRA R H/W	39.00	B
002-220-068	DOOLEY-KEPENYES FAMILY TRUST	4.74	B
002-220-069	MACIEL 2012 TRUST	2.08	B
002-220-074	MURRAY, BRENDA MARTIN	79.34	B
002-220-078	DANELL, BARBARA E SURVIVOR'S TRUST	20.53	B
002-220-079	DANELL, DANNY & LINDA LIVING TRUST	20.53	B
002-220-085	GONSALVES, FRANKIE & DANA H/W	6.52	B
002-220-086	GONSALVES, FRANKIE & DANA H/W	15.63	B
002-220-088	GONSALVES FRANKIE C & DANA L	65.40	B
002-220-090	GRILIONE, CRAIG & MONICA LIVING TRUST	2.34	B
002-220-091	GONSALVES, FRANKIE & DANA H/W	42.01	B
002-220-095	MURRAY, MICHAEL D & BRENDA M H/W	77.80	B
002-230-001	HANSE, PETER & JANIS FAM LIV TRUST	27.96	B
002-230-002	HANSE, PETER & JANIS FAM LIV TRUST	112.78	B
002-230-004	HANSE, DON & CECILIA FAM LIV TRUST 50%	5.18	B
002-230-007	KOELEWYN, HERMAN L REVOC TRUST50%	80.00	B
002-230-013	VAN GRONINGEN GARY 33.33% & NEIL 33.33%	77.00	B
002-230-017	KINGS COUNTRY CLUB	53.07	B
002-230-023	COUNTY OF KINGS	23.86	B
002-230-024	DOOLEY, RICHARD & DORIS SURV TRUST 50%	19.50	B
002-230-025	KINGS COUNTRY CLUB	4.00	B
002-230-028	COUNTY OF KINGS	3.56	B
002-230-031	A T & SANTA FE RAILROAD	7.23	B
002-230-036	GONSALVES, FRANKIE & DANA H/W	20.00	B
002-230-037	VAN GRONINGEN CLIF A & STACY M	69.98	B
002-230-038	VAN GRONINGEN, CLIF A & STACY M H/W	10.00	B
002-230-039	NETTO FAMILY LIVING TRUST 90.29%	20.00	B
002-230-040	GARCIA, JOE R FAMILY TRUST	29.79	B
002-230-045	DOOLEY, RICHARD & DORIS SURV TRUST 50%	78.05	B
002-230-048	HANSE FARMS INC	109.38	B
002-230-049	HANSE, DON & CECILIA FAM LIV TRUST 50%	19.00	B
002-230-052	ROGERS, DEBBIE	3.54	B
002-230-053	VAN GRONINGEN, CLIF A & STACY M H/W	73.62	B
002-230-058	CAETANO PROPERTIES LLC	111.42	B
002-230-059	CAETANO PROPERTIES LLC 0	2.38	B
002-240-003	MACIEL, MARY L SURVIVORS TRUST 52.84%	330.00	B
002-240-006	WARMERDAM LAND CO LP	54.85	B
002-240-008	KASBERGEN DAIRY	120.30	B

APN	Record Owner	Acres	Pumping Zone
002-240-010	HANSE FARMS INC	32.85	B
002-240-011	HANSE FARMS INC	40.00	B
002-240-012	ORMONDE, FRANK M BYPASS TRUST 66.67%	171.45	B
002-240-016	WARMERDAM, EDWARD W SURVIVORS TRUST 50% & WARMERD	59.20	B
002-240-017	SILVEIRA, DAVID L & MARY LOU REV LIV TRUST	40.00	B
002-240-018	AVILA, SHIRLEY M	40.00	B
002-240-019	AVILA, SHIRLEY M	37.50	B
002-240-021	MENDONCA MANUEL C & STACI L	2.50	A,B,C
002-240-022	WARMERDAM LAND CO LP	323.91	B
002-240-027	FERRAZ, PAM REVOCABLE TRUST	2.07	B
002-240-029	AVILA, MARY J REV TRUST	18.00	B
002-240-030	AVILA, SHIRLEY M	21.97	B
002-240-033	HANSE FARMS INC	11.38	B
002-240-034	LEMOORE CANAL & IRRIGATION CO	26.40	B
002-240-035	MACIEL, DAVID A SR & DEBRA L H/W 33.33%	19.00	B
002-240-039	WARMERDAM, AUDREY C SURVIVOR'S TRUST	22.46	B
002-240-040	WARMERDAM LAND CO LLC	148.99	B
002-240-042	NETTO WEST FARMING LLC	63.31	B
004-280-017	FOCHA, CATHERINE A	58.46	A,B,C
004-280-022	LEHN FARMS INC	320.00	A,B,C
004-280-064	COSTAMAGNA FARMS NO 4	20.00	A,B,C
004-280-065	COSTAMAGNA FARMS NO 4	20.00	A,B,C
004-280-071	COSTAMAGNA FARMS NO 4	17.46	A,B,C
004-280-074	FIGUEROA, RAYMOND A 50%	10.00	A,B,C
004-280-075	MARTIN, DARRELL & ELIZABETH H/W	10.00	A,B,C
004-280-083	MATTOS FAMILY LIVING TRUST	20.59	A,B,C
004-280-084	MELLO, JASON & ONDRIA H/W	20.00	A,B,C
005-010-002	SIMAS, STEVE & JULIE FAMILY TRUST	115.00	A,B,C
005-010-003	SIMAS, STEVE & JULIE FAMILY TRUST	45.00	A,B,C
005-010-004	CONTENTE, JOAQUIN C JR	99.98	A,B,C
005-010-005	CONTENTE, JOAQUIN C JR	22.14	A,B,C
005-010-006	WALKER, RICHARD M & MARY L H/W	2.50	A,B,C
005-010-007	WALKER, RICHARD M & MARY L H/W	31.30	A,B,C
005-010-008	WALKER, RICHARD M & MARY L H/W	6.20	A,B,C
005-020-001	B & L FARMS A PTP	6.00	A,B,C
005-020-002	B & L FARMS A PTP	142.00	A,B,C
005-020-003	B & L FARMS A PTP	27.49	A,B,C
005-020-004	B & L FARMS A PTP	124.31	A,B,C
005-020-005	B & L FARMS A PTP	19.90	A,B,C
005-020-006	BAKKER LIVING TRUST THE	19.41	A,B,C
005-020-007	BAKER, LEONARD H & B A TRUST	6.80	A,B,C
005-020-010	MEDRANO FAMILY TRUST 0	2.85	A,B,C
005-020-011	BUSH MARK NATHANIEL	2.23	A,B,C
005-020-012	EVERHART, JASON	2.23	A,B,C
005-020-013	ESCALANTE, FREDERICK & PETRA H/W	2.23	A,B,C
005-020-015	B & L FARMS A PTP	37.94	A,B,C
005-020-016	NEWBURY, KENNETH E LIVING TRUST	2.09	A,B,C
005-020-018	MIYA, HARRY & NANCY LIVING TRUST 50%	3.05	A,B,C
005-020-019	KAMEHAMIYA GROWERS LLC	29.35	A,B,C

APN	Record Owner	Acres	Pumping Zone
005-020-027	MIYA, HARRY & NANCY LIVING TRUST 50%	71.93	A,B,C
005-020-030	FIKE, DERAL H II & ANDRIA H/W	7.25	A,B,C
005-020-031	WARMERDAM LAND CO LLC	117.82	A,B,C
005-030-002	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	6.13	A,B,C
005-030-003	WARMERDAM ORCHARDS INC	45.65	A,B,C
005-030-005	CROSSWELL, JOHNNA L	8.38	A,B,C
005-030-006	MIRELES, ERIC	19.50	A,B,C
005-030-007	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	37.00	A,B,C
005-030-008	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	34.30	A,B,C
005-030-009	DIVINE, GERALD L TRUST	2.89	A,B,C
005-030-011	KINGS COUNTY WATER DISTRICT	5.85	A,B,C
005-030-012	URRUTIA, DANIEL FAMILY TRUST 50%	4.17	A,B,C
005-030-013	MENDES JOE A & MONICA E 50%	50.15	A,B,C
005-030-014	PIONEER UNION ELEMENTARY SCHOOL DISTRICT	13.81	A,B,C
005-030-015	PIONEER SCHOOL	2.27	A,B,C
005-030-020	VANDER MOREN, WILLIAM & GRACE A TRUST	6.06	A,B,C
005-030-021	VANDER MOREN, WILLIAM & GRACE REVOC LV TR	50.99	A,B,C
005-030-026	URRUTIA, NICHOLAS D & ANNE L H/W	3.05	A,B,C
005-030-027	D A BUSH FAMILY LLC	10.00	A,B,C
005-030-028	D A BUSH FAMILY LLC	3.29	A,B,C
005-030-029	PACHECO FAMILY TRUST	6.10	A,B,C
005-030-030	D A BUSH FAMILY LLC	29.70	A,B,C
005-030-031	BARRIENTOS, EDUARDO JR 50%	4.00	A,B,C
005-030-032	BROWN'S DAIRY A PTP	47.00	A,B,C
005-030-035	ONE OAK RANCH LLC	78.18	A,B,C
005-030-038	SOARES, MANUEL L & ADELIA M FAMILY TRUST	78.08	A,B,C
005-040-006	PIONEER UNION SCHOOL DISTRICT OF	6.68	A,B,C
005-050-002	SPEER, MICHELLE & JOSHUA W/H	2.08	A,B,C
005-050-005	LAST CHANCE WATER DITCH CO	8.38	A,B,C
005-050-030	FIGUEROA, RAYMOND A JR	2.00	A,B,C
005-060-001	BROWN'S DAIRY A PTP	2.65	A,B,C
005-060-002	BROWN'S DAIRY A PTP	72.64	A,B,C
005-060-004	BROWN'S DAIRY A PTP	3.05	A,B,C
005-060-005	BROWN PROPERTIES CA GN PTP	76.05	A,B,C
005-060-007	ZIMMERMAN, MARK A	14.11	A,B,C
005-060-008	LAST CHANCE WATER DITCH CO	2.87	A,B,C
005-060-009	GILLUM, SHANNON C	6.00	A,B,C
005-060-011	FARIA, NICHOLAS G & LORENA R H/W	10.44	A,B,C
005-060-013	RITCHIE REVOCABLE FAMILY TRUST THE	4.77	A,B,C
005-060-014	RITCHIE REVOCABLE FAMILY TRUST THE	4.77	A,B,C
005-060-015	RITCHIE REVOCABLE FAMILY TRUST THE	4.77	A,B,C
005-060-016	RITCHIE REVOCABLE FAMILY TRUST THE	2.02	A,B,C
005-060-019	AGRAZ, AGUSTIN & ROCIO FAMILY TRUST	19.36	A,B,C
005-060-021	RAVEN, WILLIAM M & MARLENE A H/W	16.73	A,B,C
005-060-022	BROWN'S DAIRY A PTP	59.44	A,B,C
005-060-023	BROWN DAIRY A PTP	6.06	A,B,C
005-060-024	AMICABLE 1031 LLC	42.06	A,B,C
005-060-026	BROWN'S DAIRY A PTP	19.40	A,B,C
005-060-027	WARMERDAM, NICHOLAS J & JUDITH A H/W CP	15.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
005-060-028	WANG, LIPING	4.28	A,B,C
005-060-029	THORBUS, RUBEN S REVOCABLE TRUST 50%	10.00	A,B,C
005-060-030	THORBUS, RUBEN S REVOCABLE TRUST 50%	10.00	A,B,C
005-060-033	OLAM WEST COAST INC	35.09	A,B,C
005-060-034	AMICABLE 1031 LLC	18.43	A,B,C
005-060-035	AMICABLE 1031 LLC	20.00	A,B,C
005-060-036	ALVAREZ, JAIME A 50%	3.00	A,B,C
005-060-037	COLEMAN, LUCILLE A	2.00	A,B,C
005-060-040	VANDER MOREN, WILLIAM & GRACE REVOC LV TR	10.00	A,B,C
005-060-041	VANDER MOREN, WILLIAM & GRACE REVOC LV TR	30.04	A,B,C
005-060-042	MELLO, GARY J SEPARATE PROPERTY TRUST	17.50	A,B,C
005-060-043	MELLO, GARY J & JUDY A REVOC TRUST	2.50	A,B,C
005-060-044	AMICABLE 1031 LLC	20.00	A,B,C
005-060-046	NOOR LAND COMPANY LLC 50%	27.04	A,B,C
005-060-048	MELLO, JAMES B & LINDA A TRUST	2.50	A,B,C
005-060-049	MELLO, JAMES & LINDA A TRUST	24.62	A,B,C
005-070-001	DUARTE, AGOSTINHO M	20.00	A,B,C
005-070-002	MOSLEMPOOR, ADREES M	20.00	A,B,C
005-070-003	ELLIS, MELVIN & PATRICIA LIVING TRUST	2.50	A,B,C
005-070-004	MELLO, JOHN D & MARY L H/W	2.50	A,B,C
005-070-005	MELLO, J D DAIRY A PTP	35.00	A,B,C
005-070-006	MELLO, J D DAIRY A PTP	40.00	A,B,C
005-070-007	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	9.76	A,B,C
005-070-008	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	29.44	A,B,C
005-070-009	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	80.00	A,B,C
005-070-010	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	14.80	A,B,C
005-070-011	VANDER MOREN, WILLIAM & GRACE A LIV TRST	8.85	A,B,C
005-070-014	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	36.40	A,B,C
005-070-015	NOOR LAND COMPANY LLC 50%	40.00	A,B,C
005-070-016	AVILA, PAUL C & ANGIE H/W	40.00	A,B,C
005-070-017	AVILA, JAMES G & ISABEL A LIVING TRUST	40.81	A,B,C
005-070-019	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	49.95	A,B,C
005-070-020	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	20.00	A,B,C
005-070-021	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	5.84	A,B,C
005-070-023	MELLO, J D DAIRY A PTP	50.83	A,B,C
005-070-025	MOSLEMPOOR, ADREES M	10.00	A,B,C
005-070-026	VANDER MOREN, WILLIAM & GRACE A LIV TRST	16.32	A,B,C
005-070-030	MELLO, JASON D & ONDRIA D H/W	10.05	A,B,C
005-070-031	MELLO, J D DAIRY A PTP	50.31	A,B,C
005-080-005	LU/AR DAIRY	97.50	A,B,C
005-080-006	SOARES, MANUEL L & ADELIA M REV FAM TRST	17.81	A,B,C
005-080-007	THE DOUBLE D FAMILY TRUST 100%	78.16	A,B,C
005-080-008	BROWN'S DAIRY A PTP	92.51	A,B,C
005-080-009	CARPENTER, KATHLEEN M REVOC TRUST	2.00	A,B,C
005-080-010	MELLO, J D DAIRY A PTP	80.37	A,B,C
005-080-011	BETTENCOURT, DARRELL & MICKI REVOC TR 25%	192.00	A,B,C
006-010-004	LOOGMAN, JIM A 50%	20.50	A,B,C
006-010-005	LARSON, DEBBIE M 33.33%	41.00	A,B,C
006-010-008	GREEN HARVEST PROPERTIES LLC 50% & WARMERDAM, EDWA	60.71	A,B,C

APN	Record Owner	Acres	Pumping Zone
006-010-010	TOS, JEFF & SHERI LIVING TRUST	39.97	B
006-010-015	WHITE, BORGHILD P 2007 TRUST	25.47	A,B,C
006-010-018	AVILA, LEROY A & BARBARA K REV TRUST	9.40	B
006-010-019	AVILA, LEROY A & BARBARA K REV TRUST	44.75	B
006-010-023	AVILA, THOMAS C TEST BYPASS TRUST	15.06	B
006-010-025	HANSE FARMS INC	39.48	B
006-010-027	SIMAS, GREGORY ALLEN TRUST	33.11	B
006-010-028	SIMAS, STEVE & JULIE FAMILY TRUST	50.00	A,B,C
006-010-029	SIMAS FAMILY LP	42.00	B
006-010-034	FROBERG FAMILY INVESTMENTS LLC 48%	40.21	A,B,C
006-010-038	LARSON, DEBBIE M 33.33%	39.52	A,B,C
006-010-041	KARAYAN FAMILY TRUST	39.24	B
006-010-043	AVILA, LAVINA O REV LIV TRUST	2.50	A,B,C
006-010-044	ROSE FAMILY REVOC TRUST (BY-PASS TRUST)	33.16	A,B,C
006-010-046	KARAYAN FAMILY TRUST	38.41	B
006-010-048	TOS, JOHN W & VICTORIA F LIVING TRUST	48.16	B
006-010-051	TOS GRANDCHILDREN 2017 IRREVOC TRUST	58.12	A,B,C
006-010-052	WARMERDAM, CORNELIUS & YOLANDA H/W JT	2.50	B
006-010-053	WARMERDAM CORNELIUS J	15.56	B
006-010-061	HANSE FARMS INC	15.88	B
006-010-062	OPPEGARD, JANICE M & KEITH H W/H 50%	65.11	B
006-010-064	PIRES, MARCO & TERESA H/W	2.26	B
006-010-067	HANSE FARMS INC	12.90	B
006-010-071	DUYST FAMILY GRANTOR TRUST	5.21	B
006-010-072	HANSE FARMS INC	79.90	B
006-010-073	WHITE, BORGHILD P 2007 TRUST	56.39	A,B,C
006-010-075	SUNNY ACRE FARMING INC	64.16	B
006-010-076	DUYST FAMILY GRANTOR TRUST	60.07	B
006-010-078	FROBERG FAMILY INVESTMENTS LLC 48%	60.80	A,B,C
006-010-080	LOEWEN, FRANCES 2002 TRUST	92.11	B
006-020-003	DOUBLE N FARMS A PTP	34.80	B
006-020-004	DOUBLE N FARMS A PTP	28.00	B
006-020-005	DOUBLE N FARMS A PTP	14.49	B
006-020-006	DOUBLE N FARMS A PTP	6.40	B
006-020-007	DOUBLE N FARMS A PTP	15.00	B
006-020-008	DOUBLE N FARMS A PTP	5.00	B
006-020-009	DOUBLE N FARMS PTP	20.00	B
006-020-010	DOUBLE N FARMS A PTP	5.20	B
006-020-011	DOUBLE N FARMS A PTP	39.33	B
006-020-012	NETTO FAMILY LIVING TRUST	38.00	B
006-020-015	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	13.60	B
006-020-017	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	26.40	B
006-020-018	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	16.40	B
006-020-020	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	5.00	B
006-020-022	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	23.60	B
006-020-023	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	39.00	B
006-020-030	ZONNEVELD DAIRIES INC	82.14	B
006-020-034	ZONNEVELD DAIRIES INC	39.55	B
006-020-035	DOUBLE N FARMS A PTP	30.00	B

APN	Record Owner	Acres	Pumping Zone
006-020-036	NETTO WEST FARMING LLC	60.00	B
006-020-038	DOUBLE N FARMS A PTP	76.92	B
006-020-057	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	32.85	B
006-020-062	CHHANN, STEVEN & NARIN H/W	39.30	B
006-020-068	NETTO, JAMES H FAM ENDOWMENT TRUST	10.14	B
006-020-071	HOWELL, JAMES & CINNAMON H/W	2.35	B
006-020-072	JOHNSON, KATHLEEN ANN TRUST	38.03	B
006-020-073	KENNEDY, RODNEY W & RONDA K H/W	2.51	B
006-020-074	ENLOE, GREGORY T	2.51	B
006-020-075	SIEGEL, CATHERINE R LIVING TRUST 50%	2.50	B
006-020-076	PARSONS FAMILY TRUST	2.50	B
006-020-077	PARSONS, GLEN A & SU-JREN H/W	2.50	B
006-020-078	DOUBLE N FARMS	32.53	B
006-020-079	FUKUDA, AARON K & DINA YASUKO H/W	11.20	B
006-020-081	KINGS COUNTY WATER DISTRICT	8.40	B
006-020-082	LAST CHANCE WATER DITCH CO	2.88	B
006-020-086	ZONNEVELD DAIRIES INC	61.15	B
006-020-087	SOARES, MANUEL L & ADELIA M REV FAM TRUST	2.18	B
006-020-090	DOUBLE N FARMS	41.36	B
006-020-093	DOUBLE N FARMS A PTP	18.32	B
006-020-094	DOUBLE N FARMS	8.20	B
006-020-095	DIAS, KEVIN P & KAREN H/W	3.58	B
006-020-096	SOARES, MANUEL L & ADELIA M REV LIV TST	5.10	B
006-020-097	SOARES, MANUEL L & ADELIA M FAMILY TRUST	10.04	B
006-020-100	ZONNEVELD DAIRIES INC	19.37	B
006-020-101	DOUBLE N FARMS A PTP	65.49	B
006-020-104	ENLOE GREGORY & ILEKTRA MARIA PSOUNI	2.50	B
006-020-105	BERTAO, JOEY A	2.50	B
006-020-106	BOOKOUT, LLOYD & MARIE LIVING TRUST	20.28	B
006-020-107	DOUBLE N FARMS A PTP	20.49	B
006-020-108	LA SALLE, MICHAEL E	21.60	B
006-020-109	LA SALLE, MICHAEL E	21.76	B
006-020-110	ZONNEVELD DAIRIES INC	137.59	B
006-020-111	ZONNEVELD DAIRIES INC	20.00	B
006-031-002	VAN BEEK, NORMAN D	63.19	B
006-031-003	A T & SANTA FE RAILROAD	9.85	B
006-031-004	MATSUBARA FAM TR OF 1991	37.42	B
006-031-005	LITTLE LAND COMPANY GP 50%	36.00	B
006-031-010	FAGUNDES, MANUEL G & NATALIE S WARD H/W	2.00	B
006-031-011	47 PALMS RANCH LLC	73.59	B
006-031-019	KINGS RIVER ORCHARD SERVICE INC	2.43	B
006-031-020	MCCUTCHEON, B H & B L FAM TRST	16.25	B
006-031-021	FEAVER, CHARLES R & SUSAN REVOC TRUST	12.00	B
006-031-025	LAWRENCE, WILLIAM & ANGIE H/W LF ESTATE	2.50	B
006-031-026	BERGREN, DAVID W & DIANE R REV LIV TRUST	2.50	B
006-031-027	ZONNEVELD, FRANK T & JANA C REV FAM TRU	16.62	B
006-031-033	MCCUTCHEON, BARRY & BRENDA RV FM TR 50%	27.42	B
006-031-034	PENNY NEWMAN FARMS PRODUCTS, LLC	5.39	B
006-031-035	PENNY NEWMAN FARMS PRODUCTS, LLC	4.83	B

APN	Record Owner	Acres	Pumping Zone
006-031-038	OLIVAS AND COMPANY LLC	3.95	B
006-031-039	GRILIONE BLAKE & TIFFANY	14.09	B
006-031-040	FEAVER, CHARLES R & SUSAN REV FAM TRUST	77.71	B
006-031-041	FEAVER, CHARLES R & SUSAN REV FAM TRUST	2.29	B
006-031-043	ZONNEVELD, FRANK T & JANA C REV FAM TRU	16.06	B
006-031-044	A T & SANTA FE RAILROAD (BNSF)	6.99	B
006-031-049	DIAS, MICHAEL A & GERMAINE FIRST AMEND REV LIV TR	36.49	B
006-031-051	KELLER, JON & VALERIE REVOC TRUST	4.47	B
006-031-053	SEQUOIA VALLEY ORCHARDS LLC	77.49	B
006-031-055	WARMERDAM, JOHN & TARA LIVING TRUST	20.00	B
006-031-058	KINGS RIVER ORCHARD SERVICE INC	4.13	B
006-031-059	TRULOCK, JASON	2.71	B
006-031-061	SEQUOIA VALLEY ORCHARDS LLC	37.20	B
006-031-062	WARMERDAM, JOHN & TARA LIVING TRUST	20.00	B
006-032-001	LOWE, JACQUELINE S 2006 TRUST	22.36	B
006-032-002	LITTLE LAND CO 50%	22.00	B
006-032-003	LITTLE, JARED R & AMANDA M H/W	15.00	B
006-032-005	WARMERDAM, TED A & JOANNE M TRUST	32.00	B
006-032-007	MITCHELL, VIRGINIA	2.50	B
006-032-008	HERNANDEZ, SALVADOR	2.50	B
006-032-009	NIKOGHOSIAN, HAROLD & JANICE LIV TRUST	2.50	B
006-032-010	ABRAHAMSON, GLENN A & SUZANNE E H/W	2.50	B
006-032-012	WARMERDAM, JOHN & MINDY LIVING TRUST	7.94	B
006-032-014	WARMERDAM, JOHN & MINDY LIVING TRUST	8.03	B
006-032-015	LOHSE, PATRICK N AND LINDA A REV FAM TRUST	10.00	B
006-032-016	MARTINS, JOHN A	32.85	B
006-032-017	MARTINS, JOHN L & SON A PTP	12.61	B
006-032-018	MARTINS, JOHN A	33.33	B
006-032-019	MARTINS, JOHN L & SON A PTP	18.79	B
006-032-022	R & A JACKSON LAND LP	29.65	B
006-032-023	CABRERA, MARIA G & HUMBERTO W/H	4.76	B
006-032-025	COSTAMAGNA FARMS NO 3	30.00	B
006-032-026	R & A JACKSON LAND LP	41.13	B
006-032-029	DUPREE, HOLLY L REVOC TRUST	2.50	B
006-032-030	YOUNG FIOERLLA & ROMERO FERNANDO	2.50	B
006-032-031	YOUNG FIOERLLA & ROMERO FERNANDO	2.50	B
006-032-038	FISER FAMILY REVOCABLE TRUST	32.54	B
006-032-039	TOLBERT ANDREW E & NICOLE T	3.19	B
006-032-042	LOHSE, PATRICK N AND LINDA A REV FAM TRUST	19.00	B
006-032-047	LITTLE, JARED R & AMANDA M H/W	14.00	B
006-032-049	LITTLE, JARED R & AMANDA M H/W	10.61	B
006-032-050	MARTINS, JOHN & AMY H/W	36.63	B
006-032-056	MARTINS, JOHN & AMY H/W	29.15	B
006-032-057	WILLIAMS, BENJAMIN E & MAVIS H/W	2.48	B
006-032-058	JACKSON, RYAN M & AMY M H/W	9.32	B
006-032-059	R & A JACKSON LAND LP	134.88	B
006-040-004	WARMERDAM, JEROME & DINA REVOC LIV TRUST	40.00	B
006-040-007	COSTAMAGNA FARMS NO 4	27.00	B
006-040-012	MCCUTCHEON, B H & B L FAM TRST	31.56	B

APN	Record Owner	Acres	Pumping Zone
006-040-014	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	33.36	B
006-040-015	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	94.93	B
006-040-020	MIRELES, MANUEL & ROSA H/W	30.00	B
006-040-022	MENDEZ, ROBERT A & YOLANDA L H/W	2.00	B
006-040-023	MIRELES, MANUEL & ROSA H/W	40.00	B
006-040-049	REED, MARK C & CONNIE L H/W 50%	2.79	B
006-040-051	GONZALES, RICHARD K & JENNIFER L H/W	2.50	B
006-040-057	VAN DER GRAAF, ALBERT & RIEKIE LIV TRUST	41.83	B
006-040-058	PARRA, RUDY JR & LISA H/W	5.17	B
006-040-059	GRISWOLD, GERALD T	30.00	B
006-040-064	BOGAN FAMILY REVOC LIVING TRUST	5.00	B
006-040-068	REESE SURVIVORS TRUST	10.04	B
006-040-069	REESE SURVIVORS TRUST	10.04	B
006-040-070	SIKORA, KRYSTY	3.59	B
006-040-071	GALE, JAMES L LIVING TRUST	3.60	B
006-040-072	CAMPBELL, RONALD M & MEGAN C	2.50	B
006-040-075	THOMAS, JAMES CARTER	18.53	B
006-040-077	MCCUTCHEON, B H & B L FAM TRST	20.10	B
006-040-085	SMITH, KENNETH A & DARLENE M H/W	6.30	B
006-040-086	MIYA, HARRY & NANCY LIVING TRUST 50%	16.59	B
006-040-088	COUTURE, STEPHEN E & CHRISTINA H H/W	2.22	B
006-040-089	RAMIREZ, RAUL V & MARIA I LOPEZ H/W	2.52	B
006-040-094	KINGS COUNTY WATER DISTRICT	5.35	B
006-040-095	OWENS CLEO & BETTY	10.06	B
006-040-098	DOUBLE N FARMS A PTP	9.94	B
006-040-102	WARMERDAM LAND CO LP	298.01	B
006-040-104	HANFORD CHRISTIAN SCHOOL SOCIETY	9.10	B,C
006-040-105	HANSEN, JAKE V LIVING TRUST	10.01	B
006-040-107	ROMAN CATHOLIC BISHOP OF FRESNO	10.17	B
006-040-108	ROMAN CATHOLIC BISHOP OF FRESNO	2.02	B
006-040-112	ROMAN CATHOLIC BISHOP OF FRESNO	4.08	B
006-040-114	KOVAC TRUST AGREEMENT 8/27/09 100%	28.73	B
006-040-115	KOVAC TRUST AGREEMENT 8/27/09 100%	7.25	B
006-040-117	KOVAC TRUST AGREEMENT 8/27/09 100%	10.00	B
006-040-123	EBC FARMS LLC	144.35	B
006-040-124	RAMOS NOE & LEAH	3.33	B
006-040-125	DOUBLE N FARMS	10.00	B
006-040-126	ROSE FAMILY TRUST	124.21	B
006-040-133	ESAJIAN FAMILY TRUST	10.00	B
006-040-134	ESAJIAN FAMILY TRUST	10.00	B
006-040-135	ESAJIAN FAMILY TRUST	13.67	B
006-040-136	COTHRAN, STEVEN P 50%	2.88	B
006-040-137	SEMAS, MICHAEL & CHRISTINE REVOC FAM TST	12.33	B
006-040-138	HUNTER, ROBERT K & DEBORAH A H/W	7.81	B
006-040-139	HUNTER, ROBERT K & DEBORAH A H/W	2.25	B
006-050-001	BETTENCOURT, STEVE 50%	4.85	B
006-050-004	NETTO FAMILY LIVING TRUST	160.00	B,C
006-050-005	DON VERNE FARMS LLC 50%	157.95	A,B,C
006-050-007	KINGS ORCHARDS INC	127.86	B

APN	Record Owner	Acres	Pumping Zone
006-050-009	DILLON, YOUNG C	7.78	B
006-050-010	VERBOON, WILLIAM D JR	157.45	B
006-050-012	DUTRA FAMILY REVOC LIV TRUST OF 2008	160.65	B,C
006-050-013	SIMAS FAMILY LP	57.02	B
006-050-016	KINGS ORCHARDS INC	16.97	B
006-050-017	WARMERDAM, JOHN & CHRISTIANA LIV TRUST	3.92	B
006-050-018	SIMAS, STEVE & JULIE FAMILY TRUST	2.96	B
006-050-019	SIMAS FAMILY LP	97.35	B
006-050-020	BETTENCOURT, STEVE .038%	160.50	B
006-050-022	NEVES, TODD R 33.334%	108.49	B
006-050-023	LU/AR DAIRY A PTP	43.86	B
006-060-002	ROSE FAMILY REVOCABLE TRUST	80.24	A,B,C
006-060-003	DUTRA, GARY B 33.33%	7.00	A,B,C
006-060-004	BETTENCOURT LARRY & CARMEN H/W	10.00	A,B,C
006-060-005	MATTOS FAMILY LIVING TRUST	25.00	A,B,C
006-060-012	SIMAS FAMILY LP	116.97	A,B,C
006-060-013	SIMAS, KENNETH ANTHONY	71.93	B
006-060-015	MUSSEL SLOUGH RANCH LLC 50%	38.58	A,B,C
006-060-016	MUSSEL SLOUGH RANCH LLC 50%	40.40	A,B,C
006-060-017	BAKKER LIVING TRUST THE	72.00	A,B,C
006-060-019	BAKKER LIVING TRUST THE	4.00	A,B,C
006-060-020	SIMAS LIVING REVOCABALE TRUST THE	32.50	A,B,C
006-060-021	BAKKER LIVING TRUST	4.40	A,B,C
006-060-022	SIMAS LIVING REVOCABLE TRUST THE	6.00	A,B,C
006-060-023	BAKKER LIVING TRUST	34.10	A,B,C
006-060-024	SIMAS FAMILY LP	4.00	A,B,C
006-060-027	MATTOS FAMILY LIVING TRUST THE	20.00	A,B,C
006-060-028	ROSE FAMILY REVOCABLE TRUST	20.00	A,B,C
006-060-029	SIMAS FAMILY LP	20.00	A,B,C
006-060-032	BETTENCOURT, KEITH & BARBARA FAM TRUST	40.00	A,B,C
006-060-033	BETTENCOURT, KEITH & BARBARA FAM TRUST	30.00	A,B,C
006-060-034	CUNHA, ELISEU & THERESA LIVING TRUST	2.50	A,B,C
006-060-038	DUTRA, MANUEL M JR & DEBORA M H/W	43.07	A,B,C
006-060-039	CANTRELL, BRYNN & NICHOLAS W/H	2.93	A,B,C
006-060-040	LOSEY, LINDA M REVOCABLE TRUST	2.25	B,C
006-060-043	SIMAS FAMILY LP	36.00	A,B,C
006-060-046	ROSE FAMILY REVOC TRUST (SURVIVOR'S TR)	2.50	A,B,C
006-060-047	ROSE FAMILY REVOCABLE TRUST	45.57	A,B,C
006-060-049	ROSE FAMILY REVOCABLE TRUST	19.13	A,B,C
006-060-050	BAKKER LIVING TRUST THE	67.00	A,B,C
006-060-051	BAKKER LIVING TRUST THE 0	9.00	A,B,C
006-060-052	SOUTHERN PACIFIC TRANSPORTATION CO	3.62	A,B,C
006-060-054	GREEN HARVEST PROPERTIES LLC 50% & WARMERDAM, EDWA	17.31	A,B,C
006-060-055	BETTENCOURT, KEITH & BARBARA FAM TRUST	23.08	A,B,C
006-060-057	BETTENCOURT, LARRY & CARMEN H/W	19.30	A,B,C
006-060-058	BAKKER LIVING TRUST	6.22	A,B,C
006-060-059	BETTENCOURT, KEITH & BARBARA FAM TRUST	49.43	A,B,C
006-060-060	GREEN HARVEST PROPERTIES LLC 50% & WARMERDAM, EDWA	31.32	A,B,C
006-060-062	BETTENCOURT, LARRY & CARMEN H/W	31.91	A,B,C

APN	Record Owner	Acres	Pumping Zone
006-060-063	BETTENCOURT, LARRY & CARMEN H/W	23.47	A,B,C
006-060-064	BETTENCOURT, LARRY & CARMEN H/W	50.48	A,B,C
006-060-065	BETTENCOURT, LARRY & CARMEN H/W	22.78	A,B,C
007-010-006	DAVIS FAMILY TRUST	2.60	B,C
007-010-008	ROBISON, ROBERT L LIVING TRUST	2.17	B,C
007-010-013	HUNT, NATHAN & NANCY H/W	3.16	B,C
007-010-014	SUMAYA, DAVID D & BARBARA E H/W	2.86	B,C
007-030-001	HEADRICK JEB	3.44	B,C
007-030-002	HEADRICK JEB	46.56	B,C
007-030-008	HEADRICK JEB S	10.00	B,C
007-030-018	BECK, STEVEN W & ALICE M H/W	5.00	B,C
007-170-006	ANDERSON, KARL R & CATHLENE M H/W	2.50	B,C
007-180-001	TESSMAN, GORDON K & JEAN A REV FAM TRUST	2.50	B,C
007-180-002	FLORES, GEORGE & MARIA O H/W	2.50	B,C
007-180-003	HASTINGS JO ANNE	2.50	B,C
007-180-004	THORBUS, WENDY C	2.50	B,C
007-180-005	JONES, PHILLIP L & CHERYL A H/W	2.50	B,C
007-180-006	GRILIONE, JUSTIN & HAILEY	2.50	B,C
007-180-007	MORGAN, MICHAEL G & SALLY B H/W	2.50	B,C
009-010-002	MIYA, MELINDA K REV TRUST 33.333%	80.00	A,B,C
009-010-005	HOOK, RICHARD J & CHARLENE M H/W	4.00	A,B,C
009-010-019	COSTAMAGNA, ERNEST B	11.01	A,B,C
009-010-020	COSTAMAGNA, ERNEST B	10.00	A,B,C
009-010-021	COSTAMAGNA, ERNEST B	41.09	A,B,C
009-010-022	COSTAMAGNA, ERNEST B	41.77	A,B,C
009-010-026	COSTAMAGNA, ERNEST B	70.88	A,B,C
009-010-027	COSTAMAGNA, ERNEST B	10.00	A,B,C
009-010-028	BAKER, LEONARD H & B A TRUST	151.49	A,B,C
009-010-031	BAKER FAMILY TRUST 2019	77.88	A,B,C
009-010-032	BVC LLC 50%	77.26	A,B,C
009-010-033	CLEMENT, VIVIAN P LF EST	2.03	A,B,C
009-010-036	COSTAMAGNA, ERNEST B	10.00	A,B,C
009-010-037	EBC FARM LLC	19.10	A,B,C
009-010-038	EBC FARMS LLC	19.10	A,B,C
009-020-002	SOARES, RONALD E & LISA H/W	10.03	B,C
009-020-003	MIYA, HARRY & NANCY LIVING TRUST	10.03	B,C
009-020-004	MIYA, MARK K REV TRUST 16.667%	10.03	B,C
009-020-005	DURHAM, MICHAEL & TERRI LIVING TRUST	2.61	B,C
009-020-007	DURHAM, MICHAEL & TERRI LIVING TRUST	17.49	B,C
009-020-009	VERBOON, WILLIAM D JR	17.65	B,C
009-020-010	SILVA, JOSEPH & AMANDA H/W	3.94	B,C
009-020-011	VERBOON WILLIAM D JR	9.76	B,C
009-020-012	TEWS, CYNTHIA S. & AVILA, SAM J.	2.50	B,C
009-020-013	BOBADILLA, FIDEL JR & DAISY H/W	2.50	B,C
009-020-014	JONES, ERIC & MELANIE H/W 0	2.50	B,C
009-020-018	DURHAM, MICHAEL & TERRI LIVING TRUST	28.85	B,C
009-020-019	DURHAM, MICHAEL & TERRI LIVING TRUST	40.24	B,C
009-020-020	KINGS COUNTY WATER DISTRICT	12.34	B,C
009-020-021	CLAYCAMP, STACEY NEVES FAMILY TRUST 16.67%	6.29	B,C

APN	Record Owner	Acres	Pumping Zone
009-020-023	CLAYCAMP, STACEY NEVES FAMILY TRUST 16.67%	70.91	B,C
009-020-024	MONTOYA, MARVIN G TRUST 50%	2.50	B,C
009-020-025	MONTOYA, MARVIN G TRUST 50%	2.50	B,C
009-020-026	ELDER DAVID F & MARY ANN	2.50	B,C
009-020-029	VERHOEVEN, PETER G & LUJEAN G H/W	38.00	A,B,C
009-020-030	JUNELL, TOBY R & SHARON E H/W JT	4.40	A,B,C
009-020-032	MONTGOMERY FAMILY LIVING TRUST	5.00	A,B,C
009-020-033	VAN GRONIGEN, SHAWN & KRISTINA H/W	2.26	A,B,C
009-020-034	BLOCH, CATHERINE R	2.32	A,B,C
009-020-037	DE RUITER, LEONARD E FAMILY TRUST 50%	34.00	A,B,C
009-020-040	KINGS COUNTY WATER DISTRICT	8.45	B,C
009-020-041	MIYA FAMILY REV TRUST 16.667%	35.73	B,C
009-020-046	OLIVEIRA, JOHN W & TERESA H/W 50%	10.12	A,B,C
009-020-047	CLAYCAMP, STACEY NEVES FAMILY TRUST 16.66%	51.25	B,C
009-020-052	KAMEHAMIYA GROWERS LLC	119.07	A,B,C
009-020-053	MIYA, HARRY & NANCY LIVING TRUST	2.94	A,B,C
009-020-054	COSTAMAGNA, ERNEST B	8.76	B,C
009-020-058	PAROLINI, LEO B & VERONICA J REV TRUST	23.29	B,C
009-020-060	CODY, RICHARD & JOYCE LIVING TRUST	11.06	A,B,C
009-020-061	CODY, RICHARD & JOYCE LIVING TRUST	10.84	A,B,C
009-030-001	MIYA, HARRY & NANCY LIVING TRUST 50%	29.88	A,B,C
009-030-002	MIYA, MELYNDA K 2008 REVOCABLE TRUST	10.12	A,B,C
009-050-030	BUSK, HELEN M SURVIVOR'S TRUST	8.11	A,B,C
009-050-035	FOUR SEASONS ESTATES LLC	8.82	A,B,C
009-050-036	WOOD, JAMES A	4.90	A,B,C
009-070-006	GARCIA, PEDRO ANGEL URIBE GARCIA 50% & GUTIERREZ,	2.54	A,B,C
009-070-007	WALTERS LIVING TRUST THE	7.50	A,B,C
009-070-008	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	29.70	A,B,C
009-070-009	KIINO, STANLEY 16.667%	59.95	A,B,C
009-070-012	DE RUITER, LEONARD E FAMILY TRUST 50%	18.06	A,B,C
009-070-013	STEVENSON, MICHAEL O TRUST	20.00	A,B,C
009-070-014	MARTINS, JOHN L & SON A PTP	13.33	A,B,C
009-070-019	MARTINS, JOHN L & SON A PTP	68.65	A,B,C
009-070-020	WARMERDAM, NICHOLAS J & JUDITH A H/W	19.97	A,B,C
009-070-021	LLOYD, MICHAEL K & DOR E H/W	19.18	A,B,C
009-070-022	HAGEN, EARL O TESTAMENTARY FAMILY TRUST	9.70	A,B,C
009-070-023	SOUZA, ROBERT W & ALEX N H/W	2.50	A,B,C
009-070-025	SCHNELL, JENNIFER L LIVING TRUST	2.20	A,B,C
009-070-026	VALLEY AG HARVESTING LLC	9.16	A,B,C
009-070-027	LAST CHANCE WATER DITCH CO	2.32	A,B,C
009-070-028	WILLIAMS, MILTON D & SUSAN I REV LIVING TRUST	3.39	A,B,C
009-070-029	VALLEY AG HARVESTING LLC	7.26	A,B,C
009-070-030	VALLEY AG HARVESTING LLC	11.18	A,B,C
009-070-031	WARMERDAM, NICHOLAS J & JUDITH A H/W	38.50	A,B,C
009-070-032	VALLEY AG HARVESTING LLC	9.50	A,B,C
009-070-036	AVALOS, JOSE JR	11.59	A,B,C
009-070-038	WEST, THOMAS P & SUSANNE M H/W	4.14	A,B,C
009-070-039	WARMERDAM ORCHARDS INC	18.00	A,B,C
009-070-040	FACCHINI, LEO J & BELL R REV TRUST	20.06	A,B,C

APN	Record Owner	Acres	Pumping Zone
009-070-041	WARMERDAM, NICHOLAS J & JUDITH A H/W	20.06	A,B,C
009-070-042	FIRST BAPTIST CHURCH OF HANFORD	18.85	A,B,C
009-070-045	GINGLES MICHAEL T 50%	21.75	A,B,C
009-070-046	STEVENSON, MICHAEL O TRUST	35.02	A,B,C
009-070-048	GRAHAM COMMERCIAL PROPERTIES LP	30.00	A,B,C
009-070-050	CAF LLC	8.74	A,B,C
009-080-027	COON, CHARLES R & JAMIE REV LIV TRUST	3.77	A,B,C
009-090-008	WARMERDAM ORCHARDS INC	13.83	A,B,C
009-100-001	SUNNY ACRE FARMING INC	158.48	A,B,C
009-100-002	AVILA, DAVID J & NAEDE M H/W	6.33	A,B,C
009-100-003	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	30.00	A,B,C
009-100-004	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	47.46	A,B,C
009-100-005	DE RUITER, LEONARD E FAMILY TRUST 50%	32.40	A,B,C
009-100-006	COSTAMAGNA, FRANKLIN L & LUZ P H/W	7.90	A,B,C
009-100-007	FIKE, KARIN R	4.60	A,B,C
009-100-008	KOELEWYN, R D & J A REV FAMILY TRUST	2.50	A,B,C
009-100-009	BRADLEY RACHEL & CODY	2.51	A,B,C
009-100-010	BETTENCOURT FAMILY TRUST	2.50	A,B,C
009-100-012	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	2.12	A,B,C
009-100-013	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	12.64	A,B,C
009-100-015	BRADLEY, WILLIAM H & JANET K H/W	3.33	A,B,C
009-100-016	PEREIRA BRANDI & ALLYN JASON	3.03	A,B,C
009-100-018	MAHLING, DENNIS & ANNA S H/W	2.64	A,B,C
009-100-019	GARCIA, SYLVIA	2.10	A,B,C
009-100-020	KAHN, JAN L & JENNIFER A H/W	2.27	A,B,C
009-100-021	CAL-CLARK FARMS INC	2.36	A,B,C
009-100-022	BUCHANAN, FRANK T & ELIZABETH L LIV TR	3.60	A,B,C
009-100-023	CAL-CLARK FARMS INC	144.08	A,B,C
009-110-001	LEE, FLOYD R SURVIVOR'S TRUST	10.09	A,B,C
009-110-002	BATIN, MARJORIE A	2.50	A,B,C
009-110-003	LEE, SHIRLEY EXEMPTION TRUST	2.50	A,B,C
009-120-005	LUONG, THOMAS & STELLA LIVING TRUST	11.65	A,B,C
009-130-003	JOHNSON, REBECCA HOFFMAN	3.25	A,B,C
009-160-005	SIMAS, KENNETH A	20.50	A,B,C
011-010-001	COSTEN, ROBERT E & PATRICIA TRUST	32.41	A,B,C
011-010-002	TRINITY RANCHES LLC	59.55	A,B,C
011-010-003	RICHARDSON, L L ESTATE	2.50	A,B,C
011-010-004	RICHARDSON, L L ESTATE	2.50	A,B,C
011-010-005	RICHARDSON, L L ESTATE	3.38	A,B,C
011-010-006	RICHARDSON, L L ESTATE	5.08	A,B,C
011-010-031	MORGAN, BRADLEY L	4.56	A,B,C
011-010-036	ROBBINS, LANCE & KELLY H/W 66.66%	2.19	A,B,C
011-010-038	SOLORIO, NABOR & YOLANDA H/W	2.51	A,B,C
011-010-039	TRUE CRAIG D & DEBBIE	2.50	A,B,C
011-010-040	MACCAGNO, MICHAEL J & ARLENE H/W	2.69	A,B,C
011-010-048	KARAYAN FAMILY TRUST 92%	11.97	A,B,C
011-010-049	KARAYAN FAMILY TRUST	10.00	A,B,C
011-010-050	KARAYAN FAMILY TRUST	4.66	A,B,C
011-040-001	BARBA, RONALD A & CHRISTINE A H/W	2.50	A,B,C

APN	Record Owner	Acres	Pumping Zone
011-040-008	MIDDLEFIELD MANOR LLC	17.51	A,B,C
011-040-010	MIDDLEFIELD MANOR LLC	51.10	A,B,C
011-040-021	MUSICK, BARBARA 33.33%	20.00	A,B,C
011-040-022	CRUZ, ALBERTO R R & ELENA L H/W	2.00	A,B,C
011-040-023	COSTA, MANUEL & JUSTINE L H/W	70.87	A,B,C
011-040-025	MORENO, FRANCISCO & ELIZABETH LOPEZ H/W	18.36	A,B,C
011-040-026	NAVARRO FRANCISCO H & CARMEN Q	16.25	A,B,C
011-040-027	MIDDLEFIELD MANOR LLC	19.48	A,B,C
011-040-028	DUTRA, LEONARD & MARGARET H/W	10.46	A,B,C
011-040-029	MADRUGA, JANICE I SURVIVOR'S TRUST 50%	45.33	A,B,C
011-040-030	THOMAS RICK & DONNA	11.81	A,B,C
011-040-031	CUNHA CHAD J & MELISSA	2.96	A,B,C
011-040-032	SANTOS, FERNANDO & ERICA H/W	2.41	A,B,C
011-040-033	JOHNSON FAMILY TRUST THE	2.42	A,B,C
011-040-034	BARBA, RONALD A & CHRISTINE A H/W	2.90	A,B,C
011-040-035	CERVANTES, JOSE G & LUCILA H/W	2.54	A,B,C
011-040-036	BARBA, JORDAN	2.54	A,B,C
011-110-023	WILKINSON, LARRY L & PHYLLIS L H/W	5.44	A,B,C
011-110-024	PEREZ, FRANK J & SANDRA R H/W	4.56	A,B,C
011-110-025	SMITH, PETER M & NANCY L H/W	2.07	A,B,C
011-110-026	WALKER, WILLIAM S REV TRUST	6.08	A,B,C
011-420-007	TAFOYA, SAUL & LETICIA H/W	9.98	B,C
011-420-008	CASON, WILLIAM & SHEILA H/W 50%	5.00	B,C
011-430-002	COLLIER MICHALENE M & RAMIREZ LUIS JR	2.68	B,C
011-440-002	MURRAY, JOHN JR & BEATRIZ H/W	4.64	B,C
011-440-003	AGUILERA, CESAR A A & KARLA M R E H/W	2.25	B,C
011-440-004	AGUILERA, CESAR A A & KARLA M R E H/W	2.85	B,C
011-440-005	CORNERSTONE COMM ALCOHOL & OTHER DRUG	4.20	B,C
011-440-007	OROZCO, LESLIE	8.29	B,C
011-440-010	NEAL, DARLENE REVOC TRUST	19.40	B,C
011-440-011	HANFORD CEMETERY DISTRICT	19.16	B,C
011-440-012	HANFORD CEMETERY DISTRICT	14.85	B,C
011-440-013	HANFORD CEMETERY DISTRICT	35.04	B,C
014-010-002	TOS, JEFF & SHERI LIVING TRUST 50%	37.92	B
014-010-003	SUMMERS, JOHN P	20.00	B
014-010-004	SUMMERS, JOHN P	20.00	B
014-010-005	TOS LAND CO INC	44.00	B
014-010-010	RIOS, JOSE L	24.29	B
014-010-014	TOS LAND CO INC	23.79	B
014-010-018	GARNER, JOHN G REV TRUST	40.00	B
014-010-023	RAMIREZ, JILL L	2.77	B
014-010-024	TOS LAND COMPANY INC	41.32	B
014-010-027	KINGS COUNTY WATER DISTRICT	8.30	B
014-010-028	JENSEN, CARLYN & JANET LIVING TRUST	79.00	B
014-010-030	CARDARAS NICK & MARILLEE LIV TRUST	3.60	B
014-010-033	KINGS COUNTY WATER DISTRICT	54.29	B
014-010-034	MACHADO FAMILY LIMITED PTP	64.24	B
014-010-039	KINGS COUNTY WATER DISTRICT	26.00	B
014-010-040	HARDING, SHANE & STEFANI H/W	14.00	B

APN	Record Owner	Acres	Pumping Zone
014-010-041	MARTINEZ, LOUIS JR & AUTUMN L H/W	2.50	B
014-010-042	SHELDON, DANIEL & JENNIFER H/W	2.50	B
014-010-043	KEITH, DOYLE & JEANETTE LIVING TRUST	2.50	B
014-010-045	WEDEL JUSTIN	7.58	B
014-010-049	RIOS, JOSE & NORMA H/W	3.82	B
014-010-050	ESTES, RYAN & KELLY H/W	2.50	B
014-010-051	YOUNG, RAYMOND	2.53	B
014-010-052	JENSEN, CARLYN & JANET LIVING TRUST	154.26	B
014-010-055	HIELSCHER, DARRELL 66.66%	3.10	B
014-010-056	ORTEGA, MANUEL	3.34	B
014-010-057	MACHADO FAMILY LIMITED PARTNERSHIP THE	55.00	B
014-010-059	TOS LAND CO INC	64.18	B
014-010-060	PERRY FAMILY TRUST	40.00	B
014-010-061	MOTTE 1999 LIVING TRUST	38.88	B
014-010-062	TOS LAND CO INC	78.87	B
014-010-065	BARCELLOS, MARY J REVOC LIV TRUST	39.53	B
014-010-066	MACHADO FAMILY LIMITED PARTNERSHIP THE	15.00	B
014-010-069	RIOS, JOSE L	12.21	B
014-010-071	CONSOLE, RUSSELL J & HELENE M H/W	2.00	B
014-010-073	TOS, WILLIAM JR & LINDA LIVING TRUST	50.57	B
014-010-074	TOS, WILLIAM JR & LINDA LIVING TRUST	25.36	B
014-010-075	TOS, JEFF & SHERI LIVING TRUST	25.07	B
014-010-077	TOS LAND CO INC	104.97	B
014-010-078	FRAGOSO, JARED L & CRYSTAL M H/W	23.92	B
014-010-079	FRAGOSO, JARED L & CRYSTAL M H/W	17.14	B
014-020-006	LOHSE BROS, LLC	80.00	B
014-020-008	PINNACLE PACIFIC COAST OPERATING CO LLC	166.00	B
014-020-010	CAMPBELL, RON & JENNIE LIVING TRUST	40.50	B
014-020-013	COELHO, JOE F JR & BONNIE M REV TRUST	135.00	B
014-020-015	BETTENCOURT, JOHN & LUCY LIVING TRUST	80.00	B
014-020-017	MELLO, BRYAN J	2.50	B
014-020-018	TE VELDE, KARL J & LAUREN N REVOC FAM TRUST	182.50	B
014-020-019	GARNER, JOHN G REV TRUST	52.28	B
014-020-021	MONTGOMERY, GARY & DIANE FAMILY TRUST	61.67	B
014-020-022	MONTGOMERY FAMILY LIVING TRUST	60.29	B
014-020-025	STATE OF CALIFORNIA	2.11	B
014-020-026	LOHSE BROS LLC	77.89	B
014-020-027	STATE OF CALIFORNIA	2.23	B
014-020-028	BETTENCOURT, JOHN & LUCY LIVING TRUST	77.77	B
014-020-029	STATE OF CALIFORNIA	7.50	B
014-020-030	GARNER, JOHN G REV TRUST	102.18	B
014-020-032	STATE OF CALIFORNIA	7.49	B
014-020-033	TE VALDE, KARL J & LAUREN N REV FAM TRST	130.38	B
014-020-034	TE VELDE, KARL J & LAUREN N REV FAM TRST	22.30	B
014-030-005	WAWONA FARM CO LLC	200.00	B
014-030-006	TE VELDE, KARL J & LAUREN N REV FAM TRST	38.35	B
014-030-010	NETTO, FRANK P & CINDY M LIVING TRUST	80.26	B
014-030-012	PIPKIN, EVELYN M REV LIVING TRUST	77.50	B
014-030-013	PIPKIN, EVELYN M REV LIVING TRUST	2.50	B

APN	Record Owner	Acres	Pumping Zone
014-030-019	SOZINHO JERSEYS A PTP	111.08	B
014-030-020	SOZINHO JERSEYS A PTP	88.13	B
014-030-025	LOVATO EMPIRE LLC	39.94	B
014-030-026	LOVATO EMPIRE LLC	39.94	B
014-030-027	LOVATO EMPIRE LLC	39.94	B
014-030-028	DUTY, CARLTON & COLEAN LIVING TRUST	119.82	B
014-040-017	TE VELDE, GARRET D & CHELSEY Y REV FAM TRUST	117.68	B
014-040-037	MYERS, GLENN C REVOCABLE TRUST	114.88	B
014-040-039	TE VELDE, DAVID & ALICE FAMILY TRUST	162.81	B
014-040-040	TE VELDE, DAVID & ALICE FAMILY TRUST	164.00	B
014-050-001	BROWN'S DAIRY A PTP	80.00	B
014-050-008	DUTRA, MYRON D & SANDRA I H/W 50%	160.00	B
014-050-016	DIAS, GREGORY O & STEVEN DIAS INC	80.00	B
014-050-022	HARP, JAMES S & THERESA L H/W	2.65	B
014-050-032	DUTRA, BRIAN A 50%	12.00	B
014-050-033	DIAS, STEVEN P & THERESA M LIVING TRUST	80.00	B
014-050-034	DIAS, GREGORY O & STEVEN DIAS INC	76.35	B
014-050-039	DUTRA, BRIAN A 50%	40.00	B
014-050-040	DUTRA, BRIAN A 50%	28.00	B
014-050-041	RODRIGUEZ, JOHNNY P & SANDRA M H/W	3.00	B
014-050-042	DUTRA, MYRON D & SANDRA I H/W 50%	35.00	B
014-050-045	DUTRA, BRIAN A 50%	10.00	B
014-050-046	DUTRA, BRIAN A 50%	10.00	B
014-050-047	DUTRA, BRIAN A	10.00	B
014-050-048	DUTRA, BRIAN A 50%	10.00	B
014-050-049	DUTRA, BRIAN A 50%	2.00	B
014-060-008	BROWN'S DAIRY A PTP	160.00	B
014-060-010	WILGENBURG FAMILY LP	80.00	B
014-060-012	FAGUNDES AGRIBUSINESS A PTP	80.00	B
014-060-013	FLINT AVENUE HANFORD LP	79.01	B
014-060-022	FELIPE FAMILY TRUST	20.57	B
014-060-029	TEIXEIRA, LEONA J 50%	2.55	B
014-060-030	SILVA, JOHN A & MARIA O H/W	2.50	B
014-060-031	BONTRAGER, MARC & CASSANDRA H/W	2.50	B
014-060-032	OLIVEIRA REVOCABLE TRUST	73.82	B
014-060-039	FAGUNDES, MYRON & ELLEN H/W	2.00	B
014-060-041	FELIPE FAMILY TRUST	2.49	B
014-060-047	EVANGELO, TERESA SURVIVOR'S TRUST	60.79	B
014-060-049	MC CUTCHEON, BARRY H & BRENDA FAM TRUST	5.00	B
014-060-050	MCCUTCHEON, B H & B L FAM TRST	75.00	B
014-060-052	GUECHO, RICHARD L LIVING TRUST	20.00	B
014-060-053	GUECHO, RICHARD L LIVING TRUST	61.43	B
014-060-054	EVANGELO, TERESA SURVIVOR'S TRUST	14.36	B
014-060-055	EVANGELO, TERESA SURVIVOR'S TRUST	3.87	B
014-060-058	TE VELDE, KARL J & LAUREN N REV FAM TRUST	2.00	B
014-060-059	TE VELDE, KARL J & LAUREN N REV FAM TRUST	79.84	B
014-060-061	SIMAS, KENNETH A & VICTORIA L H/W	79.45	B
014-060-064	STATE OF CALIFORNIA	7.12	B
014-060-065	BARCELLOS DEAN & RENEE LIVING TRUST 50%	12.97	B

APN	Record Owner	Acres	Pumping Zone
014-060-066	STATE OF CALIFORNIA	2.20	B
014-060-068	STATE OF CALIFORNIA	4.40	B
014-060-069	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	115.60	B
014-060-070	FELIPE FAMILY TRUST	71.89	B
014-060-071	STATE OF CALIFORNIA	3.72	B
014-060-072	FELIPE FAMILY TRUST	52.31	B
014-060-073	STATE OF CALIFORNIA	4.17	B
014-060-076	STATE OF CALIFORNIA	3.72	B
014-060-077	FELIPE FAMILY TRUST	8.98	B
014-060-078	STATE OF CALIFORNIA	4.94	B
014-060-081	STATE OF CALIFORNIA	10.36	B
014-060-082	TE VELDE, KARL J & LAUREN N REV FAM TRUST	67.64	B
014-070-002	RICHARDS FAMILY LAND LLC	240.00	B
014-070-004	KINGS COUNTY WATER DISTRICT	78.50	B
014-070-005	RIBEIRO, FRANCISCO G REV TRUST	78.79	B
014-070-008	MACHADO FAMILY LIMITED PTP	30.00	B
014-070-011	BERNARDO, LEONARD E TRUST 50%	105.00	B
014-070-020	BERNARDO, LEONARD E TRUST 50%	40.00	B
014-070-021	FAGUNDES, JASON M & KATHLEEN L H/W	2.97	B
014-070-022	SUMMERS, JOHN P	37.03	B
014-070-035	DUARTE, JEREMY & KELSIE FAMILY TRUST	2.61	B
014-070-036	KINGS COUNTY WATER DISTRICT	154.21	B
014-070-038	AVILA, LE ROY A & BARBARA K TRUST	2.50	B
014-070-039	AVILA, LE ROY A & BARBARA K TRUST	16.59	B
014-070-042	FAGUNDES, RICHARD L & SHIRLEY TRUST 50%	2.59	B
014-070-044	SUMMERS, JOHN P	39.34	B
014-070-046	MACHADO FAMILY LIMITED PARTNERSHIP	18.15	B
014-070-047	STANFIELD, DAVID P & VICKI J REV LIV TRU	20.27	B
014-070-049	AVILA, LE ROY A & BARBARA K TRUST 50%	19.41	B
014-070-052	SANTOS, BRIAN C & JOY M H/W	5.69	B
014-070-053	MACHADO FAMILY LTD PTP	29.69	B
014-070-055	STANFIELD, DAVID P & VICKI J REV LIV TRS	10.00	B
014-070-056	STANFIELD, DAVID P & VICKI J REV LIV TRS	64.00	B
014-070-057	STANFIELD, DAVID P & VICKI J REV LIV TRS	20.31	B
014-070-059	AVILA, LE ROY A & BARBARA K TRUST	36.35	B
014-070-071	VICKERS, TRAVIS & STACEY H/W	20.19	B
014-070-072	MC GAHAN, JOE & TERRY LIVING TRUST	99.81	B
014-070-073	SANDRIDGE PARTNERS LP	92.50	B
014-070-074	JOHN TEIXEIRA FARMS INC	2.50	B
014-080-004	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	114.23	B,C
014-080-005	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	5.00	B,C
014-080-015	VAN DER GRAAF, A & R LIV TRUST 50%	43.25	B,C
014-080-020	MENDEZ, MICHAEL	69.06	B,C
014-080-021	NETTO DELIA FAMILY ENDOWMENT TRUST	80.00	B,C
014-080-022	DIAS, MICHAEL A & G FIRST AMENDED TRUST	40.00	B,C
014-080-023	MENDEZ, MICHAEL	40.00	B,C
014-080-027	FAGUNDES, JOHN L SR REVOCABLE TRUST	60.00	B,C
014-080-028	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	20.00	B,C
014-080-032	FAGUNDES, CLARENCE SURVIVOR'S TRUST	10.00	B,C

APN	Record Owner	Acres	Pumping Zone
014-080-033	FAGUNDES, NATIVA REVOCABLE TRUST 50%	10.00	B,C
014-080-039	FAGUNDES, BRUCE A 50%	10.00	B,C
014-080-040	FAGUNDES, BRUCE A 50%	10.00	B,C
014-080-041	FAGUNDES, BRUCE A 50%	20.00	B,C
014-080-046	2020 KEVIN CUELHO SEP PROP TRUST	2.36	B,C
014-080-048	MYERS FAMILY TRUST OF 1990	2.36	B,C
014-080-060	WARMERDAM, EDWARD N	5.94	B,C
014-080-061	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	2.51	B,C
014-080-062	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	11.55	B,C
014-080-063	REALL, PATRICK L & BEBELINDA C H/W	2.57	B,C
014-080-064	MYERS FAMILY TRUST OF 1990	2.50	B,C
014-080-065	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	30.00	B,C
014-080-066	WARMERDAM, NICHOLAS J & JUDITH A H/W	40.68	B,C
014-080-068	BARCELLOS, DEAN & RENEE LIV TRUST 50%	120.00	B,C
014-080-069	FAGUNDES, JOHN L	20.00	B,C
014-080-070	BARCELLOS, DEAN & RENEE LIV TRUST 50%	20.00	B,C
014-080-075	SOUZA, ERNEST & SHARON H/W	5.01	B,C
014-080-076	FLINT AVENUE HANFORD LP	114.99	B,C
014-080-077	KINGS COUNTY WATER DISTRICT	107.07	B,C
014-080-086	HENDERSON, JAMES C & SHARI A H/W	10.00	B,C
014-080-088	VANDER GRAAF, ADRIAN J	2.64	B,C
014-080-089	STRYD, STEPHEN C & BRENDA ENGLAND H/W	2.64	B,C
014-080-092	PUNLA MARIE ROSE	10.01	B,C
014-080-093	MYERS FAMILY TRUST OF 1990	2.73	B,C
014-080-094	MYERS, STACIE FAMILY TRUST 2013	7.55	B,C
014-080-104	BROWN, LOUIS A SR	10.00	B,C
014-080-105	SOLIS, BRENDA I	10.00	B,C
014-080-106	HENDERSON JAMES & SHARI	7.50	B,C
014-080-107	WILLIAMS, TEDDY B & JEANNIE A H/W	2.50	B,C
014-090-005	WILGENBURG WEST LLC	50.00	B,C
014-090-009	WILGENBURG WEST LLC	40.00	B,C
014-090-012	WILGENBURG WEST LLC	80.00	B,C
014-090-018	HURD JOHN HENRY & CHACON GABRIELLE	3.00	B,C
014-090-020	TE VELDE, KARL J & LAUREN N REV FAM TRST	37.50	B,C
014-090-021	TEIXEIRA, LEOBERTO	2.50	B,C
014-090-027	ARTS, WILLY J	31.54	B,C
014-090-029	WILGENBURG FAMILY LP	2.49	B
014-090-030	OLIVEIRA, FRANKLIN B & HEATHER A LIV TRS	37.90	B,C
014-090-031	BLANCHARD, TIMOTHY & CINDY H/W	2.77	B,C
014-090-033	WASHBURN HELEN M	28.21	B,C
014-090-036	WILGENBURG FAMILY LP	121.19	B,C
014-090-037	WILGENBURG FAMILY LP	210.79	B,C
014-090-038	BLANCHARD, TIMOTHY & CINDY H/W	2.23	B,C
014-090-039	SHARP, SHON & MARLA D H/W	2.70	B,C
014-090-040	COELHO MARGARET C & JOHNATHAN R	4.41	B,C
014-090-043	GARCIA, ANTONIO & MARIA 1996 FAM TRUST	20.19	B,C
014-090-045	CARDOZA, ANTHONY & JUANITA H/W	18.07	B,C
014-090-046	CARDOZA, ANTHONY & JUANITA H/W	2.12	B,C
014-090-047	DIAS, MICHAEL & GERMAINE AMND REV TR	20.00	B,C

APN	Record Owner	Acres	Pumping Zone
014-090-048	DIAS, MICHAEL & GERMAINE AMND REV TR 50%	19.93	B,C
014-090-051	SANDRIDGE PARTNERS LP	71.30	B,C
014-090-053	SANDRIDGE PARTNERS LP	84.29	B,C
014-090-054	STATE OF CALIFORNIA	14.60	B,C
014-090-055	SILVA, BRIAN M	55.40	B,C
014-090-056	STATE OF CALIFORNIA	8.55	B,C
014-090-057	DIAS, MICHAEL & GERMAINE AMND REV TR 50%	11.52	B,C
014-090-058	BARCELLOS, DEAN & RENEE LIVING TRUST 50% & BARCELL	79.80	B,C
014-090-062	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	65.68	B,C
014-090-063	STATE OF CALIFORNIA	7.41	B,C
014-090-064	STATE OF CALIFORNIA	3.91	B
014-090-065	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	64.00	B,C
014-090-066	STATE OF CALIFORNIA	6.00	B,C
014-090-067	STATE OF CALIFORNIA	7.12	B,C
014-090-068	WILGENBURG WEST LLC	42.88	B,C
014-090-069	STATE OF CALIFORNIA	20.00	B,C
014-100-004	DUTRA, WILLIAM G	55.00	B,C
014-100-005	DUTRA, WILLIAM G & DANETTE H/W	52.50	B,C
014-100-006	ROSE, LAURA P LIV TRUST	52.50	B,C
014-100-022	WILGENBURG FAMILY LIMITED PARTNERSHIP	160.00	B,C
014-100-023	MYERS, STANLEY & TRACY REVOCABLE TRUST	80.00	B,C
014-100-024	MYERS, STANLEY & TRACY REVOCABLE TRUST	80.00	B,C
014-100-029	DUTRA, ROGER S 44%	83.50	B,C
014-100-030	DUTRA, MYRON D & SANDRA I H/W 50%	77.43	B,C
014-120-001	WILGENBURG FAMILY LP	160.00	B,C
014-120-003	GIACOMAZZI, BOB & SONS LIMITED PTP	160.00	B,C
014-120-005	DUTRA, M DUANE 50%	54.38	B,C
014-120-014	WILGENBURG FAMILY LP	40.00	B,C
014-120-016	GONSALVES, FRANKIE C & DANA L H/W	40.12	B,C
014-120-017	GONSALVES, FRANKIE C & DANA L H/W	40.12	B,C
014-120-018	DUTRA, BRIAN A 50%	20.00	B,C
014-120-019	DUTRA, MYRON D 25%	15.22	B,C
014-120-020	DUTRA, M DUANE & SANDRA I H/W 50%	3.87	B,C
014-120-026	DRAGT, HAROLD & SON DAIRIES LLC	159.64	B,C
014-120-028	DRAGT, HAROLD & JEANETTE LIVING TR	2.00	B,C
014-120-029	DRAGT, HAROLD & JEANETTE LIVING TR	144.14	B,C
014-120-030	DRAGT, HAROLD & SONS DAIRIES LLC	13.50	B,C
014-120-041	DUTRA, BRIAN A 50%	84.79	B,C
014-120-042	DUTRA, M DUANE	20.00	B,C
014-130-002	NOBLE, LARREN R	5.00	B,C
014-130-012	HENNING, CELINE LIVING TRUST	40.23	B,C
014-130-013	SOARES, GEORGE & GLORIA REV FAMILY TRUST	20.00	B,C
014-130-014	SOARES, GEORGE & GLORIA REV FAMILY TRUST	30.00	B,C
014-130-015	SOARES, GEORGE & GLORIA REV FAMILY TRUST	10.00	B,C
014-130-016	SOARES, GEORGE & GLORIA REV FAMILY TRUST	26.66	B,C
014-130-017	SOARES, GEORGE & GLORIA REV FAMILY TRUST	13.33	B,C
014-130-024	HOWE FAMILY LP	120.00	B,C
014-130-027	GIACOMAZZI, BOB & SONS LIMITED PTP	79.98	B,C
014-130-029	CASTANEDA, VIRGEN & MARTHA H/W	5.00	B,C

APN	Record Owner	Acres	Pumping Zone
014-130-031	MENDEZ, MICHAEL	5.00	B,C
014-130-038	WASHBURN, HELEN M	73.90	B,C
014-130-041	BALLESTEROS, LEDUVINA 50%	5.00	B,C
014-130-045	PRATER, JOHN & ALICE BARNES REV LIV TRST	15.17	B,C
014-130-046	BETTENCOURT, R C & J L TRUST	2.50	B,C
014-130-051	ROGERS, MANUEL W 1994 LIVING TRUST	31.59	B,C
014-130-055	GARCIA, ANTONIO & MARIA FAMILY TRUST	63.34	B,C
014-130-058	SOARES, GEORGE & GLORIA REV FAMILY TRUST	38.16	B,C
014-130-060	BLANCHARD FARMS INC	105.91	B,C
014-130-061	GARCIA, ANTONIO & MARIA 1996 FAMILY TRUST	55.54	B,C
014-130-063	BETTENCOURT, R C & J L TRUST	20.21	B,C
014-130-064	DODD, LORI A	2.50	B,C
014-130-065	HOWZE FAMILY TRUST	9.82	B,C
014-130-069	STATE OF CALIFORNIA	13.42	B,C
014-130-070	STATE OF CALIFORNIA	13.42	B,C
014-130-071	STATE OF CALIFORNIA	13.42	B,C
014-130-073	SOARES, GEORGE & GLORIA REV FAMILY TRUST	12.08	B,C
014-130-074	SOARES, GEORGE & GLORIA REV FAMILY TRUST	10.22	B,C
014-130-075	SOARES, GEORGE & GLORIA REV FAMILY TRUST	10.06	B,C
014-130-076	TDH LAND & CATTLE LLC	10.06	B,C
014-130-078	CAVIEZEL FAMILY TRUST	27.55	B,C
014-130-079	DUTRA MYRON DUANE & DUTRA BRIAN A	10.10	B,C
014-130-080	DUTRA, BRIAN A 50%	82.34	B,C
014-130-082	GARCIA ELVIS & MARIA	2.56	B,C
014-130-083	GARCIA ELVIS & MARIA	2.64	B,C
014-130-093	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	10.09	B,C
014-130-094	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	11.02	B,C
014-130-095	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	18.45	B,C
014-130-096	FUKANO, STEVEN E & ROBIN L REV FAM TR 40%	39.00	B,C
014-130-104	STATE OF CALIFORNIA	5.97	B,C
014-130-106	STATE OF CALIFORNIA	5.81	B,C
014-130-108	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	33.89	B,C
014-130-109	STATE OF CALIFORNIA	6.12	B,C
014-130-110	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	33.64	B,C
014-130-112	HOWE FAMILY LP	15.10	B,C
014-130-114	HOWE FAMILY LP	11.09	B,C
014-130-116	HOWE FAMILY LP	13.31	B,C
014-130-118	HOWE FAMILY LP	74.73	B,C
014-142-001	FAGUNDES, BRUCE A	20.44	B,C
014-142-002	FAGUNDES, NATIVA REVOCABLE TRUST 50%	39.42	B,C
014-142-007	MENDEZ, MICHAEL	40.42	B,C
014-142-008	MARTINEZ RAFAEL CERDA & CALDERON DE CERDA, ALBA LU	2.50	B,C
014-142-009	GONZALEZ, LUIS ERIC	2.50	B,C
014-142-010	2020 MELISSA CARY-CUELHO SEP PROP TRUST	2.53	B,C
014-142-011	CAETANA, LEROY D & LUCINDA J H/W	2.53	B,C
014-142-012	NATALI, ANTOINETTE	5.07	B,C
014-142-013	COULON, DANNY E & KAREN D REVOC TRUST	5.06	B,C
014-142-014	SOCIEDADE DE SAO JOAO INC	13.68	B,C
014-142-015	MENDEZ, MICHAEL	40.39	B,C

APN	Record Owner	Acres	Pumping Zone
014-142-016	GREWAL FAMILY TRUST	20.00	B,C
014-142-017	GREWAL FAMILY TRUST	26.17	B,C
014-142-021	EBC FARMS LLC	50.00	B,C
014-142-023	EBC FARMS LLC	60.73	B,C
014-142-024	EBC FARMS LLC	10.12	B,C
014-142-025	ALI ALAMSI MUFID MOHAMMED	10.00	B,C
014-142-026	GREWAL FAMILY LAND CO LLC	14.34	B,C
014-142-027	FAGUNDES, JOHN L SR REVOCABLE TRUST	14.07	B,C
014-142-028	FAGUNDES, JOHN JR	8.56	B,C
014-142-030	ALCORN, JOHN A & M LORRAINE H/W	9.40	B,C
014-142-032	LOOGMAN, JAMES & NANCY A H/W	10.30	B,C
014-142-035	LOYA, RICK R & NICOLE K H/W	2.50	B,C
014-142-036	HIGHFILL, JAMES & SANDRA REV FAM TRUST	2.50	B,C
014-142-037	MORRA, FREDERICK J JR	2.42	B,C
014-142-038	LAIRD, JENIFER L	2.50	B,C
014-142-041	GREWAL FAMILY TRUST	34.98	B,C
014-142-042	GREWAL FAMILY TRUST	20.00	B,C
014-142-045	HARRIS, CINDY L REVOCABLE LIVING TRUST	2.53	B,C
014-142-046	CANCHOLA, LARRY A & SALLY G LIVING TRUST	2.53	B,C
014-142-047	CASTRO, ARTHUR V & DEBORAH C H/W	2.75	B,C
014-142-048	NEWTON, FORREST W & MARGARET A H/W	2.25	B,C
014-142-050	J & A ROJAS INVESTMENTS INC	14.87	B,C
014-142-051	R & C QUINN REV LIV TRUST	2.50	B,C
014-142-052	LATIS LLC	77.50	B,C
014-142-053	LOCKE TOMMY & SUSAN	2.54	B,C
014-142-054	FAGUNDES, JOHN L JR	2.54	B,C
014-142-055	AZEVEDO, MICHAEL F & MAUREEN S TRUST	12.31	B,C
014-142-056	AZEVEDO, MICHAEL F & MAUREEN S REV TRUST	4.29	B,C
014-142-068	MENEZES, FRANK & JENEEN LIVING TRUST	19.22	B,C
014-142-073	STODDARD, THOMAS D LIVING TRUST	2.50	B,C
014-142-074	CAREY MARY JANE	2.50	B,C
014-143-022	DIAS, CYNTHIA J & JOSEPH G W/H	3.00	B,C
014-143-069	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	46.62	B,C
014-143-078	DADIGIAN FAMILY TRUST 2001	37.32	B,C
014-221-007	SHARP, SIDNEY J W & JANET E BYPASS TR 50%	2.09	B,C
014-221-017	DAVIS, LARRY D & LONA B H/W	2.88	B,C
014-221-022	FONTANA, JOHN & KATHLEEN REVOC TRUST	8.46	B,C
014-221-033	PATEL, AVNI 33.333%	2.96	B,C
014-221-036	LITTLE KINGS CORPORATION	2.43	B,C
014-221-037	LITTLE KINGS CORP	3.07	B,C
014-221-041	LAVENSON-AVEDISIAN TRUST	6.55	B,C
014-221-046	LAVENSON-AVEDISIAN TRUST	11.08	B,C
014-221-047	CITY OF HANFORD	3.70	B,C
014-230-006	VANDERZIEL, RUSSELL & MARJORIE TRUST	2.95	B,C
014-230-007	JCH FAMILY LIMITED PARTNERSHIP 33.33%	3.80	B,C
014-230-009	ICKIS JULIENE A	3.09	B,C
014-230-013	COSTAMAGNA, ERNEST B	9.25	B,C
014-230-020	PIMENTEL, MICHAEL S & NICOLE M H/W	5.88	B,C
014-230-021	C P O FARMS LLC	5.93	B,C

APN	Record Owner	Acres	Pumping Zone
014-230-030	LOOGMAN THOMAS G	60.00	B,C
014-230-031	LOOGMAN, JAMES A & NANCY A H/W	100.00	B,C
014-230-033	BADASCI, JOHN K JR	9.00	B,C
014-230-034	EBC FARMS LLC	53.19	B,C
014-230-035	EBC FARMS LLC	17.76	B,C
014-230-053	MYERS BROS A PTP	4.22	B,C
014-230-061	SOUTHERN PACIFIC TRANSPORTATION CO	17.76	B,C
014-230-065	BADASCI, GEORGE G LIVING TRUST	14.98	B,C
014-230-066	GARCIA, GUS	4.80	B,C
014-230-073	DAVIS, JOHN L & MARGARET L H/W	4.00	B,C
014-230-075	BADASCI, GEORGE G LIVING TRUST	41.31	B,C
014-230-076	MYERS BROTHERS A PTP	7.81	B,C
014-230-083	CAL-CLARK FARMS INC	39.97	B,C
014-230-084	CAL-CLARK FARMS INC	40.03	B,C
014-230-085	CAL-CLARK FARMS INC	24.95	B,C
014-230-086	CAL-CLARK FARMS INC	40.05	B,C
014-230-087	CAL-CLARK FARMS INC	31.49	B,C
014-230-088	CAL-CLARK FARMS INC	44.24	B,C
014-230-089	COSTAMAGNA INVESTMENTS LLC	59.72	B,C
014-230-092	RIOS JEROME P & CHALSEY N	10.05	B,C
014-230-093	RIOS, DAVID P & JENNIFER J LIVING TRUST	10.05	B,C
014-230-096	CITY OF HANFORD	9.92	B,C
014-241-004	FONSECA, FEDERICO M & SUZIE B H/W	3.50	B,C
014-241-007	HANFORD JOINT UNION HIGH SCHOOL DISTRICT	2.94	B,C
014-241-008	HANFORD JOINT UNION HIGH SCHOOL DISTRICT	4.59	B,C
014-241-020	BUFORD OIL COMPANY INC	2.05	B,C
014-251-007	GRITTON TRUST	2.83	B,C
014-251-045	CARRILLO, LYDIA V LF ESTATE 0	3.45	B,C
014-260-007	PATEL, JADISHBHAI P	2.50	B,C
014-260-015	VALLE MAGIA FARMS LLC	42.85	B,C
014-260-016	VALLE MAGIA FARMS LLC	49.40	B,C
014-260-017	COELHO, JUANITA G TRUST	47.57	B,C
014-260-018	KIT CARSON SCHOOL	10.00	B,C
014-260-020	MENDOZA, ANTHONY A	2.43	B,C
014-260-025	WESTLAKE FARMS INC	78.43	B,C
014-260-026	WESTLAKE FARMS INC	72.48	B,C
014-260-034	COLLAR, LARRY S & CAROL A H/W JT	5.00	B,C
014-260-036	TE VELDE, KARL J & LAUREN N REV FAM TRST	153.98	B,C
014-260-039	ROBLES, GILBERT L & JOSEFINA LIMJOCO H/W	3.31	B,C
014-260-042	RAULINO IRREVOCABLE LIVING TRUST	5.00	B,C
014-260-043	RAMIREZ-RAMOS, CATARINO	2.49	B,C
014-260-045	SAPIEN, JUAN JR	2.50	B,C
014-260-047	DIAS, LEONARD G & TAMMY A H/W	2.54	B,C
014-260-048	ACOSTA, ALEJANDRO & MARTHA L H/W	2.50	B,C
014-260-049	HAMBLIN, CHARLES & MARGARET LIVING TRUST	11.71	B,C
014-260-051	BOULLOSA, JEFFREY M & LISA M H/W	2.70	B,C
014-260-056	SIDA, JAVIER & LISA J H/W	3.50	B,C
014-260-057	AZEVEDO, JOAO M & TRINDA S H/W	2.70	B,C
014-260-061	SAPIEN, JUAN JR	2.87	B,C

APN	Record Owner	Acres	Pumping Zone
014-260-065	SOUTHERN PACIFIC TRANSPORTATION CO	13.05	B,C
014-260-066	SOUTHERN PACIFIC TRANSPORTATION CO	19.52	B,C
014-260-068	VALLE MAGIA FARMS LLC	129.28	B,C
014-260-073	VALLE MAGIA FARMS LLC	12.86	B,C
014-260-077	GILL'S TRUCK STOP GP	5.32	B,C
014-260-080	VALLE MAGIA FARMS LLC	4.13	B,C
014-260-085	SALAS, DANIEL C & JAMIE H/W	6.13	B,C
014-260-089	FELIPE FAMILY TRUST	10.11	B,C
014-260-090	FELIPE FAMILY TRUST	10.00	B,C
014-260-091	FELIPE FAMILY TRUST	10.00	B,C
014-260-101	SOUTHERN CALIFORNIA EDISON CO	4.95	B,C
014-260-105	STATE OF CALIFORNIA	3.54	B,C
014-260-107	HURST JOHN CAMPBELL III	20.70	B,C
014-260-108	FERRELL, DENNIS D & PATRICIA L H/W	6.39	B,C
014-260-109	FERRELL, DENNIS D & PATRICIA L M/C 90%	5.10	B,C
014-260-111	RICHARDS FAMILY LAND LLC	151.83	B,C
014-260-113	STATE OF CALIFORNIA	25.12	B,C
014-260-114	EBC FARMS LLC	26.04	B,C
014-260-115	EBC FARMS LLC	36.05	B,C
014-260-116	MARQUEZ INVESTMENT GROUP LLC	49.40	B,C
014-270-002	VEENENDAAL, JOSHUA 25%	8.00	B,C
014-270-003	GIACOMAZZI, DINO J 2007 IRREVOCABLE TR	139.54	B,C
014-270-005	GIACOMAZZI, FRED & DONALD FARMS 94.79%	77.68	B,C
014-270-021	GARCIA, ANTONIO & MARIA FAMILY TRUST THE	7.40	B,C
014-270-028	GARCIA, ANTONIO & MARIA H/W JT	4.72	B,C
014-270-029	GIACOMAZZI, FRED & DONALD FARMS 94.79%	140.62	B,C
014-270-030	SOUTHERN PACIFIC TRANSPORTATION CO	6.30	B,C
014-270-031	SOUTHERN PACIFIC TRANSPORTATION CO	5.21	B,C
014-270-039	DE HOOP, ART & ELLIE REV TRUST	20.22	B,C
014-270-040	DE HOOP, ART & ELLIE REV TRUST	17.83	B,C
014-270-041	DE HOOP, ART & ELLIE REV TRUST	17.91	B,C
014-270-042	DE HOOP, ART & ELLIE REVOC FAMILY TRUST	17.91	B,C
014-270-043	GIACOMAZZI, FRED & DONALD FARMS 94.79%	127.33	B,C
014-270-044	WARD FAMILY TRUST	20.00	B,C
014-270-045	WARD FAMILY TRUST THE	2.50	B,C
014-410-004	STATE OF CALIFORNIA	2.93	B,C
014-540-005	MASON, MARK W & MICHAELE L H/W	2.25	B,C
014-810-003	HURST JOHN CAMPBELL III	11.55	B,C
014-810-004	HURST JOHN CAMPBELL III	11.55	B,C
014-810-005	HURST JOHN CAMPBELL III	12.84	B,C
014-810-006	HURST JOHN CAMPBELL III	11.35	B,C
014-810-007	HURST JOHN CAMPBELL III	11.60	B,C
014-810-008	HURST JOHN CAMPBELL III	11.55	B,C
014-810-009	HURST JOHN CAMPBELL III	11.55	B,C
014-810-010	HURST JOHN CAMPBELL III	11.55	B,C
014-810-013	STATE OF CALIFORNIA	8.02	B,C
014-810-015	STATE OF CALIFORNIA	7.19	B,C
014-810-017	HURST JOHN CAMPBELL III	15.89	B,C
014-810-018	HURST JOHN CAMPBELL III	15.07	B,C

APN	Record Owner	Acres	Pumping Zone
014-830-006	EDWARDS, LUCILLE G REVOCABLE TRUST	4.49	B,C
014-830-007	THOMAS, KELLI A	3.04	B,C
014-830-011	WEST, PHILLIP H TRUST	20.08	B,C
014-830-013	HERT FAMILY GRANTOR TRUST	2.54	B,C
014-830-014	SISNEROZ, ROBERT A & RAYLENE H/W	2.07	B,C
014-830-017	LOOGMAN, JAMES A & NANCY A H/W	24.04	B,C
014-830-019	ARMBRUSTER, BARBARA M TRUST	23.36	B,C
014-830-020	MARTINEZ, RUBEN M & PATRICIA A H/W	2.65	B,C
014-830-021	MARTINEZ, PATRICIA A & RUBEN M W/H	2.58	B,C
014-830-022	ARMBRUSTER, BARBARA M TRUST	22.23	B,C
014-830-024	ASAKI, THOMAS S & RUTH K FAMILY TRUST	2.17	B,C
014-830-025	DRUMMOND FAMILY LIVING TRUST	2.17	B,C
014-830-026	DAVIS, WALTER J & GLENDA S LIVING TRUST	2.17	B,C
016-041-014	PICAZO CHRISTOPHER E	2.00	B,C
016-041-026	NUNES, CHARLES P & DARLENE M H/W	2.00	B,C
016-041-036	DANELL, RANCE	4.64	B,C
016-041-037	LEMAY, HEATHER	2.57	B,C
016-041-038	RUVALCABA AMALIA 50%	2.53	B,C
016-041-040	MEREDITH, JOHN E & LYN M H/W	2.50	B,C
016-041-041	RODRIGUEZ, TERESA	2.50	B,C
016-041-046	LOPEZ, JAMES & VERONICA H/W	2.13	B,C
016-041-047	ATKINS RAY D & CARLA	2.18	B,C
016-042-012	DE LEON, JAVIER J & SOCORRO LIV TRUST 0	2.33	B,C
016-042-013	BURGESS STONE BORBOLLA	2.34	B,C
016-042-019	DANELL, RANCE & DENISE LIVING TRUST	9.00	B,C
016-042-032	DANELL, RANCE 2005 IRREV TRUST	3.78	B,C
016-042-033	DANELL, DANNY & LINDA LIV TRUST	18.53	B,C
016-042-043	BRADFORD, MARK C	2.43	B,C
016-042-048	MURRAY, JOHN JR & BEATRIZ H/W	2.52	B,C
016-042-049	ELLIOTT, MARTY & DIANA H/W	2.52	B,C
016-042-050	SIMOES, JOSE M & MARIA F H/W JT	2.52	B,C
016-042-051	HATFIELD CODY	2.52	B,C
016-042-052	CARNLEY MELVIN D & FRANCES	3.27	B,C
016-042-053	CHACON GILBERT PATRICK SPECIAL NEEDS TRUST	2.52	B,C
016-042-054	SANCHEZ RITA	2.23	B,C
016-042-061	ARCHER-GREEN TRUST	3.14	B,C
016-042-069	ELLIOTT JAMES ROBERT & CLARK SOPHIA JANE	2.39	B,C
016-042-070	MARROQUIN, HECTOR C & DIANA L H/W	2.39	B,C
016-042-076	KLING, JERRY & BEVERLY LIVING TRUST	8.44	B,C
016-043-011	CLEMENT, LONNIE J	4.67	B,C
016-043-012	WEAVER, MELVON C & MARDEL I TRUST	2.07	B,C
016-043-027	BARBEIRO, MYRON A & JANET L LIV TRUST	2.30	B,C
016-043-028	ELLIOTT, KINNEY L & CHERYL H/W	2.39	B,C
016-043-032	ROGERS, DOYLE J & CHARLOTTE M H/W	2.45	B,C
016-043-039	HATFIELD FAMILY TRUST	2.06	B,C
016-043-052	BINDING CONTRACT LLC	12.09	B,C
016-060-006	HIDDEN VALLEY GROUP LLC	9.72	B,C
016-060-009	TRI WEST INVESTMENTS LLC	34.73	B,C
016-060-011	TRI WEST INVESTMENTS LLC	80.00	B,C

APN	Record Owner	Acres	Pumping Zone
016-060-012	TRI WEST INVESTMENTS LLC	80.00	B,C
016-060-014	COELHO, LAWRENCE & SHIRLEY REVOC TRUST	33.65	B,C
016-060-022	TRI WEST INVESTMENTS LLC	71.00	B,C
016-060-024	COELHO, LAWRENCE & SHIRLEY REVOC TRUST	14.10	B,C
016-060-036	BRASIL JOAO E & LILIAN	2.50	B,C
016-060-037	SOUSA, BRIAN A & JENNIFER A H/W	2.18	B,C
016-060-038	OVERLAND STOCK YARDS	20.00	B,C
016-060-040	OVERLAND STOCKYARDS	10.00	B,C
016-060-041	COELHO, LAWRENCE & SHIRLEY 1995 TRUST	47.74	B,C
016-060-045	EVETTS, MONTY H P	3.55	B,C
016-060-046	OVERLAND STOCK YARDS	8.08	B,C
016-060-053	MALTA BERNARDO & MARISELA	5.11	B,C
016-060-054	MALTA, BERNARDO	4.88	B,C
016-060-056	PANNU, KAWALJIT S	4.70	B,C
016-060-057	PANNU KAWALJIT S	5.45	B,C
016-060-058	PANNU, KAWALJIT S	7.55	B,C
016-070-005	DANELL, MICHAEL J BYPASS TRUST 33.33%	73.11	B,C
016-070-009	DANELL BROTHERS FARMS A PTP	20.00	B,C
016-070-010	TAYLOR, EARLE W	10.00	B,C
016-070-015	BAKER RENDERING CORP	49.90	B,C
016-070-021	JOHN C JAQUES & SON DAIRY GP	60.60	B,C
016-070-026	JACQUES, JOHN C & SON DAIRY GN PTP	40.00	B,C
016-070-027	JOHN C JAQUES AND SON DAIRY	60.00	B,C
016-070-031	GAITAN, ADRIAN	2.00	B,C
016-070-032	SANTOS, HAMILTON & JOSEPHINE H/W	5.00	B,C
016-070-037	LEVARIO, ELSIE FAMILY TRUST	2.16	B,C
016-070-042	LEVARIO, DENNIS & DONNA LIV TRUST 50%	9.28	B,C
016-070-043	EGC INVESTMENTS	42.00	B,C
016-070-045	CORREIA, FAMILY TRUST	6.90	B,C
016-070-046	BORGES, CARLOS & LUZIA TRUST	7.08	B,C
016-070-049	STATE OF CALIFORNIA	2.50	B,C
016-070-050	GONZALEZ, DAVID & MARIA A H/W	2.50	B,C
016-070-051	COX, WALLACE G & ALICE 50% H/W	2.50	B,C
016-070-055	DENHAM, ROGER A & FLORENCE A H/W	4.42	B,C
016-070-056	WIENS, BARBARA A LIVING TRUST	3.20	B,C
016-070-057	TIPTON FAMILY LIVING TRUST	2.50	B,C
016-070-060	DUTRA, EDWARD S	5.10	B,C
016-070-061	GARZA, IGNACIO G LIVING TRUST	5.00	B,C
016-070-062	NEW MEDIA BROADCASTING INC	15.00	B,C
016-070-063	NEW MEDIA BROADCASTING INC	24.09	B,C
016-070-064	TIPTON, ERIC S & BRITTANEE I H/W	2.94	B,C
016-070-066	MEYER FAMILY TRUST	2.55	B,C
016-070-067	ELLIS, JOHN & LYNNE FAMILY TRUST	2.55	B,C
016-070-068	ENRIQUEZ, MARTIN & ROCIO REVOC TRUST	2.50	B,C
016-070-070	DANELL, MICHAEL J BYPASS TRUST 33.33%	6.32	B,C
016-070-073	MARTIN, EXAUL & MARLEN E H/W 50%	4.27	B,C
016-070-074	SMITH, JOHN T & MARTHA G H/W	2.50	B,C
016-070-075	WILLARD, JAMES E & JUDY F H/W	13.01	B,C
016-070-076	LEAL, DANIEL & BELLE LIVING TRUST	17.79	B,C

APN	Record Owner	Acres	Pumping Zone
016-070-077	JACQUES, JOHN C & SON DAIRY GN PTP	43.03	B,C
016-070-078	SANTOS, JOHN A & CIDALIA H/W	2.02	B,C
016-070-079	SANTOS, HAMILTON A & JOSEPHINE H/W	4.96	B,C
016-070-080	BRASIL, JOE I BYPASS TRUST 50%	2.50	B,C
016-070-081	TAMEZ, RICARDO V & GLORIA G H/W JT	2.50	B,C
016-070-082	ENRIQUEZ, MARTIN & ROCIO REVOC TRUST	6.51	B,C
016-070-083	BAKER COMMODITIES INC	27.42	B,C
016-070-084	GUTIERREZ MARIA PATRICIA 50%	12.67	B,C
016-070-086	LARA, ERNESTO S & ARAGON, AQUILINA H	2.39	B,C
016-070-087	MORALES, DAVID C & ANTOINETTE H/W	2.39	B,C
016-070-088	KELLENBERGER, DAVID & TAMMI LIVING TRUST	3.07	B,C
016-070-089	JAMES, ANDREW A 50%	2.27	B,C
016-070-090	LEAL, DANIEL & BELLE LIVING TRUST	38.59	B,C
016-070-092	LEAL, DANIEL & BELLE LIVING TRUST	16.83	B,C
016-070-096	JACQUES, JOHN C & SON DAIRY GN PTP	2.77	B,C
016-070-097	JACQUES, JOHN C & SON DAIRY GN PTP	57.26	B,C
016-070-098	JACQUES, JOHN C & SON DAIRY GN PTP	19.21	B,C
016-070-099	JACQUES, JOHN C & SON DAIRY GN PTP	7.10	B,C
016-070-101	KINGS COUNTY WATER DISTRICT	47.34	B,C
016-070-102	JACQUES, JOHN C & SON DAIRY GN PTP	107.53	B,C
016-070-104	CORONADO, FLORIBERTA	2.33	B,C
016-070-106	BAKER COMMODITIES, INC	36.92	B,C
016-070-107	BAKER RENDERING CORP	25.49	B,C
016-070-108	STATE OF CALIFORNIA	4.51	B,C
016-070-109	STATE OF CALIFORNIA	19.37	B,C
016-070-110	BAKER RENDERING CORP	60.63	B,C
016-070-112	STATE OF CALIFORNIA	8.59	B,C
016-070-117	COELHO, GLORIA J LIVING TRUST	69.09	B,C
016-070-119	COELHO, GLORIA J LIVING TRUST	4.31	B,C
016-070-121	COELHO, GLORIA J LIVING TRUST	61.54	B,C
016-080-010	GOMES, EVELYN M 33.334%	2.81	B,C
016-080-011	ROCHA, ROBERT	117.19	B,C
016-080-012	LAKESIDE IRRIGATION WATER DISTRICT	318.89	B,C
016-080-032	RODRIGUEZ, AUDOMERO & CELIA H/W	2.50	B,C
016-080-041	RODRIGUEZ, NARCISCO	6.62	B,C
016-080-042	RODRIGUEZ, VICENTE	4.24	B,C
016-080-046	ROCHA, ROBERT	185.01	B,C
016-120-001	ROCHA, ROBERT	90.96	B,C
016-120-003	HEADRICK, DON & MELANIE LIVING TRUST	77.02	B,C
016-120-012	MELLO, JOHN & SHANDA LIVING TRUST	139.18	B,C
016-120-013	NAVARRO, LUIS V III	7.00	B,C
016-120-020	ROCHA, ROBERT	16.94	B,C
016-120-021	JOHN & SHANDA MELLO LIVING TRUST	3.00	B,C
016-120-023	KUIPER, MICAH L & MAUREEN J H/W	3.83	B,C
016-120-025	MELLO, CHIP & KELLY H/W	5.02	B,C
016-120-026	MELLO, CHIP & KELLY H/W	5.03	B,C
016-120-028	CHAMPLIN, SHAWN & CHANDALIN LIV TRST 50%	75.03	B,C
016-120-036	ROCHA, ROBERT	171.37	B,C
016-120-037	KINNEY FAMILY TRUST	24.00	B,C

APN	Record Owner	Acres	Pumping Zone
016-120-040	KINNEY FAMILY TRUST	18.00	B,C
016-120-041	KINNEY FAMILY TRUST	20.00	B,C
016-120-043	KINNEY, CHARLES W & MARY T H/W	2.00	B,C
016-120-045	RICHARDS, TARA	2.00	B,C
016-120-049	KINNEY FAMILY TRUST	2.31	B,C
016-130-010	KINGS WASTE & RECYCLING AUTHORITY	18.60	B,C
016-130-016	CHAMPLIN, STANLEY MARITAL TRUST 50%	73.86	B,C
016-130-019	DE SANTOS RUDOLPH R	4.62	B,C
016-130-023	SANDERS, HERBERT L JR & BETTY J H/W JT	5.00	B,C
016-130-028	RODRIGUEZ, SANTIAGO 16.66%	2.51	B,C
016-130-029	NORWOOD SUSIE	2.61	B,C
016-130-030	MELLO, JOHN & SHANDA LIVING TRUST	76.94	B,C
016-130-037	MELLO, JOHN & SHANDA LIVING TRUST	125.17	B,C
016-130-044	TOSTE, MANUEL B & MARIA L H/W	62.00	B,C
016-130-045	LEAL, DANIEL & BELLE LIVING TRUST	149.74	B,C
016-130-046	MELLO, CHIP & KELLY H/W	2.50	B,C
016-130-048	MELLO, CHIP & KELLY H/W	2.50	B,C
016-130-051	KINGS WASTE & RECYCLING AUTHORITY	94.56	B,C
016-130-052	LEAL, CHERYL L	2.50	B,C
016-130-059	LEAL, DANIEL & BELLE LIVING TRUST	50.00	B,C
016-130-060	CALPORTLAND COMPANY	8.05	B,C
016-130-063	KINGS WASTE & RECYCLING AUTHORITY	3.85	B,C
016-130-065	LEAL, DANIEL & BELLE LIVING TRUST	149.07	B,C
016-130-067	COUNTY OF KINGS	18.46	B,C
016-130-074	JAMES, JANET J BYPASS TRUST 91%	6.10	B,C
016-130-075	JAMES, JANET BYPASS TRUST 91%	3.03	B,C
016-130-076	JAMES, JANET BYPASS TRUST 91%	3.03	B,C
016-130-077	JAMES, JANET BYPASS TRUST 91%	15.91	B,C
016-130-078	MELLO, CHIP & KELLY H/W	8.96	B,C
016-130-085	KINGS WASTE & RECYCLING AUTHORITY	112.27	B,C
016-130-092	BLUE FLY SWATTER PROPERTIES LLC	2.60	B,C
016-130-095	STATE OF CALIFORNIA	18.00	B,C
016-130-097	LEAL, DANIEL & BELLE LIVING TRUST	60.48	B,C
016-130-098	LEAL, DANIEL & BELLE LIVING TRUST	24.00	B,C
016-130-105	MELLO, CHIP & KELLY H/W	80.44	B,C
016-130-106	TRI WEST INVESTMENTS LLC	20.79	B,C
016-130-107	TRI WEST INVESTMENTS LLC	63.50	B,C
016-130-109	DJM SALES LLC	5.72	B,C
016-130-113	DJM SALES LLC	2.17	B,C
016-130-116	STATE OF CALIFORNIA	3.02	B,C
016-140-011	SOZINHO, JOE S & MARY M FAMILY TRUST	10.00	B,C
016-140-012	SOARES, VIRGINIA L LIV TRUST	59.14	B,C
016-140-014	SOZINHO FAMILY TRUST	40.00	B,C
016-140-018	SOZINHO FAMILY TRUST	20.00	B,C
016-140-025	DANELL, MICHAEL J BYPASS TRUST 33.33%	5.00	B,C
016-140-029	GAITAN, REBA HOPE LIVING TRUST	2.00	B,C
016-140-030	ZWETSLOOT, TIA A	5.00	B,C
016-140-031	COELHO, GLORIA J LIVING TRUST	7.92	B,C
016-140-032	LOPEZ, FERNANDO & ANGELICA M H/W	2.00	B,C

APN	Record Owner	Acres	Pumping Zone
016-140-034	PEREZ FAMILY TRUST	5.00	B,C
016-140-035	DANELL, MICHAEL J BYPASS TRUST 33.33%	5.00	B,C
016-140-036	SANCHEZ BROOKE LENA	2.00	B,C
016-140-038	LAKESIDE IRRIGATION WATER DISTRICT	4.68	B,C
016-140-044	DANELL CUSTOM HARVESTING LLC	4.41	B,C
016-140-045	DANELL CUSTOM HARVESTING LLC	4.41	B,C
016-140-047	SOZINHO FAMILY TRUST	5.00	B,C
016-140-048	SOZINHO FAMILY TRUST	7.68	B,C
016-140-049	CAETANA, JUSTIN	2.50	B,C
016-140-051	COELHO FAMILY REV LIV TRUST	2.50	B,C
016-140-052	COOLEY, JOEL & MELISSA H/W	7.50	B,C
016-140-053	WOUGHTER, EDWARD E & PATRICIA K H/W	2.50	B,C
016-140-055	ENOS, JOHNNY A & LILLIAN D H/W	2.50	B,C
016-140-056	BRAY, WILBERT R & RHONDA T H/W JT	5.00	B,C
016-140-058	SOZINHO FAMILY TRUST	12.94	B,C
016-140-059	SOZINHO FAMILY TRUST	9.99	B,C
016-140-061	SOZINHO FAMILY TRUST	9.98	B,C
016-140-062	FLATHERS, JEFFERY & CHAOYING SUN H/W 50%	2.03	B,C
016-140-064	HOME GARDEN COMMUNITY SERVICES DIST	2.50	B,C
016-140-066	MARTINEZ CASTRO FRANCISCO & CABRERA-PEREZ AIDE	2.51	B,C
016-140-067	NUNES, NICOLE D	5.01	B,C
016-140-068	MENDES, ANTHONY & BERTHA REV FAM TRUST	2.50	B,C
016-140-069	BRAY, WILBERT R	6.35	B,C
016-140-070	SOZINHO FAMILY TRUST THE	35.00	B,C
016-140-073	SOARES, VIRGINIA L LIV TRUST	38.65	B,C
016-140-074	SOZINHO, JOE S & MARY FAMILY TRUST	10.00	B,C
016-140-075	SOZINHO, JOE S & MARY M FAMILY TRUST	10.00	B,C
016-140-078	TRI WEST INVESTMENTS LLC	26.35	B,C
016-140-079	TRI WEST INVESTMENTS LLC	10.00	B,C
016-140-080	TRI WEST INVESTMENTS LLC	18.72	B,C
016-140-081	SOZINHO FAMILY TRUST	82.52	B,C
016-140-082	KEVERLINE FAMILY TRUST	4.20	B,C
016-140-083	GARCIA, TINA	5.13	B,C
016-140-084	SOZINHO FAMILY TRUST THE	11.92	B,C
016-140-085	SOZINHO FAMILY TRUST	133.53	B,C
016-140-087	TEIXEIRA, JOSE L & MARIA J H/W	2.87	B,C
016-140-088	TEIXEIRA, JOSE L & MARIA J H/W	2.87	B,C
016-140-089	ZWETSLOOT, HUGO N JR & DIANE L H/W	10.00	B,C
016-140-090	VEENENDAAL, DONNIE & SHELBY H/W	8.00	B,C
016-140-091	COTTA, JOE S & NATALIA L REV LIV TRST	2.00	B,C
016-140-093	SOZINHO FAMILY TRUST	18.95	B,C
016-140-094	SOZINHO FAMILY TRUST	30.08	B,C
016-140-095	RAMIA, ROSE J 2004 REVOCABLE TRUST	10.03	B,C
016-140-097	ALMUNTASER, MOSA N	9.34	B,C
016-140-100	HANFORD COMMUNITY HOSPITAL INC	2.55	B,C
016-140-101	HANFORD COMMUNITY HOSPITAL INC	5.37	B,C
016-140-102	HANFORD COMMUNITY HOSPITAL INC	5.19	B,C
016-140-103	DANELL, DAVID & DEZERAYE LIV TRUST	2.32	B,C
016-140-104	DANELL, DANNY AND LINDA LIV REV TRUST 40%	35.35	B,C

APN	Record Owner	Acres	Pumping Zone
016-150-001	DILLARD FAMILY REVOCABLE TRUST	2.50	B,C
016-150-004	HERNANDEZ, ELVIRA G 50%	10.00	B,C
016-150-005	BROWN, ORALEAN	3.61	B,C
016-150-010	ALCOSER, ALFRED R REV TRUST	3.00	B,C
016-150-024	GOMEZ, ROMALDO C 50%	5.00	B,C
016-150-025	GONZALEZ, RAFAEL 50%	5.00	B,C
016-160-010	JAURIGUI, CARLOS & VICTORIA A H/W 50%	5.00	B,C
016-160-014	TRUJILLO, LOUIE	2.50	B,C
016-160-015	LOPEZ, GUSTAVO & OTILIA REVOCABLE TRUST	4.00	B,C
016-160-035	NICK CHAMPI ENTERPRISES INC	73.28	B,C
016-160-037	GUERRA, FELIPE J & PATRICIA H/W 50%	2.49	B,C
016-160-051	URBINA, ALEXIS	2.50	B,C
016-160-053	BARNETT, JAMES E & JANE E H/W	2.50	B,C
016-160-054	ALVES, AUGUSTINE III	2.50	B,C
016-160-055	AVALOS, LOUIS & CAROL FAMILY TRUST	2.50	B,C
016-160-056	NICK CHAMPI ENTERPRIES INC	2.65	B,C
016-160-058	HERNANDEZ GREG D 50% & LEMOS HERMINIA M 50%	2.49	B,C
016-160-059	MARISCAL JESUS 33.334% & MARIA TRINIDAD 33.333%	2.49	B,C
016-160-062	VEGA, JOSE GARCIA & LAURA MEDINA H/W	3.02	B,C
016-160-063	WASHINGTON, WILLIE JR & MAXINE J	2.07	B,C
016-160-065	VENEGAS, JESSE M	2.43	B,C
016-160-067	SCOTT, JOHN R & DARLEAN FAMILY TRUST	2.06	B,C
016-160-068	LEMOS, HERMINIA M	2.42	B,C
016-160-071	NICK CHAMPI ENTERPRISES INC	2.49	B,C
016-160-087	HA SEQUOIA LLC	9.95	B,C
016-160-088	HA SEQUOIA LLC	8.18	B,C
016-160-089	NELSON, DELORES	2.50	B,C
016-190-009	GRABOW, COLEEN SURVIVORS TRUST 50%	40.00	B,C
016-190-010	GRABOW, COLEEN SURVIVORS TRUST 50%	39.49	B,C
016-190-013	ALCALA FARMS CA GENERAL PARTNERSHIP	34.15	B,C
016-190-014	SANCHEZ TIMOTHY & TAMARA	33.35	B,C
016-190-015	SANCHEZ TIMOTHY & TAMARA	44.70	B,C
016-190-020	MELLO, CHIP J 17.4%	79.74	B,C
016-190-031	ALCALA FARMS A PTP	123.39	B,C
016-190-038	MELLO, CHIP J 50%	57.00	B,C
016-190-039	GAITAN, REBA HOPE LIVING TRUST	3.00	B,C
016-190-040	ARAUJO, ANTONIO & LUPE S H/W JT	2.50	B,C
016-190-041	CHAMBERS, KEVIN R JR & KATIE M H/W	2.50	B,C
016-190-042	LAFFERTY, DAVID W & SUSAN L H/W JT	2.50	B,C
016-190-043	STRONG FAM REV LIVING TRUST	2.50	B,C
016-190-044	ALICEA FAMILY TRUST	8.81	B,C
016-190-050	MELLO, JOHN & SHANDA LIVING TRUST	230.12	B,C
016-190-052	PAULO, EDWARD M 50%	50.87	B,C
016-190-054	MELLO, CHIP J 33.333%	156.62	B,C
016-190-055	BRASIL JOE EDUINO & SOZINHO BRASIL JEANA F	10.00	B,C
016-190-056	BRASIL JOE EDUINO & SOZINHO BRASIL JEANA F	10.00	B,C
016-190-057	GRABOW, COLEEN SURVIVORS TRUST 50%	39.47	B,C
016-190-058	GRABOW, COLEEN SURVIVORS TRUST 50%	38.22	B,C
016-190-059	RABER FAMILY LIVING TRUST	37.59	B,C

APN	Record Owner	Acres	Pumping Zone
016-190-061	SANCHEZ DENNIS J TRUST	69.52	B,C
016-190-062	SANCHEZ DENNIS J TRUST	2.50	B,C
016-190-063	ENRIQUEZ, MARTIN & ROCIO REVOC TRUST	10.00	B,C
016-190-064	RABER FAMILY LIVING TRUST	8.03	B,C
016-190-065	GRABOW, COLEEN SURVIVORS TRUST 50%	38.42	B,C
016-190-070	FRAGOSO, JARED L & CRYSTAL M H/W	28.38	B,C
016-190-071	MARTELLA, RICHARD REVOC TRUST 50%	29.07	B,C
016-190-074	MARTIN, DOUGLAS E 50% 0	2.33	B,C
016-190-075	MARTIN, DOUGLAS E 50% 0	23.48	B,C
016-200-005	SOZINHO DAIRY #5 INC	39.08	B,C
016-200-011	MARTELLA, NICKLUS E & ANNA M H/W	154.52	B,C
016-200-012	CHAMPLIN, STANLEY MARITAL TRUST 50%	79.09	B,C
016-200-015	ROCKEYE INSECT AND WEED MUNITIONS CO LLC	68.50	B,C
016-200-016	HAMPSHIRE, EDITH C REVOCABLE TRUST	80.00	B,C
016-200-018	KAWEAH DELTA WATER CONSERVATION DISTRICT	160.00	B,C
016-200-019	MARTELLA, NICKLUS E & ANNA M H/W	76.71	B,C
016-200-024	KAWEAH DELTA WATER CONSERVATION DISTRICT	25.07	B,C
016-200-028	SOZINHO DAIRY #5 INC	38.87	B,C
016-200-034	STATE OF CALIFORNIA	3.00	B,C
016-200-035	SOZINHO FAMILY TRUST	76.00	B,C
016-200-037	ARNOLD (CA) LLC	53.19	B,C
016-200-038	CHAMPLIN, STANLEY MARITAL TRUST 50%	2.16	B,C
016-200-039	CHAMPLIN, STANLEY MARITAL TRUST 50%	64.78	B,C
016-200-041	SOZINHO DAIRY #5 INC	100.71	B,C
016-200-042	FRAGOSO, JOHN L JR	19.48	B,C
016-200-043	DIAS, GABRIEL M	19.58	B,C
016-200-049	BRAZIL ANDREW W & GEANETTE N	19.75	B,C
016-200-053	J L FRAGOSO CATTLE COMPANY LLC	35.44	B,C
016-200-056	SOZINHO FAMILY TRUST	35.26	B,C
016-200-057	STATE OF CALIFORNIA	3.96	B,C
016-200-059	STATE OF CALIFORNIA	5.40	B,C
016-200-060	BRAZIL, ROBERT E REVOC TRUST	90.33	B,C
017-010-001	HAWK, STAN & LOIS LIVING TRUST	20.15	A,B,C
017-010-002	ROCHA, RICK & RITA 1999 FAMILY TRUST	2.97	A,B,C
017-010-003	HAWK, STAN & LOIS LIVING TRUST	34.03	A,B,C
017-010-004	BARRETO FAMILY AG PARTNERSHIP GP 50%	245.75	A,B,C
017-010-005	SANDRIDGE PARTNERS LP	20.10	A,B,C
017-010-006	SANDRIDGE PARTNERS LP 98%	20.09	A,B,C
017-010-007	SANDRIDGE PARTNERS LP 98%	20.13	A,B,C
017-010-008	SANDRIDGE PARTNERS LP 98%	20.14	A,B,C
017-010-009	SANDRIDGE PARTNERS LP 98%	20.14	A,B,C
017-010-010	SANDRIDGE PARTNERS LP 98%	20.14	A,B,C
017-010-011	ALCARAZ GERARDO ESPINO & CARACOZA SANDRA DIANA	10.08	A,B,C
017-010-012	GARCIA, RAYMOND & EVALENA FAMILY TRUST	5.00	A,B,C
017-010-013	GARCIA, RAYMOND & EVALENA FAMILY TRUST	5.08	A,B,C
017-010-014	MENEZES RODGER ALVIN	58.97	A,B,C
017-010-015	MARTINS, JOHN A & AMY H/W	78.98	A,B,C
017-010-016	MARTINS, JOHN & AMY H/W	34.38	A,B,C
017-010-017	GINGLES, MICHAEL T & LUPE H/W	3.09	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-010-018	DANIEL ARNOLD VEIGA & SUSAN ROSE VEIGA REV LIV TRU	2.01	A,B,C
017-010-019	POND, MICHAEL A & BROOKE M H/W	2.00	A,B,C
017-010-020	COTTA, M RICHARD	5.21	A,B,C
017-010-021	HAWK, STAN & LOIS LIVING TRUST	7.66	A,B,C
017-010-023	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	2.65	A,B,C
017-010-024	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	2.65	A,B,C
017-010-025	ROSE, JASON 50%	20.00	A,B,C
017-010-026	ROSE, JASON 50%	20.00	A,B,C
017-010-027	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	18.53	A,B,C
017-010-029	GRAHAM COMMERCIAL PROPERTIES LP	20.00	A,B,C
017-010-030	GRAHAM COMMERCIAL PROPERTIES LP	5.11	A,B,C
017-010-032	LOUIS R OLIVEIRA AND GAREN A OLIVEIRA FAM TRUST	29.12	A,B,C
017-010-034	LAST CHANCE WATER DITCH CO	2.52	A,B,C
017-010-035	ZHANG TING TING	5.76	A,B,C
017-010-036	ARMONA COMMUNITY SERVICES DISTRICT	7.69	A,B,C
017-010-037	LEMOORE CEMETERY DISTRICT	20.00	A,B,C
017-010-038	MENEZES RODGER ALVIN	20.00	A,B,C
017-010-039	LEMOORE CEMETERY DISTRICT	27.47	A,B,C
017-010-040	MENEZES RODGER ALVIN	16.00	A,B,C
017-010-041	HALL, GLENN L & DONNA M 1992 TRUST	10.00	A,B,C
017-010-042	HALL, GLENN L & DONNA M 1992 TRUST	3.64	A,B,C
017-010-043	LEMOORE CEMETERY DISTRICT	8.45	A,B,C
017-010-044	BENNETT, GARY BYPASS TRUST	2.66	A,B,C
017-010-047	DAVIDSON, PETER D & LISA A H/W	19.00	A,B,C
017-010-049	HALL, GLENN L & DONNA M 1992 TRUST	6.00	A,B,C
017-010-050	CENTRAL CA CONF ASSN OF 7TH DAY ADVENT	9.15	A,B,C
017-010-052	CENTRAL CA CONF ASSN OF 7TH DAY ADVENT	3.13	A,B,C
017-010-053	DILLON WILLIAM JAMES & LOLA F REV TRUST TR	3.14	A,B,C
017-010-066	BATES, E G 50%	2.00	A,B,C
017-010-070	CAMARA, GLENDA FAY 50% LF ESTATE & JOHN THOMAS 50%	68.00	A,B,C
017-010-071	ROCHA, RICK & RITA 1999 FAMILY TRUST	16.12	A,B,C
017-010-075	ROCHA, RICK & RITA 1999 FAMILY TRUST	10.01	A,B,C
017-010-076	ROCHA, RICK & RITA 1999 FAMILY TRUST	10.01	A,B,C
017-010-078	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	8.75	A,B,C
017-010-079	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	10.00	A,B,C
017-010-080	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	40.00	A,B,C
017-010-081	MENEZES RODGER ALVIN	40.00	A,B,C
017-010-082	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	20.00	A,B,C
017-010-083	MARTELLA, LAWRENCE W & RUTH E TRUST	2.50	A,B,C
017-010-084	SMITH, DENNIS C & MARIA L H/W	2.50	A,B,C
017-010-085	COTTA, STANLEY S 50%	2.29	A,B,C
017-010-086	MILLER DAMON I	2.74	A,B,C
017-010-088	ANDRES, ALBERTO P & ADELINA M 2008 TRUST	2.70	A,B,C
017-100-001	VERDEGAAL BROTHERS A PTP	16.74	A,B,C
017-100-003	VERDEGAAL BROTHERS INC 77%	8.72	A,B,C
017-100-005	THE RICHARD J. AVILA & SUSAN J. AVILA REVOCABLE TR	136.06	A,B,C
017-100-006	THE RICHARD J. AVILA & SUSAN J. AVILA REVOCABLE TR	2.50	A,B,C
017-100-009	CAF LLC	8.59	A,B,C
017-100-010	CAF LLC	67.17	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-100-012	ASPIRE HOMES CA, INC	15.06	A,B,C
017-100-013	ASPIRE HOMES CA INC	5.02	A,B,C
017-100-027	VERDEGAAL, GEORGE & KIMBERLY LIV TRUST 33%	8.72	A,B,C
017-110-003	MATTICE, BARBARA L	26.50	A,B,C
017-110-004	HOOPER FAMILY 2010 TRUST THE 50% & THE HEAVY META	10.00	A,B,C
017-110-007	HEAVY METAL 2022 TRUST 50%	14.80	A,B,C
017-170-001	MURRAY JOHN JR & BEATRIZ	4.26	A,B,C
017-170-002	HAMILTON, REBA E LF EST	5.00	A,B,C
017-170-003	RAISKUP, KYLE R	5.00	A,B,C
017-170-004	MENDES, JOAO R & ROSA N LF ESTATE	7.04	A,B,C
017-170-008	VELASQUEZ, JULIAN, & GLORIA E H/W	13.10	A,B,C
017-170-009	VELASQUEZ, JULIAN & GLORIA E H/W	2.50	A,B,C
017-170-010	VELASQUEZ, JULIAN & GLORIA E H/W	2.50	A,B,C
017-170-011	E & C FARMS LLC	20.96	A,B,C
017-170-012	BASS, CHARLOTTE D	3.24	A,B,C
017-170-013	BASS, CHARLOTTE D	4.14	A,B,C
017-170-014	CMV TIMES 3 HOLDINGS LLC	2.06	A,B,C
017-170-015	BICKNER, STEVE L & DAWN LIVING TRUST	37.47	A,B,C
017-170-019	VAN DER GRAAF, A & R LIV TRUST 75%	23.12	A,B,C
017-170-021	VAN DER GRAAF, A & R LIV TRUST 75%	23.67	A,B,C
017-170-022	VAN DER GRAAF, A & R LIV TRUST 75%	6.76	A,B,C
017-170-025	FAGUNDES, KEITH & RENEA H/W	20.00	A,B,C
017-170-026	FAGUNDES KEITH L & RENEA L	2.78	A,B,C
017-170-027	US HORTICULTURE FARMLAND LLC	35.30	A,B,C
017-170-028	PEDERSEN, ROBERT & MARDELL LIV TR	2.50	A,B,C
017-170-029	ALVARADO, ALBERT	2.00	A,B,C
017-170-030	US HORTICULTURE FARMLAND LLC	16.07	A,B,C
017-170-031	GARCIA ANGELINA REVOCABLE TRUST	2.50	A,B,C
017-170-033	PARSONS, MELISSA A	2.98	A,B,C
017-170-034	BROWN, LEONARD G	2.79	A,B,C
017-170-035	BARNES, FRANK R & KIRSTEN A S H/W	2.60	A,B,C
017-170-036	LOPEZ, JORGE V	2.41	A,B,C
017-170-037	GARCIA, MANUEL H 33.333%	2.32	A,B,C
017-170-038	GALLEGOS, ANTHONY S & CAROL J H/W	2.29	A,B,C
017-170-039	BROWN FAMILY REV LIVING TRUST	2.25	A,B,C
017-170-040	TISCHMACHER, BRIAN D & STEPHANIE L H/W	3.45	A,B,C
017-170-043	MARTIN FAMILY TRUST THE	2.50	A,B,C
017-170-044	US HORTICULTURE FARMLAND LLC	19.02	A,B,C
017-170-045	US HORTICULTURE FARMLAND LLC	18.70	A,B,C
017-170-046	US HORTICULTURE FARMLAND LLC	30.10	A,B,C
017-170-047	US HORTICULTURE FARMLAND LLC	150.89	A,B,C
017-170-048	US HORTICULTURE FARMLAND LLC	17.67	A,B,C
017-170-049	MARTIN MATTHEW F & KRISTI L 2022 REV TRUST 50%	2.50	A,B,C
017-170-050	MARTIN FAMILY TRUST THE	11.55	A,B,C
017-170-051	MARTIN, DONALD & SANDRA LIVING TRUST	3.60	A,B,C
017-170-052	MCCALLISTER FAMILY REVOCABLE TRUST	2.86	A,B,C
017-170-053	SOUTHERN PACIFIC TRANSPORTATION CO	12.50	A,B,C
017-170-061	FORD, FRANCES A 33.334%	5.75	A,B,C
017-170-062	AMBE PROPERTIES LLC	2.50	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-170-063	MARTELLA, JULIE SURVIVOR'S TRUST	20.45	A,B,C
017-170-068	MARTELLA, JULIE SURVIVOR'S TRUST	20.63	A,B,C
017-170-070	OUELLETTE, WALTER E & HELEN J H/W	10.00	A,B,C
017-280-013	PARCUS PROPERTIES A PTP	3.31	A,B,C
017-280-020	SILVA, CLARA MARITAL TRUST 50%	3.39	A,B,C
017-280-021	BLACK OAK LLC	10.29	A,B,C
017-280-022	VETERINARY PHARMACEUTICALS INC	10.69	A,B,C
017-280-026	LEWIS, MICHAEL D 33.334% & SIVERLY, DEBORAH A 33.3	2.50	A,B,C
017-280-027	BLACK OAK LLC	4.10	A,B,C
017-280-028	RIDER, TODD DAVID	4.50	A,B,C
017-280-032	LUGO, JOE A & KATHY M H/W	3.12	A,B,C
017-280-033	KENDALL-FARRAR SHARON & FARRAR DAVID W/H	7.17	A,B,C
017-280-035	RAEBER, MARK W & DEANNA H/W	2.29	A,B,C
017-280-036	BORGES, PAUL & DARLENE H/W	2.44	A,B,C
017-280-037	SALAZAR, SALVADOR E	4.88	A,B,C
017-280-038	BECK, VIRGIL L TRUST	2.00	A,B,C
017-280-042	NEVES, CARL F LIVING TRUST	47.79	A,B,C
017-280-043	ARMONA ELEMENTARY SCHOOL DISTRICT	10.02	A,B,C
017-280-045	BELTRAN, PAULINO RUIZ & ABIGAIL ALVARADO H/W	10.78	A,B,C
017-280-047	JOHN SLENDERS JR & ARLETE M SLENDERS TRUST	2.50	A,B,C
017-280-048	ANDRE, TONY P & CARRIE H/W 66.667%	10.45	A,B,C
017-280-062	GUTIERREZ PROPERTIES LLC	2.11	A,B,C
017-280-063	GODINEZ, ANTONIO R & ELVIRA H/W	2.89	A,B,C
017-290-001	MIDDLEFIELD MANOR LLC	11.00	A,B,C
017-290-002	MIDDLEFIELD MANOR LLC	11.00	A,B,C
017-290-003	MIDDLEFIELD MANOR LLC	10.03	A,B,C
017-290-004	MIDDLEFIELD MANOR LLC	10.03	A,B,C
017-290-005	MIDDLEFIELD MANOR LLC	10.03	A,B,C
017-290-006	MIDDLEFIELD MANOR LLC	10.06	A,B,C
017-290-007	MIDDLEFIELD MANOR LLC	10.05	A,B,C
017-290-008	MIDDLEFIELD MANOR LLC	10.01	A,B,C
017-290-009	MIDDLEFIELD MANOR LLC	16.42	A,B,C
017-290-010	MIDDLEFIELD MANOR LLC	11.06	A,B,C
017-300-001	VIRDEN, ERIC & SANDRA H/W	4.07	A,B,C
017-300-002	LIDDER, HARJOG S & PARMJIT K H/W	43.94	A,B,C
017-300-005	COSTA, MANUEL & JUSTINE L H/W	160.00	A,B,C
017-300-006	MONTGOMERY, RICHARD JR & JUANITA L REV FAM TRUST	2.51	A,B,C
017-300-007	FRANCO, GABRIELA J	2.51	A,B,C
017-300-008	WIIRRE, JOSHUA A & NICOLE L H/W	2.51	A,B,C
017-300-009	CARDOSO, JOSEPH M REV LIVING TRUST	2.51	A,B,C
017-300-010	WALKER, WILLIAM S REV TRUST	12.14	A,B,C
017-300-011	HRCK PROPERTIES LLC	13.53	A,B,C
017-300-012	COPLIN FAMILY REVOCABLE LIVING TRUST	3.83	A,B,C
017-300-013	COPLIN FAMILY REVOCABLE LIVING TRUST	3.36	A,B,C
017-300-014	JARAMILLO, ALEJANDRO & MARIA E H/W	3.24	A,B,C
017-310-001	SILVEIRA 2012 REVOC TRUST 50%	4.99	A,B,C
017-310-002	SOUTHERN PACIFIC TRANSPORTATION CO	4.63	A,B,C
017-310-003	MIDDLEFIELD MANOR LLC	5.00	A,B,C
017-310-008	SILVA, CHERYL A REVOC LIVING TRUST 10%	42.18	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-310-012	SANDRIDGE PARTNERS LP	14.60	A,B,C
017-310-013	SANDRIDGE PARTNERS LP	54.50	A,B,C
017-310-014	SERNA GOMEZ, JUAN & MARIA H/W 50%	2.07	A,B,C
017-310-017	SULLIVAN FARMING LLC	17.18	A,B,C
017-310-018	SULLIVAN FARMING LLC	11.50	A,B,C
017-310-020	SULLIVAN FARMING LLC	10.00	A,B,C
017-310-021	SULLIVAN FARMING LLC	10.00	A,B,C
017-310-022	SULLIVAN FARMING LLC	11.50	A,B,C
017-310-023	SULLIVAN FARMING LLC	18.60	A,B,C
017-310-024	SULLIVAN FARMING LLC	10.00	A,B,C
017-310-025	LAWRENCE, ROUDY & DEANA H/W	2.71	A,B,C
017-310-026	SALDANA, CESAR & MARIA T H/W	2.50	A,B,C
017-310-027	H & S RENTALS LLC	15.56	A,B,C
017-310-030	WALKER, STEVEN J	17.02	A,B,C
017-310-032	SANDRIDGE PARTNERS LP	25.79	A,B,C
017-310-033	SANDRIDGE PARTNERS LP	3.28	A,B,C
017-310-036	SANDRIDGE PARTNERS LP	10.00	A,B,C
017-310-037	SANDRIDGE PARTNERS LP	10.00	A,B,C
017-310-039	SANDRIDGE PARTNERS LP	10.00	A,B,C
017-310-040	SANDRIDGE PARTNERS LP	10.33	A,B,C
017-310-041	SMITH, RUSSELL D JR REV TRUST	15.40	A,B,C
017-310-042	MILLER, BRAD S & KATHY L H/W	3.22	A,B,C
017-310-043	COELHO, JUANITA G TRUST	22.33	A,B,C
017-310-044	SANDRIDGE PARTNERS LP	6.15	A,B,C
017-310-045	MORALES, ERNESTINE	3.42	A,B,C
017-310-047	CASTRENCE, ADELAIDE G	19.90	A,B,C
017-310-051	VAN DER GRAAF, A & R LIV TRUST 75%	17.04	A,B,C
018-210-004	SMITH, RUSSELL D JR REV TRUST	59.09	A,B,C
018-210-005	US HORTICULTURE FARMLAND LLC	20.91	A,B,C
018-210-013	HANSEN, L E FARMS INC	28.15	A,B,C
018-210-016	BADASCI, ROBERT S & ANN C REVOC TRUST	30.00	A,B,C
018-210-018	LAGIER, JOHN D L 50%	10.00	A,B,C
018-210-019	SILVEIRA, BRANDON	4.00	A,B,C
018-210-022	HANSEN, L E FARMS INC	160.00	A,B,C
018-210-023	SILVESTRE, LUCY	30.89	A,B,C
018-210-029	SMITH, RUSSELL D JR REV TRUST	25.10	A,B,C
018-210-037	SMITH, RUSSELL D JR REV TRUST	23.70	A,B,C
018-210-044	SMITH, RUSSELL D JR REV TRUST	78.18	A,B,C
018-210-045	KINGS COUNTY WATER DISTRICT	5.47	A,B,C
018-210-046	PEREZ, MANUEL S	2.50	A,B,C
018-210-047	RAYGOZA, SERGIO & EVELIA H/W	2.50	A,B,C
018-210-049	SMITH, ROBERT D	3.12	A,B,C
018-210-050	SMITH, ROBERT D	26.88	A,B,C
018-210-057	GARZA, JOE G	5.00	A,B,C
018-210-058	BRUMIT, ALLEN & SHAROLYN LIVING TRUST	5.00	A,B,C
018-210-060	SLOCUM, VERNON & BETTY TRUST	2.53	A,B,C
018-210-064	SLOCUM, VERNON & BETTY TRUST	54.46	A,B,C
018-210-065	VALENTINE, LORI	19.88	A,B,C
018-210-066	TRINITY RANCHES LLC	96.99	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-210-068	NEWTON, PAUL & JAN FAMILY TRUST	2.00	A,B,C
018-210-069	COLEMAN FAMILY REVOC LIVING TRUST	12.71	A,B,C
018-210-077	ESCARCEGA, ESTEBAN & ABRIL H/W	2.87	A,B,C
018-210-078	O'DANIEL, KEVIN M & CANDIS J A H/W	2.50	A,B,C
018-210-079	PEREZ, DINORA 90%	2.50	A,B,C
018-210-080	BADASCI, ROBERT S & ANN C REV TR 41.67%	18.20	A,B,C
018-210-081	SILVEIRA, BRANDON LIVING TRUST	2.24	A,B,C
018-210-082	BITTNER, EDDIE D & BRENDA L H/W	35.58	A,B,C
018-210-083	PEDERSEN TRIPLET TRUST 2007	3.79	A,B,C
018-210-084	US HORTICULTURE FARMLAND LLC	72.21	A,B,C
018-210-085	STROCK, BRAD R & NATALIE H/W	20.22	A,B,C
018-210-086	PALACIO, EDISON & DALIA H/W	20.00	A,B,C
018-210-087	MURPHY, EUGENE L & PAULINE J REV TRUST	20.00	A,B,C
018-210-091	WALKER, STEVEN & ELIZABETH REV TRUST	20.11	A,B,C
018-210-092	WALKER, STEVEN & ELIZABETH REV TRUST	20.11	A,B,C
018-210-093	WALKER, STEVEN & ELIZABETH REV TRUST	20.11	A,B,C
018-210-094	WALKER, STEVEN & ELIZABETH REV TRUST	28.22	A,B,C
018-210-095	SMITH ROBERT DAVID	21.50	A,B,C
018-210-096	THEADORE, GERALD J & JUSTINE L REV FAM TR	21.50	A,B,C
018-210-099	SMITH ROBERT DAVID	21.50	A,B,C
018-210-102	THEADORE, GERALD J & JUSTINE L REV FAM TR	2.50	A,B,C
018-210-103	THEADORE, GERALD J & JUSTINE L REV FAM TR	22.16	A,B,C
018-210-104	ROCHA, STEVEN & LISA A H/W	10.85	A,B,C
018-210-105	ROCHA, ALVIN 50%	16.66	A,B,C
018-210-107	BABB, JEFFREY T & LISA R H/W	18.86	A,B,C
018-210-109	FERREIRA, STEVEN J & BERNADETTE TRUST	38.70	A,B,C
018-210-111	FERREIRA, STEVEN J & ERIN M H/W	18.41	A,B,C
018-210-112	AZEVEDO, TODD A TRUST 25%	25.47	A,B,C
018-210-113	BADASCI, ROBERT S & ANN C REVOC TRUST	23.23	A,B,C
018-210-114	BADASCI, ROBERT S & ANN C REVOC TRUST	20.00	A,B,C
018-221-002	WALKER II WILLIAM S	30.00	A,B,C
018-221-007	COSTA, MANUEL & JUSTINE H/W	30.00	A,B,C
018-221-008	MADRIGAL ISAEL SANCHEZ	9.98	A,B,C
018-221-011	SMITH, R DAVID JR & KRISTEN M H/W	10.00	A,B,C
018-221-012	WALKER, WILLIAM S REV TRUST	39.37	A,B,C
018-221-013	DOBRININ, JOANN K 2019 REVOC TRUST 50%	20.00	A,B,C
018-221-014	DOBRININ, JOANN K 2019 REVOC TRUST 50%	10.63	A,B,C
018-221-021	BRAZIL, DAVID 50%	76.94	A,B,C
018-221-023	THEADORE, GERALD J & JUSTINE L REV FAM TR	39.54	A,B,C
018-221-024	WALKER II WILLIAM S	78.67	A,B,C
018-221-025	THEADORE, GERALD J & JUSTINE L REV FAM TR	20.10	A,B,C
018-221-028	COSTA, E MANUEL	40.00	A,B,C
018-221-029	THRALL, MICHELLE	10.00	A,B,C
018-221-031	MIRANDA, FRANK S	3.00	A,B,C
018-221-032	COSTA, E MANUEL & JUSTINE H/W	3.00	A,B,C
018-221-034	YARBROUGH, ARCHIE & VELMA FAMILY TRUST	4.57	A,B,C
018-221-035	YARBROUGH, ARCHIE & VELMA FAMILY TRUST	2.50	A,B,C
018-221-037	HAYNES, JAMES C JR TRUST	4.00	A,B,C
018-221-038	KINGS COUNTY WATER DISTRICT	5.14	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-221-039	BRAZIL, DAVID 50%	35.72	A,B,C
018-221-040	KINGS COUNTY WATER DISTRICT	11.05	A,B,C
018-221-042	HOLIMAN, GAIL A & JOHN W W/H	3.27	A,B,C
018-221-045	IRWIN, TRAVIS R & ALAINA C H/W	4.98	A,B,C
018-221-046	DOBRININ, JOANN K 2019 REVOC TRUST 50%	54.47	A,B,C
018-221-048	BETTENCOURT 2015 REVOC LIVING TRUST	2.32	A,B,C
018-221-050	OREGEL, FRANCISCO J	7.08	A,B,C
018-221-052	RUBLE KEVIN & MICHELE	17.46	A,B,C
018-221-053	WALKER, STEVEN & ELIZABETH REV TRUST 50%	2.50	A,B,C
018-221-054	WALKER, STEVEN J & ELIZABETH H/W	27.50	A,B,C
018-221-057	COSTA, EDUINO M & JUSTINE L H/W	29.75	A,B,C
018-222-002	SMITH, RUSSELL DAVID JR 0	19.54	A,B,C
018-222-010	ARIT, NESTOR A JR & SONIA O H/W	5.00	A,B,C
018-222-011	FIELDS, KENNETH A	20.00	A,B,C
018-222-012	WALKER, STEVEN & ELIZABETH REV TRUST	40.00	A,B,C
018-222-014	SMITH, ROBERT D	40.00	A,B,C
018-222-018	MALLORY, RICK & CAROL H/W JT	5.00	A,B,C
018-222-023	BOIM, MARIO A	5.39	A,B,C
018-222-025	TOWER DAVID A JR	3.00	A,B,C
018-222-028	HERRIAGE, GEORGE E & ANITA M H/W	3.70	A,B,C
018-222-030	RAMIREZ, ROBERT JR & MARY H/W	3.10	A,B,C
018-222-031	WELZBACKER DANIEL L & VALERIE	4.55	A,B,C
018-222-032	GUZMAN, ANA M	2.45	A,B,C
018-222-033	VAN DER GRAAF, ALBERT & RIEKIE LIV TRUST	4.96	A,B,C
018-222-035	JOYNER, LARRY J LIVING TRUST	3.00	A,B,C
018-222-039	FAGUNDES, TYLER A	2.50	A,B,C
018-222-040	SMITH, ROBERT D	77.50	A,B,C
018-222-042	JOYNER, LARRY J LIVING TRUST	4.29	A,B,C
018-222-043	KINGS COUNTY WATER DISTRICT	22.08	A,B,C
018-222-044	SMITH, ROBERT D	18.64	A,B,C
018-222-048	WATKINS, JAMES M & LUCILLE A LIVING TRUST	5.03	A,B,C
018-222-049	GONZALES, JOHN A & TERESA S H/W	5.03	A,B,C
018-222-050	KETZ, DAVID B & CHRISTYANN H/W	5.03	A,B,C
018-222-051	SANCHEZ PETER R REV LIV TRUST	71.75	A,B,C
018-222-054	JOYNER, LARRY J LIVING TRUST	2.02	A,B,C
018-222-055	HAMILTON, JANET J & CHRIS W/H	2.50	A,B,C
018-222-057	GALHANDRO, MANUEL & DIANA REV FAM TRUST	20.00	A,B,C
018-222-058	WALKER, STEVEN & ELIZABETH REV TRUST	32.30	A,B,C
018-222-059	BONILLA, DIOSDADO & MARIA M REV TRUST	25.41	A,B,C
018-222-061	MENDES, ERNEST J	20.00	A,B,C
018-222-062	GALHANDRO, MANUEL & DIANA REV FAM TRUST	20.00	A,B,C
018-222-066	WALKER, STEVEN J & ELIZABETH H/W	20.80	A,B,C
018-222-068	WALKER, STEVEN J & ELIZABETH H/W	19.74	A,B,C
018-222-069	MARTINEZ, SERGIO & VERONICA H/W	4.35	A,B,C
018-222-070	WALKER, STEVEN & ELIZABETH REV TRUST 50%	26.80	A,B,C
018-222-079	WALKER, WILLIAM S REV TRUST	20.79	A,B,C
018-222-080	WALKER, STEVEN & ELIZABETH REV TRUST	28.70	A,B,C
018-222-081	WALKER, STEVEN & ELIZABETH REV TRUST	18.01	A,B,C
018-222-082	WALKER, WILLIAM S REV TRUST	2.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-231-006	ALCALA FARMS CA GENERAL PARTNERSHIP	77.40	A,B,C
018-231-012	WALKER, WILLIAM S REV TRUST	53.14	A,B,C
018-231-013	GUY, MICHAEL J & MARTHA A H/W	5.00	A,B,C
018-231-017	WALKER, WILLIAM S REV TRUST	20.27	A,B,C
018-231-019	WALKER, WILLIAM S REV TRUST	29.00	A,B,C
018-231-021	WALKER, WILLIAM S REV TRUST	20.00	A,B,C
018-231-023	SANCHEZ PETER R REV LIV TRUST	3.22	A,B,C
018-231-028	STROLE, MARK S	2.00	A,B,C
018-231-036	SANCHEZ PETER R REV LIV TRUST	2.50	A,B,C
018-231-037	SANCHEZ PETER R REV LIV TRUST	17.57	A,B,C
018-231-038	CRAFT, MICHAEL D & ESTRELLA Z H/W	2.50	A,B,C
018-231-039	KESSINGER, WILMA S 50%	2.50	A,B,C
018-231-042	WALKER, WILLIAM S REV TRUST	16.89	A,B,C
018-231-045	CHRISTIE, JAMES & JENNIFER H/W	2.59	A,B,C
018-231-051	OVERLEY, DENNIS R	3.18	A,B,C
018-231-055	ROE LIVING TRUST	3.25	A,B,C
018-231-056	VAN DEN BERG, DOROTHY & ALEX PAREDES W/H	2.04	A,B,C
018-231-057	ZERMENO, RAUL & MARIA L FAMILY TRUST	3.52	A,B,C
018-231-058	LEMOS JOSE & BARBARA	2.50	A,B,C
018-231-060	WALKER, STEVEN & ELIZABETH REV TRUST	15.58	A,B,C
018-231-061	WALKER FARMS A PTP	49.96	A,B,C
018-231-062	WALKER, WILLIAM S REV TRUST	5.00	A,B,C
018-231-064	WALKER II WILLIAM S	71.33	A,B,C
018-231-068	WALKER, WILLIAM S REV TRUST	74.24	A,B,C
018-231-069	WALKER, WILLIAM S REV TRUST	15.61	A,B,C
018-231-071	WALKER, WILLIAM S REV TRUST	37.53	A,B,C
018-231-072	WALKER, WILLIAM S REV TRUST	7.44	A,B,C
018-232-004	SUPERIOR SOIL SUPPLEMENTS LLC	20.00	B,C
018-232-021	BRAZIL, SANDRA TRUST 50% & BRAZIL LEE A 2005 TRUS	2.65	B,C
018-232-028	CASTANEDA, SANDRA	6.00	B,C
018-232-032	GIRON, RUSSEL J & LILLIE O H/W	3.00	B,C
018-232-040	ALCALA FARMS A PTP	30.00	B,C
018-232-041	ALCALA FARMS CA GENERAL PARTNERSHIP	2.58	B,C
018-232-050	FOUR STAR DAIRY LP	46.98	B,C
018-232-066	GRILIONE ENTERPRISES LP	10.02	B,C
018-232-067	GRILIONE ENTERPRISES LP	10.03	B,C
018-232-068	GRILIONE ENTERPRISES LP	10.03	B,C
018-232-070	THIARA, NOVELEEN SINGH	15.00	B,C
018-232-072	WESTERN MILLING LLC	23.90	B,C
018-232-074	MORGAN, BRADLEY L	12.95	B,C
018-241-001	MANCILLA RAMON	2.60	A,B,C
018-241-002	BOWDEN, ORBERY D & ROSALEE M H/W	2.50	A,B,C
018-241-003	RABE, JOHN	2.50	A,B,C
018-241-004	CASTANEDA, WILLIE & PETRA H/W	2.50	A,B,C
018-241-005	AGUINIGA, TOVIAS & SABRINA J L H/W	2.50	A,B,C
018-241-006	WYATT, MANUELA	2.50	A,B,C
018-241-007	WALKER, WILLIAM S REV TRUST	2.50	A,B,C
018-241-008	GARCIA PAUL GEORGE & FELICITAS	2.27	A,B,C
018-241-010	JACOBS, DOUGLAS M & DEBORA V REV FAM TRUST	3.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-241-012	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	187.44	A,B,C
018-241-013	JOKE FAMILY TRUST	9.25	A,B,C
018-241-014	ZONNEVELD DAIRIES INC	116.97	A,B,C
018-241-015	JESUS & MARIA ALVAREZ REVOCABLE FAMILY TRUST	2.00	A,B,C
018-241-016	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	38.00	A,B,C
018-241-017	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	140.00	A,B,C
018-241-018	COSTA, VERNON J & BRENDA J H/W	20.00	A,B,C
018-241-026	WALKER, WILLIAM S REV TRUST	3.94	A,B,C
018-241-027	HAKKER, ROGER & CHERYL LIV TRST	19.98	A,B,C
018-241-029	HAKKER, ROGER & CHERYL LIVING TRUST	18.05	A,B,C
018-241-036	FIELDS, KENNETH A	17.89	A,B,C
018-241-037	ARMENTA-GONZALEZ, RICARDO & DORA H/W	4.89	A,B,C
018-241-041	WALKER, WILLIAM S REV TRUST	24.32	A,B,C
018-250-007	HAKKER, ROGER & CHERYL LIV TRUST 23.8	80.00	A,B,C
018-250-013	WALKER, STEVEN & ELIZABETH REV TRUST 50%	52.00	A,B,C
018-250-020	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	78.64	A,B,C
018-250-021	DOBRININ, JOANN K 2019 REVOC TRUST 50%	66.57	A,B,C
018-250-022	DOBRININ, JOANN K 2019 REVOC TRUST 50%	103.93	A,B,C
018-250-023	MOON, MICHAEL & PATRICIA H/W	2.24	A,B,C
018-250-025	PEREIRA, MANUEL & PHYLLIS LIVING TRUST	2.50	A,B,C
018-250-027	ZONNEVELD DAIRIES INC	316.50	A,B,C
018-250-029	PEARCE, BRANDEN 33.333%	12.47	A,B,C
018-250-031	DOBRININ, JOANN K 2019 REVOC TRUST 50%	94.51	A,B,C
018-250-033	DOBRININ, JOANN K 2019 REVOC TRUST 50%	155.12	A,B,C
018-250-036	KRUSE WESTERN HOLDINGS LLC 50%	79.00	A,B,C
018-250-038	DANELL, KAARIN KAY ESTATE	2.64	A,B,C
018-250-039	WALKER, STEVEN & ELIZABETH REV TRUST 50%	152.36	A,B,C
018-250-040	ELLSWORTH FARMS LLC	23.37	A,B,C
018-250-042	CABRERA, JUAN & LAURA H/W	32.52	A,B,C
018-250-043	POTTER, JAY R & AMBER H/W	2.50	A,B,C
018-250-044	ELLSWORTH FARMS LLC	22.27	A,B,C
018-261-004	NEGIN, NANDA L P 50%	60.00	A,B,C
018-261-006	SILVEIRA, LELAND D & MARGIE LIV TRUST	41.90	A,B,C
018-261-008	NEGIN, NANDA L P 50%	40.00	A,B,C
018-261-009	DUNNE, BERNADINE	39.25	A,B,C
018-261-013	SMITH, RUSSELL D JR REV TRUST	60.00	A,B,C
018-261-014	WEBER, WILLIAM C	2.00	A,B,C
018-261-018	STITES, JOHNNY E & LINDA B REVOC FAM TRUST	3.86	A,B,C
018-261-019	BORBA, DAVID & DENISE FAMILY TRUST	10.50	A,B,C
018-261-022	OWEN, ALDEN & LISA Y H/W	3.92	A,B,C
018-261-023	SILVEIRA, BRANDON LIVING TRUST	59.97	A,B,C
018-261-025	SMITH, RUSSELL D JR REV TRUST	33.10	A,B,C
018-261-026	MC FARREN, THOMAS & RUTH E H/W	2.50	A,B,C
018-261-030	CATTUZZO, JIMMY	2.61	A,B,C
018-261-031	AMERSON, ALLEN A & DARLA J H/W	2.50	A,B,C
018-261-032	SILVEIRA, BRANDON LIVING TRUST	31.72	A,B,C
018-261-033	WILSON, BILL J II & FINACEL M H/W	2.57	A,B,C
018-261-034	SCHWARZEBACH, JANELLE TRUST	3.92	A,B,C
018-261-035	MARTIN, ROXIE V MARTIN TRUST	26.08	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-261-036	MORENO, DOMINGA C LF EST	3.64	A,B,C
018-261-037	RODRIGUEZ MONICA & ANTHONY	4.59	A,B,C
018-261-038	RAMIREZ, JIM & ELVA H/W	2.61	A,B,C
018-261-039	SILVEIRA, LELAND D & MARGIE LIVING TRUST	2.50	A,B,C
018-261-040	SILVEIRA, LELAND D & MARGIE LIVING TRUST	36.79	A,B,C
018-261-042	SLOCUM, VERNON & BETTY TRUST	99.00	A,B,C
018-261-043	LONGMIRE, WILLIAM & ANN INTERVIVOS TRUST	12.57	A,B,C
018-261-044	MARTINEZ, CAROLINE	2.44	A,B,C
018-261-045	GARZA, LIONEL & MARIA E H/W	2.50	A,B,C
018-261-046	DAVIS, HARVEY B JR & PAMELA K H/W	5.00	A,B,C
018-261-047	LONGMIRE WILLIAM AND ANN INTERVIVOS TRUST	5.00	A,B,C
018-261-048	SANDRIDGE PARTNERS LP	28.00	A,B,C
018-261-049	FLORES, MARIA D IRREV TRUST JAN 20 2021	2.44	A,B,C
018-261-050	CORONA, ANTONIO A & REGINA D H/W	3.01	A,B,C
018-262-006	SARTOR, VIRGINIA L B TRUST 50%	40.00	A,B,C
018-262-007	WALKER, WILLIAM S REV TRUST	40.00	A,B,C
018-262-009	KASISCHKE TIM & DEBRA FAM TRUST 50%	20.00	A,B,C
018-262-010	MILLER, GARRETT & MARY H/W	10.00	A,B,C
018-262-011	SARGENT, BRANDON & ERICA H/W	10.00	A,B,C
018-262-012	SILVEIRA, LELAND D & MARGIE TRUST	40.00	A,B,C
018-262-014	SILVEIRA, LELAND D & MARGIE LIVING TRUST	39.60	A,B,C
018-262-019	GAMINO, ENRIQUE	2.68	A,B,C
018-262-020	GARCIA, JUAN & TEREZA P H/W	2.75	A,B,C
018-262-021	CALDERON, LAURA E	2.59	A,B,C
018-262-025	ALLEN, MICHAEL T	2.24	A,B,C
018-262-028	SULLIVAN, HELEN A LIVING TRUST	30.58	A,B,C
018-262-029	THREE SULLIVANS FARMING LP	306.92	A,B,C
018-262-030	UPTON, SUSAN L	66.93	A,B,C
018-262-031	MENDES, ANTHONY & NANCY REVOC LIV TRUST	13.39	A,B,C
021-030-007	FERNANDES, JOSEPH JR REV LIV TRS 85.7% 0	70.00	A,B,C
021-030-008	FERNANDES, MARK A	10.07	A,B,C
021-030-009	JONES, COLEEN D	2.50	A,B,C
021-030-010	FERNANDES, JOSEPH JR REV LIV TRUST 0	40.00	A,B,C
021-030-011	JONES DENISE COLEEN	36.00	A,B,C
021-030-013	ROCHA, RICK & RITA 1999 FAMILY TRUST	10.13	A,B,C
021-030-014	ROCHA, RICK & RITA FAMILY TRUST	10.00	A,B,C
021-030-016	M C COTTA FAMILY RANCH LLC	118.16	A,B,C
021-030-017	WHITTEN, CARL	19.59	A,B,C
021-030-018	BADASCI, JANICE	17.49	A,B,C
021-030-019	BADASCI, JANICE	2.62	A,B,C
021-030-020	HOMAN, VIRGINIA A	9.06	A,B,C
021-030-021	HOMAN, VIRGINIA A	11.06	A,B,C
021-030-022	WEBER, KENDRA D	2.52	A,B,C
021-030-023	DIAS, KEVIN E & VICKIE J H/W JT	2.50	A,B,C
021-030-027	TILLEY WAYNE L	6.22	A,B,C
021-030-028	MICHEL, GLORIA & VICTORIANO RAMIREZ W/H	19.60	A,B,C
021-030-029	MENEZES RODGER ALVIN	18.31	A,B,C
021-030-033	MALDONADO, DANIEL & MARIA H/W	10.00	A,B,C
021-030-034	JACOBO SANTIAGO	2.50	A,B,C

APN	Record Owner	Acres	Pumping Zone
021-030-035	CROMWELL, ANDREW D & KERRY N H/W	2.50	A,B,C
021-030-036	LOUQUET, PETER & ADELA H/W	10.00	A,B,C
021-030-039	NORDSTROM, MATHEW & SYDNEY H/W	3.71	A,B,C
021-030-051	FERNANDES, JOSEPH JR REV LIV TRUST	19.00	A,B,C
021-030-053	NORDSTROM, NEIL & MARJORIE LIVING TRUST	10.00	A,B,C
021-030-054	L & P PISTACHIO LLC	10.00	A,B,C
021-030-055	L & P PISTACHIO LLC	10.00	A,B,C
021-030-056	NORDSTROM, ROGER L & FRANCES A H/W	10.00	A,B,C
021-030-059	CROSSWELL, JOHNNA L 50%	14.88	A,B,C
021-030-060	RODRIGUEZ, ELIZABETH	10.55	A,B,C
021-030-063	JACOBO, LAUREANO & PATRICIA H/W	10.00	A,B,C
021-030-068	JACOBO, LAUREANO & PATRICIA H/W	10.00	A,B,C
021-030-071	MORAIS, JOAO H & DIANA M H/W	35.36	A,B,C
021-030-073	PAULSON FAMILY REVOCABLE TRUST	4.29	A,B,C
021-030-074	JACOBO JONATHAN	10.60	A,B,C
021-030-076	COELHO, VINCENT & ANDREA REVOC TRUST	19.08	A,B,C
021-030-077	L & P PISTACHIO LLC	8.00	A,B,C
021-030-078	OLDHAM, MICHAEL & DIANNE FAMILY TRUST	2.00	A,B,C
021-040-001	VALLEY AG HARVESTING LLC	164.00	A,B,C
021-040-004	MAJORS FAMILY INVESTMENTS LLC	11.49	A,B,C
021-040-005	GARCIA DAVID E & SANDY	2.01	A,B,C
021-040-006	SILVEIRA, BRANDON LIVING TRUST	65.31	A,B,C
021-040-007	SOUTHERN PACIFIC TRANSPORTATION CO	4.35	A,B,C
021-040-008	SILVEIRA, BRANDON LIVING TRUST	9.76	A,B,C
021-040-009	SILVEIRA, BRANDON LIVING TRUST	15.26	A,B,C
021-040-010	MANRRIQUEZ, ARNULFO & BRENDA H/W	5.00	A,B,C
021-040-011	HOPPERT ASHLEY & RANDY J JR	3.23	A,B,C
021-040-013	SILVEIRA, BRANDON LIVING TRUST	28.65	A,B,C
021-040-015	MAJORS FAMILY INVESTMENTS LLC	11.11	A,B,C
023-030-001	BUSH, GREGORY & CYNTHIA H/W	2.50	A,B,C
023-030-005	SHIMMON FAMILY TRUST	3.75	A,B,C
023-030-006	VEGA, MIKE & ERICKA H/W	3.71	A,B,C
023-030-009	STREETER, BRADFORD E & PATTI M H/W	3.25	A,B,C
023-030-010	BERNARD, GREGORY B & CHERYL L H/W	17.54	A,B,C
023-030-012	SANSINENA, CONSTANCE GRANTOR TRUST	10.51	A,B,C
023-030-013	RABER FARMS LLC	38.17	A,B,C
023-030-014	SILVEIRA, LELAND D & MARGIE LIV TRUST	38.13	A,B,C
023-030-015	SILVEIRA, LELAND D & MARGIE TRUST	37.78	A,B,C
023-030-016	US HORTICULTURE FARMLAND LLC	37.21	A,B,C
023-030-019	PATTERSON, DONALD SURVIVORS TRUST 50%	2.05	A,B,C
023-030-023	LARA, LUCIA & DAVID A W/H	2.35	A,B,C
023-030-024	PAYOYO, ELY G & MARCY L H/W	2.25	A,B,C
023-030-025	RADCLIFFE, CHRISTINA	2.08	A,B,C
023-030-026	BOTELHO, MARCIO F & VALERIE A H/W	2.50	A,B,C
023-030-027	DHAREY LIVING TRUST	2.13	A,B,C
023-030-028	WISWELL, RICKY A & BRENDA S H/W	2.17	A,B,C
023-030-030	SWALLOW, FILOMENA B & LORN F W/H	2.01	A,B,C
023-030-038	RAISKUP, KENNETH S & GISELA H/W	10.40	A,B,C
023-030-039	THORBUS WENDY C	5.05	A,B,C

APN	Record Owner	Acres	Pumping Zone
023-030-040	THORBUS WENDY C	5.05	A,B,C
023-030-044	YOST BRYCE W & AMY	2.12	A,B,C
023-030-050	SHIMMON, JEFFREY D & JENNIFER H/W	12.89	A,B,C
023-030-053	US HORTICULTURE FARMLAND LLC	38.15	A,B,C
023-040-013	LUIS, BENJAMIN & AMBER H/W	8.80	A,B,C
023-040-015	LAMBERT, HOWARD L LIVING TRUST 33.33% & HOWARD L	4.98	A,B,C
023-040-016	PENSCO TRUST COMPANY CUSTODIAN	7.69	A,B,C
023-040-017	STORMAX REAL ESTATE HOLDINGS LLC	5.48	A,B,C
023-040-019	STORMAX REAL ESTATE HOLDINGS LLC	5.91	A,B,C
023-040-021	PARTIDA R, FIDENCIO 50%	7.41	A,B,C
023-040-022	NAHAL FARMS LLC	2.89	A,B,C
023-040-024	REED, TIM AND JEAN LIV TRUST	4.02	A,B,C
023-040-027	NAHAL FARMS LLC	68.59	A,B,C
023-040-028	EDMONDSON, JAMES K	4.38	A,B,C
023-040-029	NAHAL, RUPINDERJIT	22.73	A,B,C
023-040-031	DIVINE, GERALD L TRUST	2.60	A,B,C
023-040-032	RICO, MIGUEL & DIANA H/W	18.21	A,B,C
023-040-034	AVILA, MANUEL D & OLIVIA M H/W 50%	68.68	A,B,C
023-040-035	AVILA MANUEL & OLIVIA	4.00	A,B,C
023-040-036	AVILA MANUEL & OLIVIA	5.10	A,B,C
023-040-068	SANCHEZ RENE GONZALEZ	21.41	A,B,C
023-040-069	GONZALES, JESSE M & CHRISTINA A H/W	20.00	A,B,C
023-040-075	ONORATI, ANTHONY B	3.90	A,B,C
023-040-076	SJ RANCH GP	75.55	A,B,C
023-040-077	NAHAL FARMS LLC	98.92	A,B,C
023-040-078	NAHAL FARMS LLC	74.72	A,B,C
023-040-079	NAHAL FARMS LLC	71.43	A,B,C
024-062-025	PEREIRA MICHAEL A	2.89	A,B,C
024-062-026	HANSEN, L E FARMS INC	36.73	A,B,C
024-062-027	GOMES, CRAIG & CIANA FAMILY TRUST	2.05	A,B,C
024-062-030	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	138.19	A,B,C
024-062-038	VENEGAS, ISAIAS 50%	2.50	A,B,C
024-062-039	MORRELL, DAVID W & KIMBERLY G H/W	2.98	A,B,C
024-062-042	RADDER FAMILY TRUST	2.50	A,B,C
024-062-043	STRONG, JOHN L & ESTHER O LIVING TRUST	2.50	A,B,C
024-062-044	DUTY, COLEAN A	2.50	A,B,C
024-062-045	STEELY FAMILY REVOCABLE TRUST	2.50	A,B,C
024-062-046	CURTISS THOMAS	2.50	A,B,C
024-062-049	CABRERA, JUAN C & LAURA E H/W	72.50	A,B,C
024-062-056	SMITH, ELEVEINE	22.12	A,B,C
024-062-058	HENDERSON TRUST	6.83	A,B,C
024-062-059	HUDSON, GERRY A TRUST	22.13	A,B,C
024-062-065	ROCHA, RYAN G & KALLI A H/W	26.44	A,B,C
024-062-066	ROCHA, RYAN G & KALLI A H/W	45.16	A,B,C
024-062-067	ROCHA, RYAN G & KALLI A H/W	57.12	A,B,C
024-062-068	ROCHA, RYAN G & KALLI A H/W	30.05	A,B,C
024-072-011	ENGLISH, SUZANNE 50%	2.50	A,B,C
024-072-012	DAVIS, JERRY H & THEREASA A H/W	2.50	A,B,C
024-072-013	MENDEZ, JESUS A & STELLA H/W 66.667%	2.50	A,B,C

APN	Record Owner	Acres	Pumping Zone
024-072-014	EDEN, KEITH E	14.62	A,B,C
024-072-031	GILCREASE, JEFFREY A & KAREN L FAM TRUST	38.43	A,B,C
024-072-035	SILVA, EDWARD J JR & DAWN E H/W	2.67	A,B,C
024-072-036	LEAL, EDWARD B & SHELLEY L FAM TRUST	2.85	A,B,C
024-072-037	GILCREASE, JEFFREY A & KAREN L TRUST	4.58	A,B,C
024-072-038	GILCREASE, JEFFREY A & KAREN L TRUST	9.16	A,B,C
024-072-039	VEENENDAAL, LESLIE J & CASE W LIV TRUST	3.84	A,B,C
024-072-040	GILCREASE, JEFFREY A & KAREN L FAM TR	4.02	A,B,C
024-072-041	GILCREASE, JEFFREY A & KAREN L FAM TR	28.54	A,B,C
024-072-042	GILCREASE, JEFFREY A & KAREN L FAM TR	2.40	A,B,C
024-072-043	GILCREASE, JEFFREY A & KAREN L FAM TR	35.44	A,B,C
024-072-045	GILCREASE, JEFFREY A & KAREN L TRUST	99.93	A,B,C
024-072-053	GILCREASE, JEFFREY A & KAREN L FAM TRST	4.58	A,B,C
024-072-054	GILCREASE, JEFFREY A & KAREN L TRUST	61.08	A,B,C
024-150-027	SILVEIRA, BRANDON LIVING TRUST	37.00	A,B,C
024-150-028	CROSE, CHARLES & ELIZABETH FAMILY TRUST	80.00	A,B,C
024-150-029	CROSE, CHARLES & ELIZABETH FAMILY TRUST	80.00	A,B,C
024-150-030	CROSE, CHARLES & ELIZABETH FAMILY TRUST	40.00	A,B,C
024-150-031	FARMFUNDR2 LLC	41.10	A,B,C
024-150-034	SILVEIRA, BRANDON LIVING TRUST	3.00	A,B,C
024-150-046	SILVEIRA, BRANDON LIVING TRUST	32.16	A,B,C
024-150-047	SILVEIRA, BRANDON LIVING TRUST	7.84	A,B,C
024-150-080	SMITH, ROBERT G SR 50%	19.21	A,B,C
024-150-081	MATTINGLY RYAN	17.21	A,B,C
024-150-091	JACK'S FARM LLC	30.54	A,B,C
024-150-092	MATTINGLY RYAN	14.24	A,B,C
024-160-011	UNITED STATES OF AMERICA IN TRUST	121.13	A,B,C
024-160-012	UNITED STATES OF AMERICA IN TRUST	200.00	A,B,C
028-010-002	PORTER, JAMES R & GLORIA A TRUST	19.85	A,B,C
028-010-003	GOMES, ANNETTE M	29.67	A,B,C
028-010-004	HANSEN, L E FARMS INC	160.00	A,B,C
028-010-005	VAN GRONINGEN, EIMERT TRUST 50%	72.50	A,B,C
028-010-010	SANDRIDGE PARTNERS LP	15.00	A,B,C
028-010-024	HOUGHTON, ROBERT LELAND	2.00	A,B,C
028-010-027	MOUW, KENDALL	10.00	A,B,C
028-010-028	THREE SULLIVANS FARMING LP	69.60	A,B,C
028-010-029	KASISCHKE TIM & DEBRA FAM TRUST 50%	17.65	A,B,C
028-010-034	SILVEIRA, BRANDON LIVING TRUST	76.95	A,B,C
028-010-035	SILVEIRA, BRANDON LIVING TRUST	2.50	A,B,C
028-010-036	SILVEIRA, BRANDON LIVING TRUST	27.48	A,B,C
028-010-037	GILCREASE, JEFFREY A & KAREN LEE FAM TRUST	2.52	A,B,C
028-010-038	DUTY, CARLTON & COLEAN LIV TRUST	2.50	A,B,C
028-010-039	SANDRIDGE PARTNERS LP	127.50	A,B,C
028-010-040	REINHARDT, DOUGLAS & MARY JANE LIV TRUST	12.25	A,B,C
028-010-041	REINHARDT, DOUGLAS & MARY JANE LIV TRUST	2.50	A,B,C
028-010-042	MUNOZ, JOHN A	2.50	A,B,C
028-010-043	MUNOZ, JOHN A	14.43	A,B,C
028-010-044	CLARK, DANIEL G & LINDA A H/W	2.50	A,B,C
028-010-045	VAN GRONINGEN, EIMERT TRUST 50%	84.50	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-010-046	JOHNSON, VIRGINIA	2.50	A,B,C
028-010-050	MARQUEZ, CESAR M & SHANTELL H/W	3.91	A,B,C
028-010-051	SIMAS, MANUEL R & TERESA C H/W	5.00	A,B,C
028-010-052	SIMAS, MANUEL & RACHEL M H/W	12.94	A,B,C
028-010-053	STRONG, LE ROY M & SUSAN M H/W	22.80	A,B,C
028-010-057	CORONADO, JESSE V 50%	5.68	A,B,C
028-010-058	VARELA, ALVARO	4.31	A,B,C
028-010-059	WALKER, DALTON C & RITA J H/W	10.00	A,B,C
028-010-060	PEREZ, LINDA	2.50	A,B,C
028-010-061	DAVIS, LARRY D REVOC LIVING TRUST	45.00	A,B,C
028-010-066	DAVIS, LARRY D REVOC LIVING TRUST	251.27	A,B,C
028-010-067	MUNOZ, JOHN A	15.03	A,B,C
028-010-068	GONZALES, GUADALUPE 2007 TRUST	16.52	A,B,C
028-010-069	MUNOZ, JOHN A	2.58	A,B,C
028-010-070	GONZALES, GUADELUPE TRUST	17.42	A,B,C
028-010-075	MC KEGNEY, JERALD & KATHLEEN M H/W	20.80	A,B,C
028-010-076	DAVIS, LARRY D REVOC LIVING TRUST	9.70	A,B,C
028-010-077	DAVIS, LARRY D REVOC LIVING TRUST	19.95	A,B,C
028-010-078	HARP, JAMES S THERESA L H/W	50.74	A,B,C
028-010-079	MEDEIROS CHAD ANTHONY & KUBIK MICHELLE LYNN	2.61	A,B,C
028-020-002	THREE SULLIVANS FARMING LP	320.00	A,B,C
028-020-005	MARTELLA, ROBERT & ANITA MARITAL TR 50%	10.00	A,B,C
028-020-006	SMITH, RUSSELL D JR REV TRUST	80.00	A,B,C
028-020-008	LAWRENCE, JOHNNY P	10.00	A,B,C
028-020-011	HAKKER, ROGER & CHERYL LIVING TRUST	59.39	A,B,C
028-020-012	S & A SOUZA FARMS INC	98.75	A,B,C
028-020-014	HAKKER, ROGER & CHERYL LIVING TRUST	45.00	A,B,C
028-020-015	HAKKER, ROGER & CHERYL LIVING TRUST	160.00	A,B,C
028-020-018	LOPEZ, JERONIMO & EMMA ALVAREZ H/W	2.50	A,B,C
028-020-024	SANTOS, ELOY & ANGELICA M H/W	4.00	A,B,C
028-020-026	PERRIERA FAYE B 33.334%	2.50	A,B,C
028-020-028	MEDEIROS FAMILY LAND LP	20.41	A,B,C
028-020-029	MEDEIROS FAMILY LAND LP	20.18	A,B,C
028-020-030	WEAVER, MELVON C & MARDEL I H/W	4.93	A,B,C
028-020-033	HAKKER, ROGER & CHERYL LIVING TRUST	15.37	A,B,C
028-020-041	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	15.10	A,B,C
028-020-042	PERRIERA FAYE B 33.334%	2.50	A,B,C
028-020-043	MEDEIROS FAMILY LAND LP	25.42	A,B,C
028-020-046	O'NEIL, STEVEN A LIVING TRUST	3.56	A,B,C
028-020-047	ALLEN, MICHAEL H & ANGELA S H/W	3.79	A,B,C
028-020-048	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	76.01	A,B,C
028-020-050	DUNNE, SEAN D	23.00	A,B,C
028-020-051	CROSSWELL, JOHN H 50%	12.00	A,B,C
028-020-055	TESORIERE, ANTHONY & LOUISE REV TRUST	6.00	A,B,C
028-020-056	TESORIERE, ANTHONY & LOUISE REV TRUST	7.67	A,B,C
028-020-057	GOMEZ, HECTOR G & MARIA J H/W	3.90	A,B,C
028-020-059	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	89.00	A,B,C
028-020-060	OZCOIDI, JEFFREY M	3.26	A,B,C
028-020-062	DAVIS, LANDON	5.05	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-020-063	DAVIS, LARRY D REVOC LIVING TRUST	11.89	A,B,C
028-020-064	DAVIS, LARRY D REVOC LIVING TRUST	121.42	A,B,C
028-020-065	HAKKER, ROGER & CHERYL IRREVOC TRUST	19.23	A,B,C
028-110-002	MARTELLA, ROBERT & ANITA MARITAL TR 50%	238.25	A,B,C
028-110-007	WALKER, WILLIAM S REV TRUST	80.00	A,B,C
028-110-009	ZONNEVELD DAIRIES INC	309.76	A,B,C
028-110-010	ZONNEVELD DAIRIES INC	320.00	A,B,C
028-110-011	FREITAS REV TRUST	78.98	A,B,C
028-110-012	FREITAS, JUDITH K	80.00	A,B,C
028-110-013	FREITAS REV TRUST	2.50	A,B,C
028-110-014	FREITAS REV TRUST	37.50	A,B,C
028-110-015	LONE OAK CANAL COMPANY 50%	2.85	A,B,C
028-110-016	FREITAS, JUDITH K	77.15	A,B,C
028-110-017	FREITAS 2015 REVOCABLE TRUST	37.01	A,B,C
028-110-018	DE JONG KELSEY DANAE	2.36	A,B,C
028-120-002	SOARES, MANUEL L & ADELIA M REV FAM TR	40.00	A,B,C
028-120-004	SOARES, MANUEL L & ADELIA M FAMILY TRUST	160.00	A,B,C
028-120-005	SOARES, MANUEL L & ADELIA M FAMILY TRUST	160.00	A,B,C
028-120-013	ALCALA FARMS A PTP	40.00	A,B,C
028-120-014	ALCALA FARMS A PTP	40.00	A,B,C
028-120-015	ALCALA FARMS A PTP	40.00	A,B,C
028-120-016	ALCALA FARMS A PTP	40.00	A,B,C
028-120-018	SOARES, MANUEL L & ADELIA M FAMILY TRUST	39.02	A,B,C
028-120-019	SOARES, MANUEL L & ADELIA M FAMILY TRUST	40.98	A,B,C
028-120-021	THREE SULLIVANS FARMING LP	198.97	A,B,C
028-120-022	MEDEIROS FAMILY LAND LP	2.50	A,B,C
028-120-028	MEDEIROS FAMILY LAND LP	37.50	A,B,C
028-120-030	MEDEIROS FAMILY LAND LP	60.82	A,B,C
028-120-032	ORRISON, PEGGY J LIVING TRUST	20.00	A,B,C
028-120-033	MEDEIROS FAMILY LAND LP	16.87	A,B,C
028-120-034	MEDEIROS FAMILY LAND LP	2.61	A,B,C
028-120-035	MARX, WILLIAM O LIVING TRUST	20.00	A,B,C
028-120-039	TURNER, TYLER	5.00	A,B,C
028-120-040	ALCALA FARMS A PTP	155.00	A,B,C
028-120-041	ORRISON, PEGGY J LIVING TRUST	20.10	A,B,C
028-120-042	ORRISON, PEGGY J LIVING TRUST	20.07	A,B,C
028-120-044	DOMINGOS, DEBBIE	3.86	A,B,C
028-120-046	SOARES, MANUEL L & ADELIA M REVOC TRUST	34.78	A,B,C
028-120-052	SOARES, MANUEL L & ADELIA M FAMILY TRUST	78.50	A,B,C
028-130-002	ARAUJO, ANTONIO & LUPE S H/W	80.00	A,B,C
028-130-010	MALAKAN INVESTMENTS LLC	80.00	A,B,C
028-130-014	SOARES, MANUEL & ADELIA REVOC FAM TRST	80.00	A,B,C
028-130-018	CROSE, CHARLES & ELIZABETH FAMILY TRUST	4.80	A,B,C
028-130-019	MALAKAN INVESTMENTS LLC	35.00	A,B,C
028-130-020	COLLINS, LARRY D & ADRIENNE M H/W JT	2.50	A,B,C
028-130-021	MALAKAN INVESTMENTS LLC	77.50	A,B,C
028-130-022	NASH, MICHAEL D & SHIRLEY L H/W	2.50	A,B,C
028-130-023	ALCALA FARMS A PTP	77.47	A,B,C
028-130-024	GOMES, CRAIG & CIANA FAMILY TRUST	2.05	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-130-025	ALCALA FARMS A PTP	77.96	A,B,C
028-130-026	HUIZAR JOSE CABRAL & OCHOA JUAN M	2.31	A,B,C
028-130-027	BRAZIL, DAVID 50%	77.73	A,B,C
028-130-028	UNITED STATES OF AMERICA IN TRUST	400.00	A,B,C
028-130-029	SOARES, MANUEL & ADELIA REVOC FAM TRST	80.00	A,B,C
028-130-031	TURNER, SCOTT & JULIE H/W	2.68	A,B,C
028-130-032	MALAKAN INVESTMENTS LLC	79.88	A,B,C
028-130-037	BRAZIL, DAVID 50%	40.13	A,B,C
028-130-038	BRAZIL, DAVID A 50%	20.00	A,B,C
028-130-039	BRAZIL, DAVID A 50%	20.00	A,B,C
028-130-040	MALAKAN INVESTMENTS LLC	37.29	A,B,C
028-140-001	WALKER, WILLIAM S REV TRUST	78.60	A,B,C
028-140-002	ALCALA FARMS A PTP	161.40	A,B,C
028-140-003	ZONNEVELD DAIRIES INC	160.00	A,B,C
028-140-004	SANDRIDGE PARTNERS LP	80.00	A,B,C
028-140-006	ALCALA FARMS A PTP	80.62	A,B,C
028-140-012	ZONNEVELD DAIRIES INC	5.00	A,B,C
028-140-013	ZONNEVELD DAIRIES INC	311.00	A,B,C
028-140-014	LAKESIDE IRRIGATION WATER DISTRICT	7.97	A,B,C
028-140-015	FERNANDES, ADAO G & MARIA O REV TRUST	146.98	A,B,C
028-140-017	RODRIGUES REVOCABLE LIVING TRUST	4.59	A,B,C
028-140-018	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.10	A,B,C
028-140-019	GARCIA FAMILY TRUST	20.09	A,B,C
028-140-020	GARCIA FAMILY TRUST	20.07	A,B,C
028-140-021	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.05	A,B,C
028-140-022	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.11	A,B,C
028-140-023	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.13	A,B,C
028-140-024	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.14	A,B,C
028-140-025	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.16	A,B,C
028-140-026	MALAKAN INVESTMENTS LLC	20.13	A,B,C
028-140-027	MALAKAN INVESTMENTS LLC	20.12	A,B,C
028-140-028	MALAKAN INVESTMENTS LLC	20.11	A,B,C
028-140-029	MALAKAN INVESTMENTS LLC	20.10	A,B,C
028-220-001	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	160.00	A,B,C
028-220-002	L & P PISTACIO LLC	163.14	A,B,C
028-220-036	MALTA, BERNARDO	80.00	A,B,C
028-220-038	PITMAN, BENJAMIN IRREVOCABLE TRUST	38.91	A,B,C
028-220-062	PITMAN, BENJAMIN IRREVOCABLE TRUST	47.00	A,B,C
028-220-063	OCHOA, RALPH & LOURDES H/W	31.14	A,B,C
028-220-076	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	159.45	A,B,C
028-220-077	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	159.35	A,B,C
028-220-080	VERWEY FAM REV TRUST	280.40	A,B,C
028-220-081	VERWEY FAM REV TRUST	161.50	A,B,C
028-230-005	VERWEY FAMILY REVOCABLE TRUST	30.90	A,B,C
028-230-009	SQUIRE, JOHN E 1996 TRUST	160.00	A,B,C
028-230-010	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	138.41	A,B,C
028-230-011	MURRAY JR JOHN & BEATRIZ	19.47	A,B,C
028-230-016	PITMAN FARMS INC	40.00	A,B,C
028-230-017	SOUZA, JOHN D & WILMA Y REV TRUST 2005	40.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-230-018	VERWEY INVESTMENTS LP	20.00	A,B,C
028-230-019	VERWEY INVESTMENTS LP	140.00	A,B,C
028-230-031	VERWEY FAMILY REVOCABLE TRUST	159.29	A,B,C
028-230-032	VERWEY FAMILY REVOCABLE TRUST	80.90	A,B,C
028-230-033	VERWEY FAMILY REVOCABLE TRUST	80.00	A,B,C
028-230-034	VERWEY FAMILY REVOCABLE TRUST	320.00	A,B,C
028-230-035	VERWEY FAMILY REVOCABLE TRUST	320.00	A,B,C
028-230-036	VERWEY FAMILY REVOCABLE TRUST	130.18	A,B,C
028-230-037	VERWEY FAMILY REVOCABLE TRUST	159.29	A,B,C
028-230-042	MARTINS MARCELO ALMEIDA	5.00	A,B,C
028-230-045	JRJ RANCH 50%	23.78	A,B,C
028-230-046	JRJ RANCH 50%	285.74	A,B,C
028-230-047	JRJ RANCH 50%	351.00	A,B,C
028-230-048	KINGS OUTREACH THE	45.70	A,B,C
028-240-008	CITY OF HANFORD	160.00	A,B,C
028-240-010	SOUZA, JOHN D & WILMA Y REV TRUST 2005	80.56	A,B,C
028-240-011	SOUZA, JOHN D & WILMA Y REV TRUST 2005	20.14	A,B,C
028-240-012	SOUZA, JOHN D & WILMA Y REV TRUST 2005	40.28	A,B,C
028-240-013	SOUZA, JOHN D & WILMA Y REV TRUST 2005	60.51	A,B,C
028-240-014	SOUZA, JOHN D & WILMA Y REV TRUST 2005	121.06	A,B,C
028-240-016	CITY OF HANFORD	160.00	A,B,C
028-240-018	CITY OF HANFORD	160.00	A,B,C
028-240-019	CITY OF HANFORD	160.00	A,B,C
028-240-020	CITY OF HANFORD	160.00	A,B,C
028-240-021	CITY OF HANFORD	160.00	A,B,C
028-250-002	VERWEY FAM REV TRUST	80.00	A,B,C
028-250-003	VERWEY FAM REV TRUST	80.00	A,B,C
028-310-005	CITY OF HANFORD	320.00	A,B,C
028-310-007	CITY OF HANFORD	60.00	A,B,C
028-310-008	CITY OF HANFORD	60.00	A,B,C
028-310-025	CITY OF HANFORD	200.00	A,B,C
	Total	82,796.62	

MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY

County of Kings
City of Hanford
Kings County Water District

Barry McCutcheon
Chair
Diane Sharp
Steven P. Dias

Dennis Mills
Secretary

200 North Campus Dr.
Hanford, CA 93230
Phone: (559) 584-6412
Fax: (559) 584-6882

MID-KINGS RIVER
GROUNDWATER SUSTAINABILITY AGENCY

RE: ***SHALLOW WELL MITIGATION POLICY***

AN MKR GSA POLICY TO PROVIDE MITIGATION FOR IMPACTS FROM OVER PUMPING THAT CAUSED HARM TO SHALLOW WELL OWNERS. The policy hereby contains as follows:

BACKGROUND

I. The Mid-Kings River GSA (MKR GSA) is committed to sustainably managing groundwater in its jurisdictional area, consistent with views of significant and unreasonable undesirable results as set out in the Tulare Lake Subbasin's Groundwater Sustainability Plan (TLS GSP).

II. MKR GSA is tasked with improving the conditions of all groundwater users over GSP Implementation Period (2020-2040) by modifying conditions such that undesirable results are eliminated and groundwater use is reliably sustainable by the end of the period.

III. MKR GSA understands that groundwater wells are re-drilled for many different reasons, not always due to declining groundwater levels. This has become very apparent through the evaluation that the MKR GSA has done on available well records from Kings County, DWR and efforts to develop a local well registry.

IV. In the Tulare Lake Subbasin 2020 Groundwater Sustainability Plan (GSP), minimum thresholds were set somewhat based on an estimate of the continued regional overdraft throughout the 2020 - 2040 Implementation Period. This method was criticized by DWR in 2022, and the Revised 2022 Tulare Lake Subbasin GSP altered the minimum thresholds. That revised method focused on the shallowest wells records (OSCWR database) in the area, which are mostly domestic. These records were used to set current minimum thresholds because a well registry had not yet been developed and more accurate information wasn't generally available. After reviewing the Revised 2022 Tulare Lake Subbasin GSP, in 2023 DWR referred the Tulare Lake Subbasin to the State Board. Both DWR and the State Board continue to communicate that the Tulare Lake GSAs should continue implementing the Revised 2022 Tulare Lake Subbasin GSP.

V. State Board staff reviewed the Revised 2022 Tulare Lake Subbasin GSP and DWR's reviews of previous GSPs and developed a "Tulare Lake Subbasin Probationary Hearing Draft Staff Report" on October 10, 2023. This document generally focuses on agricultural uses in the Subbasin causing groundwater level declines that impact other uses and users in the subbasin. The document describes shallow wells going dry as a significant and unreasonable condition that would need to be mitigated by those that are pumping significant amounts of groundwater.

VI. The State recognized in 2012 through AB 685 the human right to water. In 2016 the State Water Board adopted a resolution identifying the human right to water stating the Board would work "to preserve, enhance, and restore the quality of California's water resources and drinking water". The State has also conveyed that domestic groundwater use is a priority over agricultural or industrial groundwater use.

VII. The State Board sent notices to landowners in the Tulare Lake Subbasin area in October 2023 that if GSP issues are not addressed quickly, State Board staff has recommended that the TLS area should be: 1) put in Probation, 2) the vast majority of wells in the area be registered with the State at a cost of $300/well, and 3) pumpers be charged $40/acre-foot with fees going to the State Board. This step would be necessary before the State Board could develop an Interim Plan and begin to dictate groundwater pumping amounts in the area.

VIII. The MKR GSA understands that it is charged with eliminating long-term declining groundwater levels, subsidence and protecting groundwater quality from over pumping through the SGMA Implementation Period. The MKR GSA understands that the collective agricultural pumping in the area is the vast majority (90 percent or more) of groundwater pumping and is the most significant cause of local declining groundwater levels and local subsidence.

IX. There are three primary aquifers in the area, however not all are present at every location. In the far northeast, there is generally just one aquifer. Further southwest, the Corcoran Clay is present and creates an unconfined/semiconfined aquifer above it (B-zone) and a confined aquifer below (C-zone). On the west side of the MKR GSA there is a very shallow perched aquifer (A-zone), then deeper down there is the previously mentioned semiconfined aquifer above the Corcoran Clay (B-zone) and the confined aquifer below the Corcoran Clay (C-zone).

X. Over pumping from, or pumping that causes groundwater levels to reach new low levels, in the shallow perched aquifer (A-zone, generally west of the railroad) and the unconfined/semiconfined aquifer above the Corcoran Clay (B-zone) is understood to be the most significant cause of dry shallow rural domestic wells in the MKR GSA.

XI. For context, in 2022, Kings CWD, a JPA partner, replaced a domestic well on their Apex Ranch property and the effort was estimated to cost roughly $31,500 for a 6-inch diameter, 300 foot deep gravel packed domestic well (B-zone depth), with a 1.5 horsepower submersible motor producing roughly 18 gallons per minute. Well drilling and construction cost roughly $60 per foot of depth.

XII. Over pumping from, or pumping that causes groundwater levels to reach certain low levels, in the confined aquifer below the Corcoran Clay (C-zone) is understood to be the most significant cause of subsidence in the MKR GSA area. It is also understood that there is a small component associated with groundwater storage reductions (overdraft) in the semiconfined aquifer above the Corcoran Clay (B-zone).

OTHER LOCAL SERVICES

XIII. Self-Help Enterprises (SHE) provides emergency services and replacement funding for some landowners. SHE is a non-profit in the south valley that originally focused on affordable housing. SHE currently can provide water quality testing and emergency water service (bottled water, outdoor tank and hauled water support) for all landowners. SHE provides well modification/replacement funding for qualifying landowners who make 80% of mean household income, and are willing to not sell their property for a four year period after replacement through SAFER funds. (https://www.selfhelpenterprises.org)

XIV. Kings Water Alliance (KWA) provides bottled water or filtration development for landowners that have domestic groundwater quality that is high in nitrate or salt. KWA will pay for domestic water quality (nitrate) testing, if not tested done in the last five years. If nitrate levels are high enough (>10.0 mg/l), KWA will provide home bottled water delivery along with the free fill water station they operate at the KART Transit Center in Hanford. (https://www.kingswateralliance.org)

XV. California Department of Water Resources (DWR) has a self-reporting online system (https://mydrywell.water.ca.gov/report/) for is intended for "household drinking water wells that have gone dry due to drought impacts".

XVI. California Water Board has a summary of Emergency Drought Contacts by County and the information listed for the MKR GSA area is the Kings County Office of Emergency Services, 280 Campus Drive, Hanford, CA 93230, (559) 852-2883.

DOMESTIC WELL MITIGATION POLICY

A. MITIGATION

1) The cost to develop and outfit a new groundwater well to reestablish the use of groundwater that was lost.
2) Technical assistance.
3) Partial cost reimbursement for applicants that experienced, and still own the property, where a shallow well went dry between 2020 and 2023.

B. LEVEL OF SERVICE GOAL

The MKR GSA Board desires to provide emergency services to local landowners as quickly as possible. However, as this is a new effort for the GSA, there will be a learning curve and subsequent efforts will improve based on lessons learned. The MKR GSA Board will receive regular updates on efforts and timelines for response and attempt to guide the process toward a timely and reliable level of service.

The initial hope is to deliver bottled drinking water the next working day after reporting/application to the GSA, and external tank service within 5 working days if the setup for the system is fairly simple. Related to full well replacement, the MKR GSA hopes to have funding available within two weeks of the completion of the investigation/evaluation, and drilling of the new well completed within 4-6 months.

C. REQUIREMENTS

If an applicant qualifies to receive shallow well mitigation from the MKR GSA:

1) The applicant must agree that any replacement well be developed an acceptable offset below current minimum thresholds for water levels in the Tulare Lake Subbasin GSP. In other words the newly developed facility must be viewed by the GSA as reliable.

2) The well going dry must be registered with the MKR GSA, consistent with existing MKR GSA policies.

3) The well going dry must not be experiencing issues related to normal wear and tear or life-cycle.

4) The well going dry must not qualify for mitigation from other existing agencies or groups (Water Quality Coalition groups, some others).

5) The well going dry must not be first occurring in above average Water Years, as groundwater levels are not declining and subsidence is generally arrested.

6) The well going dry must not be drilled below the Corcoran Clay. It is currently understood that there are very few domestic wells drilled to this depth. The aquifer below the Corcoran Clay is confined and pressurized.

D. EMERGENCY SERVICES

The MKR GSA staff or consultants will provide emergency services information to parties notifying them of dry wells or seeking GSA Verifications. These services will include bottled drinking water and outdoor water tank services to parties within the GSA while the GSA Evaluation is being conducted. If it is found that mitigation should be provided, Emergency Services will continue until groundwater use is restored, or will end if mitigation should not be provided.

E. APPLICATION

Parties within the MKR GSA that wish to pursue shallow well mitigation must apply for this with the GSA, must provide requested information and authorize the GSA to conduct an investigation to determine the cause of the reported issue.

F. INVESTIGATION

Investigation of the reason for failure might include things like the construction of the well (column material, diameter, zones of perforation, blank zones), characteristics of the pump (diameter, horsepower, set depth), water level monitoring at the facility and in adjacent wells, video inspection, pump testing, water quality testing, review of maintenance/power/production records, and other items that might be needed.

G. EVALUATION

The GSA will evaluate the available information collected from the owner. The GSA will also evaluate the available information it has on local crops, groundwater pumping, monitored groundwater levels, nearby minimum thresholds, recharge amounts, surface water deliveries and water quality in the area. The GSA evaluation will consider whether the available information supports a claim that other pumpers have caused the applicant an issue that should be mitigated.

FUNDING

Funding for shallow well mitigation efforts will be collected from agricultural groundwater pumpers. The MKR GSA plans to establish a volumetric groundwater pumping charge that will in part be used to fund shallow well mitigation efforts, subsidence mitigation efforts, and groundwater quality mitigation efforts. The pumping charge will also likely be used to develop needed recharge projects. The volumetric groundwater pumping charge is planned to begin in 2024, making mitigation funding available later that year. The MKR GSA plans to comply with Proposition 218 requirements in developing the volumetric pumping charge in 2024. However if landowners in the MKR GSA do not approve the necessary funding for mitigation efforts, then more dramatic groundwater pumping restrictions will be needed to protect local shallow wells from over pumping impacts.

SEVERABILITY

If any section, sub-section, sentence, clause or phrase of this Policy is held by a court of competent jurisdiction to be invalid, such decision shall not affect the remaining portions of this Policy. The MKR GSA Board of Directors hereby declares that it would have passed this Policy, and each section, sub-section, sentence, clause, and phrase hereof, irrespective of the fact that one or more sections, sub-sections, sentences, clauses and phrases be declared invalid.

EFFECTIVE DATE

The Policy shall take effect as of April 1, 2024, and shall be published by title and summary on the MKR GSA's website together with the names of members of the MKR GSA Board of Directors voting for and against the same.

Respectfully submitted for your consideration,

Dennis Mills

Dennis Mills, General Manager

Vote of all Directors at the regular February 20, 2024 meeting:

AYES:	Barry McCutcheon, Diane Sharp, Steven P. Dias
NOES:	None
ABSTAINED:	None
ABSENT:	None

Cc: Ray Carlson, MKR GSA Attorney

MID-KINGS RIVER GROUNDWATER SUSTAINABILITY AGENCY

County of Kings
City of Hanford
Kings County Water District

Barry McCutcheon
Chair
Michael Murray
Vice-Chair
Diane Sharp
Steven P. Dias
Dennis Mills
Secretary

200 North Campus Dr.
Hanford, CA 93230
Phone: (559) 584-6412
Fax: (559) 584-6882

RE: ***GROUNDWATER PUMPING "CAP" POLICY***

AN MKR GSA POLICY TO LIMIT GROUNDWATER PUMPING AND SIGNIFICANTLY REDUCE UNDESIRABLE RESULTS. The policy hereby contains as follows:

BACKGROUND

I. The Mid-Kings River GSA (MKR GSA) is committed to sustainably managing groundwater in its jurisdictional area, consistent with views of significant and unreasonable undesirable results as set out in the Tulare Lake Subbasin's Groundwater Sustainability Plan (TLS GSP).

II. MKR GSA is tasked with improving the conditions of all groundwater users over GSP Implementation Period (2020-2040) by modifying conditions such that undesirable results are eliminated and groundwater use is reliably sustainable by the end of the period.

III. Kings County Water District has observed through their groundwater monitoring network in the GSA area that local groundwater levels have declined by roughly two (2) feet per year on average since the 1950s. This is what the MKR GSA generally considered the pre-SGMA area groundwater conditions.

IV. The MKR GSA understands that it is charged with eliminating long-term declining groundwater levels and subsidence through the SGMA Implementation Period. There are three primary aquifers in the area, however not all are present at every location. In the far northeast, there is generally just one aquifer. Further southwest, the Corcoran Clay is present and creates an unconfined/semiconfined aquifer above it (B-zone) and a confined aquifer below (C-zone). On the west side of the MKR GSA there is a very shallow perched aquifer (A-zone), then deeper down there is the previously mentioned semiconfined aquifer above the Corcoran Clay (B-zone) and the confined aquifer below the Corcoran Clay (C-zone).

V. Over pumping from, or pumping that causes groundwater levels to reach new low levels, in the shallow perched aquifer (A-zone, generally west of the railroad) and the unconfined/semiconfined aquifer above the Corcoran Clay (B-zone) is understood to be the most significant cause of dry shallow rural domestic wells in the MKR GSA.

VI. Over pumping from, or pumping that causes groundwater levels to reach new low levels, in the confined aquifer below the Corcoran Clay (C-zone) is understood to be the most significant cause of subsidence in the MKR GSA area. It is also understood that there is a small component associated with groundwater storage reductions (overdraft) in the semiconfined aquifer above the Corcoran Clay (B-zone).

VII. For many years, there used to be surface water that was available for local use from the State Water Project (SWP) and the Friant-Kern Canal (FKC) for use in above average years. This supply seemed to diminish over time and now is rare. Also for many years, KCWD tried to obtain a contract from the SWP for a planned facility called the Mid-Valley Canal. However, this 20-30 year effort was abandoned around 2015 when it became clear that the State would never make such supplies available.

VIII. Many years ago, the MKR GSA area was once known for cotton production. However, this changed as many dairies moved into the area and crops shifted. Over the last two decades, many local agricultural businesses have transitioned to more profitable permanent crops that require more water to grow and have hardened water demand so that fallowing in dry years is less frequent. Also, it should be mentioned that during the transition to dairies and permanent crops, local businesses chose to put historically marginal properties into production with a hardened water demand regardless of surface water availability.

IX. In recent years the MKR GSA understands that annually there is roughly 30,000 acre-feet of combined rural domestic and municipal (Hanford, Armona and Home Garden) groundwater pumping, while having roughly 218,000 acre-feet of agricultural pumping. This has led to an annual overdraft of roughly 50,000-70,000 acre-feet per year in dry to critical dry years.

X. During recent droughts, the MKR GSA has observed that the need to deepen wells has been very expensive for local well owners and the need to drill deeper wells has overwhelmed the capacity of available local drillers during drought periods. Both the California Department of Water Resources (DWR) and the State Board (State agencies involved in Groundwater Sustainability Plan (GSP) compliance) are very focused on this issue and how it can be resolved in the Tulare Lake Subbasin. Agricultural pumping is viewed as the most significant contributor to groundwater overdraft during droughts. However many of the shallowest wells in the area are rural domestic wells.

XI. In the MKR GSA the largest surface water supply is from the Kings River. These surface water supplies from through Peoples Ditch Company, Last Chance Water Ditch Company, Lemoore Canal & Irrigation Company and Alta Irrigation District. Lakeside Ditch Company also delivers surface water from the Kaweah River in a portion of the MKR GSA. These supplies mostly offset agricultural demands when they are available, but they also go to intentional groundwater recharge.

XII. In the MKR GSA area there are agricultural groundwater pumpers that are using surface water to offset their total agricultural demand, and there are groundwater pumpers that are only using groundwater for their total agricultural demand. Some groundwater only pumpers are choosing to not use surface water and others are having difficulty developing facilities that would allow them to contract for surface water supplies. Also there are some areas, like Last Chance Water Ditch Company's southern area and Lakeside Ditch Company, that do not receive any surface water in the driest years.

XIII. The MKR GSA views that it is not in the jurisdiction of the GSA to define groundwater rights or somehow transform surface water amounts into groundwater rights. The MKR GSA views its responsibility as estimating the amount of groundwater that can sustainably be pumped in the area given current conditions. The current policy goal is to begin the transition towards sustainable groundwater use in the area by eliminating a significant amount of overpumping. As conditions change throughout the area and more is learned about groundwater responses to management strategies, the GSA's view of sustainable pumping will be refined.

XIV. In several south valley GSAs there are evapotranspiration (ET) based transitional pumping plans or pumping allocations. Several of these plans have been reviewed and each of them seems to build in significant assumptions and views on surface water and groundwater components in order to avoid monitoring pumping directly. Often the views on surface water and groundwater are simplified so much that all inputs and outputs are considered in a "black box" which doesn't reflect the properties of local geology or aquifer systems. Some examples of such simplification are ignoring whether recharge and recovery are happening in the same aquifer, whether allocations that apply across multiple aquifers will avoid the pumping issues in each aquifer (shallow dry wells, or subsidence), whether the lateral distance between recharge and recovery is significant (lateral velocity of groundwater flow), the general direction of groundwater flow and whether components like precipitation should be viewed as additive to local groundwater or not.

XV. The MKR GSA views that totalizing groundwater flowmeters are helpful management tools for all landowners, and provide valuable direct measurement information that is very difficult to estimate through other indirect means.

EXCLUSIONS

XVI. Groundwater pumping from groundwater banks.

XVII. Groundwater pumping related to GSA permitted recharge efforts.

XVIII. Wells that are primarily rural domestic and pump less than two (2.0) acre-feet/year.

XIX. Lands outside of the MKR GSA cannot be used as justification for allowable pumping inside the MKR GSA area, as those lands are under the jurisdiction of another GSA and may also be in another subbasin.

GROUNDWATER PUMPING "CAP" POLICY

A. ALLOCATION TIMEFRAME

The MKR GSA staff will attempt to develop annual allocations on or before April 1 of each year. Allocations may need to change as additional information is obtained, in ongoing efforts to transition toward sustainability. The "cap" amount will apply to the period of April 1 of one year, to March 31 of the next year. This period is being selected to allow for the evaluation of fall to fall groundwater contours for the previous year (estimate of annual overdraft), as well as the observation of the precipitation through the winter's wettest months.

B. MEASUREMENT

The Groundwater Pumping "Cap" will be measured using a totalizing groundwater flow flowmeter, consistent with the requirements in the MKR GSA Groundwater Well Flowmeter

Policy. If an issue develops with any flowmeter, Land IQ ET information along with several conservative assumptions on use, will be used to fill in volumetric pumping gaps.

C. PUMPING CAPS PER AQUIFER ZONE

In 2024, there will be no differentiation between surface water area and groundwater only areas. To be clear these zones are not additive on a per acre basis.

1) A-Zone = 0.50 acre-feet per acre per year (AF/AC/yr)

2) B-Zone = 3.00 AF/AC/yr

3) C-Zone = 2.00 AF/AC/yr

For wells that are screened across multiple zones, if 80% of perforations or more are in one zone, the well's groundwater pumping "cap" will reflect that zone. The most common occurrence of this will likely be screening in both the B & C zones. In this case the total "cap" shall reflect a percentage of each zone (40% of perforations in the B-zone & 60 % of perforations in the C-zone = (40% x 3.00) + (60% x 2.00) = 2.4 AF/AC/yr) and shall not be greater than largest zone "Cap" involved.

Also, the MKR GSA is aware of some properties where there are a mixture of shallow wells and deep wells.

- An example might be a 40-acre property with one shallow well in the A-zone, one well in the B-zone and a third well in the C-zone. If the B-Zone well is used to irrigated the entire 40 acre field, then 120 AF/yr is available 3.0 AF/AC x 40 AC) through that well, but the A and C-zone wells cannot be pumped.
- Another example might be a 40-acre property with one shallow well in the A-zone, one well in the B-zone and a third well in the C-zone. In this example 20 acres of the field is dedicated to the B-zone well and 20 acres of the field is dedicated to the C-Zone. In this case, the two B-zone wells could be used to recover a total of (3.0 AF/AC x 20 AC) 60 AF/yr, while the C-zone well could recover (2.0 AF/AC x 20 AC) 40 AF/yr, but the A-zone well cannot be pumped.

D. CARRYOVER

Under this kind of groundwater pumping "Cap", unused portions of pumping below the "Cap" will not carried over. They will reflect a maximum amount of pumping allowed. The "cap" reflects the estimated amount of groundwater that can sustainably be pumped in a critical dry year. It is assumed that in years outside of the critical dry year, that landowners will use less groundwater as more surface water will be available. However, if landowners choose to use the full "Cap" amount every year, the "Cap" amount will have to be reduced accordingly in the future.

E. GROUNDWATER PUMPING FEES

Landowners with flow meters will be charged a per acre-foot for all groundwater pumped consistent with the aquifer zones the wells draw from consistent with the yearly Board approved fee rates as authorized through the Prop 218 proceedings. Landowners without flow meters on their wells (direct measuring devices) will require additional staff efforts and information from the landowner to calculate groundwater pumping. Due to this, landowners without flow meters will be charged an additional 5% on their estimated pumping to recover agency costs. Also, if landowners do not provide surface water use information to the GSA in a timely fashion, bills will be generated based on the total use of the field will be issued.

If groundwater pumping fees are not paid in a timely way to the GSA, a penalty will be levied on the individual related to collection of funds, or an injunction will be sought to prohibit groundwater pumping until the outstanding fees are paid.

Both DWR and the State Board have expressed concerns about the financial viability of local GSAs to accomplish the commitments made in their GSPs. The pumping fee will be the primary financial tool to fund portions of the efforts of the local GSA. Without a viable revenue stream for the local GSA, the State may find the area probationary and eventually start leveeing their own fees and eventually an Interim GSP that would manage groundwater pumping.

F. GROUNDWATER PUMPING PENALTIES

If a groundwater pumper exceeds his/her annual pumping "Cap", the amount of exceedance will be used to reduce the following year's "Cap" amount. The amount of exceedance will also have a penalty of $500/AF, as it is understood that this kind of pumping may create undesirable results that require mitigation.

SEVERABILITY

If any section, sub-section, sentence, clause or phrase of this Policy is held by a court of competent jurisdiction to be invalid, such decision shall not affect the remaining portions of this Policy. The MKR GSA Board of Directors hereby declares that it would have passed this Policy, and each section, sub-section, sentence, clause, and phrase hereof, irrespective of the fact that one or more sections, sub-sections, sentences, clauses and phrases be declared invalid.

EFFECTIVE DATE

The Policy shall take effect as of April 1, 2024, and shall be published by title and summary on the MKR GSA's website together with the names of members of the MKR GSA Board of Directors voting for and against the same.

Respectfully submitted for your consideration,

____

Dennis Mills, General Manager

Vote of all Directors at the regular March 12, 2024 meeting:

AYES: To be determined

NOES: To be determined

ABSTAINED: To be determined

ABSENT: To be determined

Cc: Ray Carlson, MKR GSA Attorney

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MEMORANDUM

To:	Mid-Kings River Groundwater Sustainability Agency Landowner
From:	Brian Ehlers, PE
Subject:	Preface to February 2024 Proposition 218 Engineers Report
Date:	February 26, 2024

The enclosed Engineer's Report was presented to the Mid-Kings River Groundwater Sustainability Agency Board of Directors on February 20, 2024 for their adoption. The Board accepted the report with the following revision to the budget, which accounted for ongoing consulting services.

Table 2-1. Revised MKRGSA Budget.

Fixed Costs	2024	2025	2026	2027	2028
KCWD/Hanford Payback	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ -
Administration					
Staff	600,000	618,000	637,000	656,000	676,000
Vehicles	100,000	0	106,000	0	112,000
Building Rental	20,000	21,000	22,000	23,000	24,000
Operations					
GSP Revisions	100,000	103,000	106,000	109,000	112,000
Annual Reports	20,000	21,000	22,000	23,000	24,000
Monitoring	150,000	155,000	160,000	165,000	170,000
Well Registration	100,000	0	0	0	0
Consultant Services	100,000	103,000	106,000	109,000	112,000
County Impact Study	50,000	0	0	0	0
New Monitor Wells	300,000	309,000	318,000	328,000	338,000
Reserves	360,000	360,000	360,000	360,000	360,000
Total Fixed Costs	$ 2,000,000	$ 1,790,000	$ 1,937,000	$ 1,873,000	$ 1,928,000
Variable Costs	2024	2025	2026	2027	2028
Dry Well Mitigation	$ 6,000,000	$ 6,000,000	$ 6,000,000	$ 6,000,000	$ 6,000,000
Recharge Basin Development	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000
Subsidence Mitigation	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Total Variable Costs	$ 9,500,000	$ 9,500,000	$ 9,500,000	$ 9,500,000	$ 9,500,000
Total Costs	$ 11,500,000	$ 11,290,000	$ 11,437,000	$ 11,373,000	$ 11,428,000

In addition, the list of affected parcels in Section 5 was updated to include properties within, but not served by, the city of Hanford and the communities of Hardwick, Home Garden, and Armona. The updated list is included as Section 6.

6. REVISED LIST OF AFFECTED PARCELS

APN	Record Owner	Acres	Pumping Zone
002-020-125	OLSON, ROBERT W & EILEEN	4.90	B
002-030-001	KINGS COUNTY WATER DISTRICT	18.00	B
002-030-006	WARD, MICHAEL G FAMILY TRUST 50%	60.00	B
002-030-007	WARD, MICHAEL G FAMILY TRUST 50%	61.54	B
002-030-008	KINGS COUNTY WATER DISTRICT	41.40	B
002-030-011	TE VELDE, DAVID & ALICE REVOC FAM TRUST	80.00	B
002-030-012	WARD, MICHAEL G FAMILY TRUST 50%	120.80	B
002-030-013	KINGS COUNTY WATER DISTRICT	89.40	B
002-030-014	WARD, MICHAEL G FAMILY TRUST 50%	42.71	B
002-030-016	PEOPLES DITCH CO	45.43	B
002-030-019	KIRSCHENMAN ENTERPRISES SALES LP 79.16%	80.00	B
002-030-021	JADJ LAND HOLDINGS LLC	2.50	B
002-030-022	DIEPERSLOOT, CALEB A	46.97	B
002-030-023	TE VELDE, DAVID & ALICE REVOC FAM TRUST	76.90	B
002-030-024	COLEMAN, ROBERT L & JULIE A H/W	3.59	B
002-030-025	TE VELDE, DAVID & ALICE REVOC FAM TRUST	39.60	B
002-030-027	TE VELDE, DAVID & ALICE REVOC FAM TRUST	39.60	B
002-030-030	SILVA, RANDALL & RHONDA H/W	20.08	B
002-030-031	CAETANO, WILLIAM 50%	20.08	B
002-030-032	WARD, MICHAEL G FAMILY TRUST	20.08	B
002-030-033	WARD, MICHAEL G FAMILY TRUST	20.08	B
002-060-025	KINGS RIVER PROPERTY LLC	4.56	B
002-060-026	TEVENDALE, ROBERT FAMILY TRUST	6.65	B
002-060-032	TEVENDALE, ROBERT FAMILY TRUST	26.55	B
002-060-035	TOS LAND CO INC	37.13	B
002-060-036	STATE OF CALIFORNIA	6.30	B
002-060-037	TOS LAND CO INC	42.74	B
002-070-050	JUAREZ, FERNANDO & PAULINE H/W	8.76	B
002-070-051	TOS, MARK & JORDAN LIVING TRUST 50%	17.00	B
002-070-083	JUAREZ, FERNANDO & PAULINE H/W	20.92	B
002-070-085	COUNTY OF KINGS	45.44	B
002-070-096	WESTFALL, BOBBY W REVOC TRUST	12.86	B
002-080-026	KINGS COUNTY WATER DISTRICT	138.15	B
002-080-027	DIEPERSLOOT JACOB & KATHRYN	20.38	B
002-080-028	DIAS FAMILY TRUST	4.86	B
002-080-030	ESCOTO, ANTELMO & CARMEN H/W 50%	20.16	B
002-080-032	KINGS COUNTY WATER DISTRICT	41.24	B
002-080-033	WARD, MICHAEL G FAMILY TRUST 50%	98.85	B
002-080-037	KINGS COUNTY WATER DISTRICT	18.60	B
002-080-041	CORCORAN IRRIGATION DISTRICT	24.24	B
002-080-051	TE VELDE, KARL J & LAUREN N REV FAM TRUST	70.24	B
002-080-054	REA, SETH	78.80	B
002-080-055	TE VELDE, DAVID & ALICE REVOC FAM TRUST	80.00	B
002-080-057	TE VELDE, KARL J & LAUREN N REV FAM TRUST	58.91	B
002-080-058	TE VELDE, DAVID & ALICE REV FAM TRUST	80.72	B
002-080-059	MORENO, JAVIER F JR	2.40	B
002-080-062	JOST 2018 REVOCABLE TRUST	76.17	B
002-080-063	ALTA IRRIGATION DISTRICT	5.47	B

APN	Record Owner	Acres	Pumping Zone
002-080-064	JOHNSTON FAMILY TRUST	14.84	B
002-080-065	JOHNSTON FAMILY TRUST	2.57	B
002-090-001	ESCOTO, ANTELMO & CARMEN H/W 50%	4.83	B
002-090-003	DIEPERSLOOT JACOB & KATHRYN	112.30	B
002-090-004	ROSANDER DECEDENT'S TRUST	129.71	B
002-090-005	TE VELDE, KARL J & LAUREN N REV FAM TRUST	27.22	B
002-090-006	TE VELDE, KARL J & LAUREN N REV FAM TRST	90.00	B
002-090-007	TE VELDE, KARL J & LAUREN N REV FAM TRST	59.10	B
002-090-010	DIEPERSLOOT, JACOB J & KATHRYN H/W	38.76	B
002-090-011	TE VELDE, KARL J & LAUREN N REV FAM TRUST	160.00	B
002-090-012	TE VELDE, KARL J & LAUREN N REV FAM TRUST	160.00	B
002-090-013	TE VELDE, KARL J & LAUREN N REV FAM TRUST	150.98	B
002-090-014	ALVES FARMS LLC	159.98	B
002-090-016	CEJA, RAFAEL JR	2.28	B
002-090-017	MPB RANCHES LLC	76.84	B
002-090-018	BUJULIAN FAMILY TRUST	2.50	B
002-090-019	MPB RANCHES LLC	77.23	B
002-090-026	DIAS FAMILY TRUST	13.14	B
002-100-002	DIEPERSLOOT, JACOB J & KATHRYN E H/W	38.56	B
002-100-006	BURRIS, DAVID & SHIRLEY BYPASS TRUST	39.25	B
002-100-009	WARMERDAM LAND CO LP	174.00	B
002-100-010	TOS, JOHN W & VICTORIA F LIV TRUST 50%	130.49	B
002-100-011	BURRIS, DAVID & SHIRLEY BYPASS TRUST	100.32	B
002-100-013	TOS, MARK & JORDAN LIVING TRUST 50%	5.80	B
002-100-014	JUAREZ HECTOR & AMANDA	9.60	B
002-100-016	TOS, MARK & JORDAN LIVING TRUST 50%	20.00	B
002-100-018	TOS, MARK & JORDAN LIVING TRUST 50%	19.25	B
002-100-019	TOS, MARK & JORDAN LIVING TRUST 50%	34.64	B
002-100-020	TOS, MARK & JORDAN LIVING TRUST 50%	19.51	B
002-100-021	BURRIS, DAVID & SHIRLEY BYPASS TRUST	35.97	B
002-100-022	DIAS MICHAEL A & GERMAINE FIRST AMENDED REV LIV TR	39.37	B
002-100-023	DIAS MICHAEL A & GERMAINE FIRST AMENDED REV LIV TR	38.57	B
002-100-024	DIAS MICHAEL A & GERMAINE FIRST AMENDED REV LIV TR	35.77	B
002-100-025	SWANSON FAM REV TRUST	39.55	B
002-100-027	TOS, MARK & JORDAN LIVING TRUST 50%	12.94	B
002-100-028	BURRIS, DAVID & SHIRLEY BYPASS TRUST	20.21	B
002-100-029	FINK, MARK & ROBIN H/W	2.50	B
002-100-030	DIEPERSLOOT, JACOB J & KATHRYN H/W	37.33	B
002-120-004	HANSEN, PHILLIP W SEP PROP TRUST 75%	40.00	B
002-120-005	DORAN, ROBERT D & CONNIE S REV FAM TRUST	30.00	B
002-120-007	LAWRENCE LAURA	8.19	B
002-120-010	BETTENCOURT KENNETH & CINDY LIV TRUST 50%	38.00	B
002-120-014	JACKSON, MATTHEW M FAM TRUST	42.00	B
002-120-015	NETTO ARNOLD & ALLISON TRUSTEE	10.00	B
002-120-016	NETTO LIVING TRUST	10.00	B
002-120-017	NETTO ARNOLD & ALLISON TRUSTEE	20.00	B
002-120-018	SIHOTA, PAUL & RAJNEET K H/W	16.63	B
002-120-044	HOLDER, ALDON & JANET LIVING TRUST	19.32	B

APN	Record Owner	Acres	Pumping Zone
002-120-051	STATE OF CALIFORNIA	2.50	B
002-120-058	TOS LAND CO INC	5.59	B
002-120-060	SIERRA VIEW FARMING COMPANY LLC	9.98	B
002-120-061	SIERRA VIEW FARMING COMPANY LLC	4.73	B
002-120-063	VAN CLEVE CONCRETE PRODUCTS INC	39.27	B
002-120-066	STATE OF CALIFORNIA	17.50	B
002-120-067	STATE OF CALIFORNIA	17.50	B
002-120-070	NETTO ARNOLD & NETTO ALLISON TRUSTEE	20.00	B
002-120-071	NETTO ARNOLD & ALLISON TRUSTEE	20.00	B
002-120-072	HANSEN, PHILLIP W SEP PROP TRUST	32.99	B
002-120-075	DILL, ANDERSON JR & GERMAINE H/W	17.50	B
002-120-076	MINTER, STACEY & ALISA H/W	2.50	B
002-120-081	HANSEN, ERIK & KRISTIE FAMILY TRUST	25.04	B
002-120-082	DORAN, ROBERT D & CONNIE S REV FAM TRUST	20.47	B
002-120-083	SUNNY RIVER FARMS FAM LTD PTP	17.50	B
002-120-084	VERDEGAAL, GEORGE & KIMBERLY 2023 LIV TRUST	2.50	B
002-120-085	DORAN, ROBERT D & CONNIE S REV FAM TRUST	13.69	B
002-120-086	DORAN, ROBERT D & CONNIE S REVOC TR	19.55	B
002-120-087	DORAN, ROBERT D & CONNIE S REV FAM TRUST	20.00	B
002-120-088	DORAN, ROBERT D & CONNIE S REV FAM TRUST	20.00	B
002-130-002	TOS, JEFF & SHERI LIVING TRUST 50%	6.51	B
002-130-003	TOS, JEFF & SHERI LIVING TRUST 50%	15.82	B
002-130-005	SIERRA VIEW FARMING COMPANY LLC	15.35	B
002-130-006	SUNNY RIVER FARMS FAM LTD PTP	18.60	B
002-130-009	SUNNY RIVER FARMS FAM LTD PTP	19.79	B
002-130-010	RAVEN, WILLIAM M & MARLENE A H/W	4.74	B
002-130-016	SCHLUND FAMILY TRUST	14.65	B
002-130-018	DUNN KAY E	18.80	B
002-130-020	NETTO LIVING TRUST	30.59	B
002-130-021	NETTO LIVING TRUST	16.53	B
002-130-022	MACIEL, DUSTIN P & THERESA J TRUST	2.17	B
002-140-003	KINGS RIVER FARMS LLC	33.00	B
002-140-004	VAN BEEK, NORMAN D	9.10	B
002-140-005	LAST CHANCE WATER DITCH CO	11.40	B
002-140-007	LAST CHANCE WATER DITCH CO	25.43	B
002-140-011	CAETANO PROPERTIES LLC	7.00	B
002-140-012	BETTENCOURT, MANUEL S JR BYPASS TRUST	19.65	B
002-140-013	FARMFUNDR3 LLC	25.60	B
002-140-014	CONTRERAS, RUBEN	20.00	B
002-140-015	KOPENHEFER, GLEN A & MARIA L H/W	29.29	B
002-140-018	WEISENHAUS, SUSAN M	5.00	B
002-140-019	THURMAN, OLIVE G 33.33%	25.83	B
002-140-022	NETTO LIVING TRUST	19.40	B
002-140-023	SOUZA, LEONARD J & MARY F LIVING TRUST	19.38	B
002-140-027	SARVER, DOUGLAS L & LINDA J REV TRUST	4.39	B
002-140-028	SARVER, DOUGLAS L & LINDA J REV TRUST	65.76	B
002-140-029	SOUZA, LEONARD J & MARY F LIVING TRUST	39.40	B
002-140-031	VAN BEEK, NORMAN D	24.75	B

APN	Record Owner	Acres	Pumping Zone
002-140-032	LAST CHANCE WATER DITCH CO	12.00	B
002-140-035	LAST CHANCE WATER DITCH CO	3.80	B
002-140-036	KINGS COUNTRY CLUB	60.00	B
002-140-039	BLACK OAK LLC	32.00	B
002-140-040	BISSIG, LOUIS F & SUSAN J 2023 TRUST	14.86	B
002-140-041	SOUZA, LEONARD J & MARY F LIVING TRUST	2.50	B
002-140-043	MIYA, MARK K REVOCABLE TRUST 2008 16.20%	102.50	B
002-140-044	VAN BEEK, NORMAN D	88.57	B
002-140-045	A T & SANTA FE RAILROAD	3.20	B
002-140-047	SOUZA, LEONARD & MARY LIVING TRUST	11.28	B
002-140-053	DUSTON, DOUGLAS J & LYNETTE L REV LIV TR	16.88	B
002-140-061	BISSIG, LAURIE	9.80	B
002-140-062	BISSIG, JODIE & RUSSELL W/H	3.11	B
002-140-063	NETTO LIVING TRUST	5.19	B
002-140-064	NETTO LIVING TRUST	106.16	B
002-140-065	MACIEL, DUSTIN P & THERESA J TRUST	2.80	B
002-150-001	BLACK OAK SHANE LLC 90%	27.64	B
002-150-002	MYERS, RICK & LINDA LIVING TRUST	7.00	B
002-150-003	MYERS, RICK & LINDA LIVING TRUST	7.00	B
002-150-004	HERNANDEZ, MARCOS	7.00	B
002-150-005	BRAZIL, JAMES F & TRACEY A H/W	11.83	B
002-150-008	HOLDER, ALDON & JANET LIVING TRUST	35.94	B
002-150-010	HUGH V JOHNS INC	115.00	B
002-150-012	AVILA, ANTHONY G	38.05	B
002-150-014	AVILA, ANTHONY G	24.00	B
002-150-016	NETTO, SARINA SPECIAL NEEDS TRUST	38.79	B
002-150-023	GRILIONE CRAIG AND MONICA LIVING TRUST	3.92	B
002-150-024	GRILIONE CRAIG AND MONICA LIVING TRUST	4.02	B
002-150-029	TOS, JOHN W & VICTORIA F LIV TRUST 50%	19.86	B
002-150-030	TOS LAND CO INC	20.13	B
002-150-031	TOS, JOHN W & VICTORIA LIVING TRUST 25%	39.05	B
002-150-032	TOS, JEFF & SHERI LIVING TRUST 25%	19.84	B
002-150-033	TOS, JEFF & SHERI LIVING TRUST 25%	60.00	B
002-150-034	TOS, JEFF & SHERI LIVING TRUST 25%	29.88	B
002-150-038	KINGS COUNTY WATER DISTRICT	12.23	B
002-150-044	NETTO LIVING TRUST	36.50	B
002-150-045	CHAVES, JOE M & RENNE L H/W	10.88	B
002-150-049	SELLERS, TIMOTHY & SARAH H/W	2.50	B
002-150-055	BETTENCOURT, RONALD W	2.50	B
002-150-056	BETTENCOURT, RONALD	36.28	B
002-150-058	TOS LAND CO INC	39.74	B
002-150-059	TOS LAND CO INC	9.85	B
002-150-062	SHELDON, RANDALL E	2.50	B
002-150-064	HOLDER, ALDON & JANET LIVING TRUST	72.60	B
002-150-065	J HOWER & ASSOCIATES	22.80	B
002-150-066	AVILA, ANTHONY G	20.00	B
002-150-067	SMALLWOOD, T KENNETH & VIRGINIA P H/W	8.68	B
002-150-069	STATE OF CALIFORNIA	2.00	B,C

APN	Record Owner	Acres	Pumping Zone
002-150-070	TOS LAND CO INC	14.10	B
002-150-071	TOS, JOHN W & VICTORIA F TRUST 50%	9.31	B
002-150-072	KINGS COUNTY WATER DISTRICT	25.18	B
002-150-073	KINGS COUNTY WATER DISTRICT	22.54	B
002-150-074	KINGS COUNTY WATER DISTRICT	20.00	B
002-150-075	DAVIS, KELTY & BENJAMIN A W/H	4.94	B
002-150-076	GRILIONE, CRAIG & MONICA LIVING TRUST	17.30	B
002-150-077	GRILIONE, CRAIG & MONICA LIVING TRUST	2.77	B
002-150-082	VALDENEGRO CHRISTIAN	8.56	B
002-150-088	JOHNS, BRAD V	47.50	B
002-150-089	JOHNS, BRAD V	72.88	B
002-150-093	JOHNS, BRAD V	25.55	B
002-150-094	JOHNS, BRAD V	9.86	B
002-150-098	TOS, JOHN W & VICTORIA F LIV TRUST 50%	75.14	B,C
002-150-102	TOS, WILLIAM JR & LINDA LIVING TRUST 50%	37.09	B
002-150-109	TOS LAND COMPANY INC	65.03	B
002-150-110	STATE OF CALIFORNIA	3.99	B
002-150-111	TOS LAND COMPANY INC	44.53	B
002-150-112	STATE OF CALIFORNIA	6.09	B
002-150-115	STATE OF CALIFORNIA	13.52	B
002-150-116	TOS JOHN W & VICTORIA F LIVING TRUST 50%	24.79	B
002-160-003	WARMERDAM LAND CO LP	160.00	B
002-160-006	GROUSE CREEK FARMS LLC	78.88	B,C
002-160-008	TOS, JEFF & SHERI LIVING TRUST	40.00	B
002-160-009	TOS, JEFF & SHERI LIVING TRUST 50%	40.00	B
002-160-010	TOS, JEFF & SHERI LIVING TRUST 50%	40.00	B
002-160-011	TOS, JEFF & SHERI LIVING TRUST 50%	40.00	B
002-160-014	EMCO INVESTMENT GROUP LLC	40.02	B
002-160-015	APRICOT 1031 LLC	40.02	B
002-160-016	APRICOT 1031 LLC	40.02	B
002-160-017	APRICOT 1031 LLC	20.03	B
002-160-018	APRICOT 1031 LLC	20.03	B
002-160-019	TOS, JEFF & SHERI LIVING TRUST 50%	38.87	B
002-160-020	TOS, JEFF & SHERI LIVING TRUST 50%	38.88	B
002-160-022	TOS, MARK & JORDAN LIVING TRUST	40.00	B
002-160-023	TOS, MARK & JORDAN LIVING TRUST 50%	40.00	B
002-160-026	VAN DYK FAMILY REVOC TRUST	60.49	B
002-160-027	TOS, JOHN W & VICTORIA F LIV TRUST 50%	100.84	B
002-160-028	TOS, JEFF & SHERI LIVING TRUST 50%	77.14	B
002-160-029	PARREIRA, HEATHER 50%	2.86	B
002-160-030	TOS, JEFF & SHERI LIVING TRUST 50%	78.61	B
002-160-032	TOS, JEFF & SHERI LIVING TRUST 50%	79.67	B
002-160-034	STATE OF CALIFORNIA	3.02	B,C
002-160-039	STATE OF CALIFORNIA	15.29	B,C
002-160-040	JOHNS, HUGH V INC	132.44	B
002-160-041	JOHNS, HUGH V INC	4.68	B,C
002-170-001	TE VELDE, KARL J & LAUREN N REV FAM TRST	45.49	B
002-170-005	TE VELDE, KARL J & LAUREN N REV FAM TRST	48.96	B

APN	Record Owner	Acres	Pumping Zone
002-170-010	GIACOMAZZI, BOB & SONS LIMITED PTP	302.95	B
002-170-022	TE VELDE, KARL J & LAUREN N REV FAM TRST	62.61	B
002-170-024	TE VELDE, KARL & LAUREN REVOC FAM TRUST	40.32	B
002-170-025	TE VELDE, KARL & LAUREN REVOC FAM TRUST	40.32	B
002-170-028	GWDJ PROPERTIES LLC 25%	84.85	B
002-170-029	JONES, JARED & MEGAN H/W	2.50	B,C
002-170-034	BARNETT, DOYLE H & LAURA J H/W	4.09	B
002-170-036	TE VELDE, KARL & LAUREN REVOC FAM TRUST	80.27	B
002-170-040	TOS, WILLIAM JR & LINDA LIVING TRUST 50%	55.91	B
002-170-041	TE VELDE, KARL J & LAUREN N REV FAM TRST	59.22	B
002-170-042	TE VELDE, KARL J & LAUREN N REV FAM TRST	100.89	B
002-170-045	JENSEN LVR RANCHES LP 50%	77.26	B
002-170-047	TOS, WILLIAM JR & LINDA LIVING TRUST 50%	17.97	B
002-170-048	TOS LAND CO INC	235.35	B
002-180-002	DOVER DAIRY HOLDINGS LLC	140.00	B,C
002-180-003	PIMENTEL, JOE & ESTHER LIVING TRUST	40.00	B,C
002-180-005	HABIB SAMUEL E	60.00	B,C
002-180-006	BARCELLOS, MARY J REVOC LIV TRUST 0	38.81	B,C
002-180-007	PIMENTEL, JOE & ESTHER LIVING TRUST	59.12	B,C
002-180-008	PIMENTEL, JOE & ESTHER LIVING TRUST	67.95	B,C
002-180-012	WADJ PROPERTIES LLC 24%	160.00	B,C
002-180-013	PIMENTEL, JOE & ESTHER LIVING TRUST	91.70	B,C
002-180-014	PIMENTEL, JOE & ESTHER LIVING TRUST	20.00	B,C
002-180-016	DOVER DAIRY HOLDINGS LLC	159.96	B,C
002-180-017	DOVER DAIRY HOLDINGS LLC	159.96	B,C
002-180-018	LJDJ PROPERTIES LLC 50%	49.85	B,C
002-180-019	GWDJ PROPERTIES LLC 50%	110.15	B,C
002-180-020	BARCELLOS, MARY J REVOC LIV TRUST	118.14	B,C
002-190-001	SULLIVAN, HELEN A LIVING TRUST 66.66% 0	40.00	B,C
002-190-002	SULLIVAN, HELEN A LIVING TRUST 66.66%	120.00	B,C
002-190-003	KINGS COUNTY WATER DISTRICT	80.00	B,C
002-190-004	DIAS, GABRIEL	80.00	B,C
002-190-009	STATE OF CALIFORNIA	40.00	B,C
002-190-016	NEGRETE, WILLIAM R & PATRICIA C TR 50%	80.00	B,C
002-190-020	MONTGOMERY FAMILY LIVING TRUST	52.65	B,C
002-190-021	MONTGOMERY FAMILY LIVING TRUST	52.64	B,C
002-190-023	DIAS, GABRIEL M	159.76	B,C
002-190-025	JESSUP, GIL A & YVONNE R H/W	10.00	B,C
002-190-026	MONTGOMERY, GARY & DIANE FAMILY TRUST	96.64	B,C
002-190-027	APRICOT 1031 LLC	243.53	B,C
002-190-029	STATE OF CALIFORNIA	3.70	B,C
002-190-030	BETTENCOURT, JOHN & LUCY LIVING TRUST	76.30	B,C
002-190-031	STATE OF CALIFORNIA	26.58	B,C
002-190-032	BETTENCOURT, JOHN & LUCY LIVING TRUST	17.83	B,C
002-190-034	APRICOT 1031 LLC	19.00	B,C
002-190-037	BRAZIL, GARY & JEANETTE H/W	11.12	B,C
002-190-038	BRASIL, JUSTIN & KAITLYN H/W 0	2.45	B,C
002-190-039	BRAZIL, GARY & JEANETTE H/W	20.49	B,C

APN	Record Owner	Acres	Pumping Zone
002-190-040	TOS LAND COMPANY INC	32.80	B,C
002-200-001	BERTRAM FAMILY TRUST	77.57	B,C
002-200-002	TOS LAND COMPANY INC	80.00	B,C
002-200-003	SULLIVAN, HELEN A LIVING TRUST 66.66% 0	140.00	B,C
002-200-007	TOS, JEFF & SHERI LIVING TRUST 25%	20.00	B,C
002-200-009	MATSUBARA FAM TR OF 1991	39.40	B,C
002-200-010	MATSUBARA FAM TR OF 1991	39.40	B,C
002-200-012	SULLIVAN, HELEN A LIVING TRUST 66.66%	48.60	B,C
002-200-013	BERTRAM FAMILY TRUST 50%	40.00	B,C
002-200-015	BRAZIL, MARY JANE LIVING TRUST 31.94%	79.50	B,C
002-200-017	BRAZIL FARMS A PTP	40.00	B,C
002-200-018	ESAJIAN, EDWARD V	40.00	B,C
002-200-022	VIERRA, MANUEL N LIVING TRUST	20.00	B,C
002-200-023	VIERRA, MANUEL N LIVING TRUST	40.00	B,C
002-200-024	VIERRA, NEIANI LEA TRUST 33.333%	40.00	B,C
002-200-025	VIERRA, NEIANI LEA TRUST 33.333%	48.86	B,C
002-200-028	TOS LAND CO INC	158.00	B,C
002-200-029	FERNANDES FAMILY TRUST THE	10.00	B,C
002-200-030	BROCK KYLE R	10.00	B,C
002-200-031	FERNANDES, LEE A & PENNY E H/W	2.50	B,C
002-200-032	TOS LAND COMPANY INC	57.50	B,C
002-200-033	TOS LAND CO INC	19.00	B,C
002-200-035	GILLUM, PAUL & JENNIFER H/W	18.58	B,C
002-200-041	SANGHA AJAYPREET SINGH	33.14	B,C
002-200-042	COSTA, EDWARD T SR & DEBRA M H/W	5.09	B,C
002-200-044	BERTRAM FAMILY TRUST	2.80	B,C
002-200-046	MATHEWS, RONALD J	40.05	B,C
002-200-047	MATHEWS, RONALD J & IVONE H/W	20.02	B,C
002-200-048	BERTRAM FAMILY TRUST 50%	38.66	B,C
002-200-049	MATHEWS, RONALD J	20.00	B,C
002-200-050	STATE OF CALIFORNIA	4.84	B,C
002-200-051	ESAJIAN, GARY E & ELENE P FAMILY TRUST	14.31	B,C
002-200-053	ESAJIAN, GARY E & ELENE P FAMILY TRUST	18.79	B,C
002-210-001	RGM LIVING TRUST THE	22.00	B
002-210-003	AVILA, ANTHONY G	80.00	B,C
002-210-004	LOWE, JACQUELINE S 2006 TRUST	20.00	B,C
002-210-009	MATSUBARA FAM TR OF 1991	20.00	B,C
002-210-018	KINGS RIVER CEMETERY	6.25	B,C
002-210-019	BETTENCOURT RONALD	150.73	B,C
002-210-022	KINGS RIVER SCHOOL DISTRICT	10.00	B,C
002-210-026	CARPENTER, WEALTHY A TRUST	40.00	B,C
002-210-027	SOUZA, LEONARD & MARY LIVING TRUST	40.00	B,C
002-210-028	SOUZA, LEONARD & MARY LIVING TRUST	40.00	B,C
002-210-031	AVILA, JOHN G & ROSEMARY E LIVING TRUST	131.81	B,C
002-210-032	SOUZA, WILLIAM A & DIANE T LIVING TRUST	30.00	B,C
002-210-036	MARTINS, JOHN A	2.50	B,C
002-210-038	BETTENCOURT, PAUL E & JULIE A H/W	2.66	B,C
002-210-039	SCHMITT, JULIANO S & ADRIANA Z H/W	16.78	B,C

APN	Record Owner	Acres	Pumping Zone
002-210-040	CHAMPI, ONAN N & SARA M REVOCABLE TRUST	2.50	B,C
002-210-041	STANDARD PROPERTIES LLC	96.63	B,C
002-210-043	RIDDLE, HAROLD E & CATHERINE A TRUST	2.62	B,C
002-210-044	ACEVEDO ROBERTO SANDOVAL 50%	2.50	B,C
002-210-046	SEWELL, HANNIE BRIAN & MARCIE KAY REVOCABLE TRUST	12.00	B,C
002-210-050	MARTINS, JOHN A	55.00	B,C
002-210-051	COSTAMAGNA, ERNEST 50%	2.50	B,C
002-210-052	LYNCH, WILLIAM K & KATHLEEN H/W	4.17	B,C
002-210-053	TOS LAND CO INC	64.42	B,C
002-210-057	WARMERDAM, TED A & JOANNE M TRUST	15.66	B,C
002-210-058	WARMERDAM, TED A & JOANNE M TRUST	2.68	B,C
002-210-061	DIAS, TONY SILVA & MARY FARIA REV LIV TRUST	3.30	B,C
002-210-063	A T & SANTA FE RAILROAD	12.81	B,C
002-210-069	WARMERDAM, SANDRA Y	12.04	B,C
002-210-070	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	20.00	B,C
002-210-071	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	20.00	B,C
002-210-072	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	20.00	B,C
002-210-081	ADC LLC	4.00	B
002-210-082	BARROS, DAVID J & E CARLEE LIVING TRUST	4.01	B,C
002-210-083	BARROS, DAVID J & E CARLEE LIVING TRUST	4.00	B,C
002-210-087	KINGS RIVER-HARDWICK UNION ELEM SCHOOL	15.00	B,C
002-210-091	CAMARA, JOSEPH & TERI FAM TRUST	12.11	B,C
002-210-092	TOSTE, STEVE M & SUSAN H/W 50%	3.35	B,C
002-210-095	KINGS RIVER-HARDWICK ELEMENTARY SCHOOL DISTRICT	14.44	B,C
002-210-096	TORRES OSCAR & SEVILLA CAROLINA	2.17	B,C
002-210-097	MATSUBARA FAM TR OF 1991	37.31	B,C
002-210-098	MATSUBARA FAM TR OF 1991	3.32	B,C
002-210-099	AVILA AND SONS FARMS LLC	26.09	B
002-210-100	AVILA AND SONS FARMS LLC	4.37	B,C
002-210-101	STANDARD PROPERTIES LLC	2.50	B,C
002-210-102	AVILA AND SONS FARMS LLC	20.87	B,C
002-210-107	TOS LAND CO INC	38.95	B,C
002-210-123	DIAS, GABRIEL	23.98	B,C
002-210-124	DIAS, GABRIEL	20.06	B,C
002-210-125	DIAS, GABRIEL	9.53	B,C
002-210-126	DIAS, GABRIEL	2.50	B,C
002-210-127	HASBROOK JAMES	4.93	B
002-210-128	EMCO INVESTMENT GROUP LLC	18.63	B
002-210-129	LITTLE LAND COMPANY GP 50%	21.51	B,C
002-220-004	DOOLEY, RICHARD & DORIS SURV TRUST 50%	7.09	B
002-220-005	MURRAY, BRENDA MARTIN	74.26	B
002-220-007	TOS, JEFF & SHERI LIVING TRUST 25%	40.00	B,C
002-220-010	ZONNEVELD, FRANK T & JANA C REV FAM TRU	40.00	B,C
002-220-012	NISHI, LESLIE 12.5%	40.47	B,C
002-220-013	MURRAY, MICHAEL D & BRENDA M H/W	80.00	B
002-220-015	VANDER VEEN, DARYL & KRISTIN H/W	2.00	B
002-220-016	MIYA, HARRY & NANCY LIVING TRUST 50%	37.49	B,C
002-220-019	GONSALVES, FRANKIE C & DANA L H/W	55.40	B,C

APN	Record Owner	Acres	Pumping Zone
002-220-025	ZONNEVELD DAIRIES INC	33.67	B,C
002-220-026	MIYA, HARRY & NANCY LIVING TRUST 50%	4.40	B,C
002-220-028	ZONNEVELD DAIRIES INC	8.60	B,C
002-220-031	MIYA, HARRY & NANCY LIVING TRUST 50%	48.55	B,C
002-220-032	GONSALVES, FRANKIE C & DANA L H/W	5.00	B,C
002-220-033	GONSALVES, FRANKIE C & DANA L H/W	10.80	B,C
002-220-034	HANSE FARMS INC	53.34	B
002-220-035	MONTEIRO, MARIA C SURV TRUST A 50%	26.67	B
002-220-036	KELLY, WILLIAM W & CINDY M REV TRUST	53.34	B
002-220-037	KELLY, WILLIAM W & CINDY M REV TRUST	106.66	B
002-220-051	DIAZ, DAVID TORRES	2.50	B,C
002-220-052	CHAMPLIN, RANDY P & DOREEN L H/W	2.50	B,C
002-220-053	CAMARA, KELLY J & TERRI L H/W	2.50	B,C
002-220-054	DUTRA CHRISTINE LIVING TRUST	2.50	B,C
002-220-056	REYNOLDS, BROOK	2.50	B,C
002-220-057	TESKE, MILDRED M LIVING TRUST	2.50	B,C
002-220-058	REYNOLDS BROOK R	35.13	B,C
002-220-064	AVILA, THOMAS C TEST BYPASS TRUST	80.05	B,C
002-220-065	EVANGELHO, RODNEY J & LINDA M TRUST	35.13	B
002-220-067	HOEHN, TERRY & KYRA R H/W	39.00	B,C
002-220-068	DOOLEY-KEPENYES FAMILY TRUST	4.74	B,C
002-220-069	MACIEL 2012 TRUST	2.08	B,C
002-220-074	MURRAY, BRENDA MARTIN	79.34	B,C
002-220-078	DANELL, BARBARA E SURVIVOR'S TRUST	20.53	B,C
002-220-079	DANELL, DANNY & LINDA LIVING TRUST	20.53	B,C
002-220-085	GONSALVES, FRANKIE & DANA H/W	6.52	B
002-220-086	GONSALVES, FRANKIE & DANA H/W	15.63	B
002-220-088	GONSALVES FRANKIE C & DANA L	65.40	B
002-220-090	GRILIONE, CRAIG & MONICA LIVING TRUST	2.34	B
002-220-091	GONSALVES, FRANKIE & DANA H/W	42.01	B
002-220-095	MURRAY, MICHAEL D & BRENDA M H/W	77.80	B,C
002-230-001	HANSE, PETER & JANIS FAM LIV TRUST	27.96	B
002-230-002	HANSE, PETER & JANIS FAM LIV TRUST	112.78	B
002-230-004	HANSE, DON & CECILIA FAM LIV TRUST 50%	5.18	B
002-230-007	KOELEWYN, HERMAN L REVOC TRUST50%	80.00	B
002-230-013	VAN GRONINGEN GARY 33.33% & NEIL 33.33%	77.00	B
002-230-017	KINGS COUNTRY CLUB	53.07	B
002-230-023	COUNTY OF KINGS	23.86	B
002-230-024	DOOLEY, RICHARD & DORIS SURV TRUST 50%	19.50	B
002-230-025	KINGS COUNTRY CLUB	4.00	B
002-230-028	COUNTY OF KINGS	3.56	B
002-230-031	A T & SANTA FE RAILROAD	7.23	B
002-230-036	GONSALVES, FRANKIE & DANA H/W	20.00	B
002-230-037	VAN GRONINGEN CLIF A & STACY M	69.98	B
002-230-038	VAN GRONINGEN, CLIF A & STACY M H/W	10.00	B
002-230-039	NETTO FAMILY LIVING TRUST 90.29%	20.00	B
002-230-040	GARCIA, JOE R FAMILY TRUST	29.79	B
002-230-045	DOOLEY, RICHARD & DORIS SURV TRUST 50%	78.05	B

APN	Record Owner	Acres	Pumping Zone
002-230-048	HANSE FARMS INC	109.38	B
002-230-049	HANSE, DON & CECILIA FAM LIV TRUST 50%	19.00	B
002-230-052	ROGERS, DEBBIE	3.54	B
002-230-053	VAN GRONINGEN, CLIF A & STACY M H/W	73.62	B
002-230-058	CAETANO PROPERTIES LLC	111.42	B
002-230-059	CAETANO PROPERTIES LLC 0	2.38	B
002-240-003	MACIEL, MARY L SURVIVORS TRUST 52.84%	330.00	B,C
002-240-006	WARMERDAM LAND CO LP	54.85	B,C
002-240-008	KASBERGEN DAIRY	120.30	B
002-240-010	HANSE FARMS INC	32.85	B,C
002-240-011	HANSE FARMS INC	40.00	B,C
002-240-012	ORMONDE, FRANK M BYPASS TRUST 66.67%	171.45	B
002-240-015	SILVEIRA, DAVID L & MARY LOU REV LIV TRUST	26.20	B,C
002-240-016	WARMERDAM, EDWARD W SURVIVORS TRUST 50% & WARMERD	59.20	B,C
002-240-017	SILVEIRA, DAVID L & MARY LOU REV LIV TRUST	40.00	B,C
002-240-018	AVILA, SHIRLEY M	40.00	B,C
002-240-019	AVILA, SHIRLEY M	37.50	B,C
002-240-021	MENDONCA MANUEL C & STACI L	2.50	A,B,C
002-240-022	WARMERDAM LAND CO LP	323.91	B,C
002-240-027	FERRAZ, PAM REVOCABLE TRUST	2.07	B,C
002-240-029	AVILA, MARY J REV TRUST	18.00	B,C
002-240-030	AVILA, SHIRLEY M	21.97	B,C
002-240-033	HANSE FARMS INC	11.38	B,C
002-240-034	LEMOORE CANAL & IRRIGATION CO	26.40	B
002-240-035	MACIEL, DAVID A SR & DEBRA L H/W 33.33%	19.00	B,C
002-240-039	WARMERDAM, AUDREY C SURVIVOR'S TRUST	22.46	B,C
002-240-040	WARMERDAM LAND CO LLC	148.99	B,C
002-240-042	NETTO WEST FARMING LLC	63.31	B,C
002-251-007	WARMERDAM, EDWARD W SURVIVORS TRUST 50% & WARMERDA	3.94	B,C
004-280-017	FOCHA, CATHERINE A	58.46	A,B,C
004-280-022	LEHN FARMS INC	320.00	A,B,C
004-280-064	COSTAMAGNA FARMS NO 4	20.00	A,B,C
004-280-065	COSTAMAGNA FARMS NO 4	20.00	A,B,C
004-280-071	COSTAMAGNA FARMS NO 4	17.46	A,B,C
004-280-074	FIGUEROA, RAYMOND A 50%	10.00	A,B,C
004-280-075	MARTIN, DARRELL & ELIZABETH H/W	10.00	A,B,C
004-280-083	MATTOS FAMILY LIVING TRUST	20.59	A,B,C
004-280-084	MELLO, JASON & ONDRIA H/W	20.00	A,B,C
005-010-002	SIMAS, STEVE & JULIE FAMILY TRUST	115.00	A,B,C
005-010-003	SIMAS, STEVE & JULIE FAMILY TRUST	45.00	A,B,C
005-010-004	CONTENTE, JOAQUIN C JR	99.98	A,B,C
005-010-005	CONTENTE, JOAQUIN C JR	22.14	A,B,C
005-010-006	WALKER, RICHARD M & MARY L H/W	2.50	A,B,C
005-010-007	WALKER, RICHARD M & MARY L H/W	31.30	A,B,C
005-010-008	WALKER, RICHARD M & MARY L H/W	6.20	A,B,C
005-020-001	B & L FARMS A PTP	6.00	A,B,C
005-020-002	B & L FARMS A PTP	142.00	A,B,C
005-020-003	B & L FARMS A PTP	27.49	A,B,C

APN	Record Owner	Acres	Pumping Zone
005-020-004	B & L FARMS A PTP	124.31	A,B,C
005-020-005	B & L FARMS A PTP	19.90	A,B,C
005-020-006	BAKKER LIVING TRUST THE	19.41	A,B,C
005-020-007	BAKER, LEONARD H & B A TRUST	6.80	A,B,C
005-020-010	MEDRANO FAMILY TRUST 0	2.85	A,B,C
005-020-011	BUSH MARK NATHANIEL	2.23	A,B,C
005-020-012	EVERHART, JASON	2.23	A,B,C
005-020-013	ESCALANTE, FREDERICK & PETRA H/W	2.23	A,B,C
005-020-015	B & L FARMS A PTP	37.94	A,B,C
005-020-016	NEWBURY, KENNETH E LIVING TRUST	2.09	A,B,C
005-020-018	MIYA, HARRY & NANCY LIVING TRUST 50%	3.05	A,B,C
005-020-019	KAMEHAMIYA GROWERS LLC	29.35	A,B,C
005-020-027	MIYA, HARRY & NANCY LIVING TRUST 50%	71.93	A,B,C
005-020-030	FIKE, DERAL H II & ANDRIA H/W	7.25	A,B,C
005-020-031	WARMERDAM LAND CO LLC	117.82	A,B,C
005-030-002	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	6.13	A,B,C
005-030-003	WARMERDAM ORCHARDS INC	45.65	A,B,C
005-030-005	CROSSWELL, JOHNNA L	8.38	A,B,C
005-030-006	MIRELES, ERIC	19.50	A,B,C
005-030-007	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	37.00	A,B,C
005-030-008	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	34.30	A,B,C
005-030-009	DIVINE, GERALD L TRUST	2.89	A,B,C
005-030-011	KINGS COUNTY WATER DISTRICT	5.85	A,B,C
005-030-012	URRUTIA, DANIEL FAMILY TRUST 50%	4.17	A,B,C
005-030-013	MENDES JOE A & MONICA E 50%	50.15	A,B,C
005-030-014	PIONEER UNION ELEMENTARY SCHOOL DISTRICT	13.81	A,B,C
005-030-015	PIONEER SCHOOL	2.27	A,B,C
005-030-020	VANDER MOREN, WILLIAM & GRACE A TRUST	6.06	A,B,C
005-030-021	VANDER MOREN, WILLIAM & GRACE REVOC LV TR	50.99	A,B,C
005-030-026	URRUTIA, NICHOLAS D & ANNE L H/W	3.05	A,B,C
005-030-027	D A BUSH FAMILY LLC	10.00	A,B,C
005-030-028	D A BUSH FAMILY LLC	3.29	A,B,C
005-030-029	PACHECO FAMILY TRUST	6.10	A,B,C
005-030-030	D A BUSH FAMILY LLC	29.70	A,B,C
005-030-031	BARRIENTOS, EDUARDO JR 50%	4.00	A,B,C
005-030-032	BROWN'S DAIRY A PTP	47.00	A,B,C
005-030-035	ONE OAK RANCH LLC	78.18	A,B,C
005-030-038	SOARES, MANUEL L & ADELIA M FAMILY TRUST	78.08	A,B,C
005-040-006	PIONEER UNION SCHOOL DISTRICT OF	6.68	A,B,C
005-050-002	SPEER, MICHELLE & JOSHUA W/H	2.00	A,B,C
005-050-030	FIGUEROA, RAYMOND A JR	2.00	A,B,C
005-060-001	BROWN'S DAIRY A PTP	2.65	A,B,C
005-060-002	BROWN'S DAIRY A PTP	72.64	A,B,C
005-060-004	BROWN'S DAIRY A PTP	3.05	A,B,C
005-060-005	BROWN PROPERTIES CA GN PTP	76.05	A,B,C
005-060-007	ZIMMERMAN, MARK A	14.11	A,B,C
005-060-008	LAST CHANCE WATER DITCH CO	2.87	A,B,C
005-060-009	GILLUM, SHANNON C	6.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
005-060-011	FARIA, NICHOLAS G & LORENA R H/W	10.44	A,B,C
005-060-013	RITCHIE REVOCABLE FAMILY TRUST THE	4.77	A,B,C
005-060-014	RITCHIE REVOCABLE FAMILY TRUST THE	4.77	A,B,C
005-060-015	RITCHIE REVOCABLE FAMILY TRUST THE	4.77	A,B,C
005-060-016	RITCHIE REVOCABLE FAMILY TRUST THE	2.02	A,B,C
005-060-019	AGRAZ, AGUSTIN & ROCIO FAMILY TRUST	19.36	A,B,C
005-060-021	RAVEN, WILLIAM M & MARLENE A H/W	16.73	A,B,C
005-060-022	BROWN'S DAIRY A PTP	59.44	A,B,C
005-060-023	BROWN DAIRY A PTP	6.06	A,B,C
005-060-024	AMICABLE 1031 LLC	42.06	A,B,C
005-060-026	BROWN'S DAIRY A PTP	19.40	A,B,C
005-060-027	WARMERDAM, NICHOLAS J & JUDITH A H/W CP	15.00	A,B,C
005-060-028	WANG, LIPING	4.28	A,B,C
005-060-029	THORBUS, RUBEN S REVOCABLE TRUST 50%	10.00	A,B,C
005-060-030	THORBUS, RUBEN S REVOCABLE TRUST 50%	10.00	A,B,C
005-060-033	OLAM WEST COAST INC	35.09	A,B,C
005-060-034	AMICABLE 1031 LLC	18.43	A,B,C
005-060-035	AMICABLE 1031 LLC	20.00	A,B,C
005-060-036	ALVAREZ, JAIME A 50%	3.00	A,B,C
005-060-037	COLEMAN, LUCILLE A	2.00	A,B,C
005-060-040	VANDER MOREN, WILLIAM & GRACE REVOC LV TR	10.00	A,B,C
005-060-041	VANDER MOREN, WILLIAM & GRACE REVOC LV TR	30.04	A,B,C
005-060-042	MELLO, GARY J SEPARATE PROPERTY TRUST	17.50	A,B,C
005-060-043	MELLO, GARY J & JUDY A REVOC TRUST	2.50	A,B,C
005-060-044	AMICABLE 1031 LLC	20.00	A,B,C
005-060-046	NOOR LAND COMPANY LLC 50%	27.04	A,B,C
005-060-048	MELLO, JAMES B & LINDA A TRUST	2.50	A,B,C
005-060-049	MELLO, JAMES & LINDA A TRUST	24.62	A,B,C
005-070-001	DUARTE, AGOSTINHO M	20.00	A,B,C
005-070-002	MOSLEMPOOR, ADREES M	20.00	A,B,C
005-070-003	ELLIS, MELVIN & PATRICIA LIVING TRUST	2.50	A,B,C
005-070-004	MELLO, JOHN D & MARY L H/W	2.50	A,B,C
005-070-005	MELLO, J D DAIRY A PTP	35.00	A,B,C
005-070-006	MELLO, J D DAIRY A PTP	40.00	A,B,C
005-070-007	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	9.76	A,B,C
005-070-008	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	29.44	A,B,C
005-070-009	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	80.00	A,B,C
005-070-010	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	14.80	A,B,C
005-070-011	VANDER MOREN, WILLIAM & GRACE A LIV TRST	8.85	A,B,C
005-070-014	CLAYCAMP, STACEY NEVES FAMILY TRUST 15.183%	36.40	A,B,C
005-070-015	NOOR LAND COMPANY LLC 50%	40.00	A,B,C
005-070-016	AVILA, PAUL C & ANGIE H/W	40.00	A,B,C
005-070-017	AVILA, JAMES G & ISABEL A LIVING TRUST	40.81	A,B,C
005-070-019	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	49.95	A,B,C
005-070-020	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	20.00	A,B,C
005-070-021	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	5.84	A,B,C
005-070-023	MELLO, J D DAIRY A PTP	50.83	A,B,C
005-070-025	MOSLEMPOOR, ADREES M	10.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
005-070-026	VANDER MOREN, WILLIAM & GRACE A LIV TRST	16.32	A,B,C
005-070-030	MELLO, JASON D & ONDRIA D H/W	10.05	A,B,C
005-070-031	MELLO, J D DAIRY A PTP	50.31	A,B,C
005-080-005	LU/AR DAIRY	97.50	A,B,C
005-080-006	SOARES, MANUEL L & ADELIA M REV FAM TRST	17.81	A,B,C
005-080-007	THE DOUBLE D FAMILY TRUST 100%	78.16	A,B,C
005-080-008	BROWN'S DAIRY A PTP	92.51	A,B,C
005-080-009	CARPENTER, KATHLEEN M REVOC TRUST	2.00	A,B,C
005-080-010	MELLO, J D DAIRY A PTP	80.37	A,B,C
005-080-011	BETTENCOURT, DARRELL & MICKI REVOC TR 25%	192.00	A,B,C
006-010-004	LOOGMAN, JIM A 50%	20.50	A,B,C
006-010-005	LARSON, DEBBIE M 33.33%	41.00	A,B,C
006-010-008	GREEN HARVEST PROPERTIES LLC 50% & WARMERDAM, EDWA	60.71	A,B,C
006-010-010	TOS, JEFF & SHERI LIVING TRUST	39.97	B,C
006-010-015	WHITE, BORGHILD P 2007 TRUST	25.47	A,B,C
006-010-018	AVILA, LEROY A & BARBARA K REV TRUST	9.40	B,C
006-010-019	AVILA, LEROY A & BARBARA K REV TRUST	44.75	B,C
006-010-023	AVILA, THOMAS C TEST BYPASS TRUST	15.06	B,C
006-010-025	HANSE FARMS INC	39.48	B,C
006-010-027	SIMAS, GREGORY ALLEN TRUST	33.11	B,C
006-010-028	SIMAS, STEVE & JULIE FAMILY TRUST	50.00	A,B,C
006-010-029	SIMAS FAMILY LP	42.00	B,C
006-010-034	FROBERG FAMILY INVESTMENTS LLC 48%	40.21	A,B,C
006-010-038	LARSON, DEBBIE M 33.33%	39.52	A,B,C
006-010-041	KARAYAN FAMILY TRUST	39.24	B,C
006-010-043	AVILA, LAVINA O REV LIV TRUST	2.50	A,B,C
006-010-044	ROSE FAMILY REVOC TRUST (BY-PASS TRUST)	33.16	A,B,C
006-010-046	KARAYAN FAMILY TRUST	38.41	B,C
006-010-048	TOS, JOHN W & VICTORIA F LIVING TRUST	48.16	B,C
006-010-051	TOS GRANDCHILDREN 2017 IRREVOC TRUST	58.12	A,B,C
006-010-052	WARMERDAM, CORNELIUS & YOLANDA H/W JT	2.50	B,C
006-010-053	WARMERDAM CORNELIUS J	15.56	B,C
006-010-056	KARAYAN FAMILY TRUST	3.00	B,C
006-010-061	HANSE FARMS INC	15.88	B,C
006-010-062	OPPEGARD, JANICE M & KEITH H W/H 50%	65.11	B,C
006-010-064	PIRES, MARCO & TERESA H/W	2.26	B,C
006-010-067	HANSE FARMS INC	12.90	B,C
006-010-071	DUYST FAMILY GRANTOR TRUST	5.21	B,C
006-010-072	HANSE FARMS INC	79.90	B,C
006-010-073	WHITE, BORGHILD P 2007 TRUST	56.39	A,B,C
006-010-075	SUNNY ACRE FARMING INC	64.16	B,C
006-010-076	DUYST FAMILY GRANTOR TRUST	60.07	B,C
006-010-078	FROBERG FAMILY INVESTMENTS LLC 48%	60.80	A,B,C
006-010-080	LOEWEN, FRANCES 2002 TRUST	92.11	B,C
006-020-003	DOUBLE N FARMS A PTP	34.80	B,C
006-020-004	DOUBLE N FARMS A PTP	28.00	B,C
006-020-005	DOUBLE N FARMS A PTP	14.49	B,C
006-020-006	DOUBLE N FARMS A PTP	6.40	B,C

APN	Record Owner	Acres	Pumping Zone
006-020-007	DOUBLE N FARMS A PTP	15.00	B,C
006-020-008	DOUBLE N FARMS A PTP	5.00	B,C
006-020-009	DOUBLE N FARMS PTP	20.00	B,C
006-020-010	DOUBLE N FARMS A PTP	5.20	B,C
006-020-011	DOUBLE N FARMS A PTP	39.33	B,C
006-020-012	NETTO FAMILY LIVING TRUST	38.00	B,C
006-020-015	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	13.60	B,C
006-020-017	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	26.40	B,C
006-020-018	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	16.40	B,C
006-020-020	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	5.00	B,C
006-020-022	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	23.60	B,C
006-020-023	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	39.00	B,C
006-020-030	ZONNEVELD DAIRIES INC	82.14	B,C
006-020-034	ZONNEVELD DAIRIES INC	39.55	B,C
006-020-035	DOUBLE N FARMS A PTP	30.00	B,C
006-020-036	NETTO WEST FARMING LLC	60.00	B,C
006-020-038	DOUBLE N FARMS A PTP	76.92	B,C
006-020-057	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	32.85	B,C
006-020-062	CHHANN, STEVEN & NARIN H/W	39.30	B,C
006-020-068	NETTO, JAMES H FAM ENDOWMENT TRUST	10.14	B,C
006-020-071	HOWELL, JAMES & CINNAMON H/W	2.35	B,C
006-020-072	JOHNSON, KATHLEEN ANN TRUST	38.03	B,C
006-020-073	KENNEDY, RODNEY W & RONDA K H/W	2.51	B,C
006-020-074	ENLOE, GREGORY T	2.51	B,C
006-020-075	SIEGEL, CATHERINE R LIVING TRUST 50%	2.50	B,C
006-020-076	PARSONS FAMILY TRUST	2.50	B,C
006-020-077	PARSONS, GLEN A & SU-JREN H/W	2.50	B,C
006-020-078	DOUBLE N FARMS	32.53	B,C
006-020-079	FUKUDA, AARON K & DINA YASUKO H/W	11.20	B,C
006-020-081	KINGS COUNTY WATER DISTRICT	8.40	B,C
006-020-082	LAST CHANCE WATER DITCH CO	2.88	B,C
006-020-086	ZONNEVELD DAIRIES INC	61.15	B,C
006-020-087	SOARES, MANUEL L & ADELIA M REV FAM TRUST	2.18	B,C
006-020-090	DOUBLE N FARMS	41.36	B,C
006-020-093	DOUBLE N FARMS A PTP	18.32	B,C
006-020-094	DOUBLE N FARMS	8.20	B,C
006-020-095	DIAS, KEVIN P & KAREN H/W	3.58	B,C
006-020-096	SOARES, MANUEL L & ADELIA M REV LIV TST	5.10	B,C
006-020-097	SOARES, MANUEL L & ADELIA M FAMILY TRUST	10.04	B,C
006-020-100	ZONNEVELD DAIRIES INC	19.37	B,C
006-020-101	DOUBLE N FARMS A PTP	65.49	B,C
006-020-104	ENLOE GREGORY & ILEKTRA MARIA PSOUNI	2.50	B,C
006-020-105	BERTAO, JOEY A	2.50	B,C
006-020-106	BOOKOUT, LLOYD & MARIE LIVING TRUST	20.28	B,C
006-020-107	DOUBLE N FARMS A PTP	20.49	B,C
006-020-108	LA SALLE, MICHAEL E	21.60	B,C
006-020-109	LA SALLE, MICHAEL E	21.76	B,C
006-020-110	ZONNEVELD DAIRIES INC	137.59	B,C

APN	Record Owner	Acres	Pumping Zone
006-020-111	ZONNEVELD DAIRIES INC	20.00	B,C
006-031-002	VAN BEEK, NORMAN D	63.19	B,C
006-031-003	A T & SANTA FE RAILROAD	9.85	B,C
006-031-004	MATSUBARA FAM TR OF 1991	37.42	B,C
006-031-005	LITTLE LAND COMPANY GP 50%	36.00	B,C
006-031-010	FAGUNDES, MANUEL G & NATALIE S WARD H/W	2.00	B,C
006-031-011	47 PALMS RANCH LLC	73.59	B,C
006-031-019	KINGS RIVER ORCHARD SERVICE INC	2.43	B,C
006-031-020	MCCUTCHEON, B H & B L FAM TRST	16.25	B,C
006-031-021	FEAVER, CHARLES R & SUSAN REVOC TRUST	12.00	B,C
006-031-025	LAWRENCE, WILLIAM & ANGIE H/W LF ESTATE	2.50	B,C
006-031-026	BERGREN, DAVID W & DIANE R REV LIV TRUST	2.50	B,C
006-031-027	ZONNEVELD, FRANK T & JANA C REV FAM TRU	16.62	B,C
006-031-033	MCCUTCHEON, BARRY & BRENDA RV FM TR 50%	27.42	B,C
006-031-034	PENNY NEWMAN FARMS PRODUCTS, LLC	5.39	B,C
006-031-035	PENNY NEWMAN FARMS PRODUCTS, LLC	4.83	B,C
006-031-038	OLIVAS AND COMPANY LLC	3.95	B,C
006-031-039	GRILIONE BLAKE & TIFFANY	14.09	B,C
006-031-040	FEAVER, CHARLES R & SUSAN REV FAM TRUST	77.71	B,C
006-031-041	FEAVER, CHARLES R & SUSAN REV FAM TRUST	2.29	B,C
006-031-043	ZONNEVELD, FRANK T & JANA C REV FAM TRU	16.06	B,C
006-031-044	A T & SANTA FE RAILROAD (BNSF)	6.99	B,C
006-031-049	DIAS, MICHAEL A & GERMAINE FIRST AMEND REV LIV TR	36.49	B,C
006-031-051	KELLER, JON & VALERIE REVOC TRUST	4.47	B,C
006-031-053	SEQUOIA VALLEY ORCHARDS LLC	77.49	B,C
006-031-055	WARMERDAM, JOHN & TARA LIVING TRUST	20.00	B,C
006-031-058	KINGS RIVER ORCHARD SERVICE INC	4.13	B,C
006-031-059	TRULOCK, JASON	2.71	B,C
006-031-061	SEQUOIA VALLEY ORCHARDS LLC	37.20	B,C
006-031-062	WARMERDAM, JOHN & TARA LIVING TRUST	20.00	B,C
006-032-001	LOWE, JACQUELINE S 2006 TRUST	22.36	B,C
006-032-002	LITTLE LAND CO 50%	22.00	B,C
006-032-003	LITTLE, JARED R & AMANDA M H/W	15.00	B,C
006-032-005	WARMERDAM, TED A & JOANNE M TRUST	32.00	B,C
006-032-007	MITCHELL, VIRGINIA	2.50	B,C
006-032-008	HERNANDEZ, SALVADOR	2.50	B,C
006-032-009	NIKOGHOSIAN, HAROLD & JANICE LIV TRUST	2.50	B,C
006-032-010	ABRAHAMSON, GLENN A & SUZANNE E H/W	2.50	B,C
006-032-012	WARMERDAM, JOHN & MINDY LIVING TRUST	7.94	B,C
006-032-014	WARMERDAM, JOHN & MINDY LIVING TRUST	8.03	B,C
006-032-015	LOHSE, PATRICK N AND LINDA A REV FAM TRUST	10.00	B,C
006-032-016	MARTINS, JOHN A	32.85	B,C
006-032-017	MARTINS, JOHN L & SON A PTP	12.61	B,C
006-032-018	MARTINS, JOHN A	33.33	B,C
006-032-019	MARTINS, JOHN L & SON A PTP	18.79	B,C
006-032-022	R & A JACKSON LAND LP	29.65	B,C
006-032-023	CABRERA, MARIA G & HUMBERTO W/H	4.76	B,C
006-032-025	COSTAMAGNA FARMS NO 3	30.00	B,C

APN	Record Owner	Acres	Pumping Zone
006-032-026	R & A JACKSON LAND LP	41.13	B,C
006-032-029	DUPREE, HOLLY L REVOC TRUST	2.50	B,C
006-032-030	YOUNG FIOERLLA & ROMERO FERNANDO	2.50	B,C
006-032-031	YOUNG FIOERLLA & ROMERO FERNANDO	2.50	B,C
006-032-038	FISER FAMILY REVOCABLE TRUST	32.54	B,C
006-032-039	TOLBERT ANDREW E & NICOLE T	3.19	B,C
006-032-042	LOHSE, PATRICK N AND LINDA A REV FAM TRUST	19.00	B,C
006-032-047	LITTLE, JARED R & AMANDA M H/W	14.00	B,C
006-032-049	LITTLE, JARED R & AMANDA M H/W	10.61	B,C
006-032-050	MARTINS, JOHN & AMY H/W	36.63	B,C
006-032-056	MARTINS, JOHN & AMY H/W	29.15	B,C
006-032-057	WILLIAMS, BENJAMIN E & MAVIS H/W	2.48	B,C
006-032-058	JACKSON, RYAN M & AMY M H/W	9.32	B,C
006-032-059	R & A JACKSON LAND LP	134.88	B,C
006-040-004	WARMERDAM, JEROME & DINA REVOC LIV TRUST	40.00	B,C
006-040-007	COSTAMAGNA FARMS NO 4	27.00	B,C
006-040-012	MCCUTCHEON, B H & B L FAM TRST	31.56	B,C
006-040-014	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	33.36	B,C
006-040-015	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	94.93	B,C
006-040-020	MIRELES, MANUEL & ROSA H/W	30.00	B,C
006-040-022	MENDEZ, ROBERT A & YOLANDA L H/W	2.00	B,C
006-040-023	MIRELES, MANUEL & ROSA H/W	40.00	B,C
006-040-049	REED, MARK C & CONNIE L H/W 50%	2.79	B,C
006-040-051	GONZALES, RICHARD K & JENNIFER L H/W	2.50	B,C
006-040-057	VAN DER GRAAF, ALBERT & RIEKIE LIV TRUST	41.83	B,C
006-040-058	PARRA, RUDY JR & LISA H/W	5.17	B,C
006-040-059	GRISWOLD, GERALD T	30.00	B,C
006-040-064	BOGAN FAMILY REVOC LIVING TRUST	5.00	B,C
006-040-068	REESE SURVIVORS TRUST	10.04	B,C
006-040-069	REESE SURVIVORS TRUST	10.04	B,C
006-040-070	SIKORA, KRYSTY	3.59	B,C
006-040-071	GALE, JAMES L LIVING TRUST	3.60	B,C
006-040-072	CAMPBELL, RONALD M & MEGAN C	2.50	B,C
006-040-075	THOMAS, JAMES CARTER	18.53	B,C
006-040-077	MCCUTCHEON, B H & B L FAM TRST	20.10	B,C
006-040-085	SMITH, KENNETH A & DARLENE M H/W	6.30	B,C
006-040-086	MIYA, HARRY & NANCY LIVING TRUST 50%	16.59	B,C
006-040-088	COUTURE, STEPHEN E & CHRISTINA H H/W	2.22	B,C
006-040-089	RAMIREZ, RAUL V & MARIA I LOPEZ H/W	2.52	B,C
006-040-094	KINGS COUNTY WATER DISTRICT	5.35	B,C
006-040-095	OWENS CLEO & BETTY	10.06	B,C
006-040-098	DOUBLE N FARMS A PTP	9.94	B,C
006-040-102	WARMERDAM LAND CO LP	298.01	B,C
006-040-104	HANFORD CHRISTIAN SCHOOL SOCIETY	9.10	B,C
006-040-105	HANSEN, JAKE V LIVING TRUST	10.01	B,C
006-040-107	ROMAN CATHOLIC BISHOP OF FRESNO	10.17	B,C
006-040-108	ROMAN CATHOLIC BISHOP OF FRESNO	2.02	B,C
006-040-112	ROMAN CATHOLIC BISHOP OF FRESNO	4.08	B,C

APN	Record Owner	Acres	Pumping Zone
006-040-114	KOVAC TRUST AGREEMENT 8/27/09 100%	28.73	B,C
006-040-115	KOVAC TRUST AGREEMENT 8/27/09 100%	7.25	B,C
006-040-117	KOVAC TRUST AGREEMENT 8/27/09 100%	10.00	B,C
006-040-123	EBC FARMS LLC	144.35	B,C
006-040-124	RAMOS NOE & LEAH	3.33	B,C
006-040-125	DOUBLE N FARMS	10.00	B,C
006-040-126	ROSE FAMILY TRUST	124.21	B,C
006-040-133	ESAJIAN FAMILY TRUST	10.00	B,C
006-040-134	ESAJIAN FAMILY TRUST	10.00	B,C
006-040-135	ESAJIAN FAMILY TRUST	13.67	B,C
006-040-136	COTHRAN, STEVEN P 50%	2.88	B,C
006-040-137	SEMAS, MICHAEL & CHRISTINE REVOC FAM TST	12.33	B,C
006-040-138	HUNTER, ROBERT K & DEBORAH A H/W	7.81	B,C
006-040-139	HUNTER, ROBERT K & DEBORAH A H/W	2.25	B,C
006-050-001	BETTENCOURT, STEVE 50%	4.85	B,C
006-050-004	NETTO FAMILY LIVING TRUST	160.00	B,C
006-050-005	DON VERNE FARMS LLC 50%	157.95	A,B,C
006-050-007	KINGS ORCHARDS INC	127.86	B,C
006-050-009	DILLON, YOUNG C	7.78	B,C
006-050-010	VERBOON, WILLIAM D JR	157.45	B,C
006-050-012	DUTRA FAMILY REVOC LIV TRUST OF 2008	160.65	B,C
006-050-013	SIMAS FAMILY LP	57.02	B,C
006-050-016	KINGS ORCHARDS INC	16.97	B,C
006-050-017	WARMERDAM, JOHN & CHRISTIANA LIV TRUST	3.92	B,C
006-050-018	SIMAS, STEVE & JULIE FAMILY TRUST	2.96	B,C
006-050-019	SIMAS FAMILY LP	97.35	B,C
006-050-020	BETTENCOURT, STEVE .038%	160.50	B,C
006-050-022	NEVES, TODD R 33.334%	108.49	B,C
006-050-023	LU/AR DAIRY A PTP	43.86	B,C
006-060-002	ROSE FAMILY REVOCABLE TRUST	80.24	A,B,C
006-060-003	DUTRA, GARY B 33.33%	7.00	A,B,C
006-060-004	BETTENCOURT LARRY & CARMEN H/W	10.00	A,B,C
006-060-005	MATTOS FAMILY LIVING TRUST	25.00	A,B,C
006-060-012	SIMAS FAMILY LP	116.97	A,B,C
006-060-013	SIMAS, KENNETH ANTHONY	71.93	B,C
006-060-015	MUSSEL SLOUGH RANCH LLC 50%	38.58	A,B,C
006-060-016	MUSSEL SLOUGH RANCH LLC 50%	40.40	A,B,C
006-060-017	BAKKER LIVING TRUST THE	72.00	A,B,C
006-060-019	BAKKER LIVING TRUST THE	4.00	A,B,C
006-060-020	SIMAS LIVING REVOCABALE TRUST THE	32.50	A,B,C
006-060-021	BAKKER LIVING TRUST	4.40	A,B,C
006-060-022	SIMAS LIVING REVOCABLE TRUST THE	6.00	A,B,C
006-060-023	BAKKER LIVING TRUST	34.10	A,B,C
006-060-024	SIMAS FAMILY LP	4.00	A,B,C
006-060-027	MATTOS FAMILY LIVING TRUST THE	20.00	A,B,C
006-060-028	ROSE FAMILY REVOCABLE TRUST	20.00	A,B,C
006-060-029	SIMAS FAMILY LP	20.00	A,B,C
006-060-032	BETTENCOURT, KEITH & BARBARA FAM TRUST	40.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
006-060-033	BETTENCOURT, KEITH & BARBARA FAM TRUST	30.00	A,B,C
006-060-034	CUNHA, ELISEU & THERESA LIVING TRUST	2.50	A,B,C
006-060-038	DUTRA, MANUEL M JR & DEBORA M H/W	43.07	A,B,C
006-060-039	CANTRELL, BRYNN & NICHOLAS W/H	2.93	A,B,C
006-060-040	LOSEY, LINDA M REVOCABLE TRUST	2.25	B,C
006-060-043	SIMAS FAMILY LP	36.00	A,B,C
006-060-046	ROSE FAMILY REVOC TRUST (SURVIVOR'S TR)	2.50	A,B,C
006-060-047	ROSE FAMILY REVOCABLE TRUST	45.57	A,B,C
006-060-049	ROSE FAMILY REVOCABLE TRUST	19.13	A,B,C
006-060-050	BAKKER LIVING TRUST THE	67.00	A,B,C
006-060-051	BAKKER LIVING TRUST THE 0	9.00	A,B,C
006-060-052	SOUTHERN PACIFIC TRANSPORTATION CO	3.62	A,B,C
006-060-054	GREEN HARVEST PROPERTIES LLC 50% & WARMERDAM, EDWA	17.31	A,B,C
006-060-055	BETTENCOURT, KEITH & BARBARA FAM TRUST	23.08	A,B,C
006-060-057	BETTENCOURT, LARRY & CARMEN H/W	19.30	A,B,C
006-060-058	BAKKER LIVING TRUST	6.22	A,B,C
006-060-059	BETTENCOURT, KEITH & BARBARA FAM TRUST	49.43	A,B,C
006-060-060	GREEN HARVEST PROPERTIES LLC 50% & WARMERDAM, EDWA	31.32	A,B,C
006-060-062	BETTENCOURT, LARRY & CARMEN H/W	31.91	A,B,C
006-060-063	BETTENCOURT, LARRY & CARMEN H/W	23.47	A,B,C
006-060-064	BETTENCOURT, LARRY & CARMEN H/W	50.48	A,B,C
006-060-065	BETTENCOURT, LARRY & CARMEN H/W	22.78	A,B,C
007-010-006	DAVIS FAMILY TRUST	2.60	B,C
007-010-008	ROBISON, ROBERT L LIVING TRUST	2.17	B,C
007-010-013	HUNT, NATHAN & NANCY H/W	3.16	B,C
007-010-014	SUMAYA, DAVID D & BARBARA E H/W	2.86	B,C
007-010-031	SINGH, PAUL FAMILY LP	151.96	B,C
007-020-004	DOMINGOS, CARL & DENISE H/W	2.50	B,C
007-020-005	EDWARDS KYLE E & KONEECHIA C	2.50	B,C
007-020-006	GORRELL, LYMAN Q JR & P M REVOC LVNG TR	2.50	B,C
007-020-007	DROOGH FAMILY REVOCABLE TRUST	2.50	B,C
007-020-008	MC GINN, SEAN M & TAMARA M RAVALIN H/W	2.50	B,C
007-020-009	FREITAS, JOSEPH & SHIREEN LIVING TRUST	2.50	B,C
007-020-019	SMITH, LEE E FAM LIV TRUST	2.17	B,C
007-020-021	DUDLEY, ROGER K & JANA C H/W	2.17	B,C
007-030-001	HEADRICK JEB	3.44	B,C
007-030-002	HEADRICK JEB	46.56	B,C
007-030-008	HEADRICK JEB S	10.00	B,C
007-030-018	BECK, STEVEN W & ALICE M H/W	5.00	B,C
007-170-006	ANDERSON, KARL R & CATHLENE M H/W	2.50	B,C
007-180-001	TESSMAN, GORDON K & JEAN A REV FAM TRUST	2.50	B,C
007-180-002	FLORES, GEORGE & MARIA O H/W	2.50	B,C
007-180-003	HASTINGS JO ANNE	2.50	B,C
007-180-004	THORBUS, WENDY C	2.50	B,C
007-180-005	JONES, PHILLIP L & CHERYL A H/W	2.50	B,C
007-180-006	GRILIONE, JUSTIN & HAILEY	2.50	B,C
007-180-007	MORGAN, MICHAEL G & SALLY B H/W	2.50	B,C
007-360-018	SINGH, PAUL FAMILY LP	149.73	B,C

APN	Record Owner	Acres	Pumping Zone
008-360-028	MIYA, MARK K REVOCABLE TRUST 2008 42.50%	19.17	B,C
009-010-002	MIYA, MELINDA K REV TRUST 33.333%	80.00	A,B,C
009-010-005	HOOK, RICHARD J & CHARLENE M H/W	4.00	A,B,C
009-010-019	COSTAMAGNA, ERNEST B	11.01	A,B,C
009-010-020	COSTAMAGNA, ERNEST B	10.00	A,B,C
009-010-021	COSTAMAGNA, ERNEST B	41.09	A,B,C
009-010-022	COSTAMAGNA, ERNEST B	41.77	A,B,C
009-010-026	COSTAMAGNA, ERNEST B	70.88	A,B,C
009-010-027	COSTAMAGNA, ERNEST B	10.00	A,B,C
009-010-028	BAKER, LEONARD H & B A TRUST	151.49	A,B,C
009-010-031	BAKER FAMILY TRUST 2019	77.88	A,B,C
009-010-032	BVC LLC 50%	77.26	A,B,C
009-010-033	CLEMENT, VIVIAN P LF EST	2.03	A,B,C
009-010-036	COSTAMAGNA, ERNEST B	10.00	A,B,C
009-010-037	EBC FARM LLC	19.10	A,B,C
009-010-038	EBC FARMS LLC	19.10	A,B,C
009-020-002	SOARES, RONALD E & LISA H/W	10.03	B,C
009-020-003	MIYA, HARRY & NANCY LIVING TRUST	10.03	B,C
009-020-004	MIYA, MARK K REV TRUST 16.667%	10.03	B,C
009-020-005	DURHAM, MICHAEL & TERRI LIVING TRUST	2.61	B,C
009-020-007	DURHAM, MICHAEL & TERRI LIVING TRUST	17.49	B,C
009-020-009	VERBOON, WILLIAM D JR	17.65	B,C
009-020-010	SILVA, JOSEPH & AMANDA H/W	3.94	B,C
009-020-011	VERBOON WILLIAM D JR	9.76	B,C
009-020-012	TEWS, CYNTHIA S. & AVILA, SAM J.	2.50	B,C
009-020-013	BOBADILLA, FIDEL JR & DAISY H/W	2.50	B,C
009-020-014	JONES, ERIC & MELANIE H/W 0	2.50	B,C
009-020-018	DURHAM, MICHAEL & TERRI LIVING TRUST	28.85	B,C
009-020-019	DURHAM, MICHAEL & TERRI LIVING TRUST	40.24	B,C
009-020-020	KINGS COUNTY WATER DISTRICT	12.34	B,C
009-020-021	CLAYCAMP, STACEY NEVES FAMILY TRUST 16.67%	6.29	B,C
009-020-023	CLAYCAMP, STACEY NEVES FAMILY TRUST 16.67%	70.91	B,C
009-020-024	MONTOYA, MARVIN G TRUST 50%	2.50	B,C
009-020-025	MONTOYA, MARVIN G TRUST 50%	2.50	B,C
009-020-026	ELDER DAVID F & MARY ANN	2.50	B,C
009-020-029	VERHOEVEN, PETER G & LUJEAN G H/W	38.00	A,B,C
009-020-030	JUNELL, TOBY R & SHARON E H/W JT	4.40	A,B,C
009-020-032	MONTGOMERY FAMILY LIVING TRUST	5.00	A,B,C
009-020-033	VAN GRONIGEN, SHAWN & KRISTINA H/W	2.26	A,B,C
009-020-034	BLOCH, CATHERINE R	2.32	A,B,C
009-020-037	DE RUITER, LEONARD E FAMILY TRUST 50%	34.00	A,B,C
009-020-040	KINGS COUNTY WATER DISTRICT	8.45	B,C
009-020-041	MIYA FAMILY REV TRUST 16.667%	35.73	B,C
009-020-046	OLIVEIRA, JOHN W & TERESA H/W 50%	10.12	A,B,C
009-020-047	CLAYCAMP, STACEY NEVES FAMILY TRUST 16.66%	51.25	B,C
009-020-052	KAMEHAMIYA GROWERS LLC	119.07	A,B,C
009-020-053	MIYA, HARRY & NANCY LIVING TRUST	2.94	A,B,C
009-020-054	COSTAMAGNA, ERNEST B	8.76	B,C

APN	Record Owner	Acres	Pumping Zone
009-020-058	PAROLINI, LEO B & VERONICA J REV TRUST	23.29	B,C
009-020-060	CODY, RICHARD & JOYCE LIVING TRUST	11.06	A,B,C
009-020-061	CODY, RICHARD & JOYCE LIVING TRUST	10.84	A,B,C
009-030-001	MIYA, HARRY & NANCY LIVING TRUST 50%	29.88	A,B,C
009-030-002	MIYA, MELYNDA K 2008 REVOCABLE TRUST	10.12	A,B,C
009-050-001	R-HEARTHSTONE LOT OPTION POOL 02 LP	8.23	A,B,C
009-050-005	R-HEARTHSTONE LOT OPTION POOL 02 LP	13.24	A,B,C
009-050-012	VERDEGAAL, VIVIAN E SURVIVOR'S TRUST 50%	10.10	A,B,C
009-050-029	CITY OF HANFORD 33.33%	10.00	A,B,C
009-050-030	BUSK, HELEN M SURVIVOR'S TRUST	8.11	A,B,C
009-050-036	WOOD, JAMES A	4.90	A,B,C
009-050-039	CITY OF HANFORD 33.33%	10.14	A,B,C
009-050-040	CITY OF HANFORD 33.334%	9.09	A,B,C
009-050-044	CITY OF HANFORD 33.333%	5.00	A,B,C
009-050-045	CITY OF HANFORD 33.33%	2.50	A,B,C
009-050-046	CITY OF HANFORD 33.334%	92.94	A,B,C
009-050-049	ENLOE, THOMAS S JR & KATHRYN L REV TRST	2.50	A,B,C
009-050-101	HANFORD ELEMENTARY SCHOOL DISTRICT	24.10	A,B,C
009-050-102	BURRIS FOUNDATION	49.46	A,B,C
009-050-104	ENLOE, THOMAS S JR & KATHRYN L TRUST	4.74	A,B,C
009-050-112	LIBBY, RICHARD D REVOCABLE TRUST	3.31	A,B,C
009-050-113	R-HEARTHSTONE LOT OPTION POOL 02 LP	15.00	A,B,C
009-070-006	GARCIA, PEDRO ANGEL URIBE GARCIA 50% & GUTIERREZ,	2.54	A,B,C
009-070-007	WALTERS LIVING TRUST THE	7.50	A,B,C
009-070-008	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	29.70	A,B,C
009-070-009	KIINO, STANLEY 16.667%	59.95	A,B,C
009-070-012	DE RUITER, LEONARD E FAMILY TRUST 50%	18.06	A,B,C
009-070-013	STEVENSON, MICHAEL O TRUST	20.00	A,B,C
009-070-014	MARTINS, JOHN L & SON A PTP	13.33	A,B,C
009-070-019	MARTINS, JOHN L & SON A PTP	68.65	A,B,C
009-070-020	WARMERDAM, NICHOLAS J & JUDITH A H/W	19.97	A,B,C
009-070-021	LLOYD, MICHAEL K & DOR E H/W	19.18	A,B,C
009-070-022	HAGEN, EARL O TESTAMENTARY FAMILY TRUST	9.70	A,B,C
009-070-023	SOUZA, ROBERT W & ALEX N H/W	2.50	A,B,C
009-070-025	SCHNELL, JENNIFER L LIVING TRUST	2.20	A,B,C
009-070-026	VALLEY AG HARVESTING LLC	9.16	A,B,C
009-070-027	LAST CHANCE WATER DITCH CO	2.32	A,B,C
009-070-028	WILLIAMS, MILTON D & SUSAN I REV LIVING TRUST	3.39	A,B,C
009-070-029	VALLEY AG HARVESTING LLC	7.26	A,B,C
009-070-030	VALLEY AG HARVESTING LLC	11.18	A,B,C
009-070-031	WARMERDAM, NICHOLAS J & JUDITH A H/W	38.50	A,B,C
009-070-032	VALLEY AG HARVESTING LLC	9.50	A,B,C
009-070-036	AVALOS, JOSE JR	11.59	A,B,C
009-070-038	WEST, THOMAS P & SUSANNE M H/W	4.14	A,B,C
009-070-039	WARMERDAM ORCHARDS INC	18.00	A,B,C
009-070-040	FACCHINI, LEO J & BELL R REV TRUST	20.06	A,B,C
009-070-041	WARMERDAM, NICHOLAS J & JUDITH A H/W	20.06	A,B,C
009-070-042	FIRST BAPTIST CHURCH OF HANFORD	18.85	A,B,C

APN	Record Owner	Acres	Pumping Zone
009-070-045	GINGLES MICHAEL T 50%	21.75	A,B,C
009-070-046	STEVENSON, MICHAEL O TRUST	35.02	A,B,C
009-070-048	GRAHAM COMMERCIAL PROPERTIES LP	30.00	A,B,C
009-070-050	CAF LLC	8.74	A,B,C
009-080-027	COON, CHARLES R & JAMIE REV LIV TRUST	3.77	A,B,C
009-090-008	WARMERDAM ORCHARDS INC	13.83	A,B,C
009-100-001	SUNNY ACRE FARMING INC	158.48	A,B,C
009-100-002	AVILA, DAVID J & NAEDE M H/W	6.33	A,B,C
009-100-003	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	30.00	A,B,C
009-100-004	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	47.46	A,B,C
009-100-005	DE RUITER, LEONARD E FAMILY TRUST 50%	32.40	A,B,C
009-100-006	COSTAMAGNA, FRANKLIN L & LUZ P H/W	7.90	A,B,C
009-100-007	FIKE, KARIN R	4.60	A,B,C
009-100-008	KOELEWYN, R D & J A REV FAMILY TRUST	2.50	A,B,C
009-100-009	BRADLEY RACHEL & CODY	2.51	A,B,C
009-100-010	BETTENCOURT FAMILY TRUST	2.50	A,B,C
009-100-012	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	2.12	A,B,C
009-100-013	SEQUEIRA, JOSEPH A & KATHLEEN A TRUST	12.64	A,B,C
009-100-015	BRADLEY, WILLIAM H & JANET K H/W	3.33	A,B,C
009-100-016	PEREIRA BRANDI & ALLYN JASON	3.03	A,B,C
009-100-018	MAHLING, DENNIS & ANNA S H/W	2.64	A,B,C
009-100-019	GARCIA, SYLVIA	2.10	A,B,C
009-100-020	KAHN, JAN L & JENNIFER A H/W	2.27	A,B,C
009-100-021	CAL-CLARK FARMS INC	2.36	A,B,C
009-100-022	BUCHANAN, FRANK T & ELIZABETH L LIV TR	3.60	A,B,C
009-100-023	CAL-CLARK FARMS INC	144.08	A,B,C
009-110-001	LEE, FLOYD R SURVIVOR'S TRUST	10.09	A,B,C
009-110-002	BATIN, MARJORIE A	2.50	A,B,C
009-110-003	LEE, SHIRLEY EXEMPTION TRUST	2.50	A,B,C
009-120-005	LUONG, THOMAS & STELLA LIVING TRUST	11.65	A,B,C
009-130-003	JOHNSON, REBECCA HOFFMAN	3.25	A,B,C
009-160-005	SIMAS, KENNETH A	20.50	A,B,C
011-010-001	COSTEN, ROBERT E & PATRICIA TRUST	32.41	A,B,C
011-010-002	TRINITY RANCHES LLC	59.55	A,B,C
011-010-003	RICHARDSON, L L ESTATE	2.50	A,B,C
011-010-004	RICHARDSON, L L ESTATE	2.50	A,B,C
011-010-005	RICHARDSON, L L ESTATE	3.38	A,B,C
011-010-006	RICHARDSON, L L ESTATE	5.08	A,B,C
011-010-010	KARAYAN FAMILY TRUST	38.89	A,B,C
011-010-013	ROYE, LINDA 25% 0	21.35	A,B,C
011-010-017	PHONG, SAM	3.00	A,B,C
011-010-020	KENNEDY, JERRY A & SUSAN J TRUST	2.51	A,B,C
011-010-022	FIRST PENTECOSTAL CHURCH OF HANFORD	10.43	A,B,C
011-010-024	FIRST PENTECOSTAL CHURCH OF HANFORD	10.22	A,B,C
011-010-026	HOOPER FAMILY 2010 TRUST THE 50% & THE HEAVY META	10.00	A,B,C
011-010-027	HOOPER FAMILY 2010 TRUST THE 50% & THE HEAVY META	9.87	A,B,C
011-010-030	WALKER, STEVEN & ELIZABETH REV TRUST 50%	24.71	A,B,C
011-010-031	MORGAN, BRADLEY L	4.56	A,B,C

APN	Record Owner	Acres	Pumping Zone
011-010-036	ROBBINS, LANCE & KELLY H/W 66.66%	2.19	A,B,C
011-010-038	SOLORIO, NABOR & YOLANDA H/W	2.51	A,B,C
011-010-039	TRUE CRAIG D & DEBBIE	2.50	A,B,C
011-010-040	MACCAGNO, MICHAEL J & ARLENE H/W	2.69	A,B,C
011-010-041	PATEL, JAGDISH P	5.56	A,B,C
011-010-042	STORMAX REAL ESTATE HOLDINGS LLC	5.26	A,B,C
011-010-043	STORMAX REAL ESTATE HOLDINGS LLC	5.26	A,B,C
011-010-044	FIRST FREE WILL BAPTIST CHURCH OF HANFORD	5.00	A,B,C
011-010-045	PATEL, JAGDISH P 33.33%	9.58	A,B,C
011-010-046	KARAYAN FAMILY TRUST 92%	10.00	A,B,C
011-010-047	KARAYAN FAMILY TRUST 92%	10.00	A,B,C
011-010-048	KARAYAN FAMILY TRUST 92%	11.97	A,B,C
011-010-049	KARAYAN FAMILY TRUST	10.00	A,B,C
011-010-050	KARAYAN FAMILY TRUST	4.66	A,B,C
011-020-034	CENTENNIAL-HANFORD CENTER WEST LLC	2.74	A,B,C
011-020-041	HOFMANS FAMILY TRUST	2.00	A,B,C
011-020-043	THE VILLAGE AT HANFORD SQUARE LLC	2.03	A,B,C
011-020-044	THE VILLAGE AT HANFORD SQUARE LLC	2.57	A,B,C
011-020-045	HANFORD MILLENNIUM, LLC	13.11	A,B,C
011-020-046	ENCLAVE 66 LLC	14.12	A,B,C
011-020-054	CENTENNIAL-HANFORD CENTER WEST LLC	2.89	A,B,C
011-020-056	SUMMERSTONE 46 INC	8.55	A,B,C
011-020-057	HANFORD-SOUTHPORT LLC	10.20	A,B,C
011-040-001	BARBA, RONALD A & CHRISTINE A H/W	2.50	A,B,C
011-040-004	NOOR LAND COMPANY LLC 50%	21.15	A,B,C
011-040-005	PAK, SOKHEMARA REVOCABLE LIVING TRUST	13.30	A,B,C
011-040-007	BILLINGSLEY, LORETTA M REV FAM TRUST	21.12	A,B,C
011-040-008	MIDDLEFIELD MANOR LLC	17.51	A,B,C
011-040-010	MIDDLEFIELD MANOR LLC	51.10	A,B,C
011-040-017	FOREBAY FARMS LLC	81.90	A,B,C
011-040-019	FOREBAY FARMS LLC	108.00	A,B,C
011-040-021	MUSICK, BARBARA 33.33%	20.00	A,B,C
011-040-022	CRUZ, ALBERTO R R & ELENA L H/W	2.00	A,B,C
011-040-023	COSTA, MANUEL & JUSTINE L H/W	70.87	A,B,C
011-040-025	MORENO, FRANCISCO & ELIZABETH LOPEZ H/W	18.36	A,B,C
011-040-026	NAVARRO FRANCISCO H & CARMEN Q	16.25	A,B,C
011-040-027	MIDDLEFIELD MANOR LLC	19.48	A,B,C
011-040-028	DUTRA, LEONARD & MARGARET H/W	10.46	A,B,C
011-040-029	MADRUGA, JANICE I SURVIVOR'S TRUST 50%	45.33	A,B,C
011-040-030	THOMAS RICK & DONNA	11.81	A,B,C
011-040-031	CUNHA CHAD J & MELISSA	2.96	A,B,C
011-040-032	SANTOS, FERNANDO & ERICA H/W	2.41	A,B,C
011-040-033	JOHNSON FAMILY TRUST THE	2.42	A,B,C
011-040-034	BARBA, RONALD A & CHRISTINE A H/W	2.90	A,B,C
011-040-035	CERVANTES, JOSE G & LUCILA H/W	2.54	A,B,C
011-040-036	BARBA, JORDAN	2.54	A,B,C
011-060-007	LIEBERT, NORMAN S MANAGEMENT TRUST	8.79	A,B,C
011-060-008	ROBINSON, MICHAEL S BYPASS TRUST	4.51	A,B,C

APN	Record Owner	Acres	Pumping Zone
011-060-010	LIEB FAMILY TRUST 42.9%	14.93	A,B,C
011-110-015	SANCHEZ DENNIS J TRUST	10.00	A,B,C
011-110-016	IMPLACABLE PROPERTIES LLC	24.00	A,B,C
011-110-017	LININGER, MONTE R & PENNY L LIVING TRUST	8.00	A,B,C
011-110-021	MATSUFUJI, VIC & SUZETTE YUKA FAM TRUST	9.66	A,B,C
011-110-023	WILKINSON, LARRY L & PHYLLIS L H/W	5.44	A,B,C
011-110-024	PEREZ, FRANK J & SANDRA R H/W	4.56	A,B,C
011-110-025	SMITH, PETER M & NANCY L H/W	2.07	A,B,C
011-110-026	WALKER, WILLIAM S REV TRUST	6.08	A,B,C
011-110-028	SANCHEZ, GREGORY D & BARBARA H/W	4.91	A,B,C
011-110-031	GARCIA, GREGORY A REVOCABLE TRUST	4.30	A,B,C
011-110-046	IMPLACABLE PROPERTIES LLC	60.84	A,B,C
011-420-007	TAFOYA, SAUL & LETICIA H/W	9.98	B,C
011-420-008	CASON, WILLIAM & SHEILA H/W 50%	5.00	B,C
011-430-002	COLLIER MICHALENE M & RAMIREZ LUIS JR	2.68	B,C
011-440-002	MURRAY, JOHN JR & BEATRIZ H/W	4.64	B,C
011-440-003	AGUILERA, CESAR A A & KARLA M R E H/W	2.25	B,C
011-440-004	AGUILERA, CESAR A A & KARLA M R E H/W	2.85	B,C
011-440-005	CORNERSTONE COMM ALCOHOL & OTHER DRUG	4.20	B,C
011-440-007	OROZCO, LESLIE	8.29	B,C
011-440-010	NEAL, DARLENE REVOC TRUST	19.40	B,C
011-440-011	HANFORD CEMETERY DISTRICT	19.16	B,C
011-440-012	HANFORD CEMETERY DISTRICT	14.85	B,C
011-440-013	HANFORD CEMETERY DISTRICT	35.04	B,C
011-440-014	FADENRECHT, DANIEL M & BETTY TRUST	40.00	B,C
011-440-015	BETTY FADENRECHT MARITAL TRUST 100% 0	55.00	B,C
012-070-022	MARQUEZ INVESTMENT GROUP LLC	2.18	B,C
012-070-029	MARQUEZ INVESTMENT GROUP LLC	3.13	B,C
012-070-030	MARQUEZ INVESTMENT GROUP LLC	4.15	B,C
012-151-014	VALERO ENERGY CORPORATION	25.22	B,C
012-171-001	VALERO ENERGY CORPORATION	2.52	B,C
012-171-002	VALERO ENERGY CORPORATION	2.74	B,C
012-223-001	HANFORD CEMETERY	8.67	B,C
012-290-042	ROBINSON, MICHAEL S BYPASS TRUST	2.51	A,B,C
012-290-054	GARAVELLO, ROBERT & KRISTY FAMILY TRUST	23.35	A,B,C
014-010-002	TOS, JEFF & SHERI LIVING TRUST 50%	37.92	B,C
014-010-003	SUMMERS, JOHN P	20.00	B,C
014-010-004	SUMMERS, JOHN P	20.00	B,C
014-010-005	TOS LAND CO INC	44.00	B,C
014-010-010	RIOS, JOSE L	24.29	B,C
014-010-014	TOS LAND CO INC	23.79	B,C
014-010-018	GARNER, JOHN G REV TRUST	40.00	B,C
014-010-023	RAMIREZ, JILL L	2.77	B,C
014-010-024	TOS LAND COMPANY INC	41.32	B,C
014-010-027	KINGS COUNTY WATER DISTRICT	8.30	B,C
014-010-028	JENSEN, CARLYN & JANET LIVING TRUST	79.00	B,C
014-010-030	CARDARAS NICK & MARILLEE LIV TRUST	3.60	B,C
014-010-033	KINGS COUNTY WATER DISTRICT	54.29	B,C

APN	Record Owner	Acres	Pumping Zone
014-010-034	MACHADO FAMILY LIMITED PTP	64.24	B,C
014-010-039	KINGS COUNTY WATER DISTRICT	26.00	B,C
014-010-040	HARDING, SHANE & STEFANI H/W	14.00	B,C
014-010-041	MARTINEZ, LOUIS JR & AUTUMN L H/W	2.50	B,C
014-010-042	SHELDON, DANIEL & JENNIFER H/W	2.50	B,C
014-010-043	KEITH, DOYLE & JEANETTE LIVING TRUST	2.50	B,C
014-010-045	WEDEL JUSTIN	7.58	B,C
014-010-049	RIOS, JOSE & NORMA H/W	3.82	B,C
014-010-050	ESTES, RYAN & KELLY H/W	2.50	B,C
014-010-051	YOUNG, RAYMOND	2.53	B,C
014-010-052	JENSEN, CARLYN & JANET LIVING TRUST	154.26	B,C
014-010-055	HIELSCHER, DARRELL 66.66%	3.10	B,C
014-010-056	ORTEGA, MANUEL	3.34	B,C
014-010-057	MACHADO FAMILY LIMITED PARTNERSHIP THE	55.00	B,C
014-010-059	TOS LAND CO INC	64.18	B,C
014-010-060	PERRY FAMILY TRUST	40.00	B,C
014-010-061	MOTTE 1999 LIVING TRUST	38.88	B,C
014-010-062	TOS LAND CO INC	78.87	B,C
014-010-065	BARCELLOS, MARY J REVOC LIV TRUST	39.53	B,C
014-010-066	MACHADO FAMILY LIMITED PARTNERSHIP THE	15.00	B,C
014-010-069	RIOS, JOSE L	12.21	B,C
014-010-071	CONSOLE, RUSSELL J & HELENE M H/W	2.00	B,C
014-010-073	TOS, WILLIAM JR & LINDA LIVING TRUST	50.57	B,C
014-010-074	TOS, WILLIAM JR & LINDA LIVING TRUST	25.36	B,C
014-010-075	TOS, JEFF & SHERI LIVING TRUST	25.07	B,C
014-010-077	TOS LAND CO INC	104.97	B,C
014-010-078	FRAGOSO, JARED L & CRYSTAL M H/W	23.92	B,C
014-010-079	FRAGOSO, JARED L & CRYSTAL M H/W	17.14	B,C
014-020-006	LOHSE BROS, LLC	80.00	B,C
014-020-008	PINNACLE PACIFIC COAST OPERATING CO LLC	166.00	B,C
014-020-010	CAMPBELL, RON & JENNIE LIVING TRUST	40.50	B,C
014-020-013	COELHO, JOE F JR & BONNIE M REV TRUST	135.00	B,C
014-020-015	BETTENCOURT, JOHN & LUCY LIVING TRUST	80.00	B,C
014-020-017	MELLO, BRYAN J	2.50	B,C
014-020-018	TE VELDE, KARL J & LAUREN N REVOC FAM TRUST	182.50	B,C
014-020-019	GARNER, JOHN G REV TRUST	52.28	B,C
014-020-021	MONTGOMERY, GARY & DIANE FAMILY TRUST	61.67	B,C
014-020-022	MONTGOMERY FAMILY LIVING TRUST	60.29	B,C
014-020-025	STATE OF CALIFORNIA	2.11	B,C
014-020-026	LOHSE BROS LLC	77.89	B,C
014-020-027	STATE OF CALIFORNIA	2.23	B,C
014-020-028	BETTENCOURT, JOHN & LUCY LIVING TRUST	77.77	B,C
014-020-029	STATE OF CALIFORNIA	7.50	B,C
014-020-030	GARNER, JOHN G REV TRUST	102.18	B,C
014-020-032	STATE OF CALIFORNIA	7.49	B,C
014-020-033	TE VALDE, KARL J & LAUREN N REV FAM TRST	130.38	B,C
014-020-034	TE VELDE, KARL J & LAUREN N REV FAM TRST	22.30	B,C
014-030-005	WAWONA FARM CO LLC	200.00	B,C

APN	Record Owner	Acres	Pumping Zone
014-030-006	TE VELDE, KARL J & LAUREN N REV FAM TRST	38.35	B,C
014-030-010	NETTO, FRANK P & CINDY M LIVING TRUST	80.26	B,C
014-030-012	PIPKIN, EVELYN M REV LIVING TRUST	77.50	B,C
014-030-013	PIPKIN, EVELYN M REV LIVING TRUST	2.50	B,C
014-030-019	SOZINHO JERSEYS A PTP	111.08	B,C
014-030-020	SOZINHO JERSEYS A PTP	88.13	B,C
014-030-025	LOVATO EMPIRE LLC	39.94	B,C
014-030-026	LOVATO EMPIRE LLC	39.94	B,C
014-030-027	LOVATO EMPIRE LLC	39.94	B,C
014-030-028	DUTY, CARLTON & COLEAN LIVING TRUST	119.82	B,C
014-040-017	TE VELDE, GARRET D & CHELSEY Y REV FAM TRUST	117.68	B,C
014-040-037	MYERS, GLENN C REVOCABLE TRUST	114.88	B,C
014-040-039	TE VELDE, DAVID & ALICE FAMILY TRUST	44.80	B,C
014-040-040	TE VELDE, DAVID & ALICE FAMILY TRUST	76.20	B,C
014-050-001	BROWN'S DAIRY A PTP	80.00	B,C
014-050-008	DUTRA, MYRON D & SANDRA I H/W 50%	160.00	B,C
014-050-016	DIAS, GREGORY O & STEVEN DIAS INC	80.00	B,C
014-050-022	HARP, JAMES S & THERESA L H/W	2.65	B,C
014-050-032	DUTRA, BRIAN A 50%	12.00	B,C
014-050-033	DIAS, STEVEN P & THERESA M LIVING TRUST	80.00	B,C
014-050-034	DIAS, GREGORY O & STEVEN DIAS INC	76.35	B,C
014-050-039	DUTRA, BRIAN A 50%	40.00	B,C
014-050-040	DUTRA, BRIAN A 50%	28.00	B,C
014-050-041	RODRIGUEZ, JOHNNY P & SANDRA M H/W	3.00	B,C
014-050-042	DUTRA, MYRON D & SANDRA I H/W 50%	35.00	B,C
014-050-045	DUTRA, BRIAN A 50%	10.00	B,C
014-050-046	DUTRA, BRIAN A 50%	10.00	B,C
014-050-047	DUTRA, BRIAN A	10.00	B,C
014-050-048	DUTRA, BRIAN A 50%	10.00	B,C
014-050-049	DUTRA, BRIAN A 50%	2.00	B,C
014-060-008	BROWN'S DAIRY A PTP	160.00	B,C
014-060-010	WILGENBURG FAMILY LP	80.00	B,C
014-060-012	FAGUNDES AGRIBUSINESS A PTP	80.00	B,C
014-060-013	FLINT AVENUE HANFORD LP	79.01	B,C
014-060-022	FELIPE FAMILY TRUST	20.57	B,C
014-060-029	TEIXEIRA, LEONA J 50%	2.55	B,C
014-060-030	SILVA, JOHN A & MARIA O H/W	2.50	B,C
014-060-031	BONTRAGER, MARC & CASSANDRA H/W	2.50	B,C
014-060-032	OLIVEIRA REVOCABLE TRUST	73.82	B,C
014-060-039	FAGUNDES, MYRON & ELLEN H/W	2.00	B,C
014-060-041	FELIPE FAMILY TRUST	2.49	B,C
014-060-047	EVANGELO, TERESA SURVIVOR'S TRUST	60.79	B,C
014-060-049	MC CUTCHEON, BARRY H & BRENDA FAM TRUST	5.00	B,C
014-060-050	MCCUTCHEON, B H & B L FAM TRST	75.00	B,C
014-060-052	GUECHO, RICHARD L LIVING TRUST	20.00	B,C
014-060-053	GUECHO, RICHARD L LIVING TRUST	61.43	B,C
014-060-054	EVANGELO, TERESA SURVIVOR'S TRUST	14.36	B,C
014-060-055	EVANGELO, TERESA SURVIVOR'S TRUST	3.87	B,C

APN	Record Owner	Acres	Pumping Zone
014-060-058	TE VELDE, KARL J & LAUREN N REV FAM TRUST	2.00	B,C
014-060-059	TE VELDE, KARL J & LAUREN N REV FAM TRUST	79.84	B,C
014-060-061	SIMAS, KENNETH A & VICTORIA L H/W	79.45	B,C
014-060-064	STATE OF CALIFORNIA	7.12	B,C
014-060-065	BARCELLOS DEAN & RENEE LIVING TRUST 50%	12.97	B,C
014-060-066	STATE OF CALIFORNIA	2.20	B,C
014-060-068	STATE OF CALIFORNIA	4.40	B,C
014-060-069	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	115.60	B,C
014-060-070	FELIPE FAMILY TRUST	71.89	B,C
014-060-071	STATE OF CALIFORNIA	3.72	B,C
014-060-072	FELIPE FAMILY TRUST	52.31	B,C
014-060-073	STATE OF CALIFORNIA	4.17	B,C
014-060-076	STATE OF CALIFORNIA	3.72	B,C
014-060-077	FELIPE FAMILY TRUST	8.98	B,C
014-060-078	STATE OF CALIFORNIA	4.94	B,C
014-060-081	STATE OF CALIFORNIA	10.36	B,C
014-060-082	TE VELDE, KARL J & LAUREN N REV FAM TRUST	67.64	B,C
014-070-002	RICHARDS FAMILY LAND LLC	240.00	B,C
014-070-004	KINGS COUNTY WATER DISTRICT	78.50	B,C
014-070-005	RIBEIRO, FRANCISCO G REV TRUST	78.79	B,C
014-070-008	MACHADO FAMILY LIMITED PTP	30.00	B,C
014-070-011	BERNARDO, LEONARD E TRUST 50%	105.00	B,C
014-070-020	BERNARDO, LEONARD E TRUST 50%	40.00	B,C
014-070-021	FAGUNDES, JASON M & KATHLEEN L H/W	2.97	B,C
014-070-022	SUMMERS, JOHN P	37.03	B,C
014-070-035	DUARTE, JEREMY & KELSIE FAMILY TRUST	2.61	B,C
014-070-036	KINGS COUNTY WATER DISTRICT	154.21	B,C
014-070-038	AVILA, LE ROY A & BARBARA K TRUST	2.50	B,C
014-070-039	AVILA, LE ROY A & BARBARA K TRUST	16.59	B,C
014-070-042	FAGUNDES, RICHARD L & SHIRLEY TRUST 50%	2.59	B,C
014-070-044	SUMMERS, JOHN P	39.34	B,C
014-070-046	MACHADO FAMILY LIMITED PARTNERSHIP	18.15	B,C
014-070-047	STANFIELD, DAVID P & VICKI J REV LIV TRU	20.27	B,C
014-070-049	AVILA, LE ROY A & BARBARA K TRUST 50%	19.41	B,C
014-070-052	SANTOS, BRIAN C & JOY M H/W	5.69	B,C
014-070-053	MACHADO FAMILY LTD PTP	29.69	B,C
014-070-055	STANFIELD, DAVID P & VICKI J REV LIV TRS	10.00	B,C
014-070-056	STANFIELD, DAVID P & VICKI J REV LIV TRS	64.00	B,C
014-070-057	STANFIELD, DAVID P & VICKI J REV LIV TRS	20.31	B,C
014-070-059	AVILA, LE ROY A & BARBARA K TRUST	36.35	B,C
014-070-071	VICKERS, TRAVIS & STACEY H/W	20.19	B,C
014-070-072	MC GAHAN, JOE & TERRY LIVING TRUST	99.81	B,C
014-070-073	SANDRIDGE PARTNERS LP	92.50	B,C
014-070-074	JOHN TEIXEIRA FARMS INC	2.50	B,C
014-080-004	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	114.23	B,C
014-080-005	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	5.00	B,C
014-080-015	VAN DER GRAAF, A & R LIV TRUST 50%	43.25	B,C
014-080-020	MENDEZ, MICHAEL	69.06	B,C

APN	Record Owner	Acres	Pumping Zone
014-080-021	NETTO DELIA FAMILY ENDOWMENT TRUST	80.00	B,C
014-080-022	DIAS, MICHAEL A & G FIRST AMENDED TRUST	40.00	B,C
014-080-023	MENDEZ, MICHAEL	40.00	B,C
014-080-027	FAGUNDES, JOHN L SR REVOCABLE TRUST	60.00	B,C
014-080-028	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	20.00	B,C
014-080-032	FAGUNDES, CLARENCE SURVIVOR'S TRUST	10.00	B,C
014-080-033	FAGUNDES, NATIVA REVOCABLE TRUST 50%	10.00	B,C
014-080-039	FAGUNDES, BRUCE A 50%	10.00	B,C
014-080-040	FAGUNDES, BRUCE A 50%	10.00	B,C
014-080-041	FAGUNDES, BRUCE A 50%	20.00	B,C
014-080-046	2020 KEVIN CUELHO SEP PROP TRUST	2.36	B,C
014-080-048	MYERS FAMILY TRUST OF 1990	2.36	B,C
014-080-049	BELL, ERIN J & CORTNEY M H/W	5.78	B,C
014-080-051	BAYRAKDARIAN, ISHKHAN DEC OF TRUST	8.84	B,C
014-080-060	WARMERDAM, EDWARD N	5.94	B,C
014-080-061	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	2.51	B,C
014-080-062	WARMERDAM, EDWARD W SURVIVORS TRUST 50%	11.55	B,C
014-080-063	REALL, PATRICK L & BEBELINDA C H/W	2.57	B,C
014-080-064	MYERS FAMILY TRUST OF 1990	2.50	B,C
014-080-065	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	30.00	B,C
014-080-066	WARMERDAM, NICHOLAS J & JUDITH A H/W	40.68	B,C
014-080-068	BARCELLOS, DEAN & RENEE LIV TRUST 50%	120.00	B,C
014-080-069	FAGUNDES, JOHN L	20.00	B,C
014-080-070	BARCELLOS, DEAN & RENEE LIV TRUST 50%	20.00	B,C
014-080-075	SOUZA, ERNEST & SHARON H/W	5.01	B,C
014-080-076	FLINT AVENUE HANFORD LP	114.99	B,C
014-080-077	KINGS COUNTY WATER DISTRICT	107.07	B,C
014-080-086	HENDERSON, JAMES C & SHARI A H/W	10.00	B,C
014-080-088	VANDER GRAAF, ADRIAN J	2.64	B,C
014-080-089	STRYD, STEPHEN C & BRENDA ENGLAND H/W	2.64	B,C
014-080-092	PUNLA MARIE ROSE	10.01	B,C
014-080-093	MYERS FAMILY TRUST OF 1990	2.73	B,C
014-080-094	MYERS, STACIE FAMILY TRUST 2013	7.55	B,C
014-080-104	BROWN, LOUIS A SR	10.00	B,C
014-080-105	SOLIS, BRENDA I	10.00	B,C
014-080-106	HENDERSON JAMES & SHARI	7.50	B,C
014-080-107	WILLIAMS, TEDDY B & JEANNIE A H/W	2.50	B,C
014-090-005	WILGENBURG WEST LLC	50.00	B,C
014-090-009	WILGENBURG WEST LLC	40.00	B,C
014-090-012	WILGENBURG WEST LLC	80.00	B,C
014-090-018	HURD JOHN HENRY & CHACON GABRIELLE	3.00	B,C
014-090-020	TE VELDE, KARL J & LAUREN N REV FAM TRST	37.50	B,C
014-090-021	TEIXEIRA, LEOBERTO	2.50	B,C
014-090-027	ARTS, WILLY J	31.54	B,C
014-090-029	WILGENBURG FAMILY LP	2.49	B,C
014-090-030	OLIVEIRA, FRANKLIN B & HEATHER A LIV TRS	37.90	B,C
014-090-031	BLANCHARD, TIMOTHY & CINDY H/W	2.77	B,C
014-090-033	WASHBURN HELEN M	28.21	B,C

APN	Record Owner	Acres	Pumping Zone
014-090-036	WILGENBURG FAMILY LP	121.19	B,C
014-090-037	WILGENBURG FAMILY LP	210.79	B,C
014-090-038	BLANCHARD, TIMOTHY & CINDY H/W	2.23	B,C
014-090-039	SHARP, SHON & MARLA D H/W	2.70	B,C
014-090-040	COELHO MARGARET C & JOHNATHAN R	4.41	B,C
014-090-043	GARCIA, ANTONIO & MARIA 1996 FAM TRUST	20.19	B,C
014-090-045	CARDOZA, ANTHONY & JUANITA H/W	18.07	B,C
014-090-046	CARDOZA, ANTHONY & JUANITA H/W	2.12	B,C
014-090-047	DIAS, MICHAEL & GERMAINE AMND REV TR	20.00	B,C
014-090-048	DIAS, MICHAEL & GERMAINE AMND REV TR 50%	19.93	B,C
014-090-051	SANDRIDGE PARTNERS LP	71.30	B,C
014-090-053	SANDRIDGE PARTNERS LP	84.29	B,C
014-090-054	STATE OF CALIFORNIA	14.60	B,C
014-090-055	SILVA, BRIAN M	55.40	B,C
014-090-056	STATE OF CALIFORNIA	8.55	B,C
014-090-057	DIAS, MICHAEL & GERMAINE AMND REV TR 50%	11.52	B,C
014-090-058	BARCELLOS, DEAN & RENEE LIVING TRUST 50% & BARCELL	79.80	B,C
014-090-062	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	65.68	B,C
014-090-063	STATE OF CALIFORNIA	7.41	B,C
014-090-064	STATE OF CALIFORNIA	3.91	B,C
014-090-065	BARCELLOS, DEAN & RENEE LIVING TRUST 50%	64.00	B,C
014-090-066	STATE OF CALIFORNIA	6.00	B,C
014-090-067	STATE OF CALIFORNIA	7.12	B,C
014-090-068	WILGENBURG WEST LLC	42.88	B,C
014-090-069	STATE OF CALIFORNIA	20.00	B,C
014-100-004	DUTRA, WILLIAM G	55.00	B,C
014-100-005	DUTRA, WILLIAM G & DANETTE H/W	52.50	B,C
014-100-006	ROSE, LAURA P LIV TRUST	52.50	B,C
014-100-022	WILGENBURG FAMILY LIMITED PARTNERSHIP	160.00	B,C
014-100-023	MYERS, STANLEY & TRACY REVOCABLE TRUST	80.00	B,C
014-100-024	MYERS, STANLEY & TRACY REVOCABLE TRUST	80.00	B,C
014-100-029	DUTRA, ROGER S 44%	83.50	B,C
014-100-030	DUTRA, MYRON D & SANDRA I H/W 50%	77.43	B,C
014-120-001	WILGENBURG FAMILY LP	160.00	B,C
014-120-003	GIACOMAZZI, BOB & SONS LIMITED PTP	160.00	B,C
014-120-005	DUTRA, M DUANE 50%	54.38	B,C
014-120-014	WILGENBURG FAMILY LP	40.00	B,C
014-120-016	GONSALVES, FRANKIE C & DANA L H/W	40.12	B,C
014-120-017	GONSALVES, FRANKIE C & DANA L H/W	40.12	B,C
014-120-018	DUTRA, BRIAN A 50%	20.00	B,C
014-120-019	DUTRA, MYRON D 25%	15.22	B,C
014-120-020	DUTRA, M DUANE & SANDRA I H/W 50%	3.87	B,C
014-120-026	DRAGT, HAROLD & SON DAIRIES LLC	159.64	B,C
014-120-028	DRAGT, HAROLD & JEANETTE LIVING TR	2.00	B,C
014-120-029	DRAGT, HAROLD & JEANETTE LIVING TR	144.14	B,C
014-120-030	DRAGT, HAROLD & SONS DAIRIES LLC	13.50	B,C
014-120-041	DUTRA, BRIAN A 50%	84.79	B,C
014-120-042	DUTRA, M DUANE	20.00	B,C

APN	Record Owner	Acres	Pumping Zone
014-130-002	NOBLE, LARREN R	5.00	B,C
014-130-012	HENNING, CELINE LIVING TRUST	40.23	B,C
014-130-013	SOARES, GEORGE & GLORIA REV FAMILY TRUST	20.00	B,C
014-130-014	SOARES, GEORGE & GLORIA REV FAMILY TRUST	30.00	B,C
014-130-015	SOARES, GEORGE & GLORIA REV FAMILY TRUST	10.00	B,C
014-130-016	SOARES, GEORGE & GLORIA REV FAMILY TRUST	26.66	B,C
014-130-017	SOARES, GEORGE & GLORIA REV FAMILY TRUST	13.33	B,C
014-130-024	HOWE FAMILY LP	120.00	B,C
014-130-027	GIACOMAZZI, BOB & SONS LIMITED PTP	79.98	B,C
014-130-029	CASTANEDA, VIRGEN & MARTHA H/W	5.00	B,C
014-130-031	MENDEZ, MICHAEL	5.00	B,C
014-130-038	WASHBURN, HELEN M	73.90	B,C
014-130-041	BALLESTEROS, LEDUVINA 50%	5.00	B,C
014-130-045	PRATER, JOHN & ALICE BARNES REV LIV TRST	15.17	B,C
014-130-046	BETTENCOURT, R C & J L TRUST	2.50	B,C
014-130-051	ROGERS, MANUEL W 1994 LIVING TRUST	31.59	B,C
014-130-055	GARCIA, ANTONIO & MARIA FAMILY TRUST	63.34	B,C
014-130-058	SOARES, GEORGE & GLORIA REV FAMILY TRUST	38.16	B,C
014-130-060	BLANCHARD FARMS INC	105.91	B,C
014-130-061	GARCIA, ANTONIO & MARIA 1996 FAMILY TRUST	55.54	B,C
014-130-063	BETTENCOURT, R C & J L TRUST	20.21	B,C
014-130-064	DODD, LORI A	2.50	B,C
014-130-065	HOWZE FAMILY TRUST	9.82	B,C
014-130-069	STATE OF CALIFORNIA	13.42	B,C
014-130-070	STATE OF CALIFORNIA	13.42	B,C
014-130-071	STATE OF CALIFORNIA	13.42	B,C
014-130-073	SOARES, GEORGE & GLORIA REV FAMILY TRUST	12.08	B,C
014-130-074	SOARES, GEORGE & GLORIA REV FAMILY TRUST	10.22	B,C
014-130-075	SOARES, GEORGE & GLORIA REV FAMILY TRUST	10.06	B,C
014-130-076	TDH LAND & CATTLE LLC	10.06	B,C
014-130-078	CAVIEZEL FAMILY TRUST	27.55	B,C
014-130-079	DUTRA MYRON DUANE & DUTRA BRIAN A	10.10	B,C
014-130-080	DUTRA, BRIAN A 50%	82.34	B,C
014-130-082	GARCIA ELVIS & MARIA	2.56	B,C
014-130-083	GARCIA ELVIS & MARIA	2.64	B,C
014-130-093	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	10.09	B,C
014-130-094	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	11.02	B,C
014-130-095	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	18.45	B,C
014-130-096	FUKANO, STEVEN E & ROBIN L REV FAM TR 40%	39.00	B,C
014-130-104	STATE OF CALIFORNIA	5.97	B,C
014-130-106	STATE OF CALIFORNIA	5.81	B,C
014-130-108	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	33.89	B,C
014-130-109	STATE OF CALIFORNIA	6.12	B,C
014-130-110	DIAS, MICHAEL A & GERMAINE REV LIV TRUST	33.64	B,C
014-130-112	HOWE FAMILY LP	15.10	B,C
014-130-114	HOWE FAMILY LP	11.09	B,C
014-130-116	HOWE FAMILY LP	13.31	B,C
014-130-118	HOWE FAMILY LP	74.73	B,C

APN	Record Owner	Acres	Pumping Zone
014-142-001	FAGUNDES, BRUCE A	20.44	B,C
014-142-002	FAGUNDES, NATIVA REVOCABLE TRUST 50%	39.42	B,C
014-142-007	MENDEZ, MICHAEL	40.42	B,C
014-142-008	MARTINEZ RAFAEL CERDA & CALDERON DE CERDA, ALBA LU	2.50	B,C
014-142-009	GONZALEZ, LUIS ERIC	2.50	B,C
014-142-010	2020 MELISSA CARY-CUELHO SEP PROP TRUST	2.53	B,C
014-142-011	CAETANA, LEROY D & LUCINDA J H/W	2.53	B,C
014-142-012	NATALI, ANTOINETTE	5.07	B,C
014-142-013	COULON, DANNY E & KAREN D REVOC TRUST	5.06	B,C
014-142-014	SOCIEDADE DE SAO JOAO INC	13.68	B,C
014-142-015	MENDEZ, MICHAEL	40.39	B,C
014-142-016	GREWAL FAMILY TRUST	20.00	B,C
014-142-017	GREWAL FAMILY TRUST	26.17	B,C
014-142-021	EBC FARMS LLC	50.00	B,C
014-142-023	EBC FARMS LLC	60.73	B,C
014-142-024	EBC FARMS LLC	10.12	B,C
014-142-025	ALI ALAMSI MUFID MOHAMMED	10.00	B,C
014-142-026	GREWAL FAMILY LAND CO LLC	14.34	B,C
014-142-027	FAGUNDES, JOHN L SR REVOCABLE TRUST	14.07	B,C
014-142-028	FAGUNDES, JOHN JR	8.56	B,C
014-142-030	ALCORN, JOHN A & M LORRAINE H/W	9.40	B,C
014-142-032	LOOGMAN, JAMES & NANCY A H/W	10.30	B,C
014-142-035	LOYA, RICK R & NICOLE K H/W	2.50	B,C
014-142-036	HIGHFILL, JAMES & SANDRA REV FAM TRUST	2.50	B,C
014-142-037	MORRA, FREDERICK J JR	2.42	B,C
014-142-038	LAIRD, JENIFER L	2.50	B,C
014-142-041	GREWAL FAMILY TRUST	34.98	B,C
014-142-042	GREWAL FAMILY TRUST	20.00	B,C
014-142-045	HARRIS, CINDY L REVOCABLE LIVING TRUST	2.53	B,C
014-142-046	CANCHOLA, LARRY A & SALLY G LIVING TRUST	2.53	B,C
014-142-047	CASTRO, ARTHUR V & DEBORAH C H/W	2.75	B,C
014-142-048	NEWTON, FORREST W & MARGARET A H/W	2.25	B,C
014-142-050	J & A ROJAS INVESTMENTS INC	14.87	B,C
014-142-051	R & C QUINN REV LIV TRUST	2.50	B,C
014-142-052	LATIS LLC	77.50	B,C
014-142-053	LOCKE TOMMY & SUSAN	2.54	B,C
014-142-054	FAGUNDES, JOHN L JR	2.54	B,C
014-142-055	AZEVEDO, MICHAEL F & MAUREEN S TRUST	12.31	B,C
014-142-056	AZEVEDO, MICHAEL F & MAUREEN S REV TRUST	4.29	B,C
014-142-068	MENEZES, FRANK & JENEEN LIVING TRUST	19.22	B,C
014-142-073	STODDARD, THOMAS D LIVING TRUST	2.50	B,C
014-142-074	CAREY MARY JANE	2.50	B,C
014-143-022	DIAS, CYNTHIA J & JOSEPH G W/H	3.00	B,C
014-143-069	WARMERDAM, EDWARD W SURVIVORS TRUST 50% 0	46.62	B,C
014-143-078	DADIGIAN FAMILY TRUST 2001	37.32	B,C
014-221-022	FONTANA, JOHN & KATHLEEN REVOC TRUST	8.46	B,C
014-221-033	PATEL, AVNI 33.333%	2.96	B,C
014-221-046	LAVENSON-AVEDISIAN TRUST	11.08	B,C

APN	Record Owner	Acres	Pumping Zone
014-221-047	CITY OF HANFORD	3.70	B,C
014-230-006	VANDERZIEL, RUSSELL & MARJORIE TRUST	2.95	B,C
014-230-007	JCH FAMILY LIMITED PARTNERSHIP 33.33%	3.80	B,C
014-230-009	ICKIS JULIENE A	3.09	B,C
014-230-013	COSTAMAGNA, ERNEST B	9.25	B,C
014-230-020	PIMENTEL, MICHAEL S & NICOLE M H/W	5.88	B,C
014-230-021	C P O FARMS LLC	5.93	B,C
014-230-030	LOOGMAN THOMAS G	60.00	B,C
014-230-031	LOOGMAN, JAMES A & NANCY A H/W	100.00	B,C
014-230-033	BADASCI, JOHN K JR	9.00	B,C
014-230-034	EBC FARMS LLC	53.19	B,C
014-230-035	EBC FARMS LLC	17.76	B,C
014-230-053	MYERS BROS A PTP	4.22	B,C
014-230-061	SOUTHERN PACIFIC TRANSPORTATION CO	17.76	B,C
014-230-065	BADASCI, GEORGE G LIVING TRUST	14.98	B,C
014-230-066	GARCIA, GUS	4.80	B,C
014-230-073	DAVIS, JOHN L & MARGARET L H/W	4.00	B,C
014-230-075	BADASCI, GEORGE G LIVING TRUST	41.31	B,C
014-230-076	MYERS BROTHERS A PTP	7.81	B,C
014-230-079	EBC FARMS LLC	2.09	B,C
014-230-082	GARCIA, MONICA TRUST 50%	9.11	B,C
014-230-083	CAL-CLARK FARMS INC	39.97	B,C
014-230-084	CAL-CLARK FARMS INC	40.03	B,C
014-230-085	CAL-CLARK FARMS INC	24.95	B,C
014-230-086	CAL-CLARK FARMS INC	40.05	B,C
014-230-087	CAL-CLARK FARMS INC	31.49	B,C
014-230-088	CAL-CLARK FARMS INC	44.24	B,C
014-230-089	COSTAMAGNA INVESTMENTS LLC	59.72	B,C
014-230-092	RIOS JEROME P & CHALSEY N	10.05	B,C
014-230-093	RIOS, DAVID P & JENNIFER J LIVING TRUST	10.05	B,C
014-230-096	CITY OF HANFORD	9.92	B,C
014-241-004	FONSECA, FEDERICO M & SUZIE B H/W	3.50	B,C
014-241-007	HANFORD JOINT UNION HIGH SCHOOL DISTRICT	2.94	B,C
014-241-008	HANFORD JOINT UNION HIGH SCHOOL DISTRICT	4.59	B,C
014-241-020	BUFORD OIL COMPANY INC	2.05	B,C
014-251-007	GRITTON TRUST	2.83	B,C
014-251-040	JOHNSON, JIMMIE D & DEANNA I TRUST A 50%	11.52	B,C
014-251-045	CARRILLO, LYDIA V LF ESTATE 0	3.45	B,C
014-251-049	HELENA CHEMICAL COMPANY	4.66	B,C
014-251-050	HELENA CHEMICAL COMPANY	12.39	B,C
014-251-064	PINNACLE POINTE LLC	2.49	B,C
014-251-067	PINNACLE POINT LLC	5.60	B,C
014-260-007	PATEL, JADISHBHAI P	2.50	B,C
014-260-015	VALLE MAGIA FARMS LLC	42.85	B,C
014-260-016	VALLE MAGIA FARMS LLC	49.40	B,C
014-260-017	COELHO, JUANITA G TRUST	47.57	B,C
014-260-018	KIT CARSON SCHOOL	10.00	B,C
014-260-020	MENDOZA, ANTHONY A	2.43	B,C

APN	Record Owner	Acres	Pumping Zone
014-260-025	WESTLAKE FARMS INC	78.43	B,C
014-260-026	WESTLAKE FARMS INC	72.48	B,C
014-260-034	COLLAR, LARRY S & CAROL A H/W JT	5.00	B,C
014-260-036	TE VELDE, KARL J & LAUREN N REV FAM TRST	153.98	B,C
014-260-039	ROBLES, GILBERT L & JOSEFINA LIMJOCO H/W	3.31	B,C
014-260-042	RAULINO IRREVOCABLE LIVING TRUST	5.00	B,C
014-260-043	RAMIREZ-RAMOS, CATARINO	2.49	B,C
014-260-045	SAPIEN, JUAN JR	2.50	B,C
014-260-047	DIAS, LEONARD G & TAMMY A H/W	2.54	B,C
014-260-048	ACOSTA, ALEJANDRO & MARTHA L H/W	2.50	B,C
014-260-049	HAMBLIN, CHARLES & MARGARET LIVING TRUST	11.71	B,C
014-260-051	BOULLOSA, JEFFREY M & LISA M H/W	2.70	B,C
014-260-056	SIDA, JAVIER & LISA J H/W	3.50	B,C
014-260-057	AZEVEDO, JOAO M & TRINDA S H/W	2.70	B,C
014-260-061	SAPIEN, JUAN JR	2.87	B,C
014-260-065	SOUTHERN PACIFIC TRANSPORTATION CO	13.05	B,C
014-260-066	SOUTHERN PACIFIC TRANSPORTATION CO	19.52	B,C
014-260-068	VALLE MAGIA FARMS LLC	129.28	B,C
014-260-073	VALLE MAGIA FARMS LLC	12.86	B,C
014-260-077	GILL'S TRUCK STOP GP	5.32	B,C
014-260-080	VALLE MAGIA FARMS LLC	4.13	B,C
014-260-085	SALAS, DANIEL C & JAMIE H/W	6.13	B,C
014-260-089	FELIPE FAMILY TRUST	10.11	B,C
014-260-090	FELIPE FAMILY TRUST	10.00	B,C
014-260-091	FELIPE FAMILY TRUST	10.00	B,C
014-260-101	SOUTHERN CALIFORNIA EDISON CO	4.95	B,C
014-260-105	STATE OF CALIFORNIA	3.54	B,C
014-260-107	HURST JOHN CAMPBELL III	20.70	B,C
014-260-108	FERRELL, DENNIS D & PATRICIA L H/W	6.39	B,C
014-260-109	FERRELL, DENNIS D & PATRICIA L M/C 90%	5.10	B,C
014-260-111	RICHARDS FAMILY LAND LLC	151.83	B,C
014-260-113	STATE OF CALIFORNIA	25.12	B,C
014-260-114	EBC FARMS LLC	26.04	B,C
014-260-115	EBC FARMS LLC	36.05	B,C
014-260-116	MARQUEZ INVESTMENT GROUP LLC	49.40	B,C
014-270-002	VEENENDAAL, JOSHUA 25%	8.00	B,C
014-270-003	GIACOMAZZI, DINO J 2007 IRREVOCABLE TR	139.54	B,C
014-270-005	GIACOMAZZI, FRED & DONALD FARMS 94.79%	77.68	B,C
014-270-021	GARCIA, ANTONIO & MARIA FAMILY TRUST THE	7.40	B,C
014-270-028	GARCIA, ANTONIO & MARIA H/W JT	4.72	B,C
014-270-029	GIACOMAZZI, FRED & DONALD FARMS 94.79%	140.62	B,C
014-270-030	SOUTHERN PACIFIC TRANSPORTATION CO	6.30	B,C
014-270-031	SOUTHERN PACIFIC TRANSPORTATION CO	5.21	B,C
014-270-039	DE HOOP, ART & ELLIE REV TRUST	20.22	B,C
014-270-040	DE HOOP, ART & ELLIE REV TRUST	17.83	B,C
014-270-041	DE HOOP, ART & ELLIE REV TRUST	17.91	B,C
014-270-042	DE HOOP, ART & ELLIE REVOC FAMILY TRUST	17.91	B,C
014-270-043	GIACOMAZZI, FRED & DONALD FARMS 94.79%	127.33	B,C

APN	Record Owner	Acres	Pumping Zone
014-270-044	WARD FAMILY TRUST	20.00	B,C
014-270-045	WARD FAMILY TRUST THE	2.50	B,C
014-400-001	HART FAMILY TRUST	2.51	B,C
014-400-002	CARDOSO, RICARDO G & PAMELA M H/W	2.53	B,C
014-400-003	SOTO, JOE A & SOPHIA H/W	2.53	B,C
014-400-004	PAYSSE, JOHN G & APRIL D H/W	2.51	B,C
014-400-005	DELACRUZ STEVEN	2.65	B,C
014-400-006	RODRIGUEZ, ZENAIDA & FELIBERTO W/H	2.65	B,C
014-400-007	SPINDOLA CAMPOS MARCO ANTONIO	2.51	B,C
014-400-008	ELLIS, COLT & MELISSA L H/W	2.54	B,C
014-400-009	ESSEPIAN, STEVE & LAURA G H/W JT	2.51	B,C
014-400-010	GARZA, ARNOLD & KAREN L H/W	2.53	B,C
014-400-011	CHAP, CHANTHOEUN	2.53	B,C
014-400-012	MATTAS FAMILY TRUST	2.51	B,C
014-410-004	STATE OF CALIFORNIA	2.93	B,C
014-540-005	MASON, MARK W & MICHAELE L H/W	2.25	B,C
014-810-003	HURST JOHN CAMPBELL III	11.55	B,C
014-810-004	HURST JOHN CAMPBELL III	11.55	B,C
014-810-005	HURST JOHN CAMPBELL III	12.84	B,C
014-810-006	HURST JOHN CAMPBELL III	11.35	B,C
014-810-007	HURST JOHN CAMPBELL III	11.60	B,C
014-810-008	HURST JOHN CAMPBELL III	11.55	B,C
014-810-009	HURST JOHN CAMPBELL III	11.55	B,C
014-810-010	HURST JOHN CAMPBELL III	11.55	B,C
014-810-013	STATE OF CALIFORNIA	8.02	B,C
014-810-015	STATE OF CALIFORNIA	7.19	B,C
014-810-017	HURST JOHN CAMPBELL III	15.89	B,C
014-810-018	HURST JOHN CAMPBELL III	15.07	B,C
014-830-002	GOMES FAMILY LIVING TRUST	4.91	B,C
014-830-003	GOMES FAMILY LIVING TRUST	4.88	B,C
014-830-006	EDWARDS, LUCILLE G REVOCABLE TRUST	4.49	B,C
014-830-007	THOMAS, KELLI A	3.04	B,C
014-830-011	WEST, PHILLIP H TRUST	20.08	B,C
014-830-013	HERT FAMILY GRANTOR TRUST	2.54	B,C
014-830-014	SISNEROZ, ROBERT A & RAYLENE H/W	2.07	B,C
014-830-017	LOOGMAN, JAMES A & NANCY A H/W	24.04	B,C
014-830-019	ARMBRUSTER, BARBARA M TRUST	23.36	B,C
014-830-020	MARTINEZ, RUBEN M & PATRICIA A H/W	2.65	B,C
014-830-021	MARTINEZ, PATRICIA A & RUBEN M W/H	2.58	B,C
014-830-022	ARMBRUSTER, BARBARA M TRUST	22.23	B,C
014-830-024	ASAKI, THOMAS S & RUTH K FAMILY TRUST	2.17	B,C
014-830-025	DRUMMOND FAMILY LIVING TRUST	2.17	B,C
014-830-026	DAVIS, WALTER J & GLENDA S LIVING TRUST	2.17	B,C
016-032-009	HANFORD CEMETERY ASSN	33.41	B,C
016-032-010	ALDAR MINI STORAGE LP	16.80	B,C
016-032-012	ALDAR MINI STORAGE LP	12.90	B,C
016-032-016	24-A DISTRICT AGRICULTURE ASSN THE	79.72	B,C
016-032-017	SMITH, HOWARD M REVOCABLE TRUST	4.56	B,C

APN	Record Owner	Acres	Pumping Zone
016-041-001	PANELLA PROPERTIES LTD	9.42	B,C
016-041-003	DANNY AND ELLEN BERGSTROM REVOCABLE LIVING TRUST	2.50	B,C
016-041-004	SOLIS, MARTIN VIEYRA	2.47	B,C
016-041-014	PICAZO CHRISTOPHER E	2.00	B,C
016-041-026	NUNES, CHARLES P & DARLENE M H/W	2.00	B,C
016-041-036	DANELL, RANCE	4.64	B,C
016-041-037	LEMAY, HEATHER	2.57	B,C
016-041-038	RUVALCABA AMALIA 50%	2.53	B,C
016-041-040	MEREDITH, JOHN E & LYN M H/W	2.50	B,C
016-041-041	RODRIGUEZ, TERESA	2.50	B,C
016-041-046	LOPEZ, JAMES & VERONICA H/W	2.13	B,C
016-041-047	ATKINS RAY D & CARLA	2.18	B,C
016-042-012	DE LEON, JAVIER J & SOCORRO LIV TRUST 0	2.33	B,C
016-042-013	BURGESS STONE BORBOLLA	2.34	B,C
016-042-016	DANELL, DANNY & LINDA LIV TRUST	6.40	B,C
016-042-019	DANELL, RANCE & DENISE LIVING TRUST	9.00	B,C
016-042-024	OLAM WEST COAST INC	7.45	B,C
016-042-031	LK RANCHES PTP	6.26	B,C
016-042-032	DANELL, RANCE 2005 IRREV TRUST	3.78	B,C
016-042-033	DANELL, DANNY & LINDA LIV TRUST	18.53	B,C
016-042-043	BRADFORD, MARK C	2.43	B,C
016-042-048	MURRAY, JOHN JR & BEATRIZ H/W	2.52	B,C
016-042-049	ELLIOTT, MARTY & DIANA H/W	2.52	B,C
016-042-050	SIMOES, JOSE M & MARIA F H/W JT	2.52	B,C
016-042-051	HATFIELD CODY	2.52	B,C
016-042-052	CARNLEY MELVIN D & FRANCES	3.27	B,C
016-042-053	CHACON GILBERT PATRICK SPECIAL NEEDS TRUST	2.52	B,C
016-042-054	SANCHEZ RITA	2.23	B,C
016-042-057	THE RICHARD J. AVILA AND SUSAN J. AVILA REVOCABLE	2.00	B,C
016-042-061	ARCHER-GREEN TRUST	3.14	B,C
016-042-064	OLAM WEST COAST INC	16.92	B,C
016-042-069	ELLIOTT JAMES ROBERT & CLARK SOPHIA JANE	2.39	B,C
016-042-070	MARROQUIN, HECTOR C & DIANA L H/W	2.39	B,C
016-042-076	KLING, JERRY & BEVERLY LIVING TRUST	8.44	B,C
016-043-011	CLEMENT, LONNIE J	4.67	B,C
016-043-012	WEAVER, MELVON C & MARDEL I TRUST	2.07	B,C
016-043-020	JESPERSEN, CHARLENE REVOCABLE TRUST THE	7.06	B,C
016-043-023	JESPERSEN, CHARLENE REVOCABLE TRUST THE	2.97	B,C
016-043-027	BARBEIRO, MYRON A & JANET L LIV TRUST	2.30	B,C
016-043-028	ELLIOTT, KINNEY L & CHERYL H/W	2.39	B,C
016-043-032	ROGERS, DOYLE J & CHARLOTTE M H/W	2.45	B,C
016-043-039	HATFIELD FAMILY TRUST	2.06	B,C
016-043-042	LOWRIE FAMILY PARTNERSHIP	3.33	B,C
016-043-043	LOWRIE FAMILY PARTNERSHIP	3.84	B,C
016-043-052	BINDING CONTRACT LLC	12.09	B,C
016-060-006	HIDDEN VALLEY GROUP LLC	9.72	B,C
016-060-009	TRI WEST INVESTMENTS LLC	34.73	B,C
016-060-011	TRI WEST INVESTMENTS LLC	80.00	B,C

APN	Record Owner	Acres	Pumping Zone
016-060-012	TRI WEST INVESTMENTS LLC	80.00	B,C
016-060-014	COELHO, LAWRENCE & SHIRLEY REVOC TRUST	33.65	B,C
016-060-022	TRI WEST INVESTMENTS LLC	71.00	B,C
016-060-024	COELHO, LAWRENCE & SHIRLEY REVOC TRUST	14.10	B,C
016-060-027	JESPERSEN, CHARLENE REVOCABLE TRUST THE	13.50	B,C
016-060-036	BRASIL JOAO E & LILIAN	2.50	B,C
016-060-037	SOUSA, BRIAN A & JENNIFER A H/W	2.18	B,C
016-060-038	OVERLAND STOCK YARDS	20.00	B,C
016-060-040	OVERLAND STOCKYARDS	10.00	B,C
016-060-041	COELHO, LAWRENCE & SHIRLEY 1995 TRUST	47.74	B,C
016-060-045	EVETTS, MONTY H P	3.55	B,C
016-060-046	OVERLAND STOCK YARDS	8.08	B,C
016-060-053	MALTA BERNARDO & MARISELA	5.11	B,C
016-060-054	MALTA, BERNARDO	4.88	B,C
016-060-056	PANNU, KAWALJIT S	4.70	B,C
016-060-057	PANNU KAWALJIT S	5.45	B,C
016-060-058	PANNU, KAWALJIT S	7.55	B,C
016-070-005	DANELL, MICHAEL J BYPASS TRUST 33.33%	73.11	B,C
016-070-009	DANELL BROTHERS FARMS A PTP	20.00	B,C
016-070-010	TAYLOR, EARLE W	10.00	B,C
016-070-015	BAKER RENDERING CORP	49.90	B,C
016-070-021	JOHN C JAQUES & SON DAIRY GP	60.60	B,C
016-070-026	JACQUES, JOHN C & SON DAIRY GN PTP	40.00	B,C
016-070-027	JOHN C JAQUES AND SON DAIRY	60.00	B,C
016-070-031	GAITAN, ADRIAN	2.00	B,C
016-070-032	SANTOS, HAMILTON & JOSEPHINE H/W	5.00	B,C
016-070-037	LEVARIO, ELSIE FAMILY TRUST	2.16	B,C
016-070-042	LEVARIO, DENNIS & DONNA LIV TRUST 50%	9.28	B,C
016-070-043	EGC INVESTMENTS	42.00	B,C
016-070-045	CORREIA, FAMILY TRUST	6.90	B,C
016-070-046	BORGES, CARLOS & LUZIA TRUST	7.08	B,C
016-070-049	STATE OF CALIFORNIA	2.50	B,C
016-070-050	GONZALEZ, DAVID & MARIA A H/W	2.50	B,C
016-070-051	COX, WALLACE G & ALICE 50% H/W	2.50	B,C
016-070-055	DENHAM, ROGER A & FLORENCE A H/W	4.42	B,C
016-070-056	WIENS, BARBARA A LIVING TRUST	3.20	B,C
016-070-057	TIPTON FAMILY LIVING TRUST	2.50	B,C
016-070-060	DUTRA, EDWARD S	5.10	B,C
016-070-061	GARZA, IGNACIO G LIVING TRUST	5.00	B,C
016-070-062	NEW MEDIA BROADCASTING INC	15.00	B,C
016-070-063	NEW MEDIA BROADCASTING INC	24.09	B,C
016-070-064	TIPTON, ERIC S & BRITTANEE I H/W	2.94	B,C
016-070-066	MEYER FAMILY TRUST	2.55	B,C
016-070-067	ELLIS, JOHN & LYNNE FAMILY TRUST	2.55	B,C
016-070-068	ENRIQUEZ, MARTIN & ROCIO REVOC TRUST	2.50	B,C
016-070-070	DANELL, MICHAEL J BYPASS TRUST 33.33%	6.32	B,C
016-070-073	MARTIN, EXAUL & MARLEN E H/W 50%	4.27	B,C
016-070-074	SMITH, JOHN T & MARTHA G H/W	2.50	B,C

APN	Record Owner	Acres	Pumping Zone
016-070-075	WILLARD, JAMES E & JUDY F H/W	13.01	B,C
016-070-076	LEAL, DANIEL & BELLE LIVING TRUST	17.79	B,C
016-070-077	JACQUES, JOHN C & SON DAIRY GN PTP	43.03	B,C
016-070-078	SANTOS, JOHN A & CIDALIA H/W	2.02	B,C
016-070-079	SANTOS, HAMILTON A & JOSEPHINE H/W	4.96	B,C
016-070-080	BRASIL, JOE I BYPASS TRUST 50%	2.50	B,C
016-070-081	TAMEZ, RICARDO V & GLORIA G H/W JT	2.50	B,C
016-070-082	ENRIQUEZ, MARTIN & ROCIO REVOC TRUST	6.51	B,C
016-070-083	BAKER COMMODITIES INC	27.42	B,C
016-070-084	GUTIERREZ MARIA PATRICIA 50%	12.67	B,C
016-070-086	LARA, ERNESTO S & ARAGON, AQUILINA H	2.39	B,C
016-070-087	MORALES, DAVID C & ANTOINETTE H/W	2.39	B,C
016-070-088	KELLENBERGER, DAVID & TAMMI LIVING TRUST	3.07	B,C
016-070-089	JAMES, ANDREW A 50%	2.27	B,C
016-070-090	LEAL, DANIEL & BELLE LIVING TRUST	38.59	B,C
016-070-092	LEAL, DANIEL & BELLE LIVING TRUST	16.83	B,C
016-070-096	JACQUES, JOHN C & SON DAIRY GN PTP	2.77	B,C
016-070-097	JACQUES, JOHN C & SON DAIRY GN PTP	57.26	B,C
016-070-098	JACQUES, JOHN C & SON DAIRY GN PTP	19.21	B,C
016-070-099	JACQUES, JOHN C & SON DAIRY GN PTP	7.10	B,C
016-070-101	KINGS COUNTY WATER DISTRICT	47.34	B,C
016-070-102	JACQUES, JOHN C & SON DAIRY GN PTP	107.53	B,C
016-070-104	CORONADO, FLORIBERTA	2.33	B,C
016-070-106	BAKER COMMODITIES, INC	36.92	B,C
016-070-107	BAKER RENDERING CORP	25.49	B,C
016-070-108	STATE OF CALIFORNIA	4.51	B,C
016-070-109	STATE OF CALIFORNIA	19.37	B,C
016-070-110	BAKER RENDERING CORP	60.63	B,C
016-070-112	STATE OF CALIFORNIA	8.59	B,C
016-070-117	COELHO, GLORIA J LIVING TRUST	69.09	B,C
016-070-119	COELHO, GLORIA J LIVING TRUST	4.31	B,C
016-070-121	COELHO, GLORIA J LIVING TRUST	61.54	B,C
016-080-010	GOMES, EVELYN M 33.334%	2.81	B,C
016-080-011	ROCHA, ROBERT	117.19	B,C
016-080-012	LAKESIDE IRRIGATION WATER DISTRICT	318.89	B,C
016-080-032	RODRIGUEZ, AUDOMERO & CELIA H/W	2.50	B,C
016-080-041	RODRIGUEZ, NARCISCO	6.62	B,C
016-080-042	RODRIGUEZ, VICENTE	4.24	B,C
016-080-046	ROCHA, ROBERT	185.01	B,C
016-120-001	ROCHA, ROBERT	90.96	B,C
016-120-003	HEADRICK, DON & MELANIE LIVING TRUST	77.02	B,C
016-120-012	MELLO, JOHN & SHANDA LIVING TRUST	139.18	B,C
016-120-013	NAVARRO, LUIS V III	7.00	B,C
016-120-020	ROCHA, ROBERT	16.94	B,C
016-120-021	JOHN & SHANDA MELLO LIVING TRUST	3.00	B,C
016-120-023	KUIPER, MICAH L & MAUREEN J H/W	3.83	B,C
016-120-025	MELLO, CHIP & KELLY H/W	5.02	B,C
016-120-026	MELLO, CHIP & KELLY H/W	5.03	B,C

APN	Record Owner	Acres	Pumping Zone
016-120-028	CHAMPLIN, SHAWN & CHANDALIN LIV TRST 50%	75.03	B,C
016-120-036	ROCHA, ROBERT	171.37	B,C
016-120-037	KINNEY FAMILY TRUST	24.00	B,C
016-120-040	KINNEY FAMILY TRUST	18.00	B,C
016-120-041	KINNEY FAMILY TRUST	20.00	B,C
016-120-043	KINNEY, CHARLES W & MARY T H/W	2.00	B,C
016-120-045	RICHARDS, TARA	2.00	B,C
016-120-049	KINNEY FAMILY TRUST	2.31	B,C
016-130-010	KINGS WASTE & RECYCLING AUTHORITY	18.60	B,C
016-130-016	CHAMPLIN, STANLEY MARITAL TRUST 50%	73.86	B,C
016-130-019	DE SANTOS RUDOLPH R	4.62	B,C
016-130-023	SANDERS, HERBERT L JR & BETTY J H/W JT	5.00	B,C
016-130-028	RODRIGUEZ, SANTIAGO 16.66%	2.51	B,C
016-130-029	NORWOOD SUSIE	2.61	B,C
016-130-030	MELLO, JOHN & SHANDA LIVING TRUST	76.94	B,C
016-130-037	MELLO, JOHN & SHANDA LIVING TRUST	125.17	B,C
016-130-044	TOSTE, MANUEL B & MARIA L H/W	62.00	B,C
016-130-045	LEAL, DANIEL & BELLE LIVING TRUST	149.74	B,C
016-130-046	MELLO, CHIP & KELLY H/W	2.50	B,C
016-130-048	MELLO, CHIP & KELLY H/W	2.50	B,C
016-130-051	KINGS WASTE & RECYCLING AUTHORITY	94.56	B,C
016-130-052	LEAL, CHERYL L	2.50	B,C
016-130-059	LEAL, DANIEL & BELLE LIVING TRUST	50.00	B,C
016-130-060	CALPORTLAND COMPANY	8.05	B,C
016-130-063	KINGS WASTE & RECYCLING AUTHORITY	3.85	B,C
016-130-065	LEAL, DANIEL & BELLE LIVING TRUST	149.07	B,C
016-130-067	COUNTY OF KINGS	18.46	B,C
016-130-074	JAMES, JANET J BYPASS TRUST 91%	6.10	B,C
016-130-075	JAMES, JANET BYPASS TRUST 91%	3.03	B,C
016-130-076	JAMES, JANET BYPASS TRUST 91%	3.03	B,C
016-130-077	JAMES, JANET BYPASS TRUST 91%	15.91	B,C
016-130-078	MELLO, CHIP & KELLY H/W	8.96	B,C
016-130-085	KINGS WASTE & RECYCLING AUTHORITY	112.27	B,C
016-130-092	BLUE FLY SWATTER PROPERTIES LLC	2.60	B,C
016-130-095	STATE OF CALIFORNIA	18.00	B,C
016-130-097	LEAL, DANIEL & BELLE LIVING TRUST	60.48	B,C
016-130-098	LEAL, DANIEL & BELLE LIVING TRUST	24.00	B,C
016-130-105	MELLO, CHIP & KELLY H/W	80.44	B,C
016-130-106	TRI WEST INVESTMENTS LLC	20.79	B,C
016-130-107	TRI WEST INVESTMENTS LLC	63.50	B,C
016-130-109	DJM SALES LLC	5.72	B,C
016-130-113	DJM SALES LLC	2.17	B,C
016-130-116	STATE OF CALIFORNIA	3.02	B,C
016-140-011	SOZINHO, JOE S & MARY M FAMILY TRUST	10.00	B,C
016-140-012	SOARES, VIRGINIA L LIV TRUST	59.14	B,C
016-140-014	SOZINHO FAMILY TRUST	40.00	B,C
016-140-018	SOZINHO FAMILY TRUST	20.00	B,C
016-140-025	DANELL, MICHAEL J BYPASS TRUST 33.33%	5.00	B,C

APN	Record Owner	Acres	Pumping Zone
016-140-029	GAITAN, REBA HOPE LIVING TRUST	2.00	B,C
016-140-030	ZWETSLOOT, TIA A	5.00	B,C
016-140-031	COELHO, GLORIA J LIVING TRUST	7.92	B,C
016-140-032	LOPEZ, FERNANDO & ANGELICA M H/W	2.00	B,C
016-140-034	PEREZ FAMILY TRUST	5.00	B,C
016-140-035	DANELL, MICHAEL J BYPASS TRUST 33.33%	5.00	B,C
016-140-036	SANCHEZ BROOKE LENA	2.00	B,C
016-140-038	LAKESIDE IRRIGATION WATER DISTRICT	4.68	B,C
016-140-044	DANELL CUSTOM HARVESTING LLC	4.41	B,C
016-140-045	DANELL CUSTOM HARVESTING LLC	4.41	B,C
016-140-047	SOZINHO FAMILY TRUST	5.00	B,C
016-140-048	SOZINHO FAMILY TRUST	7.68	B,C
016-140-049	CAETANA, JUSTIN	2.50	B,C
016-140-051	COELHO FAMILY REV LIV TRUST	2.50	B,C
016-140-052	COOLEY, JOEL & MELISSA H/W	7.50	B,C
016-140-053	WOUGHTER, EDWARD E & PATRICIA K H/W	2.50	B,C
016-140-055	ENOS, JOHNNY A & LILLIAN D H/W	2.50	B,C
016-140-056	BRAY, WILBERT R & RHONDA T H/W JT	5.00	B,C
016-140-058	SOZINHO FAMILY TRUST	12.94	B,C
016-140-059	SOZINHO FAMILY TRUST	9.99	B,C
016-140-061	SOZINHO FAMILY TRUST	9.98	B,C
016-140-062	FLATHERS, JEFFERY & CHAOYING SUN H/W 50%	2.03	B,C
016-140-066	MARTINEZ CASTRO FRANCISCO & CABRERA-PEREZ AIDE	2.51	B,C
016-140-067	NUNES, NICOLE D	5.01	B,C
016-140-068	MENDES, ANTHONY & BERTHA REV FAM TRUST	2.50	B,C
016-140-069	BRAY, WILBERT R	6.35	B,C
016-140-070	SOZINHO FAMILY TRUST THE	35.00	B,C
016-140-073	SOARES, VIRGINIA L LIV TRUST	38.65	B,C
016-140-074	SOZINHO, JOE S & MARY FAMILY TRUST	10.00	B,C
016-140-075	SOZINHO, JOE S & MARY M FAMILY TRUST	10.00	B,C
016-140-078	TRI WEST INVESTMENTS LLC	26.35	B,C
016-140-079	TRI WEST INVESTMENTS LLC	10.00	B,C
016-140-080	TRI WEST INVESTMENTS LLC	18.72	B,C
016-140-081	SOZINHO FAMILY TRUST	82.52	B,C
016-140-082	KEVERLINE FAMILY TRUST	4.20	B,C
016-140-083	GARCIA, TINA	5.13	B,C
016-140-084	SOZINHO FAMILY TRUST THE	11.92	B,C
016-140-085	SOZINHO FAMILY TRUST	133.53	B,C
016-140-087	TEIXEIRA, JOSE L & MARIA J H/W	2.87	B,C
016-140-088	TEIXEIRA, JOSE L & MARIA J H/W	2.87	B,C
016-140-089	ZWETSLOOT, HUGO N JR & DIANE L H/W	10.00	B,C
016-140-090	VEENENDAAL, DONNIE & SHELBY H/W	8.00	B,C
016-140-091	COTTA, JOE S & NATALIA L REV LIV TRST	2.00	B,C
016-140-093	SOZINHO FAMILY TRUST	18.95	B,C
016-140-094	SOZINHO FAMILY TRUST	30.08	B,C
016-140-095	RAMIA, ROSE J 2004 REVOCABLE TRUST	10.03	B,C
016-140-097	ALMUNTASER, MOSA N	9.34	B,C
016-140-100	HANFORD COMMUNITY HOSPITAL INC	2.55	B,C

APN	Record Owner	Acres	Pumping Zone
016-140-101	HANFORD COMMUNITY HOSPITAL INC	5.37	B,C
016-140-102	HANFORD COMMUNITY HOSPITAL INC	5.19	B,C
016-140-103	DANELL, DAVID & DEZERAYE LIV TRUST	2.32	B,C
016-140-104	DANELL, DANNY AND LINDA LIV REV TRUST 40%	35.35	B,C
016-150-001	DILLARD FAMILY REVOCABLE TRUST	2.50	B,C
016-150-004	HERNANDEZ, ELVIRA G 50%	10.00	B,C
016-150-005	BROWN, ORALEAN	3.61	B,C
016-150-010	ALCOSER, ALFRED R REV TRUST	3.00	B,C
016-150-024	GOMEZ, ROMALDO C 50%	5.00	B,C
016-150-025	GONZALEZ, RAFAEL 50%	5.00	B,C
016-160-010	JAURIGUI, CARLOS & VICTORIA A H/W 50%	5.00	B,C
016-160-014	TRUJILLO, LOUIE	2.50	B,C
016-160-015	LOPEZ, GUSTAVO & OTILIA REVOCABLE TRUST	4.00	B,C
016-160-033	CITY OF HANFORD	2.58	B,C
016-160-035	NICK CHAMPI ENTERPRISES INC	73.28	B,C
016-160-037	GUERRA, FELIPE J & PATRICIA H/W 50%	2.49	B,C
016-160-047	CITY OF HANFORD	63.90	B,C
016-160-048	CITY OF HANFORD	38.97	B,C
016-160-049	CITY OF HANFORD	21.85	B,C
016-160-050	CITY OF HANFORD	18.21	B,C
016-160-051	URBINA, ALEXIS	2.50	B,C
016-160-053	BARNETT, JAMES E & JANE E H/W	2.50	B,C
016-160-054	ALVES, AUGUSTINE III	2.50	B,C
016-160-055	AVALOS, LOUIS & CAROL FAMILY TRUST	2.50	B,C
016-160-056	NICK CHAMPI ENTERPRIES INC	2.65	B,C
016-160-058	HERNANDEZ GREG D 50% & LEMOS HERMINIA M 50%	2.49	B,C
016-160-059	MARISCAL JESUS 33.334% & MARIA TRINIDAD 33.333%	2.49	B,C
016-160-062	VEGA, JOSE GARCIA & LAURA MEDINA H/W	3.02	B,C
016-160-063	WASHINGTON, WILLIE JR & MAXINE J	2.07	B,C
016-160-065	VENEGAS, JESSE M	2.43	B,C
016-160-067	SCOTT, JOHN R & DARLEAN FAMILY TRUST	2.06	B,C
016-160-068	LEMOS, HERMINIA M	2.42	B,C
016-160-071	NICK CHAMPI ENTERPRISES INC	2.49	B,C
016-160-087	HA SEQUOIA LLC	9.95	B,C
016-160-088	HA SEQUOIA LLC	8.18	B,C
016-160-089	NELSON, DELORES	2.50	B,C
016-190-009	GRABOW, COLEEN SURVIVORS TRUST 50%	40.00	B,C
016-190-010	GRABOW, COLEEN SURVIVORS TRUST 50%	39.49	B,C
016-190-013	ALCALA FARMS CA GENERAL PARTNERSHIP	34.15	B,C
016-190-014	SANCHEZ TIMOTHY & TAMARA	33.35	B,C
016-190-015	SANCHEZ TIMOTHY & TAMARA	44.70	B,C
016-190-020	MELLO, CHIP J 17.4%	79.74	B,C
016-190-031	ALCALA FARMS A PTP	123.39	B,C
016-190-038	MELLO, CHIP J 50%	57.00	B,C
016-190-039	GAITAN, REBA HOPE LIVING TRUST	3.00	B,C
016-190-040	ARAUJO, ANTONIO & LUPE S H/W JT	2.50	B,C
016-190-041	CHAMBERS, KEVIN R JR & KATIE M H/W	2.50	B,C
016-190-042	LAFFERTY, DAVID W & SUSAN L H/W JT	2.50	B,C

APN	Record Owner	Acres	Pumping Zone
016-190-043	STRONG FAM REV LIVING TRUST	2.50	B,C
016-190-044	ALICEA FAMILY TRUST	8.81	B,C
016-190-050	MELLO, JOHN & SHANDA LIVING TRUST	230.12	B,C
016-190-052	PAULO, EDWARD M 50%	50.87	B,C
016-190-054	MELLO, CHIP J 33.333%	156.62	B,C
016-190-055	BRASIL JOE EDUINO & SOZINHO BRASIL JEANA F	10.00	B,C
016-190-056	BRASIL JOE EDUINO & SOZINHO BRASIL JEANA F	10.00	B,C
016-190-057	GRABOW, COLEEN SURVIVORS TRUST 50%	39.47	B,C
016-190-058	GRABOW, COLEEN SURVIVORS TRUST 50%	38.22	B,C
016-190-059	RABER FAMILY LIVING TRUST	37.59	B,C
016-190-061	SANCHEZ DENNIS J TRUST	69.52	B,C
016-190-062	SANCHEZ DENNIS J TRUST	2.50	B,C
016-190-063	ENRIQUEZ, MARTIN & ROCIO REVOC TRUST	10.00	B,C
016-190-064	RABER FAMILY LIVING TRUST	8.03	B,C
016-190-065	GRABOW, COLEEN SURVIVORS TRUST 50%	38.42	B,C
016-190-070	FRAGOSO, JARED L & CRYSTAL M H/W	28.38	B,C
016-190-071	MARTELLA, RICHARD REVOC TRUST 50%	29.07	B,C
016-190-074	MARTIN, DOUGLAS E 50% 0	2.33	B,C
016-190-075	MARTIN, DOUGLAS E 50% 0	23.48	B,C
016-200-005	SOZINHO DAIRY #5 INC	39.08	B,C
016-200-011	MARTELLA, NICKLUS E & ANNA M H/W	154.52	B,C
016-200-012	CHAMPLIN, STANLEY MARITAL TRUST 50%	79.09	B,C
016-200-015	ROCKEYE INSECT AND WEED MUNITIONS CO LLC	68.50	B,C
016-200-016	HAMPSHIRE, EDITH C REVOCABLE TRUST	80.00	B,C
016-200-018	KAWEAH DELTA WATER CONSERVATION DISTRICT	160.00	B,C
016-200-019	MARTELLA, NICKLUS E & ANNA M H/W	76.71	B,C
016-200-024	KAWEAH DELTA WATER CONSERVATION DISTRICT	25.07	B,C
016-200-028	SOZINHO DAIRY #5 INC	38.87	B,C
016-200-034	STATE OF CALIFORNIA	3.00	B,C
016-200-035	SOZINHO FAMILY TRUST	76.00	B,C
016-200-037	ARNOLD (CA) LLC	53.19	B,C
016-200-038	CHAMPLIN, STANLEY MARITAL TRUST 50%	2.16	B,C
016-200-039	CHAMPLIN, STANLEY MARITAL TRUST 50%	64.78	B,C
016-200-041	SOZINHO DAIRY #5 INC	100.71	B,C
016-200-042	FRAGOSO, JOHN L JR	19.48	B,C
016-200-043	DIAS, GABRIEL M	19.58	B,C
016-200-049	BRAZIL ANDREW W & GEANETTE N	19.75	B,C
016-200-053	J L FRAGOSO CATTLE COMPANY LLC	35.44	B,C
016-200-056	SOZINHO FAMILY TRUST	35.26	B,C
016-200-057	STATE OF CALIFORNIA	3.96	B,C
016-200-059	STATE OF CALIFORNIA	5.40	B,C
016-200-060	BRAZIL, ROBERT E REVOC TRUST	90.33	B,C
017-010-001	HAWK, STAN & LOIS LIVING TRUST	20.15	A,B,C
017-010-002	ROCHA, RICK & RITA 1999 FAMILY TRUST	2.97	A,B,C
017-010-003	HAWK, STAN & LOIS LIVING TRUST	34.03	A,B,C
017-010-004	BARRETO FAMILY AG PARTNERSHIP GP 50%	245.75	A,B,C
017-010-005	SANDRIDGE PARTNERS LP	20.10	A,B,C
017-010-006	SANDRIDGE PARTNERS LP 98%	20.09	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-010-007	SANDRIDGE PARTNERS LP 98%	20.13	A,B,C
017-010-008	SANDRIDGE PARTNERS LP 98%	20.14	A,B,C
017-010-009	SANDRIDGE PARTNERS LP 98%	20.14	A,B,C
017-010-010	SANDRIDGE PARTNERS LP 98%	20.14	A,B,C
017-010-011	ALCARAZ GERARDO ESPINO & CARACOZA SANDRA DIANA	10.08	A,B,C
017-010-012	GARCIA, RAYMOND & EVALENA FAMILY TRUST	5.00	A,B,C
017-010-013	GARCIA, RAYMOND & EVALENA FAMILY TRUST	5.08	A,B,C
017-010-014	MENEZES RODGER ALVIN	58.97	A,B,C
017-010-015	MARTINS, JOHN A & AMY H/W	78.98	A,B,C
017-010-016	MARTINS, JOHN & AMY H/W	34.38	A,B,C
017-010-017	GINGLES, MICHAEL T & LUPE H/W	3.09	A,B,C
017-010-018	DANIEL ARNOLD VEIGA & SUSAN ROSE VEIGA REV LIV TRU	2.01	A,B,C
017-010-019	POND, MICHAEL A & BROOKE M H/W	2.00	A,B,C
017-010-020	COTTA, M RICHARD	5.21	A,B,C
017-010-021	HAWK, STAN & LOIS LIVING TRUST	7.66	A,B,C
017-010-023	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	2.65	A,B,C
017-010-024	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	2.65	A,B,C
017-010-025	ROSE, JASON 50%	20.00	A,B,C
017-010-026	ROSE, JASON 50%	20.00	A,B,C
017-010-027	GAGNE, RODNEY D & CYNTHIA M REV FAM TRUST	18.53	A,B,C
017-010-029	GRAHAM COMMERCIAL PROPERTIES LP	20.00	A,B,C
017-010-030	GRAHAM COMMERCIAL PROPERTIES LP	5.11	A,B,C
017-010-032	LOUIS R OLIVEIRA AND GAREN A OLIVEIRA FAM TRUST	29.12	A,B,C
017-010-034	LAST CHANCE WATER DITCH CO	2.52	A,B,C
017-010-035	ZHANG TING TING	5.76	A,B,C
017-010-036	ARMONA COMMUNITY SERVICES DISTRICT	7.69	A,B,C
017-010-037	LEMOORE CEMETERY DISTRICT	20.00	A,B,C
017-010-038	MENEZES RODGER ALVIN	20.00	A,B,C
017-010-039	LEMOORE CEMETERY DISTRICT	27.47	A,B,C
017-010-040	MENEZES RODGER ALVIN	16.00	A,B,C
017-010-041	HALL, GLENN L & DONNA M 1992 TRUST	10.00	A,B,C
017-010-042	HALL, GLENN L & DONNA M 1992 TRUST	3.64	A,B,C
017-010-043	LEMOORE CEMETERY DISTRICT	8.45	A,B,C
017-010-044	BENNETT, GARY BYPASS TRUST	2.66	A,B,C
017-010-047	DAVIDSON, PETER D & LISA A H/W	19.00	A,B,C
017-010-049	HALL, GLENN L & DONNA M 1992 TRUST	6.00	A,B,C
017-010-050	CENTRAL CA CONF ASSN OF 7TH DAY ADVENT	9.15	A,B,C
017-010-052	CENTRAL CA CONF ASSN OF 7TH DAY ADVENT	3.13	A,B,C
017-010-053	DILLON WILLIAM JAMES & LOLA F REV TRUST TR	3.14	A,B,C
017-010-066	BATES, E G 50%	2.00	A,B,C
017-010-070	CAMARA, GLENDA FAY 50% LF ESTATE & JOHN THOMAS 50%	68.00	A,B,C
017-010-071	ROCHA, RICK & RITA 1999 FAMILY TRUST	16.12	A,B,C
017-010-075	ROCHA, RICK & RITA 1999 FAMILY TRUST	10.01	A,B,C
017-010-076	ROCHA, RICK & RITA 1999 FAMILY TRUST	10.01	A,B,C
017-010-078	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	8.75	A,B,C
017-010-079	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	10.00	A,B,C
017-010-080	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	40.00	A,B,C
017-010-081	MENEZES RODGER ALVIN	40.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-010-082	THE RODNEY GAGNE AND CYNTHIA M. GAGNE REVOCABLE TR	20.00	A,B,C
017-010-083	MARTELLA, LAWRENCE W & RUTH E TRUST	2.50	A,B,C
017-010-084	SMITH, DENNIS C & MARIA L H/W	2.50	A,B,C
017-010-085	COTTA, STANLEY S 50%	2.29	A,B,C
017-010-086	MILLER DAMON I	2.74	A,B,C
017-010-088	ANDRES, ALBERTO P & ADELINA M 2008 TRUST	2.70	A,B,C
017-100-001	VERDEGAAL BROTHERS A PTP	16.74	A,B,C
017-100-003	VERDEGAAL BROTHERS INC 77%	8.72	A,B,C
017-100-005	THE RICHARD J. AVILA & SUSAN J. AVILA REVOCABLE TR	136.06	A,B,C
017-100-006	THE RICHARD J. AVILA & SUSAN J. AVILA REVOCABLE TR	2.50	A,B,C
017-100-009	CAF LLC	8.59	A,B,C
017-100-010	CAF LLC	67.17	A,B,C
017-100-012	ASPIRE HOMES CA, INC	15.06	A,B,C
017-100-013	ASPIRE HOMES CA INC	5.02	A,B,C
017-100-025	VERDEGAAL BROTHERS A PTP	28.46	A,B,C
017-100-027	VERDEGAAL, GEORGE & KIMBERLY LIV TRUST 33%	8.72	A,B,C
017-110-003	MATTICE, BARBARA L	26.50	A,B,C
017-110-004	HOOPER FAMILY 2010 TRUST THE 50% & THE HEAVY META	10.00	A,B,C
017-110-007	HEAVY METAL 2022 TRUST 50%	14.80	A,B,C
017-110-008	TDH LAND & CATTLE LLC	26.07	A,B,C
017-170-001	MURRAY JOHN JR & BEATRIZ	4.26	A,B,C
017-170-002	HAMILTON, REBA E LF EST	5.00	A,B,C
017-170-003	RAISKUP, KYLE R	5.00	A,B,C
017-170-004	MENDES, JOAO R & ROSA N LF ESTATE	7.04	A,B,C
017-170-008	VELASQUEZ, JULIAN, & GLORIA E H/W	13.10	A,B,C
017-170-009	VELASQUEZ, JULIAN & GLORIA E H/W	2.50	A,B,C
017-170-010	VELASQUEZ, JULIAN & GLORIA E H/W	2.50	A,B,C
017-170-011	E & C FARMS LLC	20.96	A,B,C
017-170-012	BASS, CHARLOTTE D	3.24	A,B,C
017-170-013	BASS, CHARLOTTE D	4.14	A,B,C
017-170-014	CMV TIMES 3 HOLDINGS LLC	2.06	A,B,C
017-170-015	BICKNER, STEVE L & DAWN LIVING TRUST	37.47	A,B,C
017-170-019	VAN DER GRAAF, A & R LIV TRUST 75%	23.12	A,B,C
017-170-021	VAN DER GRAAF, A & R LIV TRUST 75%	23.67	A,B,C
017-170-022	VAN DER GRAAF, A & R LIV TRUST 75%	6.76	A,B,C
017-170-025	FAGUNDES, KEITH & RENEA H/W	20.00	A,B,C
017-170-026	FAGUNDES KEITH L & RENEA L	2.78	A,B,C
017-170-027	US HORTICULTURE FARMLAND LLC	35.30	A,B,C
017-170-028	PEDERSEN, ROBERT & MARDELL LIV TR	2.50	A,B,C
017-170-029	ALVARADO, ALBERT	2.00	A,B,C
017-170-030	US HORTICULTURE FARMLAND LLC	16.07	A,B,C
017-170-031	GARCIA ANGELINA REVOCABLE TRUST	2.50	A,B,C
017-170-033	PARSONS, MELISSA A	2.98	A,B,C
017-170-034	BROWN, LEONARD G	2.79	A,B,C
017-170-035	BARNES, FRANK R & KIRSTEN A S H/W	2.60	A,B,C
017-170-036	LOPEZ, JORGE V	2.41	A,B,C
017-170-037	GARCIA, MANUEL H 33.333%	2.32	A,B,C
017-170-038	GALLEGOS, ANTHONY S & CAROL J H/W	2.29	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-170-039	BROWN FAMILY REV LIVING TRUST	2.25	A,B,C
017-170-040	TISCHMACHER, BRIAN D & STEPHANIE L H/W	3.45	A,B,C
017-170-043	MARTIN FAMILY TRUST THE	2.50	A,B,C
017-170-044	US HORTICULTURE FARMLAND LLC	19.02	A,B,C
017-170-045	US HORTICULTURE FARMLAND LLC	18.70	A,B,C
017-170-046	US HORTICULTURE FARMLAND LLC	30.10	A,B,C
017-170-047	US HORTICULTURE FARMLAND LLC	150.89	A,B,C
017-170-048	US HORTICULTURE FARMLAND LLC	17.67	A,B,C
017-170-049	MARTIN MATTHEW F & KRISTI L 2022 REV TRUST 50%	2.50	A,B,C
017-170-050	MARTIN FAMILY TRUST THE	11.55	A,B,C
017-170-051	MARTIN, DONALD & SANDRA LIVING TRUST	3.60	A,B,C
017-170-052	MCCALLISTER FAMILY REVOCABLE TRUST	2.86	A,B,C
017-170-053	SOUTHERN PACIFIC TRANSPORTATION CO	12.50	A,B,C
017-170-061	FORD, FRANCES A 33.334%	5.75	A,B,C
017-170-062	AMBE PROPERTIES LLC	2.50	A,B,C
017-170-063	MARTELLA, JULIE SURVIVOR'S TRUST	20.45	A,B,C
017-170-068	MARTELLA, JULIE SURVIVOR'S TRUST	20.63	A,B,C
017-170-070	OUELLETTE, WALTER E & HELEN J H/W	10.00	A,B,C
017-280-013	PARCUS PROPERTIES A PTP	3.31	A,B,C
017-280-020	SILVA, CLARA MARITAL TRUST 50%	3.39	A,B,C
017-280-021	BLACK OAK LLC	10.29	A,B,C
017-280-022	VETERINARY PHARMACEUTICALS INC	10.69	A,B,C
017-280-026	LEWIS, MICHAEL D 33.334% & SIVERLY, DEBORAH A 33.3	2.50	A,B,C
017-280-027	BLACK OAK LLC	4.10	A,B,C
017-280-028	RIDER, TODD DAVID	4.50	A,B,C
017-280-032	LUGO, JOE A & KATHY M H/W	3.12	A,B,C
017-280-033	KENDALL-FARRAR SHARON & FARRAR DAVID W/H	7.17	A,B,C
017-280-035	RAEBER, MARK W & DEANNA H/W	2.29	A,B,C
017-280-036	BORGES, PAUL & DARLENE H/W	2.44	A,B,C
017-280-037	SALAZAR, SALVADOR E	4.88	A,B,C
017-280-038	BECK, VIRGIL L TRUST	2.00	A,B,C
017-280-042	NEVES, CARL F LIVING TRUST	47.79	A,B,C
017-280-043	ARMONA ELEMENTARY SCHOOL DISTRICT	10.02	A,B,C
017-280-045	BELTRAN, PAULINO RUIZ & ABIGAIL ALVARADO H/W	10.78	A,B,C
017-280-046	SLENDERS, ANDREW J JR & ARLETE M TRUST	12.82	A,B,C
017-280-047	JOHN SLENDERS JR & ARLETE M SLENDERS TRUST	2.50	A,B,C
017-280-048	ANDRE, TONY P & CARRIE H/W 66.667%	10.45	A,B,C
017-280-062	GUTIERREZ PROPERTIES LLC	2.11	A,B,C
017-280-063	GODINEZ, ANTONIO R & ELVIRA H/W	2.89	A,B,C
017-290-001	MIDDLEFIELD MANOR LLC	11.00	A,B,C
017-290-002	MIDDLEFIELD MANOR LLC	11.00	A,B,C
017-290-003	MIDDLEFIELD MANOR LLC	10.03	A,B,C
017-290-004	MIDDLEFIELD MANOR LLC	10.03	A,B,C
017-290-005	MIDDLEFIELD MANOR LLC	10.03	A,B,C
017-290-006	MIDDLEFIELD MANOR LLC	10.06	A,B,C
017-290-007	MIDDLEFIELD MANOR LLC	10.05	A,B,C
017-290-008	MIDDLEFIELD MANOR LLC	10.01	A,B,C
017-290-009	MIDDLEFIELD MANOR LLC	16.42	A,B,C

APN	Record Owner	Acres	Pumping Zone
017-290-010	MIDDLEFIELD MANOR LLC	11.06	A,B,C
017-300-001	VIRDEN, ERIC & SANDRA H/W	4.07	A,B,C
017-300-002	LIDDER, HARJOG S & PARMJIT K H/W	43.94	A,B,C
017-300-005	COSTA, MANUEL & JUSTINE L H/W	160.00	A,B,C
017-300-006	MONTGOMERY, RICHARD JR & JUANITA L REV FAM TRUST	2.51	A,B,C
017-300-007	FRANCO, GABRIELA J	2.51	A,B,C
017-300-008	WIIRRE, JOSHUA A & NICOLE L H/W	2.51	A,B,C
017-300-009	CARDOSO, JOSEPH M REV LIVING TRUST	2.51	A,B,C
017-300-010	WALKER, WILLIAM S REV TRUST	12.14	A,B,C
017-300-011	HRCK PROPERTIES LLC	13.53	A,B,C
017-300-012	COPLIN FAMILY REVOCABLE LIVING TRUST	3.83	A,B,C
017-300-013	COPLIN FAMILY REVOCABLE LIVING TRUST	3.36	A,B,C
017-300-014	JARAMILLO, ALEJANDRO & MARIA E H/W	3.24	A,B,C
017-310-001	SILVEIRA 2012 REVOC TRUST 50%	4.99	A,B,C
017-310-002	SOUTHERN PACIFIC TRANSPORTATION CO	4.63	A,B,C
017-310-003	MIDDLEFIELD MANOR LLC	5.00	A,B,C
017-310-008	SILVA, CHERYL A REVOC LIVING TRUST 10%	42.18	A,B,C
017-310-012	SANDRIDGE PARTNERS LP	14.60	A,B,C
017-310-013	SANDRIDGE PARTNERS LP	54.50	A,B,C
017-310-014	SERNA GOMEZ, JUAN & MARIA H/W 50%	2.07	A,B,C
017-310-017	SULLIVAN FARMING LLC	17.18	A,B,C
017-310-018	SULLIVAN FARMING LLC	11.50	A,B,C
017-310-020	SULLIVAN FARMING LLC	10.00	A,B,C
017-310-021	SULLIVAN FARMING LLC	10.00	A,B,C
017-310-022	SULLIVAN FARMING LLC	11.50	A,B,C
017-310-023	SULLIVAN FARMING LLC	18.60	A,B,C
017-310-024	SULLIVAN FARMING LLC	10.00	A,B,C
017-310-025	LAWRENCE, ROUDY & DEANA H/W	2.71	A,B,C
017-310-026	SALDANA, CESAR & MARIA T H/W	2.50	A,B,C
017-310-027	H & S RENTALS LLC	15.56	A,B,C
017-310-030	WALKER, STEVEN J	17.02	A,B,C
017-310-032	SANDRIDGE PARTNERS LP	25.79	A,B,C
017-310-033	SANDRIDGE PARTNERS LP	3.28	A,B,C
017-310-036	SANDRIDGE PARTNERS LP	10.00	A,B,C
017-310-037	SANDRIDGE PARTNERS LP	10.00	A,B,C
017-310-039	SANDRIDGE PARTNERS LP	10.00	A,B,C
017-310-040	SANDRIDGE PARTNERS LP	10.33	A,B,C
017-310-041	SMITH, RUSSELL D JR REV TRUST	15.40	A,B,C
017-310-042	MILLER, BRAD S & KATHY L H/W	3.22	A,B,C
017-310-043	COELHO, JUANITA G TRUST	22.33	A,B,C
017-310-044	SANDRIDGE PARTNERS LP	6.15	A,B,C
017-310-045	MORALES, ERNESTINE	3.42	A,B,C
017-310-047	CASTRENCE, ADELAIDE G	19.90	A,B,C
017-310-051	VAN DER GRAAF, A & R LIV TRUST 75%	17.04	A,B,C
018-210-004	SMITH, RUSSELL D JR REV TRUST	59.09	A,B,C
018-210-005	US HORTICULTURE FARMLAND LLC	20.91	A,B,C
018-210-013	HANSEN, L E FARMS INC	28.15	A,B,C
018-210-016	BADASCI, ROBERT S & ANN C REVOC TRUST	30.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-210-018	LAGIER, JOHN D L 50%	10.00	A,B,C
018-210-019	SILVEIRA, BRANDON	4.00	A,B,C
018-210-022	HANSEN, L E FARMS INC	160.00	A,B,C
018-210-023	SILVESTRE, LUCY	30.89	A,B,C
018-210-029	SMITH, RUSSELL D JR REV TRUST	25.10	A,B,C
018-210-037	SMITH, RUSSELL D JR REV TRUST	23.70	A,B,C
018-210-044	SMITH, RUSSELL D JR REV TRUST	78.18	A,B,C
018-210-045	KINGS COUNTY WATER DISTRICT	5.47	A,B,C
018-210-046	PEREZ, MANUEL S	2.50	A,B,C
018-210-047	RAYGOZA, SERGIO & EVELIA H/W	2.50	A,B,C
018-210-049	SMITH, ROBERT D	3.12	A,B,C
018-210-050	SMITH, ROBERT D	26.88	A,B,C
018-210-057	GARZA, JOE G	5.00	A,B,C
018-210-058	BRUMIT, ALLEN & SHAROLYN LIVING TRUST	5.00	A,B,C
018-210-060	SLOCUM, VERNON & BETTY TRUST	2.53	A,B,C
018-210-064	SLOCUM, VERNON & BETTY TRUST	54.46	A,B,C
018-210-065	VALENTINE, LORI	19.88	A,B,C
018-210-066	TRINITY RANCHES LLC	96.99	A,B,C
018-210-068	NEWTON, PAUL & JAN FAMILY TRUST	2.00	A,B,C
018-210-069	COLEMAN FAMILY REVOC LIVING TRUST	12.71	A,B,C
018-210-077	ESCARCEGA, ESTEBAN & ABRIL H/W	2.87	A,B,C
018-210-078	O'DANIEL, KEVIN M & CANDIS J A H/W	2.50	A,B,C
018-210-079	PEREZ, DINORA 90%	2.50	A,B,C
018-210-080	BADASCI, ROBERT S & ANN C REV TR 41.67%	18.20	A,B,C
018-210-081	SILVEIRA, BRANDON LIVING TRUST	2.24	A,B,C
018-210-082	BITTNER, EDDIE D & BRENDA L H/W	35.58	A,B,C
018-210-083	PEDERSEN TRIPLET TRUST 2007	3.79	A,B,C
018-210-084	US HORTICULTURE FARMLAND LLC	72.21	A,B,C
018-210-085	STROCK, BRAD R & NATALIE H/W	20.22	A,B,C
018-210-086	PALACIO, EDISON & DALIA H/W	20.00	A,B,C
018-210-087	MURPHY, EUGENE L & PAULINE J REV TRUST	20.00	A,B,C
018-210-091	WALKER, STEVEN & ELIZABETH REV TRUST	20.11	A,B,C
018-210-092	WALKER, STEVEN & ELIZABETH REV TRUST	20.11	A,B,C
018-210-093	WALKER, STEVEN & ELIZABETH REV TRUST	20.11	A,B,C
018-210-094	WALKER, STEVEN & ELIZABETH REV TRUST	28.22	A,B,C
018-210-095	SMITH ROBERT DAVID	21.50	A,B,C
018-210-096	THEADORE, GERALD J & JUSTINE L REV FAM TR	21.50	A,B,C
018-210-099	SMITH ROBERT DAVID	21.50	A,B,C
018-210-102	THEADORE, GERALD J & JUSTINE L REV FAM TR	2.50	A,B,C
018-210-103	THEADORE, GERALD J & JUSTINE L REV FAM TR	22.16	A,B,C
018-210-104	ROCHA, STEVEN & LISA A H/W	10.85	A,B,C
018-210-105	ROCHA, ALVIN 50%	16.66	A,B,C
018-210-107	BABB, JEFFREY T & LISA R H/W	18.86	A,B,C
018-210-109	FERREIRA, STEVEN J & BERNADETTE TRUST	38.70	A,B,C
018-210-111	FERREIRA, STEVEN J & ERIN M H/W	18.41	A,B,C
018-210-112	AZEVEDO, TODD A TRUST 25%	25.47	A,B,C
018-210-113	BADASCI, ROBERT S & ANN C REVOC TRUST	23.23	A,B,C
018-210-114	BADASCI, ROBERT S & ANN C REVOC TRUST	20.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-221-002	WALKER II WILLIAM S	30.00	A,B,C
018-221-007	COSTA, MANUEL & JUSTINE H/W	30.00	A,B,C
018-221-008	MADRIGAL ISAEL SANCHEZ	9.98	A,B,C
018-221-011	SMITH, R DAVID JR & KRISTEN M H/W	10.00	A,B,C
018-221-012	WALKER, WILLIAM S REV TRUST	39.37	A,B,C
018-221-013	DOBRININ, JOANN K 2019 REVOC TRUST 50%	20.00	A,B,C
018-221-014	DOBRININ, JOANN K 2019 REVOC TRUST 50%	10.63	A,B,C
018-221-021	BRAZIL, DAVID 50%	76.94	A,B,C
018-221-023	THEADORE, GERALD J & JUSTINE L REV FAM TR	39.54	A,B,C
018-221-024	WALKER II WILLIAM S	78.67	A,B,C
018-221-025	THEADORE, GERALD J & JUSTINE L REV FAM TR	20.10	A,B,C
018-221-028	COSTA, E MANUEL	40.00	A,B,C
018-221-029	THRALL, MICHELLE	10.00	A,B,C
018-221-031	MIRANDA, FRANK S	3.00	A,B,C
018-221-032	COSTA, E MANUEL & JUSTINE H/W	3.00	A,B,C
018-221-034	YARBROUGH, ARCHIE & VELMA FAMILY TRUST	4.57	A,B,C
018-221-035	YARBROUGH, ARCHIE & VELMA FAMILY TRUST	2.50	A,B,C
018-221-037	HAYNES, JAMES C JR TRUST	4.00	A,B,C
018-221-038	KINGS COUNTY WATER DISTRICT	5.14	A,B,C
018-221-039	BRAZIL, DAVID 50%	35.72	A,B,C
018-221-040	KINGS COUNTY WATER DISTRICT	11.05	A,B,C
018-221-042	HOLIMAN, GAIL A & JOHN W W/H	3.27	A,B,C
018-221-045	IRWIN, TRAVIS R & ALAINA C H/W	4.98	A,B,C
018-221-046	DOBRININ, JOANN K 2019 REVOC TRUST 50%	54.47	A,B,C
018-221-048	BETTENCOURT 2015 REVOC LIVING TRUST	2.32	A,B,C
018-221-050	OREGEL, FRANCISCO J	7.08	A,B,C
018-221-052	RUBLE KEVIN & MICHELE	17.46	A,B,C
018-221-053	WALKER, STEVEN & ELIZABETH REV TRUST 50%	2.50	A,B,C
018-221-054	WALKER, STEVEN J & ELIZABETH H/W	27.50	A,B,C
018-221-057	COSTA, EDUINO M & JUSTINE L H/W	29.75	A,B,C
018-222-002	SMITH, RUSSELL DAVID JR 0	19.54	A,B,C
018-222-010	ARIT, NESTOR A JR & SONIA O H/W	5.00	A,B,C
018-222-011	FIELDS, KENNETH A	20.00	A,B,C
018-222-012	WALKER, STEVEN & ELIZABETH REV TRUST	40.00	A,B,C
018-222-014	SMITH, ROBERT D	40.00	A,B,C
018-222-018	MALLORY, RICK & CAROL H/W JT	5.00	A,B,C
018-222-023	BOIM, MARIO A	5.39	A,B,C
018-222-025	TOWER DAVID A JR	3.00	A,B,C
018-222-028	HERRIAGE, GEORGE E & ANITA M H/W	3.70	A,B,C
018-222-030	RAMIREZ, ROBERT JR & MARY H/W	3.10	A,B,C
018-222-031	WELZBACKER DANIEL L & VALERIE	4.55	A,B,C
018-222-032	GUZMAN, ANA M	2.45	A,B,C
018-222-033	VAN DER GRAAF, ALBERT & RIEKIE LIV TRUST	4.96	A,B,C
018-222-035	JOYNER, LARRY J LIVING TRUST	3.00	A,B,C
018-222-039	FAGUNDES, TYLER A	2.50	A,B,C
018-222-040	SMITH, ROBERT D	77.50	A,B,C
018-222-042	JOYNER, LARRY J LIVING TRUST	4.29	A,B,C
018-222-043	KINGS COUNTY WATER DISTRICT	22.08	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-222-044	SMITH, ROBERT D	18.64	A,B,C
018-222-048	WATKINS, JAMES M & LUCILLE A LIVING TRUST	5.03	A,B,C
018-222-049	GONZALES, JOHN A & TERESA S H/W	5.03	A,B,C
018-222-050	KETZ, DAVID B & CHRISTYANN H/W	5.03	A,B,C
018-222-051	SANCHEZ PETER R REV LIV TRUST	71.75	A,B,C
018-222-054	JOYNER, LARRY J LIVING TRUST	2.02	A,B,C
018-222-055	HAMILTON, JANET J & CHRIS W/H	2.50	A,B,C
018-222-057	GALHANDRO, MANUEL & DIANA REV FAM TRUST	20.00	A,B,C
018-222-058	WALKER, STEVEN & ELIZABETH REV TRUST	32.30	A,B,C
018-222-059	BONILLA, DIOSDADO & MARIA M REV TRUST	25.41	A,B,C
018-222-061	MENDES, ERNEST J	20.00	A,B,C
018-222-062	GALHANDRO, MANUEL & DIANA REV FAM TRUST	20.00	A,B,C
018-222-066	WALKER, STEVEN J & ELIZABETH H/W	20.80	A,B,C
018-222-068	WALKER, STEVEN J & ELIZABETH H/W	19.74	A,B,C
018-222-069	MARTINEZ, SERGIO & VERONICA H/W	4.35	A,B,C
018-222-070	WALKER, STEVEN & ELIZABETH REV TRUST 50%	26.80	A,B,C
018-222-079	WALKER, WILLIAM S REV TRUST	20.79	A,B,C
018-222-080	WALKER, STEVEN & ELIZABETH REV TRUST	28.70	A,B,C
018-222-081	WALKER, STEVEN & ELIZABETH REV TRUST	18.01	A,B,C
018-222-082	WALKER, WILLIAM S REV TRUST	2.00	A,B,C
018-231-006	ALCALA FARMS CA GENERAL PARTNERSHIP	77.40	A,B,C
018-231-012	WALKER, WILLIAM S REV TRUST	53.14	A,B,C
018-231-013	GUY, MICHAEL J & MARTHA A H/W	5.00	A,B,C
018-231-017	WALKER, WILLIAM S REV TRUST	20.27	A,B,C
018-231-019	WALKER, WILLIAM S REV TRUST	29.00	A,B,C
018-231-021	WALKER, WILLIAM S REV TRUST	20.00	A,B,C
018-231-023	SANCHEZ PETER R REV LIV TRUST	3.22	A,B,C
018-231-028	STROLE, MARK S	2.00	A,B,C
018-231-036	SANCHEZ PETER R REV LIV TRUST	2.50	A,B,C
018-231-037	SANCHEZ PETER R REV LIV TRUST	17.57	A,B,C
018-231-038	CRAFT, MICHAEL D & ESTRELLA Z H/W	2.50	A,B,C
018-231-039	KESSINGER, WILMA S 50%	2.50	A,B,C
018-231-042	WALKER, WILLIAM S REV TRUST	16.89	A,B,C
018-231-045	CHRISTIE, JAMES & JENNIFER H/W	2.59	A,B,C
018-231-051	OVERLEY, DENNIS R	3.18	A,B,C
018-231-055	ROE LIVING TRUST	3.25	A,B,C
018-231-056	VAN DEN BERG, DOROTHY & ALEX PAREDES W/H	2.04	A,B,C
018-231-057	ZERMENO, RAUL & MARIA L FAMILY TRUST	3.52	A,B,C
018-231-058	LEMOS JOSE & BARBARA	2.50	A,B,C
018-231-060	WALKER, STEVEN & ELIZABETH REV TRUST	15.58	A,B,C
018-231-061	WALKER FARMS A PTP	49.96	A,B,C
018-231-062	WALKER, WILLIAM S REV TRUST	5.00	A,B,C
018-231-064	WALKER II WILLIAM S	71.33	A,B,C
018-231-068	WALKER, WILLIAM S REV TRUST	74.24	A,B,C
018-231-069	WALKER, WILLIAM S REV TRUST	15.61	A,B,C
018-231-071	WALKER, WILLIAM S REV TRUST	37.53	A,B,C
018-231-072	WALKER, WILLIAM S REV TRUST	7.44	A,B,C
018-232-002	FADENRECHT, ANNE 25%	7.21	B,C

APN	Record Owner	Acres	Pumping Zone
018-232-003	FADENRECHT, ANNE 25%	40.00	B,C
018-232-004	SUPERIOR SOIL SUPPLEMENTS LLC	20.00	B,C
018-232-021	BRAZIL, SANDRA TRUST 50% & BRAZIL LEE A 2005 TRUS	2.65	B,C
018-232-022	WESTERN MILLING LLC	19.66	B,C
018-232-028	CASTANEDA, SANDRA	6.00	B,C
018-232-032	GIRON, RUSSEL J & LILLIE O H/W	3.00	B,C
018-232-040	ALCALA FARMS A PTP	30.00	B,C
018-232-041	ALCALA FARMS CA GENERAL PARTNERSHIP	2.58	B,C
018-232-050	FOUR STAR DAIRY LP	46.98	B,C
018-232-054	WESTERN MILLING LLC	19.83	B,C
018-232-055	ALCALA FARMS A PTP	20.00	B,C
018-232-066	GRILIONE ENTERPRISES LP	10.02	B,C
018-232-067	GRILIONE ENTERPRISES LP	10.03	B,C
018-232-068	GRILIONE ENTERPRISES LP	10.03	B,C
018-232-070	THIARA, NOVELEEN SINGH	15.00	B,C
018-232-072	WESTERN MILLING LLC	23.90	B,C
018-232-074	MORGAN, BRADLEY L	12.95	B,C
018-241-001	MANCILLA RAMON	2.60	A,B,C
018-241-002	BOWDEN, ORBERY D & ROSALEE M H/W	2.50	A,B,C
018-241-003	RABE, JOHN	2.50	A,B,C
018-241-004	CASTANEDA, WILLIE & PETRA H/W	2.50	A,B,C
018-241-005	AGUINIGA, TOVIAS & SABRINA J L H/W	2.50	A,B,C
018-241-006	WYATT, MANUELA	2.50	A,B,C
018-241-007	WALKER, WILLIAM S REV TRUST	2.50	A,B,C
018-241-008	GARCIA PAUL GEORGE & FELICITAS	2.27	A,B,C
018-241-010	JACOBS, DOUGLAS M & DEBORA V REV FAM TRUST	3.00	A,B,C
018-241-012	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	187.44	A,B,C
018-241-013	JOKE FAMILY TRUST	9.25	A,B,C
018-241-014	ZONNEVELD DAIRIES INC	116.97	A,B,C
018-241-015	JESUS & MARIA ALVAREZ REVOCABLE FAMILY TRUST	2.00	A,B,C
018-241-016	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	38.00	A,B,C
018-241-017	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	140.00	A,B,C
018-241-018	COSTA, VERNON J & BRENDA J H/W	20.00	A,B,C
018-241-026	WALKER, WILLIAM S REV TRUST	3.94	A,B,C
018-241-027	HAKKER, ROGER & CHERYL LIV TRST	19.98	A,B,C
018-241-029	HAKKER, ROGER & CHERYL LIVING TRUST	18.05	A,B,C
018-241-036	FIELDS, KENNETH A	17.89	A,B,C
018-241-037	ARMENTA-GONZALEZ, RICARDO & DORA H/W	4.89	A,B,C
018-241-041	WALKER, WILLIAM S REV TRUST	24.32	A,B,C
018-250-007	HAKKER, ROGER & CHERYL LIV TRUST 23.8	80.00	A,B,C
018-250-013	WALKER, STEVEN & ELIZABETH REV TRUST 50%	52.00	A,B,C
018-250-020	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	78.64	A,B,C
018-250-021	DOBRININ, JOANN K 2019 REVOC TRUST 50%	66.57	A,B,C
018-250-022	DOBRININ, JOANN K 2019 REVOC TRUST 50%	103.93	A,B,C
018-250-023	MOON, MICHAEL & PATRICIA H/W	2.24	A,B,C
018-250-025	PEREIRA, MANUEL & PHYLLIS LIVING TRUST	2.50	A,B,C
018-250-027	ZONNEVELD DAIRIES INC	316.50	A,B,C
018-250-029	PEARCE, BRANDEN 33.333%	12.47	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-250-031	DOBRININ, JOANN K 2019 REVOC TRUST 50%	94.51	A,B,C
018-250-033	DOBRININ, JOANN K 2019 REVOC TRUST 50%	155.12	A,B,C
018-250-036	KRUSE WESTERN HOLDINGS LLC 50%	79.00	A,B,C
018-250-038	DANELL, KAARIN KAY ESTATE	2.64	A,B,C
018-250-039	WALKER, STEVEN & ELIZABETH REV TRUST 50%	152.36	A,B,C
018-250-040	ELLSWORTH FARMS LLC	23.37	A,B,C
018-250-042	CABRERA, JUAN & LAURA H/W	32.52	A,B,C
018-250-043	POTTER, JAY R & AMBER H/W	2.50	A,B,C
018-250-044	ELLSWORTH FARMS LLC	22.27	A,B,C
018-261-004	NEGIN, NANDA L P 50%	60.00	A,B,C
018-261-006	SILVEIRA, LELAND D & MARGIE LIV TRUST	41.90	A,B,C
018-261-008	NEGIN, NANDA L P 50%	40.00	A,B,C
018-261-009	DUNNE, BERNADINE	39.25	A,B,C
018-261-013	SMITH, RUSSELL D JR REV TRUST	60.00	A,B,C
018-261-014	WEBER, WILLIAM C	2.00	A,B,C
018-261-018	STITES, JOHNNY E & LINDA B REVOC FAM TRUST	3.86	A,B,C
018-261-019	BORBA, DAVID & DENISE FAMILY TRUST	10.50	A,B,C
018-261-022	OWEN, ALDEN & LISA Y H/W	3.92	A,B,C
018-261-023	SILVEIRA, BRANDON LIVING TRUST	59.97	A,B,C
018-261-025	SMITH, RUSSELL D JR REV TRUST	33.10	A,B,C
018-261-026	MC FARREN, THOMAS & RUTH E H/W	2.50	A,B,C
018-261-030	CATTUZZO, JIMMY	2.61	A,B,C
018-261-031	AMERSON, ALLEN A & DARLA J H/W	2.50	A,B,C
018-261-032	SILVEIRA, BRANDON LIVING TRUST	31.72	A,B,C
018-261-033	WILSON, BILL J II & FINACEL M H/W	2.57	A,B,C
018-261-034	SCHWARZEBACH, JANELLE TRUST	3.92	A,B,C
018-261-035	MARTIN, ROXIE V MARTIN TRUST	26.08	A,B,C
018-261-036	MORENO, DOMINGA C LF EST	3.64	A,B,C
018-261-037	RODRIGUEZ MONICA & ANTHONY	4.59	A,B,C
018-261-038	RAMIREZ, JIM & ELVA H/W	2.61	A,B,C
018-261-039	SILVEIRA, LELAND D & MARGIE LIVING TRUST	2.50	A,B,C
018-261-040	SILVEIRA, LELAND D & MARGIE LIVING TRUST	36.79	A,B,C
018-261-042	SLOCUM, VERNON & BETTY TRUST	99.00	A,B,C
018-261-043	LONGMIRE, WILLIAM & ANN INTERVIVOS TRUST	12.57	A,B,C
018-261-044	MARTINEZ, CAROLINE	2.44	A,B,C
018-261-045	GARZA, LIONEL & MARIA E H/W	2.50	A,B,C
018-261-046	DAVIS, HARVEY B JR & PAMELA K H/W	5.00	A,B,C
018-261-047	LONGMIRE WILLIAM AND ANN INTERVIVOS TRUST	5.00	A,B,C
018-261-048	SANDRIDGE PARTNERS LP	28.00	A,B,C
018-261-049	FLORES, MARIA D IRREV TRUST JAN 20 2021	2.44	A,B,C
018-261-050	CORONA, ANTONIO A & REGINA D H/W	3.01	A,B,C
018-262-006	SARTOR, VIRGINIA L B TRUST 50%	40.00	A,B,C
018-262-007	WALKER, WILLIAM S REV TRUST	40.00	A,B,C
018-262-009	KASISCHKE TIM & DEBRA FAM TRUST 50%	20.00	A,B,C
018-262-010	MILLER, GARRETT & MARY H/W	10.00	A,B,C
018-262-011	SARGENT, BRANDON & ERICA H/W	10.00	A,B,C
018-262-012	SILVEIRA, LELAND D & MARGIE TRUST	40.00	A,B,C
018-262-014	SILVEIRA, LELAND D & MARGIE LIVING TRUST	39.60	A,B,C

APN	Record Owner	Acres	Pumping Zone
018-262-019	GAMINO, ENRIQUE	2.68	A,B,C
018-262-020	GARCIA, JUAN & TEREZA P H/W	2.75	A,B,C
018-262-021	CALDERON, LAURA E	2.59	A,B,C
018-262-025	ALLEN, MICHAEL T	2.24	A,B,C
018-262-028	SULLIVAN, HELEN A LIVING TRUST	30.58	A,B,C
018-262-029	THREE SULLIVANS FARMING LP	306.92	A,B,C
018-262-030	UPTON, SUSAN L	66.93	A,B,C
018-262-031	MENDES, ANTHONY & NANCY REVOC LIV TRUST	13.39	A,B,C
021-030-007	FERNANDES, JOSEPH JR REV LIV TRS 85.7% 0	70.00	A,B,C
021-030-008	FERNANDES, MARK A	10.07	A,B,C
021-030-009	JONES, COLEEN D	2.50	A,B,C
021-030-010	FERNANDES, JOSEPH JR REV LIV TRUST 0	40.00	A,B,C
021-030-011	JONES DENISE COLEEN	36.00	A,B,C
021-030-013	ROCHA, RICK & RITA 1999 FAMILY TRUST	10.13	A,B,C
021-030-014	ROCHA, RICK & RITA FAMILY TRUST	10.00	A,B,C
021-030-016	M C COTTA FAMILY RANCH LLC	118.16	A,B,C
021-030-017	WHITTEN, CARL	19.59	A,B,C
021-030-018	BADASCI, JANICE	17.49	A,B,C
021-030-019	BADASCI, JANICE	2.62	A,B,C
021-030-020	HOMAN, VIRGINIA A	9.06	A,B,C
021-030-021	HOMAN, VIRGINIA A	11.06	A,B,C
021-030-022	WEBER, KENDRA D	2.52	A,B,C
021-030-023	DIAS, KEVIN E & VICKIE J H/W JT	2.50	A,B,C
021-030-027	TILLEY WAYNE L	6.22	A,B,C
021-030-028	MICHEL, GLORIA & VICTORIANO RAMIREZ W/H	19.60	A,B,C
021-030-029	MENEZES RODGER ALVIN	18.31	A,B,C
021-030-033	MALDONADO, DANIEL & MARIA H/W	10.00	A,B,C
021-030-034	JACOBO SANTIAGO	2.50	A,B,C
021-030-035	CROMWELL, ANDREW D & KERRY N H/W	2.50	A,B,C
021-030-036	LOUQUET, PETER & ADELA H/W	10.00	A,B,C
021-030-039	NORDSTROM, MATHEW & SYDNEY H/W	3.71	A,B,C
021-030-051	FERNANDES, JOSEPH JR REV LIV TRUST	19.00	A,B,C
021-030-053	NORDSTROM, NEIL & MARJORIE LIVING TRUST	10.00	A,B,C
021-030-054	L & P PISTACHIO LLC	10.00	A,B,C
021-030-055	L & P PISTACHIO LLC	10.00	A,B,C
021-030-056	NORDSTROM, ROGER L & FRANCES A H/W	10.00	A,B,C
021-030-059	CROSSWELL, JOHNNA L 50%	14.88	A,B,C
021-030-060	RODRIGUEZ, ELIZABETH	10.55	A,B,C
021-030-063	JACOBO, LAUREANO & PATRICIA H/W	10.00	A,B,C
021-030-068	JACOBO, LAUREANO & PATRICIA H/W	10.00	A,B,C
021-030-071	MORAIS, JOAO H & DIANA M H/W	35.36	A,B,C
021-030-073	PAULSON FAMILY REVOCABLE TRUST	4.29	A,B,C
021-030-074	JACOBO JONATHAN	10.60	A,B,C
021-030-076	COELHO, VINCENT & ANDREA REVOC TRUST	19.08	A,B,C
021-030-077	L & P PISTACHIO LLC	8.00	A,B,C
021-030-078	OLDHAM, MICHAEL & DIANNE FAMILY TRUST	2.00	A,B,C
021-040-001	VALLEY AG HARVESTING LLC	164.00	A,B,C
021-040-004	MAJORS FAMILY INVESTMENTS LLC	11.49	A,B,C

APN	Record Owner	Acres	Pumping Zone
021-040-005	GARCIA DAVID E & SANDY	2.01	A,B,C
021-040-006	SILVEIRA, BRANDON LIVING TRUST	65.31	A,B,C
021-040-007	SOUTHERN PACIFIC TRANSPORTATION CO	4.35	A,B,C
021-040-008	SILVEIRA, BRANDON LIVING TRUST	9.76	A,B,C
021-040-009	SILVEIRA, BRANDON LIVING TRUST	15.26	A,B,C
021-040-010	MANRRIQUEZ, ARNULFO & BRENDA H/W	5.00	A,B,C
021-040-011	HOPPERT ASHLEY & RANDY J JR	3.23	A,B,C
021-040-013	SILVEIRA, BRANDON LIVING TRUST	28.65	A,B,C
021-040-015	MAJORS FAMILY INVESTMENTS LLC	11.11	A,B,C
023-030-001	BUSH, GREGORY & CYNTHIA H/W	2.50	A,B,C
023-030-005	SHIMMON FAMILY TRUST	3.75	A,B,C
023-030-006	VEGA, MIKE & ERICKA H/W	3.71	A,B,C
023-030-009	STREETER, BRADFORD E & PATTI M H/W	3.25	A,B,C
023-030-010	BERNARD, GREGORY B & CHERYL L H/W	17.54	A,B,C
023-030-012	SANSINENA, CONSTANCE GRANTOR TRUST	10.51	A,B,C
023-030-013	RABER FARMS LLC	38.17	A,B,C
023-030-014	SILVEIRA, LELAND D & MARGIE LIV TRUST	38.13	A,B,C
023-030-015	SILVEIRA, LELAND D & MARGIE TRUST	37.78	A,B,C
023-030-016	US HORTICULTURE FARMLAND LLC	37.21	A,B,C
023-030-019	PATTERSON, DONALD SURVIVORS TRUST 50%	2.05	A,B,C
023-030-023	LARA, LUCIA & DAVID A W/H	2.35	A,B,C
023-030-024	PAYOYO, ELY G & MARCY L H/W	2.25	A,B,C
023-030-025	RADCLIFFE, CHRISTINA	2.08	A,B,C
023-030-026	BOTELHO, MARCIO F & VALERIE A H/W	2.50	A,B,C
023-030-027	DHAREY LIVING TRUST	2.13	A,B,C
023-030-028	WISWELL, RICKY A & BRENDA S H/W	2.17	A,B,C
023-030-030	SWALLOW, FILOMENA B & LORN F W/H	2.01	A,B,C
023-030-038	RAISKUP, KENNETH S & GISELA H/W	10.40	A,B,C
023-030-039	THORBUS WENDY C	5.05	A,B,C
023-030-040	THORBUS WENDY C	5.05	A,B,C
023-030-044	YOST BRYCE W & AMY	2.12	A,B,C
023-030-050	SHIMMON, JEFFREY D & JENNIFER H/W	12.89	A,B,C
023-030-053	US HORTICULTURE FARMLAND LLC	38.15	A,B,C
023-040-013	LUIS, BENJAMIN & AMBER H/W	8.80	A,B,C
023-040-015	LAMBERT, HOWARD L LIVING TRUST 33.33% & HOWARD L	4.98	A,B,C
023-040-016	PENSCO TRUST COMPANY CUSTODIAN	7.69	A,B,C
023-040-017	STORMAX REAL ESTATE HOLDINGS LLC	5.48	A,B,C
023-040-019	STORMAX REAL ESTATE HOLDINGS LLC	5.91	A,B,C
023-040-021	PARTIDA R, FIDENCIO 50%	7.41	A,B,C
023-040-022	NAHAL FARMS LLC	2.89	A,B,C
023-040-024	REED, TIM AND JEAN LIV TRUST	4.02	A,B,C
023-040-027	NAHAL FARMS LLC	68.59	A,B,C
023-040-028	EDMONDSON, JAMES K	4.38	A,B,C
023-040-029	NAHAL, RUPINDERJIT	22.73	A,B,C
023-040-031	DIVINE, GERALD L TRUST	2.60	A,B,C
023-040-032	RICO, MIGUEL & DIANA H/W	18.21	A,B,C
023-040-034	AVILA, MANUEL D & OLIVIA M H/W 50%	68.68	A,B,C
023-040-035	AVILA MANUEL & OLIVIA	4.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
023-040-036	AVILA MANUEL & OLIVIA	5.10	A,B,C
023-040-068	SANCHEZ RENE GONZALEZ	21.41	A,B,C
023-040-069	GONZALES, JESSE M & CHRISTINA A H/W	20.00	A,B,C
023-040-075	ONORATI, ANTHONY B	3.90	A,B,C
023-040-076	SJ RANCH GP	75.55	A,B,C
023-040-077	NAHAL FARMS LLC	98.92	A,B,C
023-040-078	NAHAL FARMS LLC	74.72	A,B,C
023-040-079	NAHAL FARMS LLC	71.43	A,B,C
024-062-025	PEREIRA MICHAEL A	2.89	A,B,C
024-062-026	HANSEN, L E FARMS INC	36.73	A,B,C
024-062-027	GOMES, CRAIG & CIANA FAMILY TRUST	2.05	A,B,C
024-062-030	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	138.19	A,B,C
024-062-038	VENEGAS, ISAIAS 50%	2.50	A,B,C
024-062-039	MORRELL, DAVID W & KIMBERLY G H/W	2.98	A,B,C
024-062-042	RADDER FAMILY TRUST	2.50	A,B,C
024-062-043	STRONG, JOHN L & ESTHER O LIVING TRUST	2.50	A,B,C
024-062-044	DUTY, COLEAN A	2.50	A,B,C
024-062-045	STEELY FAMILY REVOCABLE TRUST	2.50	A,B,C
024-062-046	CURTISS THOMAS	2.50	A,B,C
024-062-049	CABRERA, JUAN C & LAURA E H/W	72.50	A,B,C
024-062-056	SMITH, ELEVEINE	22.12	A,B,C
024-062-058	HENDERSON TRUST	6.83	A,B,C
024-062-059	HUDSON, GERRY A TRUST	22.13	A,B,C
024-062-065	ROCHA, RYAN G & KALLI A H/W	26.44	A,B,C
024-062-066	ROCHA, RYAN G & KALLI A H/W	45.16	A,B,C
024-062-067	ROCHA, RYAN G & KALLI A H/W	57.12	A,B,C
024-062-068	ROCHA, RYAN G & KALLI A H/W	30.05	A,B,C
024-072-011	ENGLISH, SUZANNE 50%	2.50	A,B,C
024-072-012	DAVIS, JERRY H & THEREASA A H/W	2.50	A,B,C
024-072-013	MENDEZ, JESUS A & STELLA H/W 66.667%	2.50	A,B,C
024-072-014	EDEN, KEITH E	14.62	A,B,C
024-072-031	GILCREASE, JEFFREY A & KAREN L FAM TRUST	38.43	A,B,C
024-072-035	SILVA, EDWARD J JR & DAWN E H/W	2.67	A,B,C
024-072-036	LEAL, EDWARD B & SHELLEY L FAM TRUST	2.85	A,B,C
024-072-037	GILCREASE, JEFFREY A & KAREN L TRUST	4.58	A,B,C
024-072-038	GILCREASE, JEFFREY A & KAREN L TRUST	9.16	A,B,C
024-072-039	VEENENDAAL, LESLIE J & CASE W LIV TRUST	3.84	A,B,C
024-072-040	GILCREASE, JEFFREY A & KAREN L FAM TR	4.02	A,B,C
024-072-041	GILCREASE, JEFFREY A & KAREN L FAM TR	28.54	A,B,C
024-072-042	GILCREASE, JEFFREY A & KAREN L FAM TR	2.40	A,B,C
024-072-043	GILCREASE, JEFFREY A & KAREN L FAM TR	35.44	A,B,C
024-072-045	GILCREASE, JEFFREY A & KAREN L TRUST	99.93	A,B,C
024-072-053	GILCREASE, JEFFREY A & KAREN L FAM TRST	4.58	A,B,C
024-072-054	GILCREASE, JEFFREY A & KAREN L TRUST	61.08	A,B,C
024-150-027	SILVEIRA, BRANDON LIVING TRUST	37.00	A,B,C
024-150-028	CROSE, CHARLES & ELIZABETH FAMILY TRUST	80.00	A,B,C
024-150-029	CROSE, CHARLES & ELIZABETH FAMILY TRUST	80.00	A,B,C
024-150-030	CROSE, CHARLES & ELIZABETH FAMILY TRUST	40.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
024-150-031	FARMFUNDR2 LLC	41.10	A,B,C
024-150-034	SILVEIRA, BRANDON LIVING TRUST	3.00	A,B,C
024-150-046	SILVEIRA, BRANDON LIVING TRUST	32.16	A,B,C
024-150-047	SILVEIRA, BRANDON LIVING TRUST	7.84	A,B,C
024-150-080	SMITH, ROBERT G SR 50%	19.21	A,B,C
024-150-081	MATTINGLY RYAN	17.21	A,B,C
024-150-091	JACK'S FARM LLC	30.54	A,B,C
024-150-092	MATTINGLY RYAN	14.24	A,B,C
028-010-002	PORTER, JAMES R & GLORIA A TRUST	19.85	A,B,C
028-010-003	GOMES, ANNETTE M	29.67	A,B,C
028-010-004	HANSEN, L E FARMS INC	160.00	A,B,C
028-010-005	VAN GRONINGEN, EIMERT TRUST 50%	72.50	A,B,C
028-010-010	SANDRIDGE PARTNERS LP	15.00	A,B,C
028-010-024	HOUGHTON, ROBERT LELAND	2.00	A,B,C
028-010-027	MOUW, KENDALL	10.00	A,B,C
028-010-028	THREE SULLIVANS FARMING LP	69.60	A,B,C
028-010-029	KASISCHKE TIM & DEBRA FAM TRUST 50%	17.65	A,B,C
028-010-034	SILVEIRA, BRANDON LIVING TRUST	76.95	A,B,C
028-010-035	SILVEIRA, BRANDON LIVING TRUST	2.50	A,B,C
028-010-036	SILVEIRA, BRANDON LIVING TRUST	27.48	A,B,C
028-010-037	GILCREASE, JEFFREY A & KAREN LEE FAM TRUST	2.52	A,B,C
028-010-038	DUTY, CARLTON & COLEAN LIV TRUST	2.50	A,B,C
028-010-039	SANDRIDGE PARTNERS LP	127.50	A,B,C
028-010-040	REINHARDT, DOUGLAS & MARY JANE LIV TRUST	12.25	A,B,C
028-010-041	REINHARDT, DOUGLAS & MARY JANE LIV TRUST	2.50	A,B,C
028-010-042	MUNOZ, JOHN A	2.50	A,B,C
028-010-043	MUNOZ, JOHN A	14.43	A,B,C
028-010-044	CLARK, DANIEL G & LINDA A H/W	2.50	A,B,C
028-010-045	VAN GRONINGEN, EIMERT TRUST 50%	84.50	A,B,C
028-010-046	JOHNSON, VIRGINIA	2.50	A,B,C
028-010-050	MARQUEZ, CESAR M & SHANTELL H/W	3.91	A,B,C
028-010-051	SIMAS, MANUEL R & TERESA C H/W	5.00	A,B,C
028-010-052	SIMAS, MANUEL & RACHEL M H/W	12.94	A,B,C
028-010-053	STRONG, LE ROY M & SUSAN M H/W	22.80	A,B,C
028-010-057	CORONADO, JESSE V 50%	5.68	A,B,C
028-010-058	VARELA, ALVARO	4.31	A,B,C
028-010-059	WALKER, DALTON C & RITA J H/W	10.00	A,B,C
028-010-060	PEREZ, LINDA	2.50	A,B,C
028-010-061	DAVIS, LARRY D REVOC LIVING TRUST	45.00	A,B,C
028-010-066	DAVIS, LARRY D REVOC LIVING TRUST	251.27	A,B,C
028-010-067	MUNOZ, JOHN A	15.03	A,B,C
028-010-068	GONZALES, GUADALUPE 2007 TRUST	16.52	A,B,C
028-010-069	MUNOZ, JOHN A	2.58	A,B,C
028-010-070	GONZALES, GUADELUPE TRUST	17.42	A,B,C
028-010-075	MC KEGNEY, JERALD & KATHLEEN M H/W	20.80	A,B,C
028-010-076	DAVIS, LARRY D REVOC LIVING TRUST	9.70	A,B,C
028-010-077	DAVIS, LARRY D REVOC LIVING TRUST	19.95	A,B,C
028-010-078	HARP, JAMES S THERESA L H/W	50.74	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-010-079	MEDEIROS CHAD ANTHONY & KUBIK MICHELLE LYNN	2.61	A,B,C
028-020-002	THREE SULLIVANS FARMING LP	320.00	A,B,C
028-020-005	MARTELLA, ROBERT & ANITA MARITAL TR 50%	10.00	A,B,C
028-020-006	SMITH, RUSSELL D JR REV TRUST	80.00	A,B,C
028-020-008	LAWRENCE, JOHNNY P	10.00	A,B,C
028-020-011	HAKKER, ROGER & CHERYL LIVING TRUST	59.39	A,B,C
028-020-012	S & A SOUZA FARMS INC	98.75	A,B,C
028-020-014	HAKKER, ROGER & CHERYL LIVING TRUST	45.00	A,B,C
028-020-015	HAKKER, ROGER & CHERYL LIVING TRUST	160.00	A,B,C
028-020-018	LOPEZ, JERONIMO & EMMA ALVAREZ H/W	2.50	A,B,C
028-020-024	SANTOS, ELOY & ANGELICA M H/W	4.00	A,B,C
028-020-026	PERRIERA FAYE B 33.334%	2.50	A,B,C
028-020-028	MEDEIROS FAMILY LAND LP	20.41	A,B,C
028-020-029	MEDEIROS FAMILY LAND LP	20.18	A,B,C
028-020-030	WEAVER, MELVON C & MARDEL I H/W	4.93	A,B,C
028-020-033	HAKKER, ROGER & CHERYL LIVING TRUST	15.37	A,B,C
028-020-041	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	15.10	A,B,C
028-020-042	PERRIERA FAYE B 33.334%	2.50	A,B,C
028-020-043	MEDEIROS FAMILY LAND LP	25.42	A,B,C
028-020-046	O'NEIL, STEVEN A LIVING TRUST	3.56	A,B,C
028-020-047	ALLEN, MICHAEL H & ANGELA S H/W	3.79	A,B,C
028-020-048	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	76.01	A,B,C
028-020-050	DUNNE, SEAN D	23.00	A,B,C
028-020-051	CROSSWELL, JOHN H 50%	12.00	A,B,C
028-020-055	TESORIERE, ANTHONY & LOUISE REV TRUST	6.00	A,B,C
028-020-056	TESORIERE, ANTHONY & LOUISE REV TRUST	7.67	A,B,C
028-020-057	GOMEZ, HECTOR G & MARIA J H/W	3.90	A,B,C
028-020-059	HAKKER, ROGER & CHERYL LIV TRUST 23.8%	89.00	A,B,C
028-020-060	OZCOIDI, JEFFREY M	3.26	A,B,C
028-020-062	DAVIS, LANDON	5.05	A,B,C
028-020-063	DAVIS, LARRY D REVOC LIVING TRUST	11.89	A,B,C
028-020-064	DAVIS, LARRY D REVOC LIVING TRUST	121.42	A,B,C
028-020-065	HAKKER, ROGER & CHERYL IRREVOC TRUST	19.23	A,B,C
028-110-002	MARTELLA, ROBERT & ANITA MARITAL TR 50%	238.25	A,B,C
028-110-007	WALKER, WILLIAM S REV TRUST	80.00	A,B,C
028-110-009	ZONNEVELD DAIRIES INC	309.76	A,B,C
028-110-010	ZONNEVELD DAIRIES INC	320.00	A,B,C
028-110-011	FREITAS REV TRUST	78.98	A,B,C
028-110-012	FREITAS, JUDITH K	80.00	A,B,C
028-110-013	FREITAS REV TRUST	2.50	A,B,C
028-110-014	FREITAS REV TRUST	37.50	A,B,C
028-110-015	LONE OAK CANAL COMPANY 50%	2.85	A,B,C
028-110-016	FREITAS, JUDITH K	77.15	A,B,C
028-110-017	FREITAS 2015 REVOCABLE TRUST	37.01	A,B,C
028-110-018	DE JONG KELSEY DANAE	2.36	A,B,C
028-120-002	SOARES, MANUEL L & ADELIA M REV FAM TR	40.00	A,B,C
028-120-004	SOARES, MANUEL L & ADELIA M FAMILY TRUST	160.00	A,B,C
028-120-005	SOARES, MANUEL L & ADELIA M FAMILY TRUST	160.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-120-013	ALCALA FARMS A PTP	40.00	A,B,C
028-120-014	ALCALA FARMS A PTP	40.00	A,B,C
028-120-015	ALCALA FARMS A PTP	40.00	A,B,C
028-120-016	ALCALA FARMS A PTP	40.00	A,B,C
028-120-018	SOARES, MANUEL L & ADELIA M FAMILY TRUST	39.02	A,B,C
028-120-019	SOARES, MANUEL L & ADELIA M FAMILY TRUST	40.98	A,B,C
028-120-021	THREE SULLIVANS FARMING LP	198.97	A,B,C
028-120-022	MEDEIROS FAMILY LAND LP	2.50	A,B,C
028-120-028	MEDEIROS FAMILY LAND LP	37.50	A,B,C
028-120-030	MEDEIROS FAMILY LAND LP	60.82	A,B,C
028-120-032	ORRISON, PEGGY J LIVING TRUST	20.00	A,B,C
028-120-033	MEDEIROS FAMILY LAND LP	16.87	A,B,C
028-120-034	MEDEIROS FAMILY LAND LP	2.61	A,B,C
028-120-035	MARX, WILLIAM O LIVING TRUST	20.00	A,B,C
028-120-039	TURNER, TYLER	5.00	A,B,C
028-120-040	ALCALA FARMS A PTP	155.00	A,B,C
028-120-041	ORRISON, PEGGY J LIVING TRUST	20.10	A,B,C
028-120-042	ORRISON, PEGGY J LIVING TRUST	20.07	A,B,C
028-120-044	DOMINGOS, DEBBIE	3.86	A,B,C
028-120-046	SOARES, MANUEL L & ADELIA M REVOC TRUST	34.78	A,B,C
028-120-052	SOARES, MANUEL L & ADELIA M FAMILY TRUST	78.50	A,B,C
028-130-002	ARAUJO, ANTONIO & LUPE S H/W	80.00	A,B,C
028-130-010	MALAKAN INVESTMENTS LLC	80.00	A,B,C
028-130-014	SOARES, MANUEL & ADELIA REVOC FAM TRST	80.00	A,B,C
028-130-018	CROSE, CHARLES & ELIZABETH FAMILY TRUST	4.80	A,B,C
028-130-019	MALAKAN INVESTMENTS LLC	35.00	A,B,C
028-130-020	COLLINS, LARRY D & ADRIENNE M H/W JT	2.50	A,B,C
028-130-021	MALAKAN INVESTMENTS LLC	77.50	A,B,C
028-130-022	NASH, MICHAEL D & SHIRLEY L H/W	2.50	A,B,C
028-130-023	ALCALA FARMS A PTP	77.47	A,B,C
028-130-024	GOMES, CRAIG & CIANA FAMILY TRUST	2.05	A,B,C
028-130-025	ALCALA FARMS A PTP	77.96	A,B,C
028-130-026	HUIZAR JOSE CABRAL & OCHOA JUAN M	2.31	A,B,C
028-130-027	BRAZIL, DAVID 50%	77.73	A,B,C
028-130-028	UNITED STATES OF AMERICA IN TRUST	400.00	A,B,C
028-130-029	SOARES, MANUEL & ADELIA REVOC FAM TRST	80.00	A,B,C
028-130-031	TURNER, SCOTT & JULIE H/W	2.68	A,B,C
028-130-032	MALAKAN INVESTMENTS LLC	79.88	A,B,C
028-130-037	BRAZIL, DAVID 50%	40.13	A,B,C
028-130-038	BRAZIL, DAVID A 50%	20.00	A,B,C
028-130-039	BRAZIL, DAVID A 50%	20.00	A,B,C
028-130-040	MALAKAN INVESTMENTS LLC	37.29	A,B,C
028-140-001	WALKER, WILLIAM S REV TRUST	78.60	A,B,C
028-140-002	ALCALA FARMS A PTP	161.40	A,B,C
028-140-003	ZONNEVELD DAIRIES INC	160.00	A,B,C
028-140-004	SANDRIDGE PARTNERS LP	80.00	A,B,C
028-140-006	ALCALA FARMS A PTP	80.62	A,B,C
028-140-012	ZONNEVELD DAIRIES INC	5.00	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-140-013	ZONNEVELD DAIRIES INC	311.00	A,B,C
028-140-014	LAKESIDE IRRIGATION WATER DISTRICT	7.97	A,B,C
028-140-015	FERNANDES, ADAO G & MARIA O REV TRUST	146.98	A,B,C
028-140-017	RODRIGUES REVOCABLE LIVING TRUST	4.59	A,B,C
028-140-018	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.10	A,B,C
028-140-019	GARCIA FAMILY TRUST	20.09	A,B,C
028-140-020	GARCIA FAMILY TRUST	20.07	A,B,C
028-140-021	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.05	A,B,C
028-140-022	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.11	A,B,C
028-140-023	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.13	A,B,C
028-140-024	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.14	A,B,C
028-140-025	TOOR ARPINDER K 46% & AST FARMS, LLC 54%	20.16	A,B,C
028-140-026	MALAKAN INVESTMENTS LLC	20.13	A,B,C
028-140-027	MALAKAN INVESTMENTS LLC	20.12	A,B,C
028-140-028	MALAKAN INVESTMENTS LLC	20.11	A,B,C
028-140-029	MALAKAN INVESTMENTS LLC	20.10	A,B,C
028-220-001	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	160.00	A,B,C
028-220-002	L & P PISTACIO LLC	163.14	A,B,C
028-220-036	MALTA, BERNARDO	80.00	A,B,C
028-220-038	PITMAN, BENJAMIN IRREVOCABLE TRUST	38.91	A,B,C
028-220-062	PITMAN, BENJAMIN IRREVOCABLE TRUST	47.00	A,B,C
028-220-063	OCHOA, RALPH & LOURDES H/W	31.14	A,B,C
028-220-076	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	159.45	A,B,C
028-220-077	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	159.35	A,B,C
028-220-080	VERWEY FAM REV TRUST	280.40	A,B,C
028-220-081	VERWEY FAM REV TRUST	161.50	A,B,C
028-230-005	VERWEY FAMILY REVOCABLE TRUST	30.90	A,B,C
028-230-009	SQUIRE, JOHN E 1996 TRUST	160.00	A,B,C
028-230-010	LAWRENCE, MANUEL & ALDA 2000 FAM TRUST	138.41	A,B,C
028-230-011	MURRAY JR JOHN & BEATRIZ	19.47	A,B,C
028-230-016	PITMAN FARMS INC	40.00	A,B,C
028-230-017	SOUZA, JOHN D & WILMA Y REV TRUST 2005	40.00	A,B,C
028-230-018	VERWEY INVESTMENTS LP	20.00	A,B,C
028-230-019	VERWEY INVESTMENTS LP	140.00	A,B,C
028-230-031	VERWEY FAMILY REVOCABLE TRUST	159.29	A,B,C
028-230-032	VERWEY FAMILY REVOCABLE TRUST	80.90	A,B,C
028-230-033	VERWEY FAMILY REVOCABLE TRUST	80.00	A,B,C
028-230-034	VERWEY FAMILY REVOCABLE TRUST	320.00	A,B,C
028-230-035	VERWEY FAMILY REVOCABLE TRUST	320.00	A,B,C
028-230-036	VERWEY FAMILY REVOCABLE TRUST	130.18	A,B,C
028-230-037	VERWEY FAMILY REVOCABLE TRUST	159.29	A,B,C
028-230-042	MARTINS MARCELO ALMEIDA	5.00	A,B,C
028-230-045	JRJ RANCH 50%	23.78	A,B,C
028-230-046	JRJ RANCH 50%	285.74	A,B,C
028-230-047	JRJ RANCH 50%	351.00	A,B,C
028-230-048	KINGS OUTREACH THE	45.70	A,B,C
028-240-008	CITY OF HANFORD	160.00	A,B,C
028-240-010	SOUZA, JOHN D & WILMA Y REV TRUST 2005	80.56	A,B,C

APN	Record Owner	Acres	Pumping Zone
028-240-011	SOUZA, JOHN D & WILMA Y REV TRUST 2005	20.14	A,B,C
028-240-012	SOUZA, JOHN D & WILMA Y REV TRUST 2005	40.28	A,B,C
028-240-013	SOUZA, JOHN D & WILMA Y REV TRUST 2005	60.51	A,B,C
028-240-014	SOUZA, JOHN D & WILMA Y REV TRUST 2005	121.06	A,B,C
028-240-016	CITY OF HANFORD	160.00	A,B,C
028-240-018	CITY OF HANFORD	160.00	A,B,C
028-240-019	CITY OF HANFORD	160.00	A,B,C
028-240-020	CITY OF HANFORD	160.00	A,B,C
028-240-021	CITY OF HANFORD	160.00	A,B,C
028-250-002	VERWEY FAM REV TRUST	80.00	A,B,C
028-250-003	VERWEY FAM REV TRUST	80.00	A,B,C
028-310-005	CITY OF HANFORD	320.00	A,B,C
028-310-007	CITY OF HANFORD	60.00	A,B,C
028-310-008	CITY OF HANFORD	60.00	A,B,C
028-310-025	CITY OF HANFORD	200.00	A,B,C
	Total	84,325.15	

El Rico GSA

EL RICO GROUNDWATER SUSTAINABILITY AGENCY

RULES AND REGULATIONS

ADOPTED DECEMBER 12, 2023

ARTICLE I
DEFINITIONS

1.01. "Allocation Year" means the water year (i.e., the 12-month period beginning October 1 and ending September 30 each year). The date of the ending of the year is the date of the Allocation Year.[1]

1.02. "Base Allocation" means the quantity of groundwater ratably distributed to Eligible Land in an Allocation Year based on the Sustainable Yield of the Basin (consistent with Water Code Section 10721, subd. (w)) within the GSA's boundary. The quantity is initially deemed to be 0.5 acre-feet per acre of Eligible Land per Allocation Year but may be amended by the Board from time to time as more information becomes available.

1.03. "Basin" means the Tulare Lake Subbasin, as identified by the Department of Water Resources' Bulletin 118 as Groundwater Basin 5-022.12.

1.04. "Board of Directors" or **"Board"** means the Board of Directors of the El Rico Groundwater Sustainability Agency.

1.05. "De Minimis User" means a person who extracts, for domestic purposes, two acre-feet or less per year of groundwater from the Basin.

1.06. "Eligible Land" means parcels of historically irrigated land within the GSA's boundaries, designated by assessor parcel number (APN), excluding all land within the boundaries of the City of Corcoran, or owned by Tulare Lake Drainage District, as those boundaries may exist from time to time. Historically irrigated lands are lands in agricultural use, including groundwater extraction, that have been continuously enrolled with the Regional Water Quality Control Board Irrigated Lands Regulatory Program between December 31, 2015 and December 31, 2023, subject to the California General Dairy Order, or some other approved showing of agricultural usage. Eligible Land also includes land owned by a public water agency that has been used for pumping and delivery of groundwater to the landowners in that public water agency. The GSA shall maintain and update the list and map of Eligible Lands.

1.07. "El Rico GSA" or **"GSA"** means that Joint Powers Authority consisting of the City of Corcoran, the County of Kings, Alpaugh Irrigation District, Melga Water District, Lovelace Reclamation District, Salyer Water District, Corcoran Irrigation District, Tulare Lake Drainage District, and Tulare Lake Basin Water Storage District.

1.08. "Groundwater Credit" means an amount of groundwater credited to a Landowner pursuant to these Rules and Regulations, and credited to the Landowner's Watermark account, consisting of the following categories:

- **(a) "Groundwater Credit (Banked)"** means an amount of water banked in the Subbasin pursuant to Article VII.

[1] For example, October 1, 2024 to September 30, 2025 is Allocation Year 2025.

(b) **“Groundwater Credit (Base)”** means any unused Base Allocation carried over from a previous Allocation Year.

(c) **“Groundwater Credit (Transitional)”** means any unused Transitional Allocation carried over from a previous Allocation Year.

1.09. “Groundwater Extraction Facility” means a device or method for extracting groundwater from within the Basin regardless of operational status.

1.10. “Groundwater Sustainability Plan” or **“GSP”** means that groundwater sustainability plan most recently adopted by the Board, as amended from time to time.

1.11. “GSP” means the Groundwater Sustainability Plan as may be amended from time to time covering El Rico GSA.

1.12. “Landowner” means a holder of title to Eligible Land, or the Landowner’s duly authorized agent.

1.13. “Total Allocation” means a Landowner’s combined Base Allocation and Transitional Allocation.

1.14. “Transitional Allocation” means that amount of groundwater distributed to Eligible Acres in addition to the Base Allocation as set forth in Section 3.01.

1.15. “SGMA” means the Sustainable Groundwater Management Act of 2014 (Wat. Code, § 10720 et seq.)

1.16. “Watermark” means online software contracted for by the GSA for the purpose of accounting for groundwater use.

ARTICLE II
GENERAL PROVISIONS

2.01. Authority. The GSA may adopt rules, regulations, ordinances, and resolutions for the purpose of SGMA, in compliance with any procedural requirements applicable to the adoption of the rule, regulation, ordinance, or resolution by the GSA. (Wat. Code, § 10725.2, subd. (b).)

2.02. Purpose. The purpose of these Rules and Regulations is to provide for the sustainable management of groundwater within the boundaries of the GSA.

2.03. Relationship of Rules & Regulations to GSP. The intent of these Rules and Regulations is to implement the provisions of the GSP. These Rules and Regulations may be amended at any time, as deemed necessary by the Board of Directors, to achieve consistency with that GSP and groundwater sustainability within the GSA's boundaries.

2.04. Effective Date and Changes. These Rules and Regulations shall become effective upon adoption by the Board and may be added to, amended and/or repealed at any time by later resolution of the Board with any such additions, amendments, and/or repeals becoming effective upon adoption of the resolution, or as otherwise specified by the Board. However, adoption of these Rules and Regulations will not affect the effective date of any of the GSA's policies existing as of the date the Board adopts these Rules and Regulations.

2.05. Actions Against the GSA. Nothing contained in these Rules and Regulations may be deemed a waiver by the GSA or estop the GSA from asserting any defenses or immunities from liability as provided by law, including those provided in Division 3.6 of Title 1 of the Government Code.

2.06. Severability. If any provision of these Rules and Regulations, or the application thereof to any person or circumstance, is held invalid, the remainder of these Rules and Regulations, and the application of its provisions to other persons or circumstances, shall not be affected thereby.

ARTICLE III
GROUNDWATER ALLOCATION

3.01. Allocation. From the effective date, a Landowner shall receive a Base Allocation and Transitional Allocation in each Allocation Year. Transitional Allocations shall be set by the GSA as follows:

(a) From Allocation Year 2024 through 2029, the Transitional Allocation is 1.50 acre-feet of groundwater per acre per year of Eligible Land per Allocation Year.[2]

(b) From Allocation Year 2030 through 2034, the Transitional Allocation is 1.00 acre-feet of groundwater per acre per year of Eligible Land per Allocation Year.

(c) From Allocation Year 2035 through 2039, the Transitional Allocation is 0.50 acre-feet of groundwater per acre per year of Eligible Land per Allocation Year.

(d) From Allocation Year 2040 and beyond, the Transitional Allocation is 0.00 acre-feet per acre of groundwater per acre per year of Eligible Land per Allocation Year.

3.02. Groundwater Credits. If a Landowner uses less than its Total Allocation in an Allocation Year, Landowner may carry over the amount of the unused Total Allocation to later Allocation Years as a Groundwater Credit as follows:

(a) **Groundwater Credit (Base).** If a Landowner uses less than its Base Allocation in an Allocation Year, Landowner shall receive a Groundwater Credit (Base) in the amount of the unused Base Allocation (i.e., Base Allocation less amount of groundwater pumped pursuant to Base Allocation) for use in later Allocation Years. Groundwater Credits (Base) shall remain in a Landowner's Watermark account indefinitely.

(b) **Groundwater Credit (Transitional).** If a Landowner uses less than its Transitional Allocation in an Allocation Year, Landowner shall receive a Groundwater Credit (Transitional) in the amount of the unused Transitional Allocation (i.e., Transitional Allocation less amount of groundwater pumped pursuant to Transitional Allocation) for use in later Allocation Years. Groundwater Credit (Transitional) may remain in a Landowner's GSA account for ten years commencing with the year following the Allocation Year. Any Groundwater Credit (Transitional) unused after those ten years shall be removed from the Landowner's Watermark account as of the first day of the eleventh Allocation Year after the Groundwater Credit (Transitional) is created. Notwithstanding the foregoing, all Groundwater Credit (Transitional) shall expire at the start of Allocation Year 2040.

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[2] For example, if a Landowner owns 100 acres of Eligible Land, from October 1, 2023 to September 30, 2029, that Landowner shall have a Total Allocation of 200 acre-feet per Allocation Year.

3.03. Allocation Priority. The priority of groundwater use shall be as follows: (1) Groundwater Credit (Base); (2) Base Allocation; (3) Groundwater Credit (Transitional); (4) Transitional Allocation; and (5) Groundwater Credit (Banked).

ARTICLE IV
TRANSFERS

4.01. Landowner Transfers. A Landowner may transfer its Total Allocation (i.e., Base Allocation and Transitional Allocation) and any Groundwater Credit, in whole or in part, to any of Landowner's lands.

4.02. Landowner to Landowner Transfers. A Landowner may transfer its Base Allocation, Groundwater Credit (Base) and/or Groundwater Credit (Banked) to another Landowner. However, Landowner may not transfer its Transitional Allocation or Groundwater Credit (Transitional) to another Landowner.

4.03. Corcoran Irrigation District Transfers. Corcoran Irrigation District may transfer its Total Allocation (i.e., Base Allocation and Transitional Allocation) and any Groundwater Credits, in whole or in part, to any Landowner for use within Corcoran Irrigation District. Corcoran Irrigation District shall quarterly report all its transfers in writing on a GSA-approved form.

4.04. Transfer Procedure. Landowners agreeing to a transfer shall memorialize the transfer in writing on a GSA-approved form and deliver a copy to the GSA. Within 31 days of delivery of notice of a transfer between Landowners to the GSA, the transfer shall be deemed approved by the GSA and the transfer shall be reflected in the Watermark account, unless the GSA notifies the affected Landowners of its denial of the transfer. The GSA may deny a transfer only if it conflicts with these Rules and Regulations or otherwise to avoid an Undesirable Result, as that term is defined by Water Code section 10721, subdivision (w).

ARTICLE V
WATER USE MONITORING

5.01. Registration of Groundwater Extraction Facilities. Each Groundwater Extraction Facility within the GSA's boundary shall be registered with the GSA, via Watermark, within 60 days of the effective date of these Rules and Regulations. To register a Groundwater Extraction Facility, a Landowner shall provide the following information to the GSA:

(a) Assessor's Parcel Number (APN) of the Landowner(s) of the land upon which the Groundwater Extraction Facility is located and the Landowner(s) with rights to use groundwater from the Groundwater Extraction Facility.

(b) Well Completion Report, filed with the Department of Water Resources, pursuant to California Water Code section 13751, or if not available, construction information about the Groundwater Extraction Facility, including total depth of the well casing, size of the well casing, and location or depth of perforations.

(c) Location/Coordinates, parcel number, state well number/well name/well number of the Groundwater Extraction Facility.

(d) The type of installed flowmeter, or flowmeter to be installed.

5.02. Failure to Register. Any Landowner who fails to register its Groundwater Extraction Facility pursuant to Section 5.01, shall incur a penalty of up to $500 per facility, as determined by the Board.

5.03. Change in Ownership. The name of the owner of each registered Groundwater Extraction Facility, the parcel number on which the facility is located, along with the names of all Landowners with rights to each Groundwater Extraction facility shall be reported to the GSA within 60 days upon any change of ownership or right holder, together with such other information as may be required by the GSA.

In the event that a parcel of Eligible Land is transferred or sold to another Landowner during an Allocation Year, the Eligible Land will maintain any unused Total Allocation for that year granted by the GSA to the former Landowner, in addition to any Groundwater Credits that have accumulated for the parcel prior to the transfer or sale.

5.04. Installation of Flowmeter. Each Groundwater Extraction Facility within the GSA's boundary, excluding De Minimis Users, shall install a flowmeter within 60 days of the effective date of these Rules and Regulations and shall report the replacement of a flowmeter within 60 days.

5.05. Water Use Measurement. On at least a quarterly basis, Landowner shall report the monthly amount of pumping by Groundwater Extraction Facility. For a Groundwater Extraction Facility used by multiple Landowners, the Landowners shall report their respective uses separately. The reporting requirements in this Section apply to abandoned or non-operational Groundwater Extraction Facility until the Landowner submits evidence of abandonment or decommission in accordance with applicable law to the GSA.

ARTICLE VI
GROUNDWATER ACCOUNTING AND MANAGEMENT OF ALLOCATIONS

6.01. Online Water Accounting Dashboard. The GSA shall establish and maintain an online dashboard for Landowners to account for total groundwater usage and groundwater supply offsets within the GSA boundaries. The online dashboard currently contracted for by the GSA is Watermark.

6.02. Categories of Water. The online dashboard shall account for groundwater using, at a minimum, the following categories: (a) Base Allocation; (b) Transitional Allocation; (c) Groundwater Credits (Banked); (d) Groundwater Credits (Base); and (e) Groundwater Credit (Transitional). The online dashboard shall account for Total Allocation and Groundwater Credits as lump sums.

6.03. Landowner Reporting and Debiting. Within 30 days of the end of the prior quarter, each Landowner shall submit to the GSA, via Watermark, a report detailing its groundwater extractions, APN(s) where such groundwater was applied, the crop type upon which such groundwater was applied, any reported transfers and any other required information as adopted by the GSA Board. The GSA shall review each submitted report and, using Irrigation and Training Research Center's ET factors from ETc Table for Irrigation Scheduling and Design, Zone 16 ("ITRC Table"), confirm the groundwater extraction reported within 60 days. Changes may be made to the ITRC Table for new crops and crops that are known to be grown for reasons other than maximum yield. Once a Landowner's groundwater extraction has been confirmed, the GSA shall debit each Landowner's Watermark account. Bulk reporting such as by spreadsheet will be allowed via communication with Watermark for landowners with multiple APN's and/or Extraction Facilities.

ARTICLE VII
GROUNDWATER BANKING

7.01. Banking. Surface water banked within the Subbasin by a Landowner shall be credited to the Landowner's Watermark account as a Groundwater Credit (Banked), upon GSA Board approval that the water is percolated into an approved banking site within the GSA's boundaries of the Subbasin.

ARTICLE VIII
SGMA EXTRACTION CHARGES

8.01. Charge for Excess Use. Pursuant to Water Code Section 10732, the GSA may impose a charge up to $500 per acre foot against any Landowner who extracts groundwater in excess of its Total Allocation and Groundwater Credits for that Allocation Year. All charges must be paid within 30 days of issuance of an invoice for that charge by the GSA, or within any other period established by the Board. If a Charge for Excess Use is levied, then the total amount of excess water pumped above allocated amounts shall be deducted from the Total Allocation of subsequent Allocation Years. A Landowner shall not extract more than four (4) acre feet per acre of Eligible Land in any given year.

8.02. Protest of Usage Measurement and Charge Assessment. Each Landowner may protest the GSA's measurement of the Landowner's usage of water and any assessment by the GSA of a charge. The protest shall include:

(a) Name and address of the protestor,

(b) The specific decision being protested,

(c) The date of the decision,

(d) The basis or bases for the protest,

(e) The specific action which the protestor requests, and

(f) Any information or evidence relied upon to support the protest.

8.03. Procedures for Resolving the Protest. The procedures for resolving a protest are as follows:

(a) All protests must be submitted in writing to the GSA's Board no later than 30 days of receipt of billing.

(b) Within 60 days of the protest, the GSA Board shall consider the protest at a public hearing.

(c) The decision of the GSA Board shall constitute final action on the protest, subject to judicial review pursuant to California Code of Civil Procedure Section 1094.5.

ARTICLE IX
VARIANCE PROCEDURES AND ENFORCEMENT

9.01. Variance Request. Landowner may request a variance from these Rules and Regulations. A request for a variance shall:

(a) Identify the specific Rules and Regulation that is subject of the request;

(b) The reason(s) for the request;

(c) Whether approval of the request is required to avoid physical or economic harm to Landowner and an explanation thereof; and

(d) A statement of the requested relief.

9.02. Variance Procedures. The GSA Board may grant a variance upon making the following findings:

(a) Issuing the variance will not cause or contribute to an Undesirable Result(s), as that term is defined by Water Code section 10721, subdivision (w);

(b) The actions authorized under the variance are not anticipated to cause material harm to others who have rights to use groundwater within the Basin; and

(c) The variance and the authorized actions are reasonably necessary and appropriately tailored to avoid unreasonable physical and economic harm to the Landowner.

9.03. Judicial Review. The decision of the Board of Directors shall constitute final action on the variance, subject to judicial review pursuant to California Code of Civil Procedure section 1094.5.

9.04. Enforcement; Actions By GSA. Any Landowner who violates the provisions of these Rules and Regulations may be subject to the criminal and civil sanctions set forth in SGMA. Upon the failure of any person to comply with any provision of these Rules and Regulations, the GSA may petition the Superior Court for a temporary restraining order, preliminary or permanent injunction, or such other equitable relief as may be appropriate. The right to petition for injunctive relief is an additional right to those, which may be provided elsewhere in these Rules and Regulations or otherwise allowed by law. The Landowner shall be responsible for any legal costs or fees if the GSA is successful, and the GSA may also petition the Superior Court to recover any sums due to the GSA.

RESOLUTION NO. 2020-02
EL RICO GSA
WELL METERING

WHEREAS, El Rico GSA was formed as a Groundwater Sustainability Agency ("GSA") pursuant to the Sustainable Groundwater Management Act of 2014, codified at Water Code Sections 10720 et seq. ("SGMA"); and

WHEREAS, El Rico GSA is one of five (5) GSAs that overlie the Tulare Lake Subbasin (Basin No. 5-22-12) ("Subbasin") which is classified as a high-priority subbasin by the California Department of Water Resources (DWR), and the other four GSAs that overlie the Subbasin are Mid-Kings River GSA, South Fork Kings GSA, Southwest Kings GSA, and Tri-County Water Authority GSA; and

WHEREAS, pursuant to SGMA, the five GSAs of the Subbasin have cooperatively developed and adopted a Groundwater Sustainability Plan ("Subbasin GSP") to address the management of groundwater within the Subbasin, and have submitted the GSP to DWR. A copy of the Subbasin GSP is available at https://sgma.water.ca.gov/portal/gsp/preview/42; and

WHEREAS, Water Code Section 10725.8 provides that a groundwater sustainability agency may require that the "use of every groundwater extraction facility within the management area of the groundwater sustainability agency be measured by a water-measuring device satisfactory to the groundwater sustainability agency," and that "the owner or operator of a groundwater extraction facility within the groundwater sustainability agency file an annual statement with the groundwater sustainability agency setting forth the total extraction in acre-feet of groundwater from the facility during the previous water year;" and

WHEREAS, the Subbasin GSP contemplates that each GSA participating in the Subbasin GSP will choose management actions, including the requiring of self-reporting of groundwater extraction and well meters; and

NOW THEREFORE BE IT RESOLVED, by December 31, 2020 all owners and operators of groundwater extraction facilities within El Rico GSA's management area, except "de minimis extractors" (as defined in Water Code §10721(e)), shall install meters on their extraction wells for monitoring groundwater production and shall submit proof thereof to El Rico GSA; and

RESOLVED FURTHER, that by May 6, 2020 the El Rico GSA Board will propose and publicly circulate proposed rules and regulations regarding meter selection, installation, documentation, calibration, and testing, and the reporting of groundwater production from each such groundwater extraction well, and that by July 1, 2020 the El Rico GSA Board will adopt final rules and regulations regarding the same; and

RESOLVED FURTHER, that it is the intent of the El Rico GSA Board that appropriate meters be installed, maintained and operated on all extraction wells within the El Rico GSA management area (except de minimis extractors) by December 31, 2020 so that beginning with calendar year 2021 and thereafter all groundwater production within the El Rico GSA management area (except de minimis extractors) be accurately reported.

PASSED AND ADOPTED this 14th day of January, 2020, by the following vote, to wit:

Director	**Aye**	**Nay**	**Abstain**	**Absent**
Director Gilkey	______	________	___________	_________
Director Hansen	______	________	___________	_________
Director Hurlbutt	______	________	___________	_________
Director Sween	______	________	___________	_________
Director Unruh	_______	________	___________	_________
Director Wurzel	_______	________	___________	_________
Director Wyrick	_______	________	___________	_________

I HEREBY CERTIFY that the foregoing resolution is the resolution of the El Rico GSA as duly passed and adopted by its Board of Directors at a legally convened meeting held on the 4th day of March, 2020.

____
Jeof Wyrick
Chairman of the Board of Directors
EL RICO GSA

ATTESTED:

____
Chantall Ouellet
Assistant Secretary of the Board of Directors
EL RICO GSA

Southwest Kings GSA

POLICY FOR THE INSTALLATION, MAINTENANCE, AND MONITORING OF WATER METERS FOR WELLS WITHIN THE SOUTHWEST KINGS GROUNDWATER SUSTAINABILITY AGENCY

ADOPTED: April 8, 2020

Introduction

This Policy for the Installation, Maintenance, and Monitoring of Water Meters for Wells within the Southwest Kings Groundwater Sustainability Agency (this "Policy") is adopted by the Southwest Kings Groundwater Sustainability Agency ("SWKGSA") Board of Directors. It is the intent of this Policy to assure that accurate metering and recording of all groundwater pumping of wells within the SWKGSA is maintained to facilitate the SWKGSA's responsibilities under the Sustainable Groundwater Management Act ("SGMA").

Policy

1. Meter Requirements: This Policy applies to all groundwater wells (i) with greater than 0.16 cubic feet per second ("cfs")[1] capacity, or (ii) that pump more than two (2) acre-feet per year ("af/y"). Wells with a pumping capacity of 0.16 cfs or that pump more than 2 af/y are required to install and maintain water meters in accordance with the following specifications:
    a. Meter Specifications: In-line meters meeting AWWA[2] C700 series standards. Flowrate indicators shall be in cfs and totalizers shall read in 0.00 acre-feet ("af").
    b. Meter Sizing, Installation, and Maintenance: In accordance with AWWA Standard M6 (Water Meters, Selection, Installation, Testing, and Maintenance; AWWA, 2012) and/or manufacturer's published recommendations.
    c. Meter Calibration and Certification: In accordance with AWWA Standard M6 (Water Meters, Selection, Installation, Testing, and Maintenance; AWWA, 2012), meters shall be tested and calibrated (or at the landowner's option, replaced) every four (4) years by an independent certified testing facility. If meter readings appear abnormal (indicator or totalizer), meters shall be inspected, tested, and calibrated within 30 days of first observing the

[1] 0.16 cfs = 70 gpm

[2] American Water Works Association

abnormality. Certified meter calibration and testing reports shall be submitted to the SWKGSA for review and documentation.

d. Notification to SWKGSA: For existing wells, the landowner shall provide the SWKGSA with the following information no later than July 1, 2020. Any new wells shall provide the following information within 30 days of installation of pumping equipment.
    i. Kings County Assessor's Parcel Number ("APN") of property where the well is located.
    ii. Design capacity (flowrate) of the wellhead pump.
    iii. Brand, model number, and size of the meter.
    iv. Photograph of the flowmeter indicator to clearly show:
        1. The measurement units for the flow indicator and totalizer (i.e., cfs and af); and
        2. The length and configuration of the discharge pipe at least 5 pipe diameters upstream of the meter and 2 pipe diameters downstream of the meter.
    v. A description, with APN(s) and map, of the parcel(s) served by each well, and a description of whether the parcel(s) is served by any other wells or surface water (if so, identify the other well(s) locations(s) and surface water source(s).
    vi. A statement signed by the landowner granting access to the SWKGSA to the property to verify the installation, operation, and/or readings of the meters (refer to section 2.a herein).

2. Meter Recording and Reporting:
    a. Access: The landowner shall grant the SWKGSA access in the form of the attached access agreement.
    b. Recording Schedule: The landowner shall record the totalizer reading and self-report the totalizer reading to the SWKGSA bi-annually, in April and October of each year.
    c. Calibration Schedule: Certified meter calibration and testing reports shall be submitted to the SWKGSA for review and documentation during the October to December period of every four years, beginning in 2022.

3. Schedule for Compliance:
    a. Existing wells:
        i. Information in sections 1.d and 2.a shall be submitted to the SWKGSA by July 1, 2020.

    ii. Meter reading and totalizer reporting shall be submitted to the SWKGSA within 15 days of the meter readings per the schedule in section 2.b.
    iii. Certified meter calibration and testing reports shall be submitted to the SWKGSA no later than January 15 of every fourth year, beginning in 2025.

b. New wells:
    i. Information in sections 1.d and 2.a shall be submitted to the SWKGSA within 30 days of installation of the pumping equipment.
    ii. Meter reading and totalizer reporting shall be submitted to the SWKGSA within 15 days of the meter readings per the schedule in section 2.b.
    iii. Certified meter calibration and testing reports shall be submitted to the SWKGSA no later than January 15 of every fourth year, beginning in 2025.

4. <u>Exceptions</u>: Groundwater wells with existing meters that do not comply with sections 1.a and 1.b may have until October 1, 2021 to replace the existing meter with a meter that is compliant with this Policy. However, sections 1.d, 2.a, 2.b and 3.a(i & ii) of this Policy must still be adhered with in the interim.

5. <u>Costs, Fees, and Penalties</u>:
    a. <u>Costs</u>: The landowner shall be responsible for all costs for purchasing, installing, maintaining, record-keeping, and calibrating the meter on any of its groundwater wells.
    b. <u>Fees</u>: SWKGSA shall not impose any fees for field reviews, collection and recordation of data, landowner communications, and related activities, except as addressed in section 5.c.
    c. <u>Enforcement</u>: If any action required by this Policy (e.g., failing to install, identify or calibrate a meter, or other required submittal) is more than one (1) month delinquent, the SWKGSA has the full authority to take action to make the necessary purchases, repairs, calibrations, readings, and related activities and charge the delinquent landowner the full costs for performing such actions, including any expenses incurred by a contractor(s), staff, consultant(s), attorney(s), or vendor(s) to rectify the non-conformance with this Policy.

Tri-County Water Authority GSA

Groundwater Extraction Allocations
Policy and Procedures

1. Findings

1.1 Portions of the Tule and Tulare Subbasins (collectively, the "Subbasins") are located within the Tri-County Water Authority ("TCWA") Groundwater Sustainable Agency's jurisdictional boundaries and have been designated by the California Department of Water Resources as high priority groundwater basins that are subject to critical conditions of overdraft.

1.2 TCWA adopted groundwater sustainability plans ("GSPs") for the Subbasins consistent with the Sustainable Management Groundwater Act ("SGMA") for the purpose of managing the Subbasins to address undesirable results including chronic lowering of groundwater levels and land subsidence.

1.3 A management action in the GSPs includes establishing groundwater extraction allocations based on the Subbasin's sustainable yield in order to mitigate the undesirable results while water projects are being developed and implemented.

1.4 TCWA's adaptive management approach set forth in its GSPs allows TCWA to make adjustments as more information is obtained, which reduces the currently-identified data gaps. Adaptive management provides flexibility where decisions can be adjusted with the ultimate goal of providing for sustainable management of the Subbasins.

1.5 The provisions in this Policy and Procedures for Groundwater Extraction Allocation ("Policy and Procedures") are transitional measures while projects are implemented to provide supplement water supply to achieve sustainability of the Subbasins and does not determine or alter water rights under common law or any provision of law (Water Code §10720.5(a)).

1.6 The Policy and Procedures is exempt from the California Environmental Quality Act ("CEQA") pursuant to Water Code Section 10728.6 and CEQA Guidelines Sections 10561(b)(3), 15307 and 15308.

2. Policy

Undesirable results, including overdraft conditions and land subsidence within the TCWA's jurisdiction area, must be mitigated in phases while projects to provide additional water supplies to the area are being developed and implemented.

3. Purpose and Approach

To assist landowners transition extractions to the basin-wide sustainable yield, allocations will be phased based on periodic reviews of the GSPs. TCWA established six (6) categories of water available to landowner's account for registered parcels in the TCWA's water accounting program. All qualified registered parcels will be eligible to receive a sustainable yield allocation. In addition to the sustainable yield allocation, qualified irrigated land, initially based on the 2018 Land IQ crop data, will be eligible to receive

Overdraft Transitional Tier 1 Groundwater Allocation subject to a civil penalty. If a landowner determines that an error has occurred in the determination of eligibility for Overdraft Transitional Tier 1 Groundwater Allocation, they may dispute the determination of the 2018 Land IQ crop data with crop records for 2018 and 2019 from the Irrigated Lands Regulatory Program or Dairy Program.

The default priority of use will be as listed below. A landowner may choose to use their Overdraft Transitional Groundwater Tier 1 Allocation in position 3 and move their Landowner Developed Credit to position 5. To change the priority of use the GSA must be notified no later than the first week after each quarter ends.

1. Precipitation Credit
2. Sustainable Yield Allocation / Sustainable Yield Carryover
3. Landowner Developed Credit
4. AWD Groundwater Mitigation Credit (Angiola Water District Only)
5. Overdraft Transitional Groundwater Tier 1 Allocation
6. Overdraft Groundwater Tier 2

4. Definitions

4.1 "2018 Land IQ Crop Data" means crop and vegetation data generated in 2018 from satellite and aerial imagery, land cover classification and analysis, and crop and vegetation mapping.

4.2 "AWD Groundwater Mitigation Credit" means any recharge credit available to Angiola Water District ("AWD") under existing agreements for purchases of water used by the AWD landowners which subsequently recharges the Subbasins.

4.3 "Carryover" means the sustainable yield allocation amount remaining unused from the prior 5-year block which can be added to the following 5-year block.

4.4 "Civil penalty" means a penalty payment per acre-feet for groundwater extraction above the sustainable yield.

4.5 "De minimis extractor" means a person who extracts two acre-feet or less per year. For the purpose of herein Policy and Procedures, an owner or operator with less than 5 acres of land is considered a de minimis extractor unless it is demonstrated that the owner or operator extracts more than two acre-feet per year. (See, Water Code §10721(e).)

4.6 "Extractions" means removing groundwater through groundwater extraction facilities for reasonable and beneficial use(s).

4.7 "Good standing" means landowners who have complied with any and all policies and procedures and ordinances of TCWA, while not subject to any form of violation, late fee, penalty or lien.

4.8 "Groundwater" means water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water. (Water Code §10721(g).)

4.9 "Groundwater extraction facility" means a device or method for extracting groundwater from within a basin. (Water Code §10721(h).)

4.10 "Imported Water" means any water, surface or groundwater, that enters into TCWA boundaries for direct irrigation.

4.11 "Irrigated lands" means lands irrigated by groundwater using a groundwater extraction facility(ies) for the active production of plant crops or livestock for market and uses incidental hereto. The 2018 Land IQ Crop Data will be initially used to determine whether a parcel is an irrigated land for the purpose of herein Policy and Procedures.

4.12 "Landowner developed credit" means an amount of water credited to landowner account for a water project or projects that has (have) been developed by a landowner and has (have) been determined by TCWA to help mitigate one or more undesirable results of either the Tule or Tulare Subbasin. Projects may include, but are not limited to, water banking and recharge projects, or other approved projects that benefit groundwater sustainability. The amount of credit to be added to any such landowner account shall be at the sole determination of the TCWA Board of Directors based on technical data and other supportive documentation. The TCWA Board of Directors shall be the final arbiter of establishing landowner developed credit to be added to a landowner account.

4.13 "Landowner water banking or recharge project" means any project developed and implemented by a landowner to reduce groundwater extraction or increase groundwater recharge to benefit either the Tule or Tulare Subbasin. Any landowner developed credit derived from landowner water banking or recharge project shall be determined by the TWCA Board of Directors based on technical and other data which must demonstrate that the project helps mitigate one or more undesirable results of either the Tule or Tulare Subbasin.

4.14 "Leave behind" means the amount of remaining allocation not subject to sustainable yield carryover.

4.15 "Overdraft Transitional Tier 1 Groundwater Allocation" means an allocation of groundwater extraction in rolling 5-year blocks to qualified irrigated lands above the sustainable yield allocation and subject to Tier 1 civil penalty to allow landowners a transitional period to alter their respective operations or to develop a landowner water banking or recharge project to help mitigate one or more undesirable results of either the Tule or Tulare Subbasin.

4.16 "Overdraft Tier 2 Groundwater" means groundwater extraction above the Overdraft Transitional Tier 1 Groundwater Allocation subject to Tier 2 civil penalty.

4.17 "Precipitation Credit" means precipitation that exceeded ET during the billing quarter in which the precipitation occurred and will be carried over to the next billing cycle as a credit.

4.18 "Qualified registered parcel" means land qualified to receive sustainable yield allocation because the land meets the following criteria: (a) is a registered parcel;

and (b) is in good standing with TWCA.

4.19 "Qualified irrigated land" means land qualified to receive Overdraft Transitional Tier 1 Groundwater Allocation because the land meets the following criteria: (a) is qualified to receive sustainable yield allocation; and (b) is an irrigated land based initially on the 2018 Land IQ Crop Data.

4.20 "Registered parcel" means a parcel, 5 acres or larger, registered in the TCWA's water accounting program.

4.21 "Sustainable yield" means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result. (Water Code §10721(w).)

4.22 "Sustainable yield allocation" means the maximum quantity of groundwater extraction allotted to landowners of qualified registered parcel based on the sustainable yield of the Subbasins, calculated over rolling five (5) year periods that can be used on that parcel before civil penalty is imposed.

4.23 "Tier 1 civil penalty" means civil penalty amount due by a landowner or operator of qualified irrigated land at a rate of $125/acre-feet for use of Overdraft Transitional Tier 1 Groundwater Allocation, which is above the sustainable yield allocation.

4.24 "Tier 2 civil penalty" means civil penalty amount due by a landowner of qualified irrigated land at a rate of $500/acre-feet of extracted groundwater for any exceedance of groundwater extraction above the Overdraft Transitional Tier 1 Groundwater Allocation's yearly cap or 5-year water block allocation cap.

4.25 "Transfer" means groundwater allocation sold or otherwise acquired from one landowner to another landowner of qualified registered parcel which will be added to that recipient's landowner account. Any transfer credit shall be established by the TWCA Board based on technical data and other information which must demonstrate that the transfer will not worsen one or more undesirable results of either the Tule or Tulare Subbasin. The TCWA Board of Directors shall be the final arbiter of determining the transfer credit to be deducted from transferor's landowner account and added to transferee's landowner account.

4.26 "Undesirable result" means one or more of the following effects caused by groundwater conditions occurring throughout the basins: (a) chronic lowering of groundwater levels; (b) significant and unreasonable reduction of groundwater storage; (c) significant and unreasonable seawater intrusion; (d) significant and unreasonable degraded water quality; (e) significant and unreasonable land subsidence; and/or (f) depletions of interconnected surface water.

5. Procedures

5.1 <u>Determination of Sustainable Yield Allocation.</u>

5.1.1 All owners of land 5 acres or larger must register their respective parcels in TCWA's water accounting program in order to qualify for sustainable yield allocation.

5.1.2 Sustainable yield allocation will be available to every qualified registered parcel, 5 acres or larger, for reasonable and beneficial use within the TCWA's jurisdictional boundaries. Sustainable yield allocation will be harmonized across TCWA's jurisdictional boundaries. Sustainable yield allocation is based on available documentation, data and analysis in TCWA's GSPs; and will be coordinated with other applicable GSAs with jurisdiction in the Subbasins. Sustainable yield allocation will be continually evaluated and is subject to adjustment at each five-year GSP update.

5.1.3 Sustainable yield allocation is allotted in 5-year blocks. A landowner's sustainable yield allocation may qualify for carryover to add to the landowner account for the subsequent five-year block.

5.1.4 A landowner may transfer his/her sustainable yield allocation, or a portion thereof, to another landowner with qualified registered parcel within the TCWA jurisdictional boundaries; or the Tule Subbasin or the Tulare Lake Subbasin subject to coordination with the appropriate Tule or Tulare Subbasin GSAs and with approval by the TCWA Board of Directors.

5.1.5 Transfers and carryovers within the TCWA jurisdictional boundaries will be added to the appropriate landowner accounts in the TCWA's accounting program subject to approval by the TCWA Board of Directors.

5.1.6 All transfers must be approved by the TCWA Board of Directors; and all transfers outside TCWA jurisdictional boundaries must be approved by TCWA and the GSA with jurisdiction and comply with all relevant subbasin regulations. TCWA will keep an account of all transfers in the TCWA water accounting program.

5.1.7 Only qualified registered parcels are afforded sustainable yield allocation and all non-qualified lands, other than de minimis extractors, must cease extraction of groundwater until such time the lands become qualified.

5.2 <u>Landowner Developed Credits</u>

5.2.1 Landowner developed credits may be developed through landowner water banking or recharge projects or other approved projects that help mitigate one or more undesirable results of either the Tule or Tulare subbasin. Recharge and banking projects must comply with the "Groundwater Recharge Policy". The TCWA Board of Directors shall be the final arbiter of determining landowner developed credit to be added to a landowner account.

5.2.2 In order to protect the Subbasins from undesirable results, a percentage of any landowner water banking or recharge projects will remain with TCWA. The amount of leave behind is defined in the "Groundwater Recharge Policy".

5.2.3 Landowner developed credit transfers between landowners of qualified registered parcels must be documented and approved by the TCWA Board of Directors. The TCWA Board of Directors shall be the final arbiter of determining the transfer credit to be deducted from transferor's landowner account and added to transferee's landowner account.

5.2.4 All transfers purchased from outside of TCWA boundaries must be approved by both GSAs with jurisdiction and comply with all relevant subbasin regulations of both GSAs. TWCA will develop a separate policy and procedures for transfers from outside of the TCWA jurisdictional boundaries.

5.2.5 All landowner developed credit will be maintained in TCWA water accounting program.

5.3 AWD Groundwater Mitigation Credit will be reported to TCWA yearly and may be distributed to Angiola Water District's ("AWD") or AWD landowners in the TCWA accounting program in accordance with AWD's policy upon its approval by the TCWA Board of Directors, which must occur prior to establishing an account for the AWD or the AWD landowners in the TCWA water accounting program.

5.4 Overdraft Transitional Groundwater Tier 1 Allocation

5.4.1 Overdraft Transitional Groundwater Tier 1 Allocation will be available to qualified irrigated lands within the TCWA jurisdictional boundaries based on the 2018 Land IQ crop data. Qualified irrigated lands will be eligible to receive Overdraft Transitional Groundwater Tier 1 Allocation for the duration of the program subject to a civil penalty. Overdraft Transitional Groundwater Tier 1 Allocation, including a yearly cap and a 5-year block cap, will be allotted at the beginning of each 5-year block.

5.4.2 For the first 5-year block, the yearly cap will be 3.4 AF/Acre.

5.4.3 The Overdraft Transitional Groundwater Tier 1 Allocation, in its entirely or portions thereof, may be transferred between landowners of qualified irrigated lands within TCWA subject to the TCWA Board of Directors' approval. If transferred, the credit may be added to the transferee's Overdraft Transitional Groundwater Tier 1 Allocation Credit. The TCWA Board of Directors shall be the final arbiter of determining the transfer credit to be deducted from transferor's landowner account and added to transferee's landowner account. The transfer recipient will not be allowed to carryover the credit received from any such transfer to the subsequent 5-year block.

5.4.4 Extractions above the sustainable yield allocation up to the Overdraft Transitional Groundwater Tier 1 Allocation will be imposed the Tier 1 civil penalty of $125/AF for the first 5-year block, and the civil penalty will be issued to applicable landowners on a quarterly basis. Groundwater extractions exceeding the Overdraft Transitional Groundwater Tier 1 Allocation yearly cap will be imposed as Tier 2 civil penalty. Block civil penalty will be approved by the Board of Directors before each 5-year block allocation.

Water Blocks	Tier 1
a) 2021 – 2025	12 AF/Acre
b) 2026 – 2030	7.5 AF/Acre
c) 2031 – 2035	5 AF/Acre
d) 2036 – 2040	2.5 AF/Acre

5.5 Overdraft Groundwater Tier 2

5.5.1 Overdraft Groundwater Tier 2, which is groundwater extraction above the Overdraft Transitional Groundwater Tier 1 Allocation, will be available to the qualified irrigated lands that qualified for Overdraft Transitional Groundwater Tier 1 Allocation, subject to Tier 2 penalty. Groundwater extraction that exceeds the yearly cap or the 5-year water block allocation will pay an initial civil penalty amount of $500.00/ AF. The penalty rate will be approved by the TCWA Board of Directors at the end of each 5-year block to be imposed for the following 5-year block. Civil penalty for groundwater extractions exceeding the yearly cap will be issued the Tier 2 civil penalty the first quarter of the following calendar year. Groundwater extractions exceeding the 5-year sustainable yield allocation, that were not imposed the Tier 2 civil penalty for exceeding the yearly cap, will be imposed and issued Tier 2 civil penalty in the first quarter of each 5-year block.

5.6 Precipitation Credit

5.6.1 Precipitation credit is precipitation that exceeded ET during the billing quarter in which the precipitation occurred and will be carried over to the next billing cycle as a credit.

5.6.2 Current registered parcels in production as of 2023 will receive precipitation credit.

5.6.3 Precipitation credits will be allocated to parcels and are not eligible for transfer between landowner accounts.

6. Imported Water

6.1 Any landowner within the TCWA which utilizes imported water shall cause to be reported from the applicable water entity, the diversion of imported water to direct irrigation.

7. **Landowner Water Banking or Recharge Project**

   7.1 Landowners may voluntarily develop and implement landowner water banking or recharge project to benefit the Tule or Tulare Subbasin. In developing and implementing any such project, the landowner shall be solely responsible for complying with all applicable Federal, State and local laws, rules, regulations, ordinances and policies, including but not limited to the California Environmental Quality Act. At the request of TCWA, landowner responsible for any such project shall provide TCWA with a copy of any permit, order, agreement, environmental review document or any other records indicating compliance with applicable laws.

   7.2 A landowner developing and implementing water banking or recharge project shall be solely responsible for determining the nature, location and extent of the facilities necessary for the banking or recharge project, and all associated costs and expenses, including design, permitting, construction, operation, maintenance, repair and replacement shall be the sole responsibility of the landowner.

   7.3 A landowner developing and implementing landowner water banking or recharge project shall indemnify, defend and hold harmless TCWA, its Board of Directors, officers, employees, and agents for any damage or claim or claim of damage of any nature whatsoever associated with or related to landowner water banking and recharge project, including but not limited to property damage or personal injury or death.

8. **SGMA Penalties and Civil Remedies.** Any landowner or operator who violates the provisions of the herein Policy and Procedures is subject to the criminal and civil sanctions set forth in SGMA. TWCA may commence or sustain any civil action or proceeding, either at law or in equity, to enforce any of the provisions of the GSPs, or any policy and procedures promulgated therefrom, or to enjoin or restrain any violation thereof, or to collect any sums of money, including penalties, fees, charges and/or assessments, on behalf of the TCWA. The provisions of this Section 7 are to be supplementary and complementary to all of the provisions of SGMA, other state law, and any law cognizable at common law or in equity; and nothing herein shall be read, interpreted or construed in any manner so as to bar or limit TWCA from seeking any remedy to which it may otherwise be entitled.

9. **Enforcement Policy and Procedures**. Any penalties or fines imposed shall be subject to the procedures set forth in the "Policy and Procedures for Collecting Delinquent Fees, Assessments, or Charges".

10. **Action Against TCWA**. Nothing contained in the herein Policy and Procedures shall constitute a waiver by TCWA or estop TCWA from asserting any defenses or immunities from liability as provided in law, including but not limited to those provided in Division 3.6, Title 1 of the Government Code.

TRI-COUNTY WATER AUTHORITY
WATER METER POLICY AND PROCEDURES

1. Policy

It is the policy of the TCWA to collect groundwater extraction metering data from all non-domestic wells. The data will be integrated with other data being collected to track changing conditions in the Tule and Tulare Lake Subbasins of the San Joaquin Valley Groundwater Basin in order to evaluate the sustainability indicators of the Sustainable Groundwater Management Act (SGMA); chronic lowering of groundwater levels; and reductions in groundwater storage.

2. Scope

The procedures set forth in Section 3 to further the policy provided above apply to all non-domestic groundwater wells that pump more than 70 gallons per minute or two (2) acre-feet per year (af/y). Domestic wells are exempt from this Water Meter Policy and Procedures. Domestic wells are defined as water wells used exclusively to supply residential household needs.

3. Procedures

A. Meter Requirements: All owners of non-domestic wells are required to installand maintain water meters for those wells in accordance with the following specifications:

A.1. Meter Specifications: All meters installed for non-domestic wells must comply with American Water Works Association (AWWA) Standard C700 and have flowrate indicators (gpm or cfs) and totalizers (gallons or acre-feet (af)).

A.2. Meter Sizing, Installation, and Maintenance: Meter sizing, installation and maintenance shall be in accordance with AWWA Standard M6 (Water Meters, Selection, Installation, Testing, and Maintenance) or the applicable manufacturer's published specifications.

A.3. Meter Calibration and Certification: Pursuant to AWWA Standard M6, each meter shall be tested and calibrated (or replaced) every four (4) years by an independent certified testing facility. If meter readings appear abnormal (indicator or totalizer), such meter shall be inspected, tested, and calibrated by the applicable owner within 30 days of first observing the abnormality. Certified meter calibration and testing reports shall be submitted for each meter to the TCWA for review and documentation.

B. Reporting to TCWA: For each existing non-domestic well, the applicable owner shall provide the TCWA with the following information (as provided in the form included as Attachment A) no later than November 30, 2020. For any new non-domestic well, the applicable landowner shall provide the following information to the TCWA within 30 days of installing pumping equipment in the well:

B.1. Kings County or Tulare County Assessor's Parcel Number ("APN") of real property where the well is situated, State Well ID, and the longitude and latitude of the well.

B.2. Brand, model number, size, and serial number of the meter; and

B.3. The total depth of the well and the screen intervals.

C. Meter Recording and Reporting:

C.1. Recording Schedule: An owner with a non-domestic well or wells shall record the totalizer reading and report the totalizer reading for each well to the TCWA in April and October of each year.

C.2. Calibration Schedule: Meter calibration and testing reports for each non-domestic well, certified by an independent certified testing facility, shall be submitted to the TCWA by December 31,2022, and every four years thereafter.

D. Existing Nonconforming Meters: Owners with existing meters that do not conform with the specifications set forth in Section 3.A. have until October 1, 2021, to replace the existing nonconforming meters with meters in compliant with Section 3.A. Notwithstanding the foregoing, owners with nonconforming meters shall comply with Sections 3.B and 3.C inthe interim.

E. Costs and Fees:

E.1. For each non-domestic well, applicable owners shall be responsible for all costs associated with the purchase and installation of a meter specified in Section 3.A; for maintaining, record-keeping, and calibrating of the meter(s); and for reporting to the TCWA.

E.2. Fees: The TCWA will not impose any fees to landowners for its data collection and related activities.

6. Data Confidentiality: To address concerns regarding the confidentiality of well data, the raw data will remain confidential pursuant to Government Code §6254(e), and §6254.16 included in Attachment "A". The data will be maintained for use by the TCWA, and only aggregate values of the raw data will be made publicly available.

7. Enforcement: The TCWA's enforcement of compliance with the Well Meter Policy and Procedures is imperative to ensure effective implementation. Non-domestic well owners who fail to comply with the Well Meter Policy and Procedures or who provide inaccurate data to the TWCA will be subject to penalties. Specific enforcement and penalties will be outlined in an Enforcement and Penalties Policy and Procedures to be approved by the TCWA.

Compliance Schedule	
Activity	Due Date
Notify TCWA of Existing Meter Specifications	November 30, 2020
Report Totalizer Readings to TCWA	April and October (annually)
Calibration Schedule	Every four (4) years starting December 31, 2022
Replace Nonconforming Meters	October 1, 2021

TRI-COUNTY
WATER AUTHORITY

Groundwater Recharge Policy

Tri-County Water Authority (TCWA) adopted the Groundwater Extraction Allocations Policy to support compliance with the Sustainable Groundwater Management Act (SGMA) in 2021. This Groundwater Recharge Policy is intended to promote development of recharge projects that provide benefit to the groundwater subbasin and groundwater credits (credits) to water users within TCWA. All developed credits shall be subject to the Groundwater Extraction Allocations Policy. Policies governing credits may include but are not limited to avoidance of undesirable results, quantification, transfer, and leave-behind quantity. Policy documents may be updated over time. The Groundwater Recharge Policy is intended to promote conjunctive use within TCWA and to inform the implementation of the Groundwater Sustainability Plans (GSPs). This policy will remain in place until terminated or amended by action of the TCWA Board of Directors.

Interested participants must hold an interest in real property or lease holding within TCWA geographic boundaries, follow the conditions listed below and have an existing TCWA BasinSafe account in good standing to received groundwater credit:

Landowner Groundwater Recharge & Banking Credits

Landowners within the TCWA can divert surface water into landowner owned designated recharge facilities for groundwater pumping credits. When this occurs, the landowner is allowed to bank this surface water that is recharged to groundwater under the following conditions:

1. The surface water secured must be applied directly into a specific groundwater recharge facility that meets TCWA requirements. TCWA will provide the landowner with a notice that specifies the acreage and location of the facility and that it meets all the requirements of this policy.
2. All costs of establishing and constructing a dedicated groundwater recharge facility are the responsibility of the landowner.
3. All surface water diverted to the landowner is required to be metered or use another standard measuring method approved by TCWA .
4. Surface water diverted into dedicated recharge facilities will be credited to the landowner at 90% of the surface water diverted. The remaining 10% credit will remain with TCWA for the benefit of all landowners.
5. The groundwater credits issued to landowners can be carried over to subsequent years. The groundwater recharge credits can be transferred to other landowners within TCWA based upon the requirements of the Groundwater Extraction Allocations Policy.
6. These provisions will also apply for recharge on open ground that will not be farmed in that year but that has not been designated as a groundwater recharge facility. Those deliveries will be eligible for 75% credit of the measured water applied.
7. These provisions will also apply to surface water applied to land currently in agricultural production, commonly referred to as Flood-MAR. Those deliveries will be eligible for

75% credit of the measured water applied. Recharge is not permitted on any agricultural land where pesticide or fertilizer application has occurred in the prior 30 days or in the period prohibited by applicable law, whichever is longer. In addition, the land must comply with requirements of CV-Salts Program.

Groundwater Recharge Facilities

Appropriate information must be provided by the Participant to quantify the volume of water being recharged in percolation ponds/basins. Water account and project specific information provided by the water user shall remain confidential. The amount of groundwater credit received will be allocated based on the supporting documentation and subject to staff's review. All recharge facilities must be approved by TCWA's Board of Directors to receive credit. The following checklist is required for approval:

- Land selected for this activity must be favorable for passive recharge.
- A geotechnical investigation report stamped by a professional geologist or engineer must be provided to TCWA for review and approval.
- Installation of a dedicated water meter or another standard measuring method to measure the amount of water delivered to the recharge project.
- The facility needs to be isolated from the landowner's irrigation system or have separate meters for any discharge.
- Documentation of source of water, place of diversion and amount of diversion.

Over-Application of Floodwater

During an uncontrolled flood event, TCWA will provide credit to landowners that have floodwaters on parcels above irrigation demand (as measured by ET). Appropriate information must be provided by the Participant to quantify the volume of water being recharged on fields. The amount of groundwater credit received will be allocated based on the supporting documentation and subject to TCWA review.

Indemnification

Participant shall indemnify, hold harmless and defend TCWA and each of its officers, officials, employees, agents and volunteers from any liability, claim of liability, damage, or claim of damage of any nature whatsoever, including any legal action brought by any third party, with respect to property damage, personal injury or death, or claims concerning the control, carriage, handling, use, disposal, or distribution of recharge water up to the point of delivery, incurred by TCWA, Participant or any other person, and from any and all claims, demands and actions in law or equity (including reasonable attorney's fees and litigation expenses), arising or alleged to have arisen directly or indirectly out of performance of this Application. Participant's obligations under the preceding sentence shall apply regardless of whether TCWA or any of its officers, officials, employees, agents or volunteers are passively negligent, but shall not apply to any loss, liability, fines, penalties, forfeitures, costs or damages caused by the active negligence or willful misconduct of TCWA or any of its officers, officials, employees, agents or volunteers.

Definitions

The Policy defines terms based on the Department of Water Resources Water Basics Glossary.

Flood-managed aquifer recharge (Flood-MAR) — An integrated and voluntary resource management strategy that uses floodwater resulting from, or in anticipation of, rainfall or snowmelt for managed aquifer recharge on agricultural lands; working landscapes; and managed natural landscapes, including but not limited to refuges, floodplains, and flood bypasses.

groundwater recharge facility — A structure that serves to conduct surface water into the ground for the purpose of replenishing groundwater. The facility may consist of dug or constructed spreading basins, pits, ditches, furrows, streambed modifications, or injection wells.

groundwater — Water that occurs beneath the land surface and fills the pore spaces of the alluvium, soil, or rock formation in which it is situated. It excludes soil moisture, which refers to water held by capillary action in the upper unsaturated zones of soil or rock. Groundwater classified as underflow of a surface water system, a "subterranean stream flowing through a known and definite channel," is subject to statutory permitting processes. However, most groundwater in California is presumed to be "percolating water" (i.e., water in underground basins and groundwater that has escaped from streams and is not subject to a permitting process). See also "subterranean stream."

groundwater banks — Consist of water that is "banked" during wet or above-normal water years. The water to be banked is provided by the entity that will receive the water in times of need. Although transfers or exchanges may be needed to get the water to the bank and from the bank to the water user, groundwater banks are not transfers in the typical sense. The water user stores water for future use; this is not a sale or lease of water rights. It is typical for fees to apply to the use of groundwater banks.

surface water — As defined under the California Surface Water Treatment Rule, California Code of Regulations Title 22, Section 64651.83, surface water means "all water open to the atmosphere and subject to surface runoff" and hence would include all lakes, rivers, streams, and other water bodies. Surface water includes all groundwater sources that are deemed to be under the influence of surface water (i.e., springs, shallow wells, wells close to rivers, etc.), which must comply with the same level of treatment as surface water.

South Fork Kings GSA